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USER'S GUIDE FOR CREW CHIEF:
A COMPUTER GRAPHICS SIMULATION OF AN
AIRCRAFT MAINTENANCE TECHNICIAN (VERSION 2 - CD21)

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

CHARLES BATES, JR.
Director, Human Engineering Division
Armstrong Aerospace Medical Research Laboratory

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This user's guide describes the procedures for using the CREW CHIEF system of *Computer* programs. The CREW CHIEF system of programs is a computer graphics simulation of the physical characteristics and capabilities of Air Force maintenance technicians. The system as it now exists operates interactively with the CADAM software package. The user should be knowledgeable in CADAM operations, as CADAM interactions are not included in this document.

The guide includes an introduction to the technician model and the conventions used to develop and analyze the interactions of the man-model's physical characteristics and capabilities with the elements of the work station.

CADAM is a registered trademark of CADAM, Inc., 1935 Buena Vista St., Burbank, California 91504. Use of this term does not constitute an endorsement of the CADAM system. *Keywords*

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SUMMARY

This User's Guide describes the procedures to operate the Harry G. Armstrong Aerospace Medical Research Laboratory's and the Air Force Human Resources Laboratory's CREW CHIEF system of programs. The CREW CHIEF system of programs is interactive with the CADAM* (Computer-graphics Aided Design And Manufacturing) software package, and therefore it is necessary that operators be qualified in the use of CADAM, as this document does not duplicate the CADAM operating instructions. CADAM's interface with the CREW CHIEF system of programs does not constitute an endorsement of the CADAM system by the U.S. Air Force or its contractors.

The CREW CHIEF system of programs provides for designers a tool for early identification of design-related maintainability problems by analyzing the interaction of maintenance technicians' physical capabilities and the design elements related to specific maintenance tasks. Historically, many of such maintainability problems have been found when the system design prevents timely and cost-efficient corrective action. Such problems are often passed to the logisticians to correct, or to endure, after the system has been delivered. Since maintenance accounts for approximately 35 percent of the total cost of a system during its years of use, early identification and correction of design-induced maintenance problems can result in significant cost savings.

The CREW CHIEF program is not intended to provide solutions for all problems. For example, current military standards provide guidelines for locating components for ease of access-ibility based upon such factors as frequency of

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maintenance actions required and the criticality of the sub-
system concerned. Due to space constraints, the possible
locations of sub-system components may be limited. The CREW
CHIEF program will not create designs, but will allow the
designer to evaluate the maintainability of a candidate design.
The program will also allow the user to analyze the interaction
of a maintenance technician with a system design, and will enable
the user to evaluate limitations and capabilities in three main
areas: physical accessibility, strength, and visibility.

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PREFACE

The purpose of the report is to provide a detailed guide for the user to operate the CADAM* version of the CREW CHIEF program. It does not document the theoretical approaches used in developing the programs. The introduction of the report (Section 1) gives general background of the concepts and development of the programs. Sections 2 through 7 provide details for using the CREW CHIEF programs, and Section 8 is a Quick Reference section for the seasoned user.

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GLOSSARY OF TERMINOLOGY

Access Function Key — CADAM supplied program which allows user to access their own programs

Action — A description of the user's objective and necessary input to operate the program.

Azimuth — A horizontal direction of a point from a reference point measured from 0° at the reference direction clockwise through 360°.

Body Size — The 1st, 5th, 50th, 95th, and 99th percentiles for both male and female, based on the Air Force maintenance technician population.

Connector — A device used on aircraft to mate parts to the electrical system or to provide attach/detach points in long electrical cables to accommodate maintenance. They typically have male and female components held together by lock rings.

CREW CHIEF — The system of computer programs entitled CREW CHIEF.

Crew Chief — The man-model generated by the CREW CHIEF system of programs.

Default Value — Any value initially set by the CREW CHIEF system of programs.

Drawing — Any user-generated display.

Elevation Angle — Angle from some object in the work space to the line of sight.

Enfleshment — The exterior mesh that represents the muscles and tissues of the man-model and also represents his/her clothing.

Ergonomics — Scientific study of the relationship between man and his working environment.

Example — One of several possible actions chosen to illustrate a particular function.

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Front Display   One of four types of display for the
                         man-model; the front half of the wire-
                         frame man-model as viewed from the
                         designer's location at the graphics
                         scope; display contains less clutter
                         than the full wire-frame model, but can
                         be used for limited visual interference.

Head Point of Vector   The point of application of a tool or
                         connector.

Interactive   Immediate response to input. In
                         interactive processing, an image can be
                         modified or edited and the changes seen
                         right away, as contrasted to "batch"
                         processing in which the user must wait
                         for results.

Key in   To input user-specified information via a
                         keyboard.

Man-Model   Software-generated technician as he/she
                         appears on the screen.

Mechanical Work   The product of force and displacement.

Obstacle Avoidance   Check during a Reach Analysis to ensure
                         that a man-model can perform a task with
                         no interference between the workstation
                         and the man-model's arms.

Percentile   A value in the range of a set of data
                         which separates the range into two groups
                         so that a given percentage of the
                         measures lies below this value.

Platform   The surface which supports the man-model's
                         body.

Point of Attachment   The point to which the man-model attaches
                         a tool.

Position Reference
Point   The posture-dependent point on the man-model
                         which lies in the same plane as the platform.

Profile Display   One of four types of display for the
                           man-model; a profile view of the man-
                           model as seen from the designer's
                           viewpoint at the graphics scope; the
                           least cluttered of displays, and
                           provides a two-dimensional display
                           suitable for "finished" plots.

Prompt   A short phrase on screen which cues the
                           user's actions.

Rectilinear   Consisting of or bounded by lines.

Reposition Display   One of four types of display for the
                           man-model; this display is chosen when
                           the intent is to manually reposition
                           the man-model; similar to the three-
                           dimensional wire-frame model, but
                           includes extra dashed lines to aid in
                           the repositioning process.

Result   Subsequent system response to a user's input.

Screen   Another name for cathode ray tube (CRT)

Select   To choose a menu item or an element from
                           a screen.

Shelf   The surface onto which an object is lifted.

Strength, Dynamic   A measurement of strength with motion
                           resulting in force or torque and also
                           resulting in mechanical work.

Strength, Static   A measurement of strength without motion
                           resulting in force or torque but not
                           resulting in mechanical work.

Tail Point of Vector   The line defined by this point and the
                           head point determines from which
                           direction the tool will be applied.

Window   The illuminated area of a CRT

Wire Frame Display   One of four types of display for the
                          man-model; a three-dimensional wire
                          frame figure which may be rotated and
                          moved using the appropriate CADAM
                          Window (PFK 27) Functions; a type of
                          enfleshment which may be used for
                          visually identifying potential areas of
                          interference between the man-model and
                          the workplace design.

Workplace   Any drawing which represents the man-
                          model's task area.

LIST OF ABBREVIATIONS

AAMRL	Armstrong Aerospace Medical Research Laboratory
AAMRL/HEG	Armstrong Aerospace Medical Research Laboratory's Workload and Ergonomics Branch
AFHRL	Air Force Human Resources Laboratory
AFR	Air Force Regulation
AFSC	Air Force Specialty Codes
ANKB	Alphanumeric Keyboard
CAD	Computer Aided Design
CADAM*	Computer-graphics Aided Design and Manufacturing
<CR>	Carriage Return
IUE	Interactive User Entry
LOS	Line-of-Sight
LRU	Line Replaceable Units
N/A	Not Applicable
PFK	Program Function Keyboard
UDRI	University of Dayton Research Institute
WPAFB	Wright-Patterson Air Force Base
2-D	Two-dimensional
3-D	Three-dimensional

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LIST OF FUNCTIONS

CREW CHIEF Main Programs Menu

CREW CHIEF Generation Function

CREW CHIEF Initialization Function

CREW CHIEF Regeneration Function

CREW CHIEF Manual Repositioning Function

CREW CHIEF Head Orientation Function

CREW CHIEF Task Analysis Function

Tool Analysis Function

Materials Handling Analysis Function

CREW CHIEF Carry Function

CREW CHIEF Hold Function

CREW CHIEF Lift Function

CREW CHIEF Pull Function

CREW CHIEF Push Function

CREW CHIEF Reach Function

Connector Analysis Function

Visibility Analysis Function

CREW CHIEF Accessibility Function

Interference Analysis Function

Work Envelope Analysis

Current CREW CHIEF Data Function

SECTION 1

INTRODUCTION

Approximately 35 percent of the life-time cost of a military system is spent to maintain the system. Much of this cost can be avoided if, during the system's developmental stage, the interaction between the maintenance technician and the system design can be analyzed. Past practice has been to make these analyses by visual inspection of engineering drawings and detailed mockups of the system. The mock-up, using real people to analyze the interaction, has been the most beneficial method of identifying maintainability problems. The major problem with using mock-ups is that the design must be at a mature stage before a mock-up can be constructed. When the system is at a mature stage, changes to improve maintainability are often not made because of the costs and time delays involved in design change, modification of the mock-up, and the re-analysis of the technician and mock-up interactions.

Computer Aided Design (CAD) systems and computer models which graphically portray human physical characteristics and capabilities have reached the stage where it is possible to assess the interactions of systems and technicians at early stages of design development. The earliest possible identification of maintainability problems due to the poor interaction of the system and the technician should help reduce the life-time maintenance cost of a system. Thus, the concept and development of CREW CHIEF is a logical step in the early identification of maintainability problems. The CREW CHIEF system of programs is interfaced directly with the CAD data base, allowing the designer to evaluate three human factor areas against drawings in that CAD data base. This capability allows early identification of maintainability problems and reduces, and may eventually eliminate, the requirement for mock-ups.

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Maintainability problems, as related to human factors, generally fall into three areas: Physical Accessibility, Strength, and Visibility. In the development of the CREW CHIEF system of programs, the following definitions of these human factors were used.

1. Physical accessibility: the interaction of body size, technician posture, tool size and working envelopes, location of the task object relative to adjacent or interfering components or structures, and task analysis.

2. Strength: the technician's ability to apply a specified torque, and/or to lift, position, lower, or remove an object to/from a design-specified location from the posture dictated by the working environment.

3. Visibility: the field of view of the technician relative to technician posture, location of the task object, and components and structures that may partially or wholly obscure the task location.

A maintainability problem may involve combinations of these three human factors. For example, a lack of visibility may aggravate a physical accessibility problem by making it more difficult to properly align and position a tool in a restricted working area.

Current military standards establish guidelines for placement of components for accessibility, based on such factors as item size, frequency of maintenance and/or failure, and criticality to system operation. Although the CREW CHIEF system of programs will not resolve the designer's dilemma in such areas, its ability to analyze alternative designs in the interest of maintainability can provide realistic data for design decisions.

1.1 SYSTEM REQUIREMENTS

The CREW CHIEF system of programs is designed to interact with a few popular CAD/CAM software packages and their data bases. Therefore, CREW CHIEF runs on the same hardware used to run the CAD/CAM software. The version of CREW CHIEF described in the manual runs under software package CADAM*, Version 21.0.1, and requires the user to have both the 3-D Interactive Design and Manufacturing Module and the ACCESS Module.

The CREW CHIEF system of programs is interfaced directly to the CADAM software [through Interactive User Exit (IUE)], and follows very closely the nomenclature and user interface methods employed by CADAM. Thus minimal training time is required for the experienced CADAM user to learn to use the CREW CHIEF program.

NOTE:

CADAM's interface with the CREW CHIEF system of programs does not constitute an endorsement of the CADAM system by the U.S. Air Force or its contractors.

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The CREW CHIEF program was developed with the main menu under the IUE program. The CREW CHIEF program is currently contained in its own IUE PGM DIRECTOR,Y (IUE Program Directory) and will need to be accessed accordingly. This is done to ensure that your own IUE Program Directory is not modified. See CREW CHIEF Installation for more details.

It is recommended that the version of CADAM being used with CREW CHIEF have its model size set to the maximum (32K), as some of the program's graphic representations require a significant amount of drawing space (8-10K). The maximum REGION size should be set to 2000K, due to CADAM's program structure.

When running CREW CHIEF, the use of a single scope version of CADAM is recommended, since all scopes in a particular region are "locked out" while a IUE program, hereinafter referred to simply as "function," is executing. Executing in a multiple-scope environment will result in loss of productivity by all users in the region. CADAM instructions have the information necessary to set up a single-scope version of CADAM.

1.2 MAN-MODEL GENERATION

To prevent corrupting the design drawing with unnecessary geometry, the man-model is not automatically made a part of the designer's drawing upon generation. All pertinent information concerning the man-model is automatically written to FORTRAN files and accessed when performing analyses. If the user desires to have the man-model display as a part of the drawing for future reference, he/she must "SAVE" the geometry with CADAM procedures after the function has run.

1.3 WORKPLACE DESIGN

The CREW CHIEF system of programs assumes that workplaces consist of valid 3-D CADAM drawing elements. These include, but are not limited to 3-D lines, splines, points, and surfaces. CADAM's MESH geometry are not processed by CREW CHIEF.

The length of execution time required for analysis depends on the size of the drawing on which the analysis is being done. Execution time can be minimized by "NO-SHOWING" CADAM elements that are outside the immediate work area of the CREW CHIEF man-model. This allows the program to bypass the processing of irrelevant data, e.g., when performing an Interference Analysis, the user can NO-SHOW those CADAM elements that clearly do not interfere with the man-model.

Since IUE programs can process more than one drawing, analysis of overlaid drawings will be performed only on the active drawing. Thus the user may need to change the active drawing if he/she wishes to analyze geometry contained in a non-active member of an overlay. The CREW CHIEF model will be placed in a overlay if the user so indicates during the execution of a CREW CHIEF function.

1.4 THE CREW CHIEF MAINTENANCE ANALYSIS PROGRAMS

The CREW CHIEF Main Programs consist of five distinct functions: Generation, Maintenance Task Analysis, Visibility Analysis, Accessibility Analysis, and the Current CREW CHIEF Data (Configuration) (Figure 1.1).

The user must be in a CADAM group and user that contains the drawings OVERLAY, TEMP MAN-MODEL, WORKPLACE SAVED, and ACTIVE. These drawings need not have anything in them initially, but need to be created to ensure the proper execution of CREW CHIEF (see the CREW CHIEF Installation Guide for more details).

The first step in performing any analysis under CREW CHIEF is to retrieve a CADAM 3-D drawing containing the design to be analyzed. Once the drawing has been retrieved, the user proceeds to the CREW CHIEF system of programs by depressing the ACCESS function key (PFK 11) (Figure 1.2.). Depressing ACCESS calls the ACCESS main menu. The CREW CHIEF Main menu is accessed by selected /EXECUTE IUE PGM/ and then selecting 3D INTERACTIVE PROGRAMS under the heading CADAM-SUPPLIED IUE APPLICATION PROGRAMS. The 3D APPLICATION PROGRAM menu appears and the CREW CHIEF application program can be selected from the bottom middle selection.
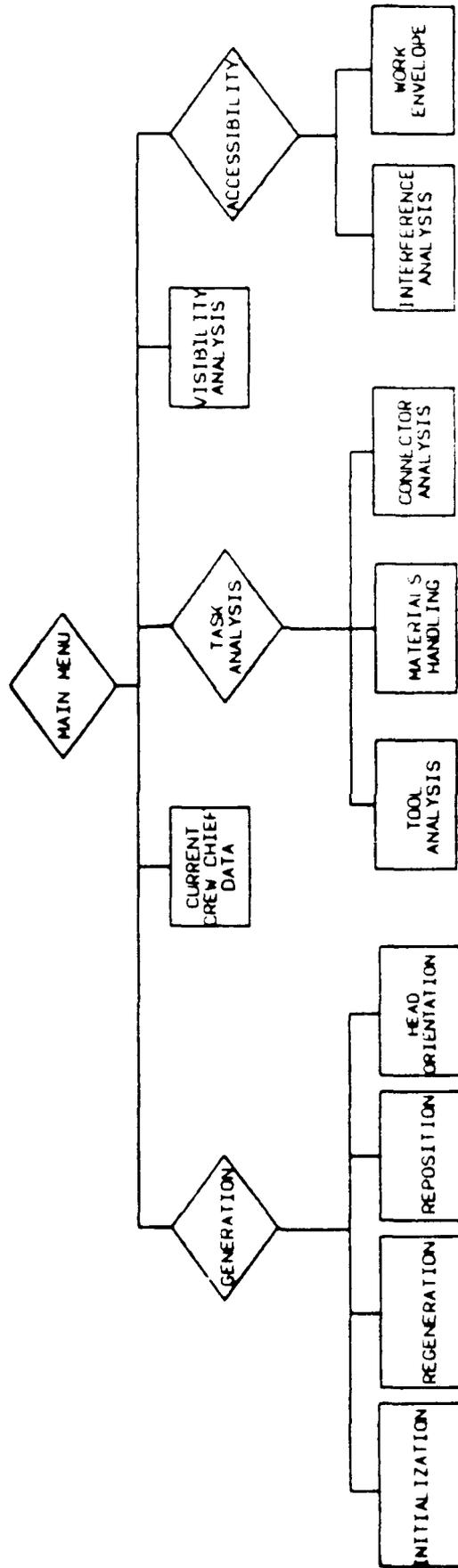
Figure 1.1. CREW CHIEF Programs.
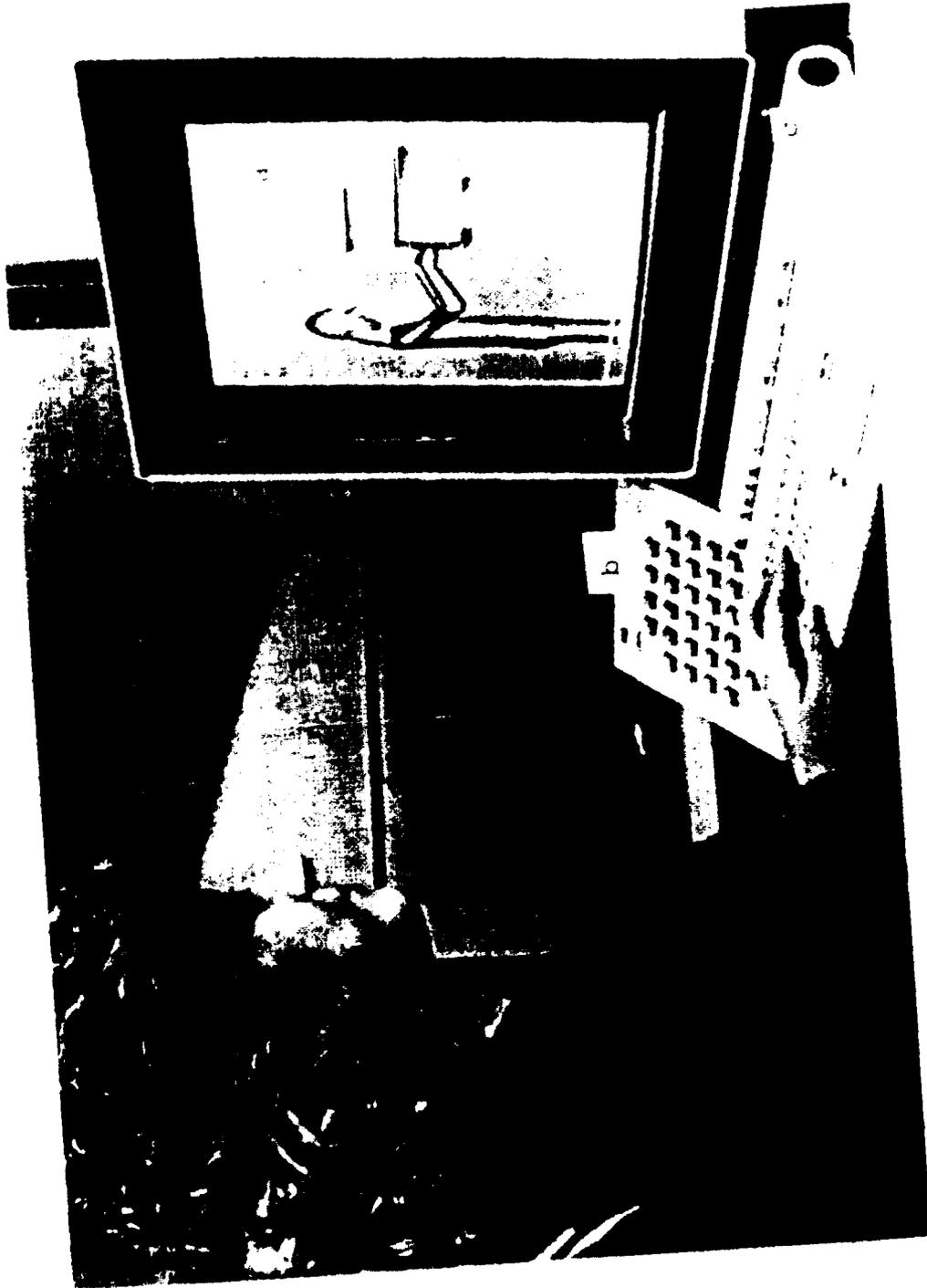
Figure 1.2. CRT Screen (a), Function Keyboard (b), and Alphanumeric Keyboard (c). The Operator Depressed the ACCESS Function Key to execute CREW CHIEF.

Once the CREW CHIEF Main menu is activated, the user is presented with the CREW CHIEF Main programs (see Figure 1.3). This menu contains the five main functions. The CREW CHIEF Generation function must be selected prior to using any of the other four major functions. To use any other function, select the function icon.

1.5 VERSION 2 ENHANCEMENTS

Several have been added to the Version 2 release of CREW CHIEF. A brief description of each follows.

- Interactive User ELxit (IUE)
  Version 2 is directly interfaced to the CADAM software through the Interactive User Exit (IUE) and uses many of the capabilities associated with this interface. With IUE, icons, along with text descriptions, have been added to each CREW CHIEF function.

- The CREW CHIEF Reposition function is now fully incorporated into Version 2. This function allows a user to manipulate specific types of man-model movement.

- The Chemical Defense Clothing type nas been changed to conform to that currently in use by the Air Force.

- The CREW CHIEF Tool Analysis interface and Tool Database have been enhanced to include additional sizes of tools in the tool box. There were 105 separate tools in the Version 1 tool box, and there are 222 in the Version 2 tool box.

CREW CHIEF
MAIN MENU   PAGE 1
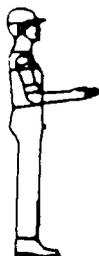
GENERATION
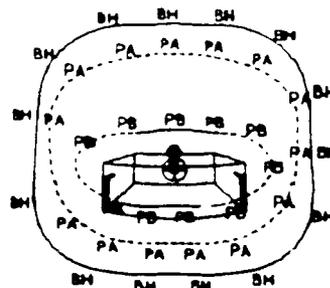
VISIBILITY
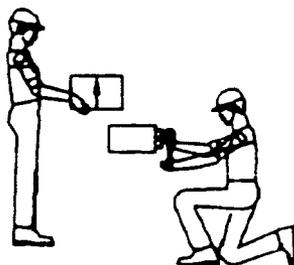
TASK ANALYSIS

CONFIGURATION
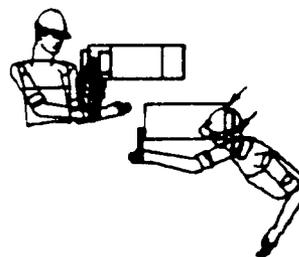
ACCESSIBILITY

/ FWD/ BACK/   /RETURN/

Figure 1.3.   Menu for CREW CHIEF Main Programs.

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- Two database maintenance programs were added to Version 2.

  ♦ The Anthropometric Database Maintenance program provides the user the ability to input a different anthropometric database (Appendix E).

  ♦ The Tool Database Maintenance program allows the user to define additional tools and add them to the tool box for their use (Appendix F).

1.6 GETTING STARTED

Since the CREW CHIEF and CADAM programs are interactive, there are basically three initial requirements to get started: (1) access the CADAM programs, (2) retrieve a 3-D drawing from the CADAM drawing files, and (3) call the CREW CHIEF system of programs. The basic steps to meet these requirements follow.

Step 1:

ACTION: Submit a CADAM job on alphanumeric keyboard (ANKB) that will access the CREW CHIEF programs. For example, key in **SUBMIT 'CREW.CHIEF.CNTL(RUNCCF)'**.

RESULT: The first prompt appears.

Step 2:

PROMPT: COLD START

WARM START (prompt appears in bottom third of window)

ACTION: Select **COLD START**

RESULT: Screen display area is blank and a new prompt appears.

Step 3:

PROMPT: KEY GROUP, USER

     ACTION: Key in user's group and sub-group ID <CR> (e.g.
                    CREW, IUE)

     RESULT: Screen display area is blank. FILES appears in
                    upper left-hand corner of window. GROUP = and
                    USER = appear in upper right-hand corner, and a
                    new prompt and menu appears.

Step 4:

PROMPT: There is no visual prompt.

     ACTION: Select **PROFILE** from bottom menu:

                    /START/CALL/FILE/DATA-M/GRPUSR/INFO/SPLIT/MERGE

                    /PROFILE/OUTPUT/LOGOFF/

     RESULT: Drawing/Screen Configuration options are shown in
                    the window with asterisks indicating status of
                    configuration (Figure 1.4). A new prompt
                    appears.

<u>Step 5</u>:

PROMPT: <u>SELECT OPTION</u>/YN RETURN

     ACTION: Select **3D** under <u>MODE</u> in bottom half of window. Next
                    select **/RETURN/** beneath right-hand corner of
                    window.

     RESULT: Asterisks appear before 3D beneath <u>MODE</u> and WINDOW,
                    and after /RETURN/ is selected, display area is

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VIEW PV | 000
SELECT OPTION / YN RETURN   WDO | 000

UNITS

- INCHES
  FEET
  MM
  CM
  METERS
  OTHER

VIEW CONVENTION

FIRST ANGLE

- THIRD ANGLE

COLOR TYPES

VIEW   = OFF   PRTY= 1
CLASS   = OFF   PRTY= 2
ELEMENT= ON   PRTY= 3
OVERLAY= OFF   PRTY= 4

MODE   *WINDOW*

TOGL   2D   2D
TOGL • 3D   • 3D
       AEC
       CAE

PRECISION

- SINGLE

FT/INCH/FRACTION

  F I F   MODE ON
- F I F   MODE OFF

/RETURN/

Figure 1.4.   User-Defined Drawing/Screen Configurations.

blank and top prompt and bottom   menus remain the same as in Step 4.

<u>Step 6</u>:

PROMPT: There is no visual prompt.

    ACTION: Select **/CALL/** from bottom menu to key in drawing name or to access user's drawing file:

          /START/CALL/FILE/DATA-M/GRPUSR/INFO/SPLIT/MERGE

          /PROFILE/OUTPUT/LOGOFF/

    RESULT: CALL is underlined and a new prompt appears.

<u>Step 7</u>:

PROMPT: KEY PN, FN / <u>Y/N CALL</u>

    ACTION: Depress **Y/N** (YES/NO) function key.

    RESULT: First page of user's drawing file index appears on screen. A new prompt and a new menu appear.

<u>Step 8</u>:

PROMPT: <u>SEL ID</u>/KEY PAGE NO

    ACTION: Select a drawing file name (ID)

    RESULT: Selected drawing is retrieved and displayed on screen. PN,FN = (ID selected) appears in the top left-hand corner of the window under FILES. The drawing may have to be oriented by depressing the CADAM Window function key. Once the drawing has

been oriented as desired, the CREW CHIEF system of programs may be called.

Step 9:

PROMPT: There is no visual prompt.

    ACTION: Depress **ACCESS** function key.

    RESULT: Screen display changes, a new prompt and a new menu appear.

Step 10:

PROMPT: SEL MENU

    ACTION: Select **/EXECUTE IUE PGM/** from the bottom menu.

    RESULT: The IUE PROGRAM DIRECTORY appears.

Step 11

PROMPT: SEL MENU/SEL PGM/ SEL PGM INDEX/KEY PAGE

    ACTION: Select **3D INTERACTIVE PROGRAMS** under the CADAM-SUPPLIED IUE APPLICATION PROGRAMS.

Step 12

PROMPT: SEL MENU/SEL PGM/ SEL PGM INDEX/KEY PAGE

    ACTION: Select the **CREW CHIEF** option.

    RESULT: The CREW CHIEF Main Programs menu appears (see Figure 1.3). Information concerning the generation of the man-model and the use of the analysis functions is contained in Sections 2

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through 6. If the user wishes to proceed directly to the init.al generation of the man-model, the user may turn to Paragraph 2.1.2 for generation procedures.

NOTE: During the execution of any CREW CHIEF function, a menu will be present at the bottom of the window:

/TO MAIN MENU/TO PREVIOUS MENU/EXIT FUNCTION/HELP/.

The options in this menu allow the user to exit to the main menu, backup to a previous menu, exit IUE, or obtain help information.

The following sections contain a PROMPT, ACTION, EXAMPLE, RESULT format. The user is invited to follow the examples **exactly** to ensure the user's ease in learning efficient use of the CREW CHIEF system of programs. Section 8 of this User's Guide is provided as a Quick Reference for a user who has become familiar with the CREW CHIEF system of programs. This section is written in a PROMPT, ACTION, RESULT format, and includes all possible branches of each CREW CHIEF function. Note that all prompts appear at the top of the window. Icons have also been included in the CREW CHIEF interface. Each icon has a text description under it for better understanding.

SECTION 2

CREW CHIEF GENERATION FUNCTIONS

The CREW CHIEF Generation Functions menu contains all
functions which pertain to the generation, display, and manual
repositioning of the CREW CHIEF man-model. This is normally the
first menu accessed, since several CREW CHIEF functions require a
man-model to be defined before use. This menu contains four
functions: CREW CHIEF Initialization, Paragraph 2.1.2, which
generates and displays the man-model; CREW CHIEF Regeneration,
Paragraph 2.2.2, which regenerates the CREW CHIEF man-model
display using the most recent saved data; CREW CHIEF Reposition,
Paragraph 2.3, which places the man-model (in the desired posture
and position) in the work space; and CREW CHIEF Head Orientation,
Paragraph 2.4.2, which turns the head to allow the man-model to
view a new location. Choose the function to be used by selecting
the appropriate icon for that function (Figure 1.3).

2.1   CREW CHIEF INITIALIZATION FUNCTION

2.1.1   Introduction to Initialization Function

The CREW CHIEF Initialization Function generates and
displays the man-model in the designer's drawing. The designer
can choose from ten body sizes (including five male and five
female), four clothing types, and twelve initial postures. These
choices allow multiple options to evaluate a design for maintain-
ability. The man-model can be placed anywhere in the drawing,
but is not made a permanent part of the drawing unless specif-
ically requested. Any man-model not made a permanent part of the
drawing is erased upon the generation of another man-model. This
prevents the programs from permanently corrupting the designer's
drawing.

The ten body sizes consist of the 1st, 5th, 50th, 95th,
and 99th percentiles for both male and female, based on the Air
Force maintenance technician population. Selection of the Nth

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percentile results in the generation of a man-model with Nth
percentile height, weight, and arm length for the selected
gender. Other necessary body dimensions are calculated from
regressions based on these three variables. Appendix A describes
the generation of the man-model, and the selection of body size
as applicable to Air Force design policy.

The four common clothing ensembles used by a technician
are fatigues, fatigues with jacket, arctic, and chemical defense
(see Figures B.1-B.4 in Appendix B). Details of the clothing
ensembles are contained in Appendix B. Figures B.5 through B.8
show the man-model as it appears in each of these clothing
ensembles.

The twelve postures represent common postures found in a
maintenance environment. These postures allow initial generation
of the man-model in a posture which closely approximates the one
desired. The initial postures can be further modified manually
(using the Reposition Function), or automatically by the Task
Analysis Functions. The twelve postures available in the
Initialization Function can be seen in Figures C.1 through C.12
in Appendix C.

2.1.2   Using the Initialization Function

These instructions for the Initialization Function assume
that the CREW CHIEF system of programs has been activated and
that the screen is configured as shown in Figure 1.3. If not,
the user must complete the procedure described in Paragraph 1.5
to call the CREW CHIEF Main Programs menu. The next step is to
generate the man-model in the desired configuration.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **GENERATION icon**

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RESULT: The CREW CHIEF Generation Functions menu is
            displayed (Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **INITIALIZATION icon**

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the Y/N function key to execute the
               Initialization function.

    EXAMPLE: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM INIUSR EXECUTING appears and
              then a new prompt and menu appear.

PROMPT: SELECT DESIRED BODY SIZE

    ACTION: Select the icon representing the body size and
            gender of the man-model (Figure 2.2). (See Appendix A
               for explanation of body size percentiles.)

    EXAMPLE: Select **50TH PERCENTILE**

    RESULT: New prompt and menu appear.

GENERATION   PAGE 2
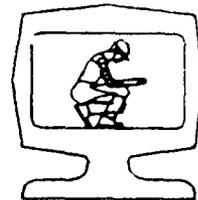
INITIALIZATION   REGENERATION

HEAD ORIENTATION   REPOSITION

RETURN TO
CREW CHIEF
MAIN MENU

/ FWD/ BACK/   /RETURN/

Figure 2.1.   Main Menu for CREW CHIEF Generation Functions.

1ST
PERCENTILE
MALE

5TH
PERCENTILE
MALE

50TH
PERCENTILE
MALE

95TH
PERCENTILE
MALE

99TH
PERCENTILE
MALE

1ST
PERCENTILE
FEMALE

5TH
PERCENTILE
FEMALE

50TH
PERCENTILE
FEMALE

95TH
PERCENTILE
FEMALE

99TH
PERCENTILE
FEMALE
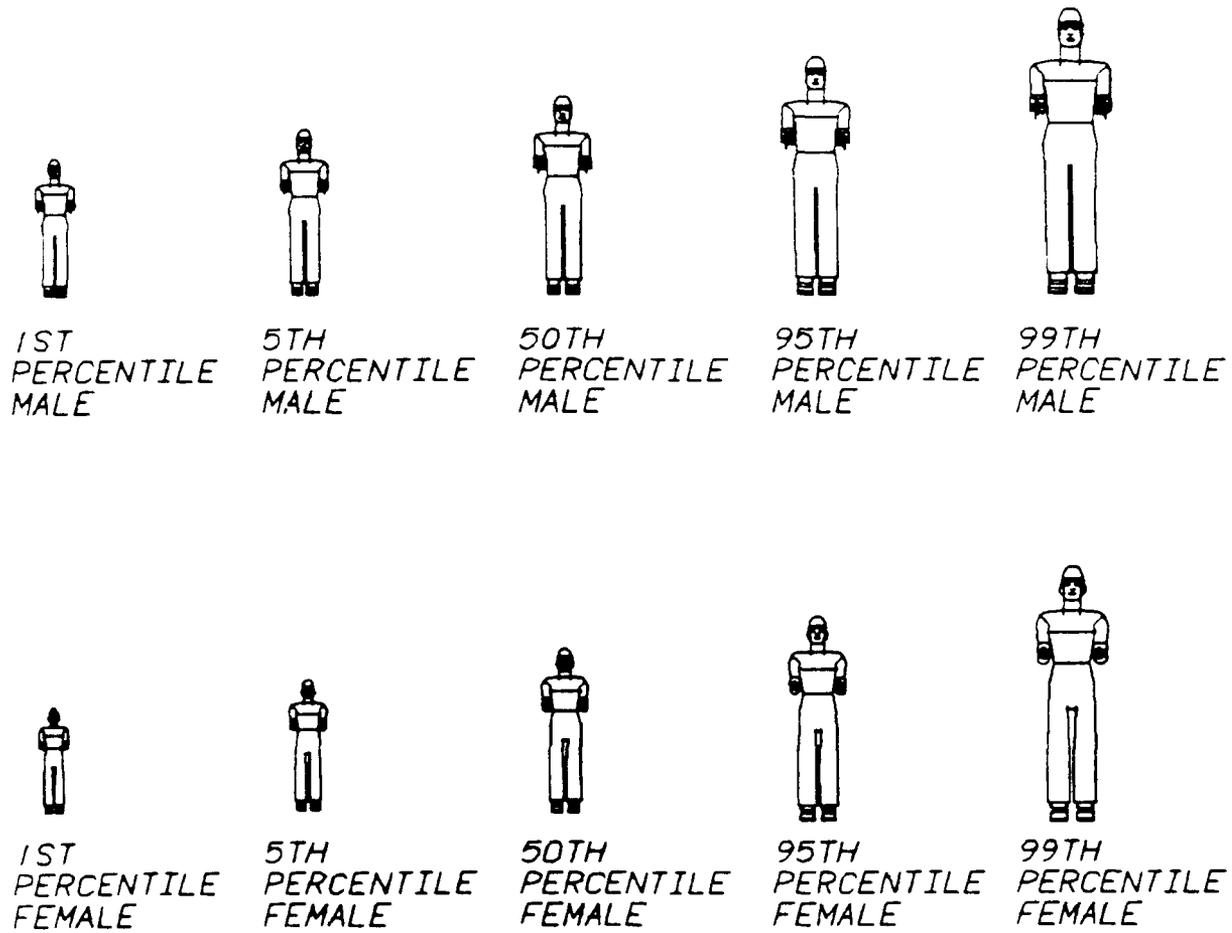
Figure 2.2. Body Size Menu.

PROMPT: SELECT DESIRED CLOTHING TYPE

     ACTION: Select the icon representing the type of clothing
         to be worn by the man-model (Figure 2.3).
         Clothing affects mobility and accessibility. See
         Appendix B for explanation of clothing types.

     EXAMPLE: Select **FATIGUES**

     RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED POSTURE

     ACTION: Select icon representing the starting posture of
         the man-model (Figure 2.4). See Appendix C,
         Figures C.1-C.12 for explanation of postures.
         Later these postures can be adjusted manually
         using the Reposition function or will be automat-
         ically adjusted when performing Task Analysis.

     EXAMPLE: Select **KNEEL 2**

     RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED POSITION MODE

     ACTION: Select choice from options in the middle of the
         screen

       •   Select **NEW POSITION AND ORIENTATION** to define
         the man-model at a new position and orientation.
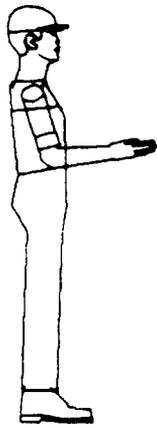
FATIGUES
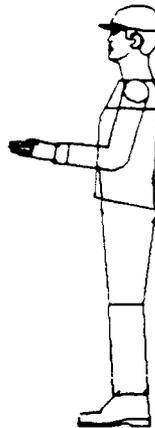
FATIGUES W/ JACKET
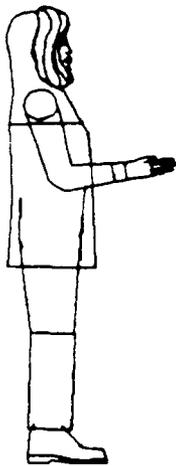
ARCTIC GEAR
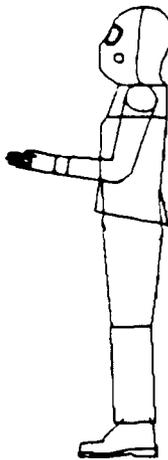
CHEMICAL DEFENSE

Figure 2.3. Clothing Menu.

STAND SIT BEND SUPINE

PRONE SIDE KNEEL ON ONE KNEE KNEEL C: TWO KNEES

SQUAT WALK CRAWL CLIMB
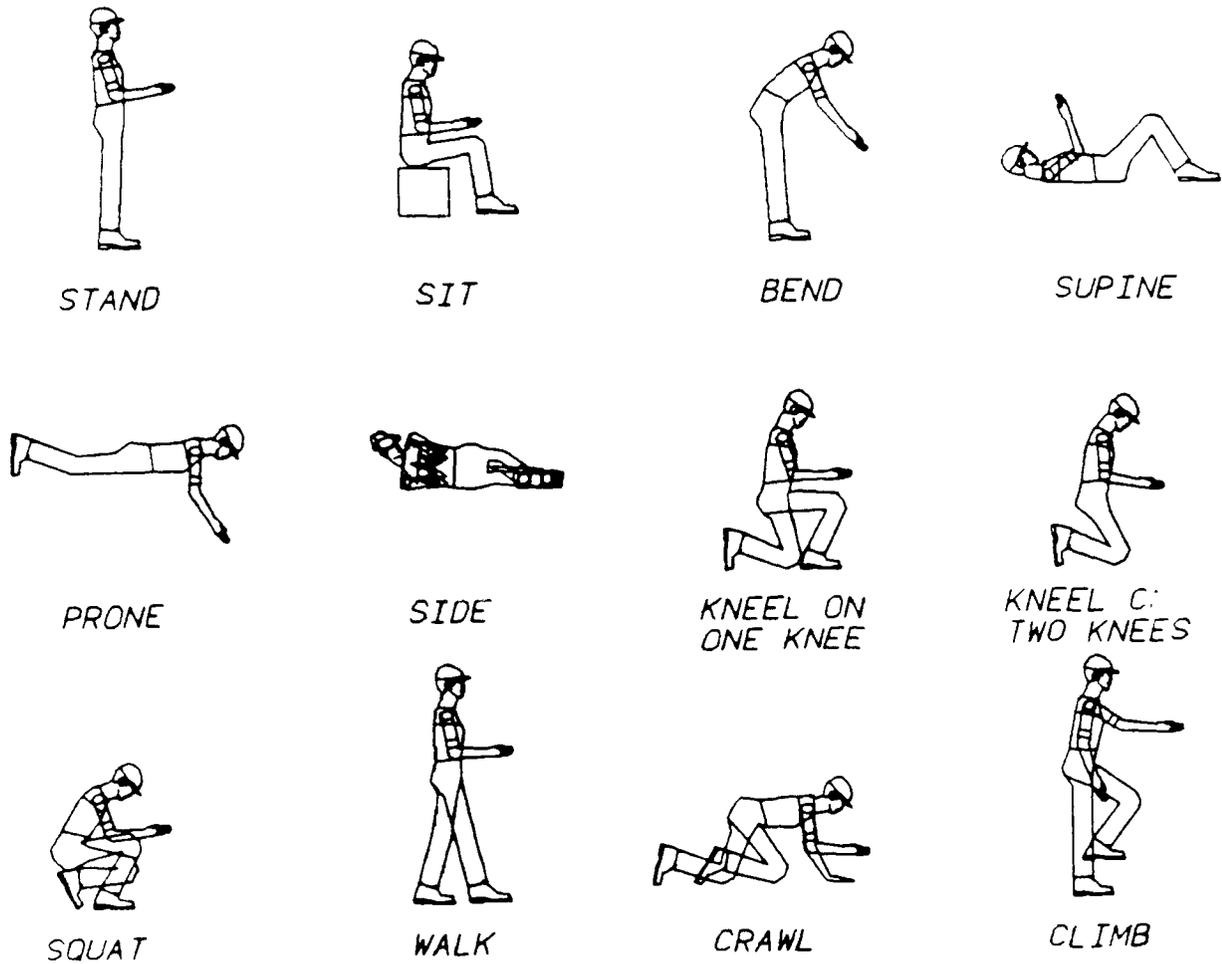
Figure 2.4. Posture Menu.

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<u>OR:</u>

- Select **OLD POSITION AND ORIENTATION** to place
  man-model in the same location and orientation as
  previously defined during Initialization. The
  user will next be prompted to choose a display
  type if this option is selected. (Gender-size,
  clothing type, and posture type may change if the
  user indicates a change.)

<u>OR:</u>

- Select **CURRENT POSITION AND ORIENTATION** to
  re-display the man-model in the current saved
  position and orientation. This position and
  orientation could have been generated in several
  of the CREW CHIEF functions such as Task Analysis.

  The user would next be prompted to choose a
  display type if this option is selected.

EXAMPLE: Select **NEW POSITION AND ORIENTATION**

RESULT: New prompt appears on screen to select display
          type.

     As a result of selecting NEW POSITION AND ORIENTATION,
the user will see the following prompt:

PROMPT: DEFINE POINT FOR LOCATION OF WORK

     ACTION: Define the location of work (bolt head or target
               area of man-model's work) by selecting an existing
               target 3-D point or by keying in the X,Y,Z coor-
               dinates of the point. The X and Y coordinates of
               this point determine the head of the direction

vector shown in Figure 2.5. <u>The man-model always faces the location of work.</u>

- Select an existing 3-D point to define the location of work.

OR:

- Key in the X,Y,Z coordinates of the location of work <CR>.

EXAMPLE: Key in **24, 163.5, 0** on ANKB <CR>.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR DIRECTION FROM WORK

ACTION: Define a *direction from the man-model to the* Location of Work. **Note that this is NOT the location of the man-model.** Define the X, Y coordinates of a point relative to the Location of Work point. This point defines the tail point of the direction vector along which the man-model will be placed as shown in Figure 2.5. The distance of this point from the Location of Work is not relevant at this stage of initialization.

- Select an existing point in the drawing. Only the location of the man-model. Only the X,Y coordinates will be used to define this direction.

OR:

- Key in the X,Y coordinates of the direction point <CR>.

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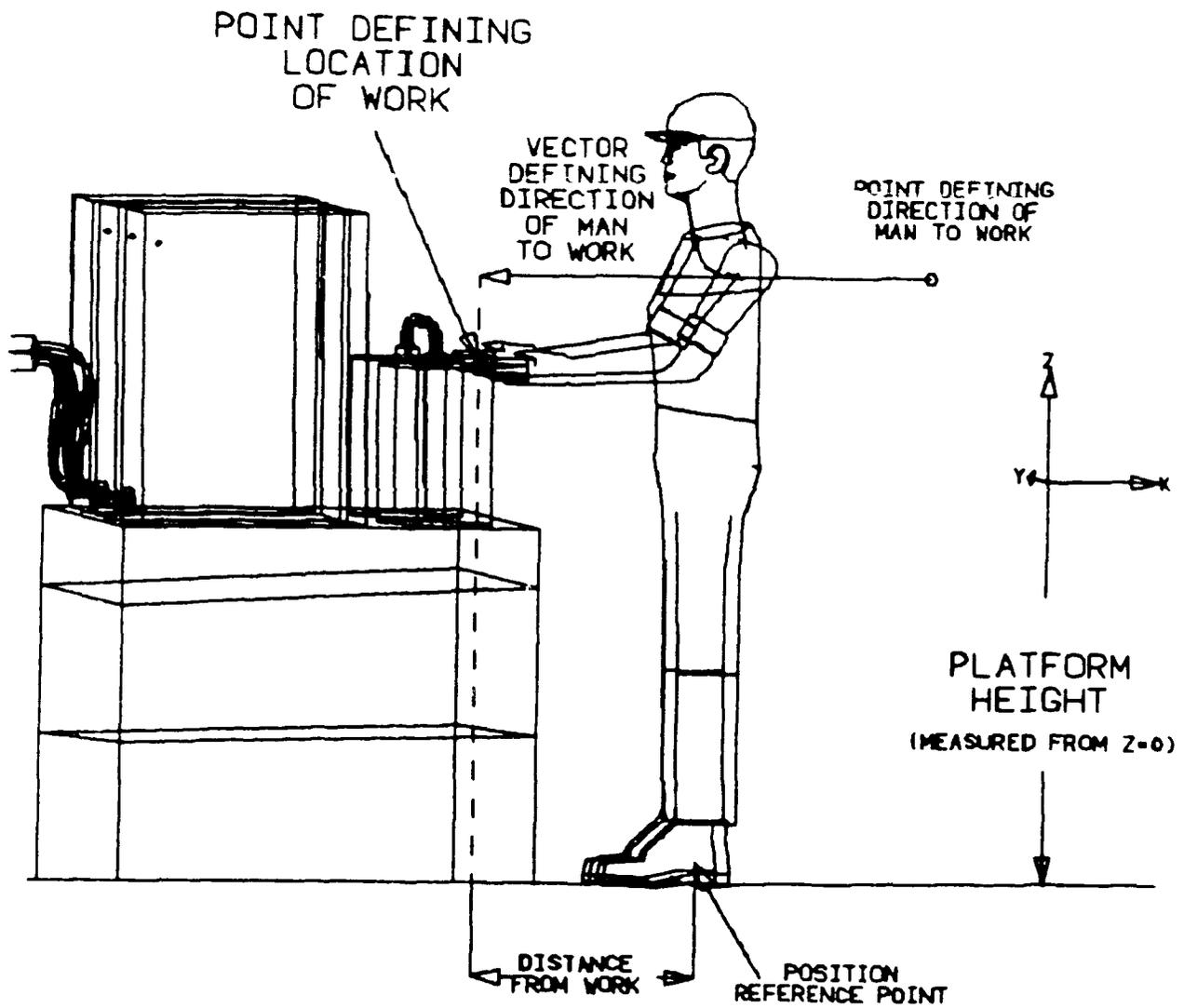
Figure 2.5.   The Man-Model at a Work Station with Arrows
Showing Position and Orientation Requirements.

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EXAMPLE: Key in **35, 163.5 <CR>**

RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE FROM WORK

    ACTION: Define the horizontal distance from the Location
            of Work point to the man-model. The Position
            Reference Point of the man-model lies along the
            vertical plane defined by the Location of Work and
            the Direction to Work (see Figure 2.5). (See
            Appendix C for location of Position Reference
            Points for various postures.) Key in the distance
            between man-model and the Location of Work **<CR>**.
            Values outside the range of 6-30 inches are
            usually unrealistic, but this distance depends
            upon the location of the Position Reference Point
            of the selected posture as shown in Figure 2.6.

    EXAMPLE: Key in **12 <CR>**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT PLATFORM INPUT MODE

    ACTION: Define the height of the platform or support
            surface upon which the man-model will be
            positioned. The Position Reference Point (see
            Figure 2.6) of the man-model will be placed at
            this height.

C) DISTANCE FROM WORK:

DISTANCE FROM THE POSITION REFERENCE POINT
OF THE CREW CHIEF TO THE LOCATION OF WORK.

(*)POSITION REFERENCE POINTS

MORE HELP AVAILABLE ON NEXT PAGE

Figure 2.6. Position Reference Points.

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- Choose **SELECT WORK PLATFORM POINT** to define an existing 3-D point in the drawing which will represent the height (Z coordinate) of the platform or support surface, and then select an existing 3-D point.

OR:

- Select **KEY-IN PLATFORM HEIGHT** to key in the height of the platform or support surface (Z coordinate) relative to the drawing origin, and key in the , coordinate <**CR**>.

EXAMPLE: Select **KEY-IN PLATFORM HEIGHT**

RESULT: New prompt appears.

PROMPT: KEY-IN PLATFORM HEIGHT

ACTION: Key-in the value representing the platform height <**CR**>

EXAMPLE: Key-in **-20** <**CR**>

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the display type icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model

TABLE 2.1.   THREE TYPES OF DISPLAY AVAILABLE FOR THE CREW
             CHIEF MAN-MODEL.

Type of Man-Model	Definition
(1) WIRE	This selection generates the man-model as a 3-D wire-frame figure which can be rotated and moved using the appropriate CADAM Window (PFK 27) functions. The man-model and drawing may be viewed from different points in the drawing. This type of enfleshment can be used for visually identifying potential areas of interference between the man-model and the workplace design (Figure 2.7.).
(2) SURFACED	This type of display will display the man-model as a 3d meshed model. The man-model can then be shaded by using CADAM's Shading program under IUE (Figure 2.8.).
(3) PROFILE	This is a profile view of the man-model, as seen from the designer's viewpoint at the graphics scope. This type of display is the least cluttered, and provides a display suitable for "finished" plots (Figure 2.9.).
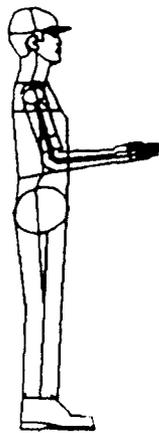
WIREFRAME

Figure 2.7.   3-D Wire-Frame Man-Model.

SURFACED

Figure 2.8. Surfaced View of Man-Model.

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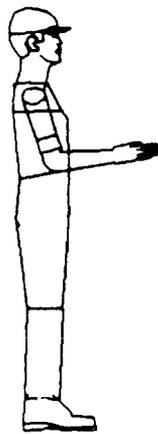
PROFILE

Figure 2.9.   Profile View of Man-Model.

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<u>OR:</u>

- Select **SURFACED** to display a meshed man-model to be used in shading

<u>OR:</u>

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**

RESULT: Man-model appears superimposed on the drawing as a wire-frame model, and new prompt and new menu appear.

> <u>NOTE:</u> If user has followed the examples, the man-model appears kneeling on both knees with his knees 20 inches below the origin and 12 inches offset from the location of work.

When the man-model has been positioned in the drawing, the Initialization function is completed. To continue the analysis, the user will generally select **/RECOVER/** from the menu at the bottom of the window. The bottom menu is a CADAM-supplied menu which also contains another selection which is available to the user at this time. The /KEEP/ option saves the man-model in a drawing called OVERLAY. If /KEEP/ is selected the drawing OVERLAY becomes the active drawing.

PROMPT: SEL MENU

    ACTION: Select choice from CADAM menu at bottom of
                window. Selecting **/RECOVER/** will return the user
                to the CREW CHIEF Generation Functions menu (see
                Figure 2.1) without saving the current
                man-model.

    EXAMPLE: Select **/RECOVER/**

    RESULT: Program returns to CREW CHIEF Generation Functions
                menu (see Figure 2.1).

Figure 2.10 diagrams the flow of actions necessary to execute an initialization of the man-model.

2.2   CREW CHIEF REGENERATION FUNCTION

2.2.1   Introduction to Regeneration Function

The Regeneration Function regenerates the man-model display, using the last saved enfleshment data from the last successful positioning operation. Positioning operations can occur during the Generation functions, or during a Task Analysis, and are saved from one program run to the next if successful positioning has occurred. The Regeneration Function provides the user the opportunity to change both the type of display presented and the viewpoint from which the user sees the man-model (for profile view). This function can be used to recover from any catastrophic errors that may occur during interactive repositioning of the man-model. These instructions for the Regeneration function assume that the man-model has been generated at least once using the Initialization function (see Paragraph 2.1.2).
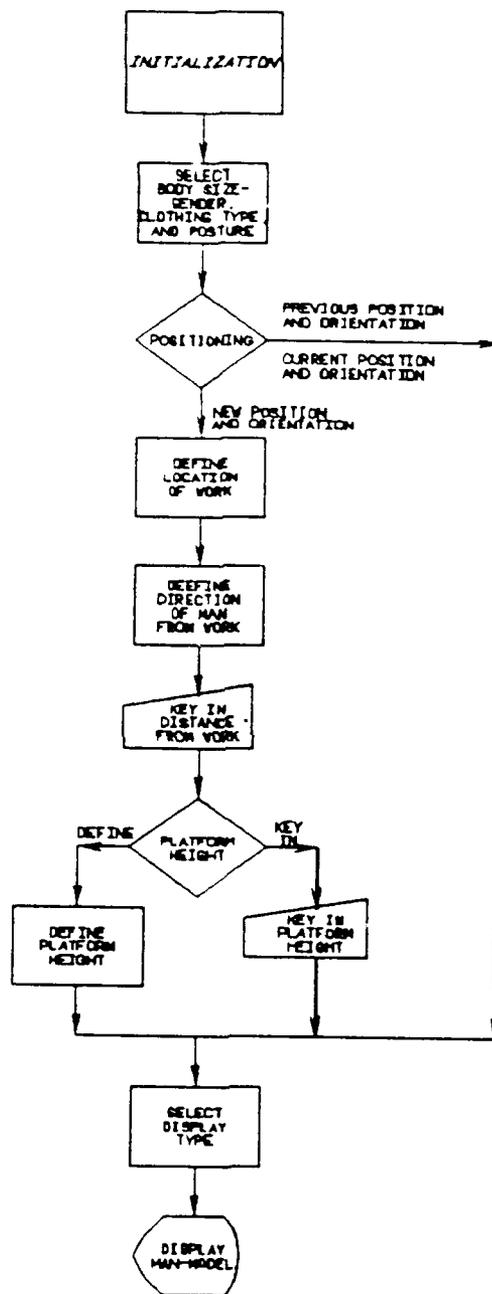
Figure 2.10. CREW CHIEF Initialization Function Flow
Diagram.

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2.2.2   Using the Regeneration Function

These instructions for the Regeneration function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **GENERATION icon**

    RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **REGENERATION icon**

    RESULT: A new prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the Y/N function key to execute the Regeneration Function.

    EXAMPLE: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM REGUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

   ACTION: Select one of the display types from the display
             icons (see Table 2.1 for definitions of WIREFRAME,
             SURFACED, or PROFILE)

       •   Select **WIREFRAME** to display a 3-D wire-frame
           man-model

   OR:

       •   Select **SURFACED** to display a meshed man-model to be
           used in shading

   OR:

       •   Select **PROFILE** to display profile view of
           man-model
   EXAMPLE: Select **WIREFRAME**

   RESULT: Man-model appears superimposed on the drawing as a
             profile model, and new prompt and new menu appear.

       NOTE: If user has followed the examples, the
               man-model will appear as he did in the last
               successful generation. The only item which may
               change is the display type.

When the man-model has been positioned in the drawing,
the Regeneration function is completed. To continue the
analysis, the user will generally select **/RECOVER/** from the menu
at the bottom of the window. The bottom menu is a CADAM-supplied
menu which also contains another selection which is available to
the user at this time. The /KEEP/ option saves the man-model in
a drawing called OVERLAY. If /KEEP/ is selected, OVERLAY becomes
the active drawing.

PROMPT: SEL MENU

ACTION: Select choice from CADAM menu at bottom of
            window. Selecting **/RECOVER/** will return the
            user to the CREW CHIEF Generation Functions menu
            without saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions
            menu.

Figure 2.11 diagrams the flow of actions necessary to
execute a regeneration of the man-model.

2.3   CREW CHIEF REPOSITION FUNCTION

2.3.1   Introduction to Reposition Function

The Reposition function is designed to augment the Task
Analysis functions which will usually position the man-model in
the chosen position. However, sometimes an uncommon position or
a position necessitating movement of peripheral body sections may
be desired. For example, a reach may only require movement of an
arm, but the user may also require that the body be twisted or a
leg be moved. Reach will not move these peripheral sections
unless the movements are required for a successful reach. Repo-
sition allows movement of up to twelve body sections at any time.
When the man-model is regenerated using the Reposition function,
mobility restraints will still be enforced, but interference is
not checked. It is possible, but slower, to accomplish a reach
using only the Reposition function.

The Reposition function is different from the rest of the
CREW CHIEF functions. This function can be executed over and
over until the user is satisfied with the positioning of the man-

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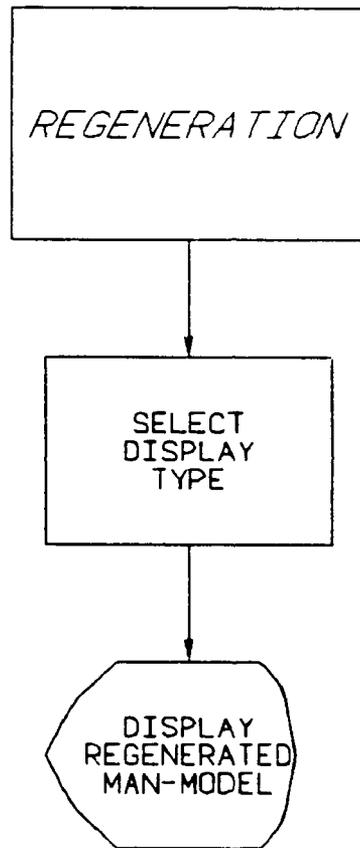
Figure 2.11.   CREW CHIEF Regeneration Function Flow Diagram.

model. The user will select **/EXIT FUNCTION/** from the bottom menu
when he is ready to exit the function. See Section 1.5 for a
description of this bottom menu.

2.3.2   Using the Reposition Function

These instructions for the Reposition Function assume
that the CREW CHIEF system of programs has been activated and
that the screen is configured as shown in Figure 1.3.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **GENERATION icon**

    RESULT: The CREW CHIEF Generation Functions menu is
              displayed (see Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **REPOSITION icon**

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the Y/N function key to execute the
              Reposition function.

    EXAMPLE: Depress the **Y/N** function key

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RESULT: APPLICATION PROGRAM RPNUSR EXECUTING appears,
           man-model is initialized in the last successful
           position and appears in the drawing, and then a
           new prompt appears.

PROMPT: SELECT THE OPTION YOU WISH TO USE

    ACTION: Select the option you wish to perform

       •   Select **REORIENT A MAN-MODEL SEGMENT** to rotate
            and/or twist specific segments of the man-model

    OR:

       •   Select **DEFINE NEW POSITION REFERENCE POINT** to
            define a new position reference point on the man-
            model. Figure 2.6 defines the position reference
            point for each posture

    OR:

       •   Select **REORIENT THE ENTIRE MAN-MODEL** to define a
            new support platform or rotate entire man-model

    OR:

       •   Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the
            man-model to be positioned in a squat posture.

    EXAMPLE: Select **REORIENT A MAN-MODEL SEGMENT**

    RESULT: New prompt appears.

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PROMPT: SELECT MAN-MODEL SEGMENT YOU WISH TO REORIENT

    ACTION: Select the body segment you wish to rotate or
                twist.

    EXAMPLE: Select a segment in the lower arm.

    RESULT: A new prompt and menu appears.

PROMPT: SELECT THE OPTION YOU WISH TO USE

    ACTION: Select option whether to flex or twist the
                selected segment.

    EXAMPLE: Select **FLEX THE SELECTED MAN-MODEL SEGMENT**

    RESULT: New prompt appears.

PROMPT: KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

    ACTION: Key in the angle of flexion in degrees **<CR>**. The
                default is ten degrees and can be obtained by
                <CR>. Otherwise key in the angle desired **<CR>**.

    EXAMPLE: Key in **15 <CR>**

    RESULT: Man-model reappears on screen with lower arm
                flexed 15 degrees. New prompt appears.

PROMPT: KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

    ACTION: Key in a new angle of flexion or **<CR>** for same
                angle. If the user is satisfied with the location
                of the body segment, he can select **/TO PREVIOUS**

MENU/ from the bottom menu. This will return him to a new menu.

EXAMPLE: **<CR>**

RESULT: Man-model reappears on screen with lower arm flexed 15 degrees more. Same prompt appears.

PROMPT: KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

 ACTION: Key in a new angle of flexion or **<CR>** for same angle. If the user is satisfied with the location of the body segment, he can select **/TO PREVIOUS MENU/** from the bottom menu. This will return him to a new menu.

 EXAMPLE: Select **/TO PREVIOUS MENU/** from bottom menu

 RESULT: New prompt and menu appears.

PROMPT: SELECT THE OPTION YOU WISH TO USE

 ACTION: Select the option to flex or twist a man-model segment from the screen. At any time the user can select one of the options from the bottom menu if he is satisfied with the position of a given segment.

 EXAMPLE: Select **/TO PREVIOUS MENU/**

 RESULT: New prompt appears.

PROMPT: SELECT THE MAN-MODEL SEGMENT YOU WISH TO REORIENT

ACTION: Select the man-model segment you wish to re-orient or select one of the options from the bottom menu.

EXAMPLE: Select **/TO PREVIOUS MENU/**

RESULT: New prompt and menu appear.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select the option you wish to perform from the screen.

- Select **ABORT CURRENT MAN-MODEL TO RECOVER** to recover position of man-model before last save command was given.

OR:

- Select **REORIENT A MAN-MODEL SEGMENT** to rotate or twist specific segments of the man-model.

OR:

- Select **DEFINE NEW POSITION REFERENCE POINT** to define a new position reference point on the man-model. Figure 2.6 defines the position reference point for each posture.

OR:

- Select **REORIENT THE ENTIRE MAN-MODEL** to define a new support platform or rotate entire man-model.

OR:

- Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the man-model to be positioned in a squat posture.

OR:

- Select one of the options at the bottom of the menu.

EXAMPLE: Select **/EXIT FUNCTION/**

RESULT: New prompt and menu appear.

PROMPT: SELECT THE OPTION YOU WISH TO USE

ACTION: Select the option from the screen you wish to use. Before exiting Reposition Function the user has the choice to save the man-model in the current configuration or exiting without saving the new man-model configuration.

- Select **SAVE THE MAN-MODEL AND RESUME THE FUNCTION** to save the current man-model configuration and continue with the Reposition function.

OR:

- Select **SAVE MAN-MODEL AND EXIT THE FUNCTION** to save current position of the man-model and exit the function.

OR:

- Select **EXIT FUNCTION WITHOUT SAVING** to exit the Reposition function and recover the position of

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the man-model before the last save command was
given.

EXAMPLE: Select **SAVE THE MAN-MODEL AND EXIT THE FUNCTION**

RESULT: New prompt and menu appear.

To continue the analysis, the user will generally
select **/RECOVER/** from the menu at the bottom of the window. The
user may select /KEEP/ to save the man-model in the drawing
OVERLAY. If /KEEP/ is selected, OVERLAY becomes the active
drawing.

PROMPT: SEL MFNU

ACTION: Select choice from CADAM menu at bottom of window.
Selecting **/RECOVER/** will return the user to the
CREW CHIEF Generation Functions menu without
saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions
menu.

Figure 2.12 diagrams the flow of actions necessary to
execute the Reposition Function.

2.4   CREW CHIEF HEAD ORIENTATION FUNCTION

2.4.1   Introduction to Head Orientation Function

This function allows the user to specify a new point
toward which the man-model will turn its head as far as mobility
constraints will allow. The man-model's head i oriented to look

48
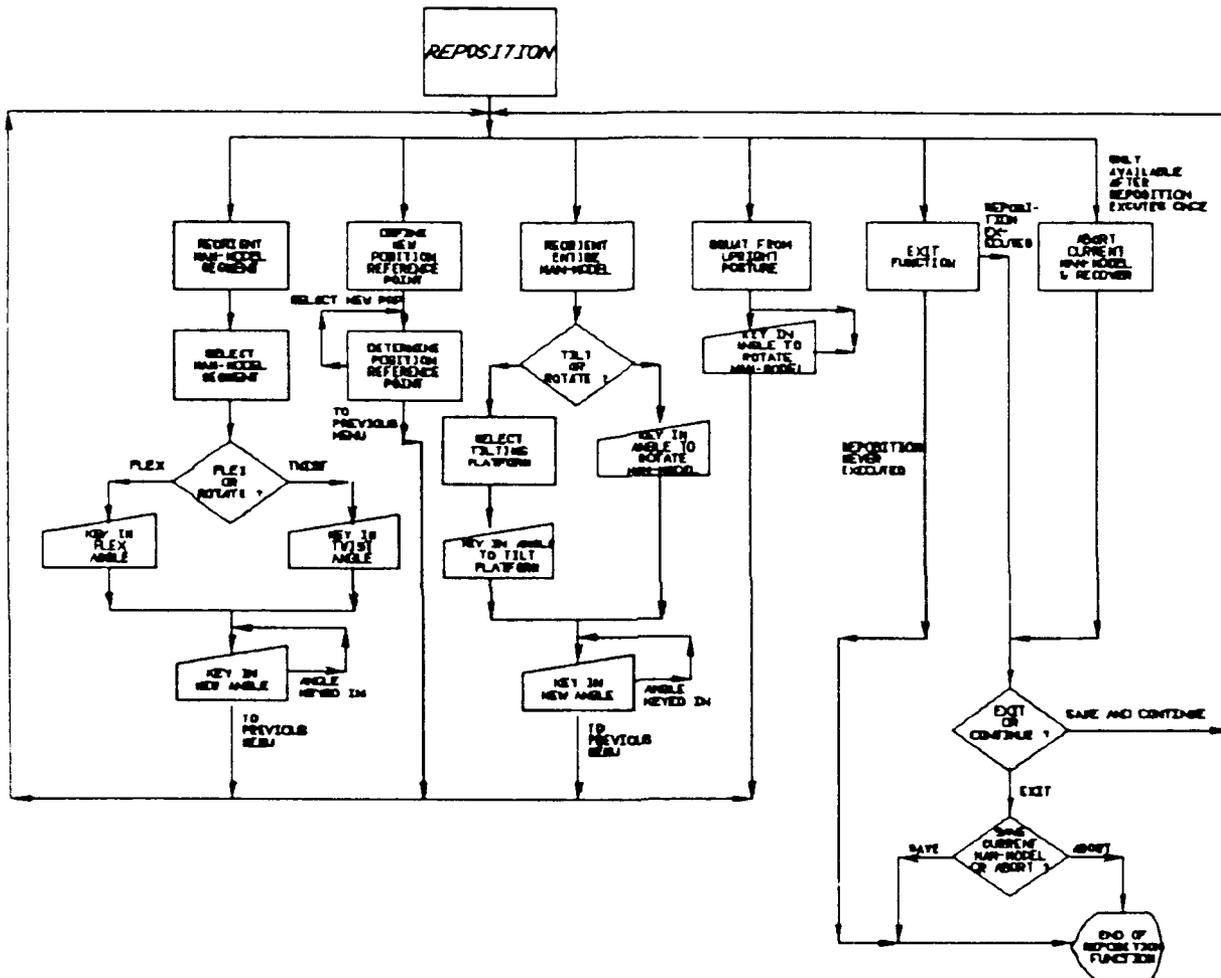
Figure 2.12. CREW CHIEF Reposition Function Flow Diagram.

toward the new location instead of toward the previously specified location.

2.4.2 Using the Head Orientation Function

These instructions for the Head Orientation Function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

     ACTION: Select the function to be performed.

     EXAMPLE: Select the **GENERATION icon**.

     RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

     ACTION: Select the function to be performed.

     EXAMPLE: Select the **HEAD ORIENTATION icon**.

     RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

     ACTION: Depress the Y/N function key to execute the Head Orientation function.

     EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM HDOUSR EXECUTING appears and then a new prompt and menu appear. PROMPT: DEFINE TARGET POINT.

ACTION: Select or key in a 3-D point which will represent the point toward which the man-model will turn its head. If mobility constraints will allow, the man-model will look directly at the point. If mobility constraints do not allow desired head positioning, the man-model's head will turn as far as possible toward the point. To determine the man-model's new head orientation:

- Select an existing 3-D point in the drawing.

OR:

- Key in X,Y,Z coordinates of the target point, **<CR>**

EXAMPLE: Key in **60, 10, 10 <CR>**.

RESULT: New prompt appears.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: New prompt appears.

RESULT: Man-model appears superimposed on the drawing as a wire-frame man-model with its head oriented toward the target poin†

When the man-model's head has been oriented, the Head Orientation function has been completed. To continue the analysis, the user will generally select **/RECOVER/** from the menu at the bottom of the window. The user may select /KEEP/ to save the man-model in the drawing OVERLAY. If /KEEP/ is selected, OVERLAY becomes the active drawing.

PROMPT: SEL MENU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions menu without saving the current man-model.

EXAMPLE: Select **/RECOVER/**

RESULT: Program returns to CREW CHIEF Generation Functions menu.

Figure 2.13 diagrams the flow of actions necessary to execute a head orientation of the man-model.
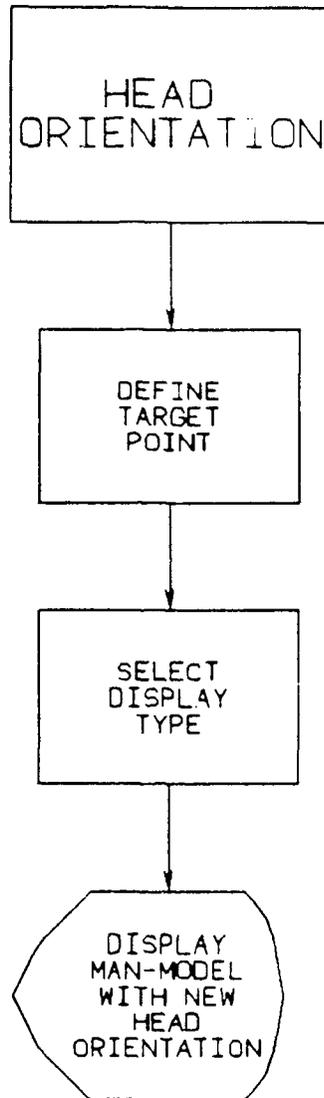
Figure 2.13. CREW CHIEF Head Orientation Function Flow Diagram.

SECTION 3
MAINTENANCE TASK ANALYSES

The Maintenance Task Analyses function is designed to evaluate the interactions of the CREW CHIEF man-model and the user's design with respect to certain physical characteristics of the man-model. The function is separated into three parts: the Tool Analysis function (Paragraph 3.1), the Materials Handling function (Paragraph 3.2), and the Connector Analysis function (Paragraph 3.3).

The Tool Analysis function evaluates the ability to reach, with a tool and from a designated posture and position, a specified task point. This includes the ability to reach around obstacles between the man-model (holding the tool) and the task point can be reached, the strength capability (force that can be applied in loosening and tightening bolts) for the particular size man-model (1st, 5th, 50th, 95th, and 99th percentiles), posture, and tool relationship will be displayed. Strength analysis with tools is limited to torque with wrenches because this is the only tool task for which strength criteria are available in Air Force technical orders. (See Appendix D for more information on hand tools.) A limited visual analysis of tool clearance may be made when the tool has been positioned. Detailed analyses of man-model and work station interference are available with the Interference Analysis and Work Envelope functions contained in the Accessibility Analyses function menu (see Section 5).

The Materials Handling Analysis function evaluates the capabilities of the technician to lift, push, pull, hold in position, carry, or reach an object. Often these objects are the Line Replaceable Units (LRUs). In this function there is also a table displaying the 1st, 5th, 50th, 95th, and 99th percentile strength capabilities for the starting and ending positions and size and weight of the object, all of which are available to

complete the task being simulated. Currently, strength data are available for CARRY, HOLD, LIFT, PUSH AND PULL.

The Connector Analysis function evaluates the capability of the technician to attach a connector at a specified location. In this function there will also be a table of the strength capability related to grip used and size of the connector. This table displays the torque applied in inch-pounds across five percentiles (1st, 5th, 50th, 95th, and 99th).

The Maintenance Task Analyses function is initia⁺ed by selecting the TASK ANALYSIS icon from the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

   ACTION: Select the analysis to be performed.

   EXAMPLE: Select the **TASK ANALYSIS icon**.

   RESULT: The CREW CHIEF Task Analyses Function menu appears
              (Figure 3.1).

Choose the desired analysis function by selecting the **TOOL ANALYSIS**, **MATERIALS HANDLING**, or **CONNECTOR** icon.

For a general guide to orient the man-model, see CREW CHIEF Initialization (Paragraph 2.1.2) or Quick Reference (Paragraph 8.1.1). This orientation includes standing posture, and the location of work is 24, 163.5, 0; the direction of man to work is 35, 163.5; the distance from work is 12.0; and the platform height is -20.
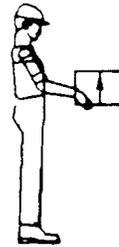
Figure 3.1.   CREW CHIEF Task Analyses Function Menu.

3.1   USING THE TOOL ANALYSIS FUNCTION

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the analysis to be performed.

    EXAMPLE: Select the **TOOL ANALYSIS icon**.

    RESULT: The Tool Selection menu is displayed (Figure 3.2).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the Y/N function key to execute the Tool
              Analysis Function .

    EXAMPLE: Depress **Y/N** function key.

    RESULT   APPLICATION PROGRAM TANUSR EXECUTING appears and
              then a new prompt and menu appear.

        A full description of each tool and its variations is
included in Appendix D. The classifications of tools are found
within the following categories and respective paragraphs:
wrenches without sockets, including open end, combination wrench
open end, combination wrench box end, standard box end, deep
offset box end, raccheting box end, allen wrench short end and
allen wrench long end (Paragraph 3.1.1); wrenches with sockets,
including breaker bar, torque, ratchet, and speedhandle
(Paragraph 3.1.2); screwdrivers, including flat bladed and offset
(Paragraph 3.1.3); pliers (Paragraph 3.1.4); and miscellaneous
tools, including nutdriver, hammer, chisel/hammer, files,
scraper, hacksaw, drill, and sander (Paragraph 3.1.5).
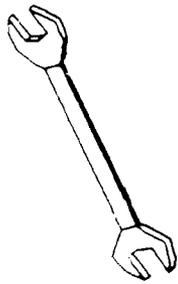
WRENCHES
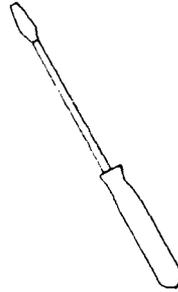
SCREWDRIVERS
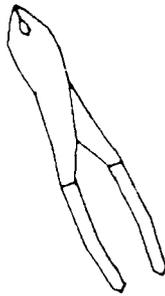
PLIERS
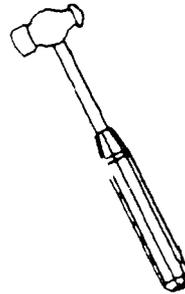
MISCELLANEOUS

Figure 3.2. Tool Selection Menu.

3.1.1   Wrenches Without Sockets

This category of tools includes the following wrenches: open end, combination wrench open end, combination wrench box end standard box end, deep offset box end, ratcheting box end, allen wrench short end, and allen wrench long end. For this example, begin by selecting the Tool Selection menu option (see Figure 3.2) from the Task Analysis menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

     ACTION: Select the type of tool to be used in the analysis.

              (See Appendix D for a discussion of hand tools.)

     EXAMPLE: Select **WRENCHES** .

     RESULT: New prompt and menu appear.

PROMPT: SELECT WRENCHES

     ACTION: Select the type of wrench to be used in the analysis (Figure 3.3).

     EXAMPLE: Select **OPEN END.**

     RESULT: New prompt and menu appear.

PROMPT: SELECT BOLT DIAMETER

     ACTION: Select the size corresponding to the bolt diameter to be used in the analysis (Figure 3.4). The head size of the bolt is given also. This

TORQUE

RATCHET

BREAKER
BAR

STANDARD
BOX-END.

DEEP
OFFSET
BOX-END

RATCHETING
BOX-END

OPEN
END

COMBINATION
OPEN-END

COMBINATION
BOX-END

SPEEDHANDLE

ALLEN
SHORT

ALLEN
LONG
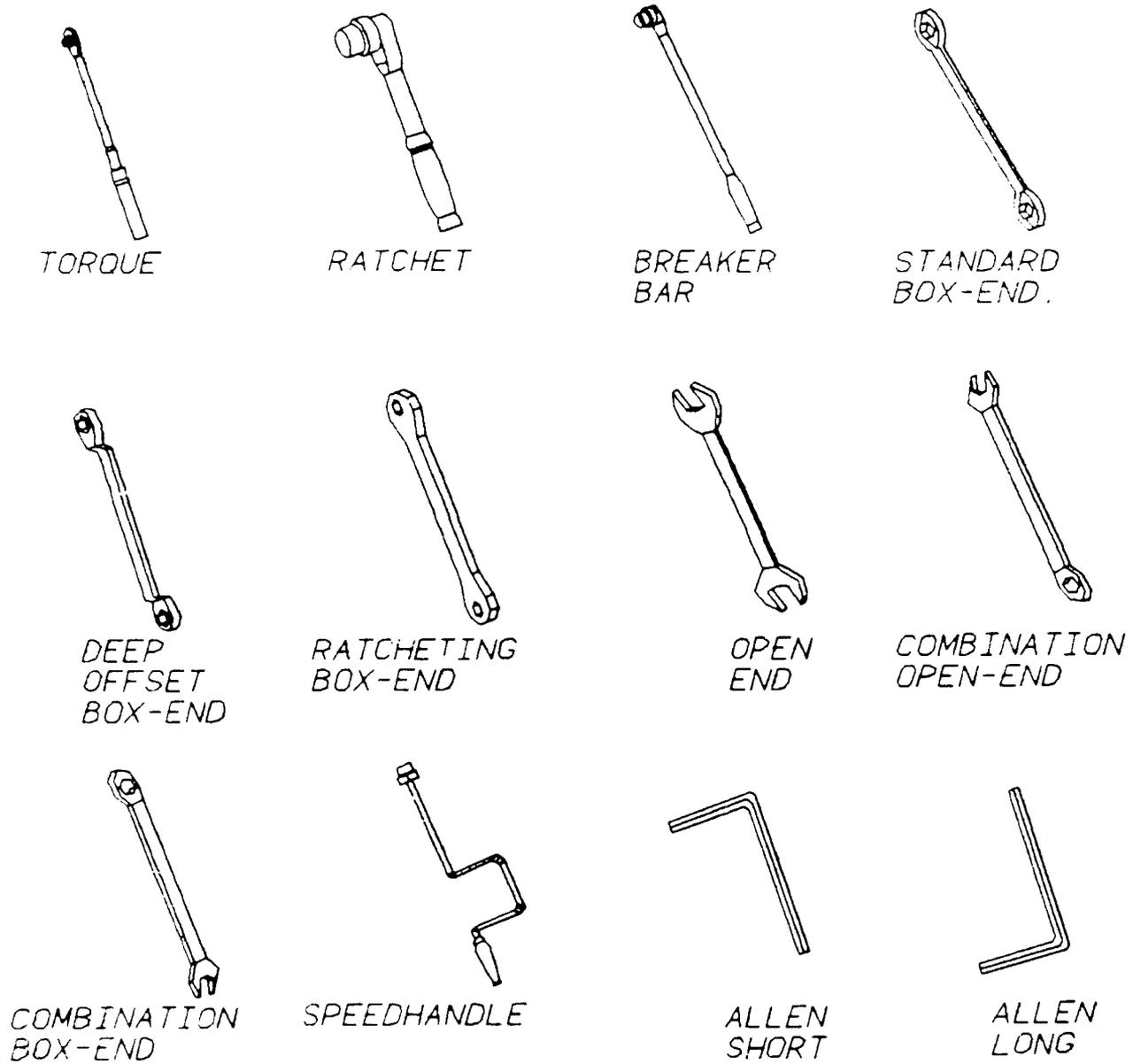
Figure 3.3.   Wrench Selection Menu.

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BOLT DIAM	HEAD SIZE
# 3, 4, 5	3/16
# 6, 8	1/4
# 10	5/16
3/16	3/8
1/4	7/16
5/16	1/2
3/8	9/16
7/16	5/8
1/2	3/4
9/16	13/16
5/8	15/16
3/4	1-1/4

Figure 3.4.   Bolt Diameter Selection Menu for Open End Wrenches.

selection determines the size of the wrench. If
one of the other wrenches without sockets is
selected, different bolt diameters may be
available for that particular wrench.

EXAMPLE: Select **3/16-1/4 INCH**.

RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

   ACTION: Select which hand will hold the tool in the
              analysis (Figure 3.5). For smaller bolt
              diameters, right and left hand options may appear
              only. This is due to the fact that the size tool
              needed to perform this task is too small to be
              used with both hands.

   EXAMPLE: Select **LEFT HAND**.

   RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TYPE

   ACTION: Select the grip type to be used in the analysis
              (Figure 3.6). There will be separate menus
              for the grip types for different tools.
              EXAMPLE: Select **REVERSE**

   RESULT: New prompt appears.
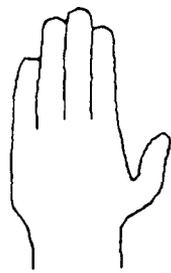
LEFT HAND   RIGHT HAND
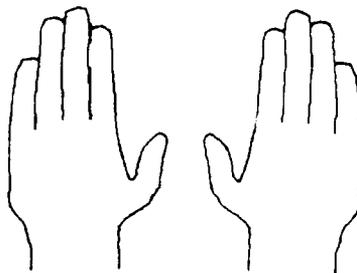
BOTH HANDS

Figure 3.5.   Hand Selection Menu (RIGHT HAND, LEFT HAND, and BOTH HANDS).

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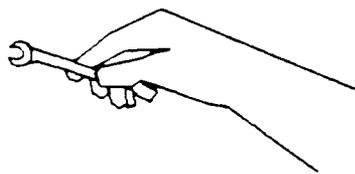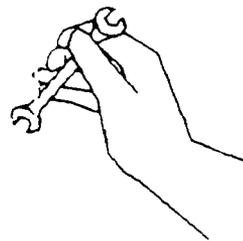
REGULAR   REVERSE

Figure 3.6.   Grip Selection Menu for Open End Wrenches.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

      ACTION: Define the location of the head point (center
              point of the bolt head) of the attach vector by
              selecting an existing target 3-D point or by
              keying in the X,Y,Z coordinates of the point.

      •   Select an existing 3-D point to define the
         location of head point of attach vector.

    OR:

      •   Key in the X,Y,Z coordinates of the location of
         head point of attach vector <CR>.

    EXAMPLE: Key in **27, 163, 40** <CR>.

    RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

      ACTION: Define the tail point of the attach vector (to
              determine orientation of the bolt axis) by
              selecting an existing target 3-D point or by
              keying in the X,Y,Z coordinates of the point.

      •   Select an existing 3-D point to define the
         orientation of the bolt axis.

    OR:

      •   Key in the X,Y,Z coordinates which define the
         orientation of the bolt axis <CR>.

    EXAMPLE: Key in **35, 163, 40** <CR>.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

    ACTION: Define the direction that the tool handle points
               away from the bolt by selecting an existing target
               3-D point or by keying in the X,Y,Z coordinates of
               the point.

      •   Select an existing 3-D point in the drawing.

    OR:

      •   Key in the X,Y,Z coordinates of the tool handle
         direction point **<CR>**.

    EXAMPLE: Key in **35, 170, 40 <CR>**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING THE TASK

    ACTION: Select one of the mobility types to be used during
               the REACH analysis (Figure 3.7).

      •   Select **ARM-SHOULDER** to allow movement of arms and
         shoulders only.

    OR:

      •   Select **UPPER BODY** to allow movement from waist
         up; includes arm/shoulder mobility.

    OR:

ARM/SHOULDER MOBILITY
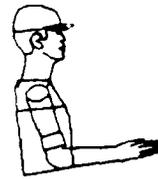
UPPER BODY MOBILITY

FULL BODY MOBILITY

Figure 3.7.   Mobility Selection Menu.

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY**.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen. If the tool type selected is the breaker bar or the speed handle, the user is not prompted to define a center of plot point, because there are no strength-related data to be displayed.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVCT^ANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display
          icons (see Table 2.1 for definitions of WIREFRAME,
          SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame
  man-model.

OR:

- Select **SURFACED** to meshed man-model to be used in
  shading.

OR:

- Select **PROFILE** to display profile view of
  man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of
          attachment, the man-model appears superimposed in
          the drawing as a wire-frame model with the tool,
          connected to the point of attachment, in his hand.
          A "TASK COMPLETED" message appears in the upper
          left-hand corner of the window. If the reach is
          unsuccessful because tne distance between the man-
          model/tool and the point of attachment is too
          great, the man-model is displayed attempting to
          perform the reach. The missed distance appears in
          the top left-hand corner of the window. If the
          reach is unsuccessful because there are too many
          obstacles in the man-model/tool's reach path,
          arrows will indicate points of interference and a
          "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF
          INTERFERENCE" message appears in top left-hand

portion of window. A new prompt and a new CADAM-
supplied menu appear.

Figure 3.8 diagrams the flow of actions necessary to
execute a tool analysis for wrenches without sockets.

To continue the analysis, the user will generally select
/RECOVER/ from the bottom of the window. Another option is also
available to the user. If /KEEP/ is selected, the drawing
OVERLAY becomes the active drawing.

3.1.2 Wrenches With Sockets

This category of tools includes the following wrenches:
breaker bar, torque, ratchet, ᵃnd speedhandle. For this example,
begin by selecting the Tool Selection menu option (see Figure 3.2)
from the Task Analysis menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

    ACTION: Select the type of tool to be used in the
                analysis. (See Appendix D for a discussion of
                hand tools.)

    EXAMPLE: Select **WRENCHES**

    RESULT: New prompt and menu appear.

PROMPT: SELECT WRENCHES

    ACTION: Select the type of wrench to be used in the
                analysis (see Figure 3.3).
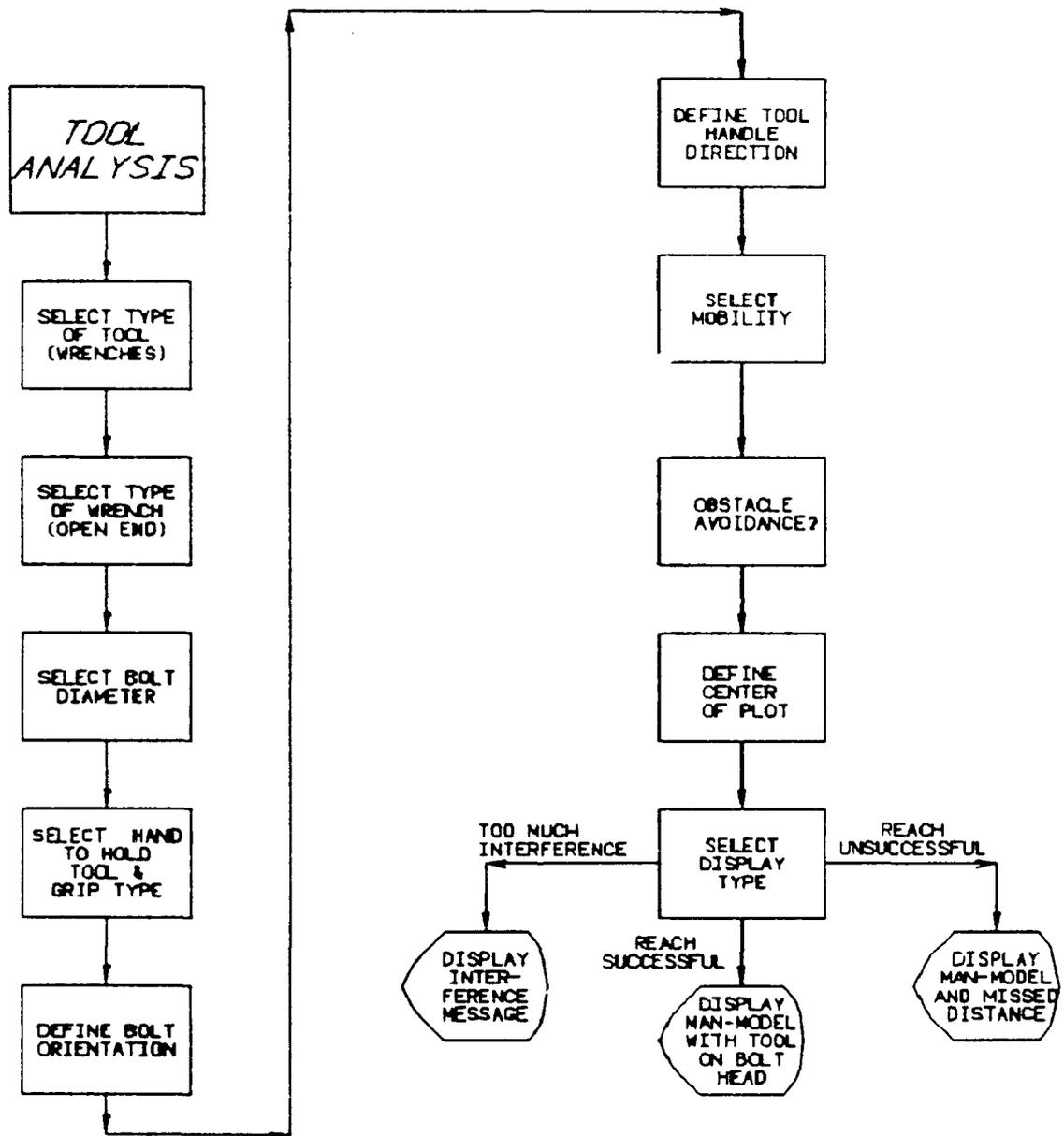
Figure 3.8. Tool Analysis Flow Diagram for Wrenches Without Sockets.

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EXAMPLE: Select **RATCHET**

RESULT: New prompt and menu appear.

PROMPT: SELECT EXTENSION

ACTION: Select desired extension length (Figure 3.9).
           Note that no extension lengths available
           speedhandle.

EXAMPLE: Select **6" EXTENSION**.

RESULT: New prompt and menu appear.

PROMPT: SELECT SOCKET

ACTION: Select desired socket type (Figure 3.10).

NOTE: If the torque wrench or speedhandle is the tool
            type selected, then the socket type selections
            are:

            Regular, Deep, and Hex Head.   The universal joint
            is not included because it distorts accuracy of torque
            See Figure D.9 for a photograph of the various sockets

    •   Select **REGULAR** to display a regular socket
        attached to the tool.

OR:

    •   Select **DEEP** to display a socket with a deep
        bolt opening.

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NO
EXTENSION

2"   3"   5"   6"   8"   10"   12"
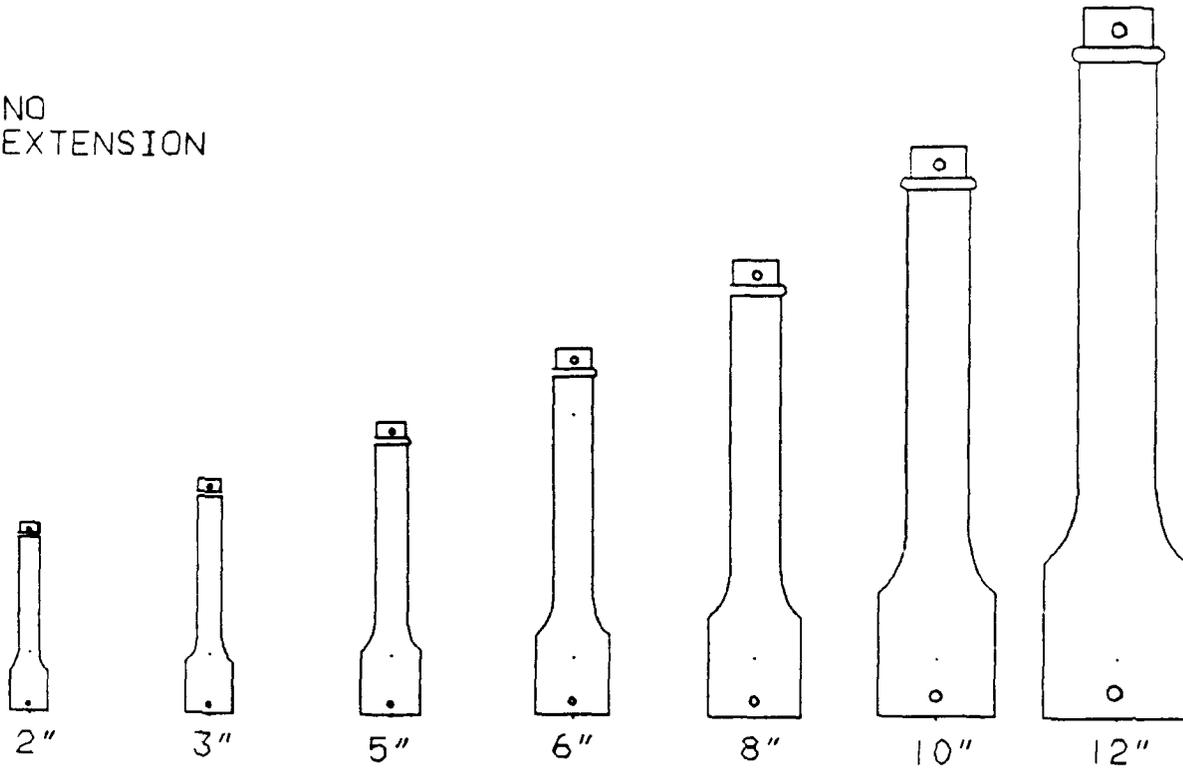
Figure 3.9.   Extension Lengths Available For Wrenches With
               Sockets.

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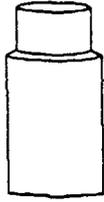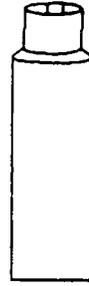
REGULAR SOCKET

DEEP SOCKET
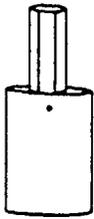
HEX HEAD SOCKET
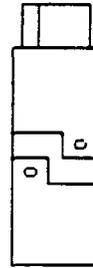
UNIVERSAL SOCKET

Figure 3.10. Sockets Available for Wrenches with Sockets.

<u>OR:</u>

- Select **HEX HEAD** to display a socket to which
  a six-sided prong is attached.

<u>OR:</u>

- Select **UNIVERSAL** to display a socket similar to
  a regular socket, but is hinged.

EXAMPLE: Select **REGULAR**

RESULT: New prompt and menu appear.

PROMPT: SELECT DRIVE SIZE

ACTION: Select the range corresponding to the bolt
          diameter to be used in the analysis (Figure 3.11).
          This is the diameter of the bolt threads. The
          drive size of the socket is also given.

EXAMPLE: Select **3/16 to 1/2 INCH** or **3/8 INCH DRIVE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT HEAD SIZE

ACTION: Select the size corresponding to the head size of
          the bolt (Figure 3.12). The diameter of the bolt
          selected along with the head size of the bolt and
          drive of the socket determine the size of the
          wrench to be used in the analysis.

EXAMPLE: Select **5/16** (BOLT DIAM.) or **1/2** (HEAD SIZE).

BOLT DIAM	DRIVE SIZE
NUMBERED SCREWS 1-10	1/4" DRIVE
3/16 TO 1/2 INCH	3/8" DRIVE
> 1/2 INCH	1/2" DRIVE

Figure 3.11. Bolt Diameter Selection Menu for Ratchet Wrenches.

BOLT DIAM	HEAD SIZE
3/16	3/8
1/4	7/16
5/16	1/2
3/8	9/16
7/16	5/8
1/2	3/4

Figure 3.12.   Bolt Diameter/Head Size Menu.

RESULT: New prompt and menu appear.

PROMPT: SELECT HANDLE LENGTH

    ACTION: Select the length of the ratchet handle (regular
              or long) to be used in the analysis. This option
              is not available for speedhandle.

    EXAMPLE: Select **LONG**

    RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool in the
              analysis (see Figure 3.5). This option is not
              available for speedhandle (both hands only used).

    EXAMPLE: Select **LEFT HAND.**

    RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TYPE

    ACTION: Select the grip type to be used in the analysis
              (Figure 3.13). There will be separate menus
              for the grip types for the different tools.

    EXAMPLE: Select **REVERSE.**

    RESULT: New prompt appears.
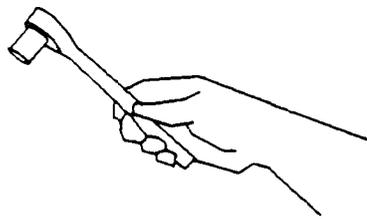
REGULAR   REVERSE
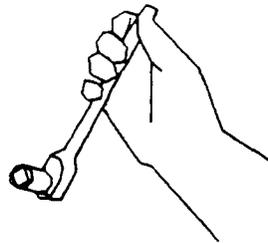
Figure 5.13.   Grip Type Selection Menu for Ratchet Wrenches.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Define the location of the head point (center
          point of the bolt head) of the attach vector by
          selecting an existing target 3-D point or by
          keying in the X,Y,Z coordinates of the point.

• Select an existing 3-D point to define the
  location of head point of attach vector.

OR:

• Key in the X,Y,Z coordinates of the location of
  head point of attach vector <CR>.

EXAMPLE: Key in **27, 163, 40** <CR>.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point (point which determines the
          bolt direction) of the attach vector (to determine
          the direction of the bolt axis) by selecting an
          existing target 3-D point or by keying in the
          X,Y,Z coordinates of the point.

• Select an existing 3-D point to define the
  orientation of the bolt axis.

OR:

• Key in the X,Y,Z coordinates which define the
  orientation of the bolt axis <CR>.

EXAMPLE: Key in **35, 163, 40** <**CR**>.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Define the point that determines the direction
that the tool handle points away from the bolt by
selecting an existing 3-D point or by keying in
the X,Y,Z coordinates of the point

- Select an existing point in the drawing.

OR:

- Key in the X,Y,Z coordinates of the tool handle
direction point <**CR**>.

EXAMPLE: Key in **35, 170, 40** <**CR**>.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used
during the reach analysis (see figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and
shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up;
includes arm/shoulder mobility .

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY.**

RESULT: New prompt and menu appear.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen. If the tool type selected is the speed handle, the user is not prompted to define a center of plot point, because there are no strength-related data to be displayed.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display
          icons (see Table 2.1 for definitions of WIREFRAME,
          SURFACED, or PROFILE).

   • Select **WIREFRAME** to display a 3-D wire-frame
     man-model.

OR:

   • Select **SURFACED** to display a meshed man-model
     to be used in shading.

OR:

   • Select **PROFILE** to display profile view of
     man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of
          attachment, the man-model appears superimposed in
          the drawing as a wire-frame model with the tool,
          attached to the point of attachment, in his hand.
          A "TASK COMPLETED" message appears in the upper
          left-hand corner of the window. The strength
          table is also displayed for ratchet and torque
          wrenches. If the reach is unsuccessful because
          the distance between the man-model/tool ,d the
          point of attachment is too great, the man-model is
          displayed attempting to perform the reach. The
          missed distance appears in the top left-hand
          corner of the window. If the reach is unsuc-
          cessful because there are too many obstacles in
          the man-model/tool's reach path, arrows will
          indicate points of interference and a "TOO MUCH

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INTERFERENCE.ARROWS INDICATE POINTS OF
INTERFERENCE" message appears in top left-hand
portion of window. A new prompt and a new
CADAM-supplied menu appear.

Figure 3.14 diagrams the flow of actions necessary to
execute a tool analysis for wrenches with sockets.

To continue the analysis, the user will generally select
/RECOVER/ from the bottom of the window. Another option is also
available to the user. If /KEEP/ is selected, the drawing
OVERLAY becomes the active drawing.

3.1.3   Screwdrivers

This classification of tools includes both flat bladed
screwdrivers and offset screwdrivers. For this example, begin by
selecting the Tool Selection menu option (see Figure 3.2) from
the Task Analysis menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

     ACTION: Select the type of tool to be used in the analysis
             (see Appendix D for a discussion of hand tools)

     EXAMPLE: Select **SCREWDRIVER.**

     RESULT: New prompt and menu appear.

PROMPT: SELECT SCREWDRIVERS

     ACTION: Select the type of screwdriver to be used in the
             analysis (Figure 3.15).
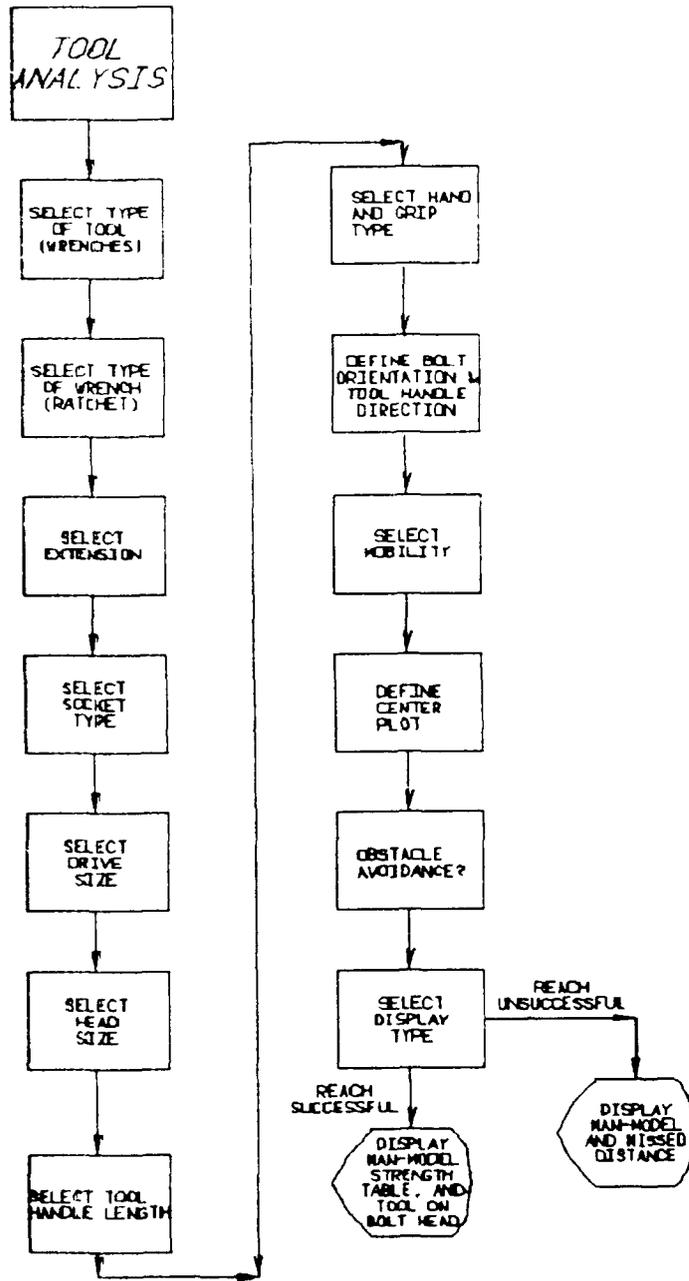
Figure 3.14. Tool Analysis Flow Diagram for Wrenches With Sockets.
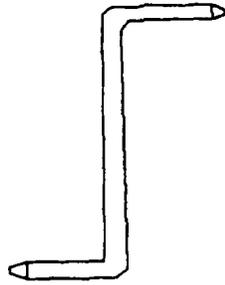
OFFSET
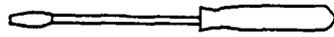
FLAT BLADED

Figure 3.15. Screwdriver Selection Menu.

EXAMPLE: Select **FLAT BLADED**.

RESULT: New prompt and menu appear.

PROMPT: SELECT BLADE LENGTH

    ACTION: Select the size corresponding to the
               screwdriver blade length to be used in the
               analysis (Figure 3.16). If an offset
               screwdriver is chosen then the choice for blade
               lengths would have been REGULAR or LONG.

    EXAMPLE: Select **BLADE LENGTH 3.0"**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool in the
               analysis (Figure 3.17).

    EXAMPLE: Select **LEFT**.

    RESULT: New prompt and menu appear.

    ACTION: Select the grip type to be used in the analysis
               (Figure 3.18).

PROMPT: SELECT GRIP TYPE

    EXAMPLE: Select **REVERSE**.

    RESULT: New prompt appears.

1.5"   3"   4"   6"   8"   10"   12"
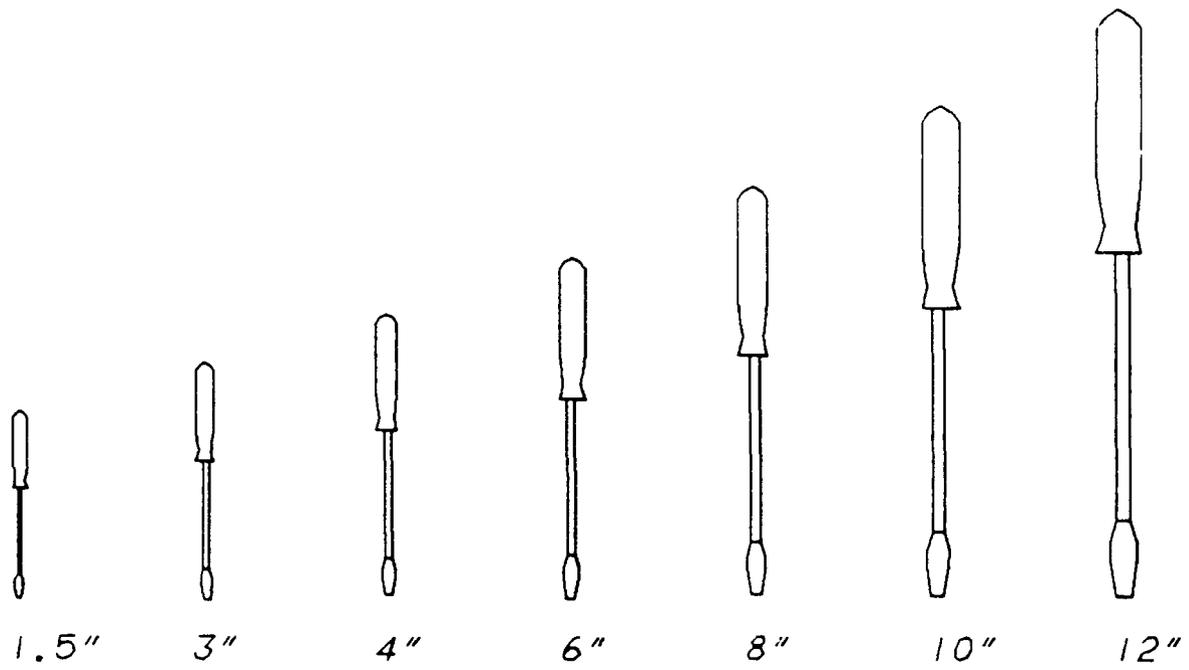
Figure 3.16. Blade Length Selection Menu.
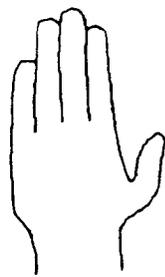
LEFT HAND   RIGHT HAND

Figure 3.17.   Hand Selection Menu (RIGHT HAND and LEFT HAND).

REGULAR   REVERSE   ALTERNATE
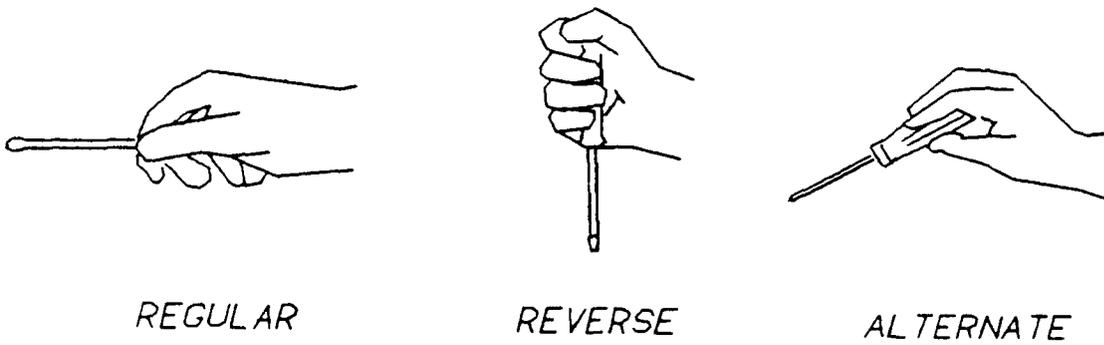
Figure 3.18.   Grip Type Selection Menu for Flat Bladed Screwdrivers.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

      ACTION: Define the location of the head point of the
attach vector (screw or point of attachment) by
selecting an existing target 3-D point or by
keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the
location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of
head point of attach vector <CR>.

      EXAMPLE: Key in **27, 163, 40** <CR>.

      RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

      ACTION: Define the tail point of the attach vector (to
determine the direction of the screw axis) by
selecting an existing target 3-D point or by
keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the
orientation of the bolt axis.

OR:

- Key in the X,Y,Z coordinates which define the
orientation of the screw axis <CR>.

      EXAMPLE: Key in **35, 163, 40** <CR>.

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RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

   ACTION: Select one of the mobility types to be used during
             the reach analysis (see Figure 3.7).

       • Select **ARM-SHOULDER** to allow movement of arms
         and shoulders only.

   OR:

       • Select **UPPER BODY** to allow movement from waist
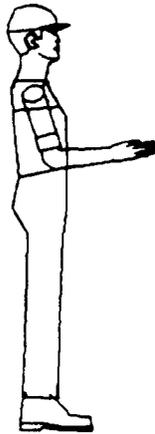   up; includes arm/shoulder mobility.

   OR:

       • Select **FULL BODY** to allow movement of all body
         joints; includes upper body mobility.

   EXAMPLE: Select **UPPER BODY**.

   RESULT: New prompt and menu appears.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

   ACTION: Select one of the obstacle avoidance choices.

       • Select **PERFORM OBSTACLE AVOIDANCE** to include
         obstacle avoidance; execution time is increased.

   OR:

       • Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit
         obstacle avoidance during REACH analysis.

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EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types from the Display
             icons (see Table 2.1 for definitions of WIREFRAME,
             SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame
  man-model.

OR:

- Select **SURFACED** to display a meshed man-model to
  be used in shading.

OR:

- Select **PROFILE** to display profile view of
  man-model.

    EXAMPLE: Select **WIREFRAME.**

    RESULT: If the man-model is able to reach the point of
             attachment, the man-model appears superimposed in
             the drawing as a wire-frame model with the tool,
             connected to the point of attachment, in his hand.
             A "TASK COMPLETED" message appears at top of the
             window. If the reach is unsuccessful because the
             distance between the man- model/tool and the point
             of attachment is too great, the man-model is
             displayed attempting to perform the reach. The
             missed distance appears in the top left-hand corner
             of the window. If the reach is unsuccessful because

there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.19 diagrams the flow of actions necessary to execute a tool analysis for flat bladed screwdrivers.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.1.4   Pliers

This category of tools includes the following pliers: combination, needle nose, safety wire, adjustable joint, and wire cutters. Since all types of pliers follow the same sequence of prompts to define their orientation in the work space, the combination pliers will be used as an example. For this example, begin by selecting the Tool Selection menu (see Figure 3.2) from the Task Analysis Menu (see Figure 3.1).

PROMPT: SELECT TOOL CLASS

    ACTION: Select the type of tool to be used in the analysis
               (see Appendix D for a discussion of hand tools).

    EXAMPLE: Select **PLIERS**.

    RESULT: New prompt and menu appear.
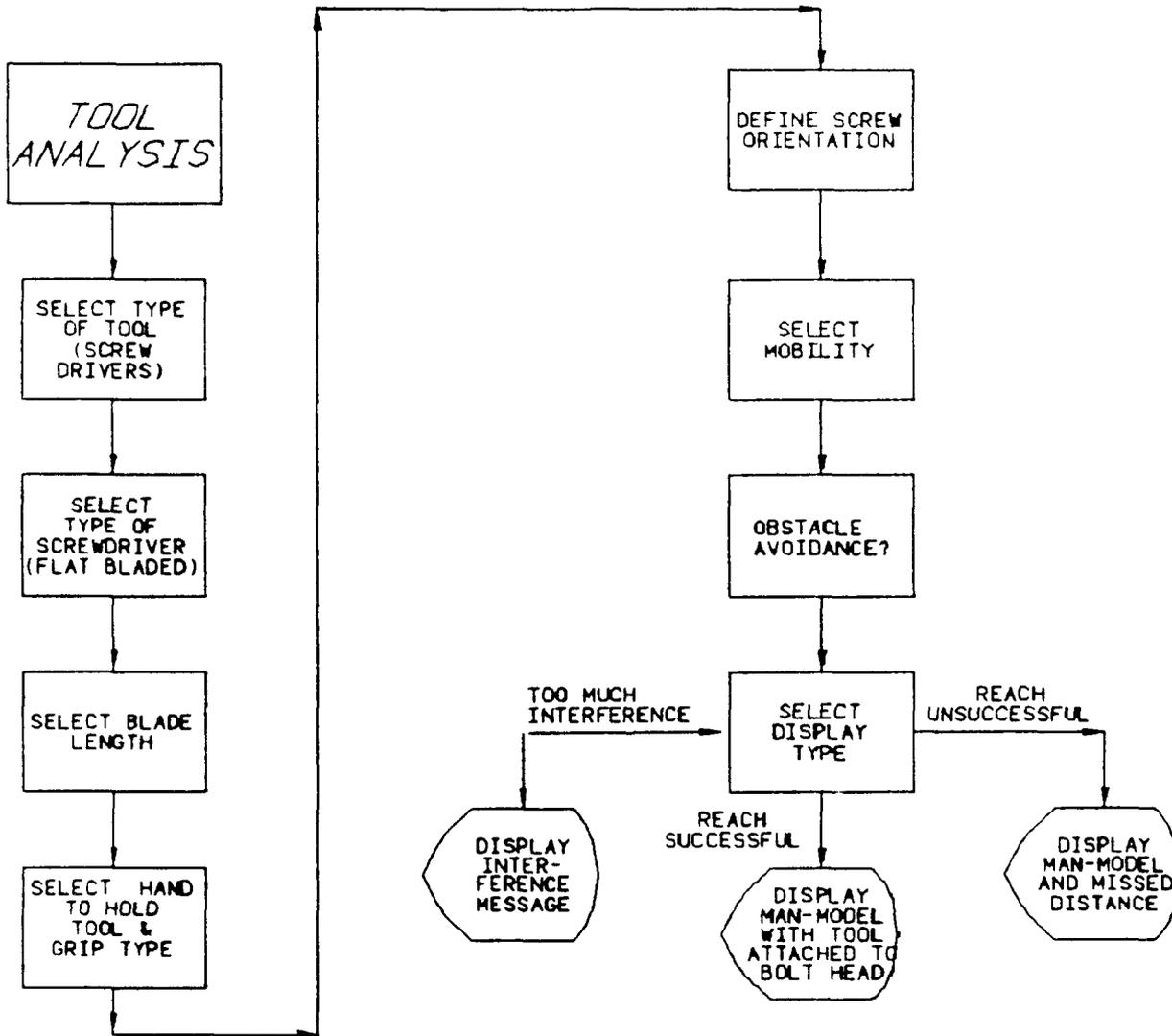
Figure 3.19.   Tool Analysis Flow Diagram for Flat Bladed
Screwdrivers.

PROMPT: SELECT PLIERS

    ACTION: Select the type of pliers to be used in the analysis (Figure 3.20).

    EXAMPLE: Select **COMBINATION**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool in the analysis (see Figure 3.17).

    EXAMPLE: Select **LEFT HAND**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TYPE

    ACTION: Select the grip type to be used in the analysis (Figure 3.21). There will be separate menus for different pliers.

    EXAMPLE: Select **REGULAR**.

    RESULT: New prompt and menu appear.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Define the location of the head point of the attach vector (point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

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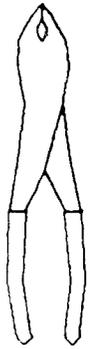
COMBINATION   NEEDLE NOSE   SAFETY
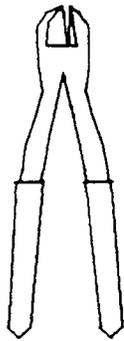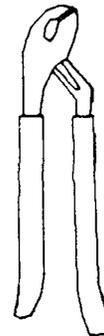
WIRE CUTTERS   ADJUSTABLE

Figure 3.20.   Pliers Selection Menu.
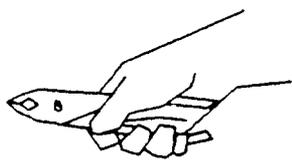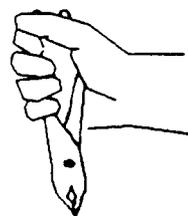
REGULAR   REVERSE

Figure 3.21. Grip Type Selection Menu for Combination Pliers.

- Select an existing 3-D point to define the
  location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of
  head point of attach vector **<CR>**.

EXAMPLE: Key in **27, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Define the tail point of the attach vector (to
determine the direction of the point of attachment
axis) by selecting an existing target 3-D point or
by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the
  tail point of attach vector.

OR:

- Key in the X,Y,Z coordinates which define the
  tail point of attach vector **<CR>**.

EXAMPLE: Key in **35, 163, 40 <CR>**.

RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Define the direction that the tool handle points
away from the point of attachment.

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- Select an existing point in the drawing.

OR:

- Key in the X,Y,Z coordinates of the tool handle direction point <CR>.

EXAMPLE: Key in **35, 170, 40** <CR>.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used during the reach analysis (see Figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

OR:

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **UPPER BODY**.

RESULT: New prompt and menu appear.

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PROMPT: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the obstacle avoidance choices .

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during REACH analysis; execution time is increased.

    <u>OR:</u>

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

    EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE.**

    RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

    <u>OR:</u>

- Select **SURFACED** to display a meshed man-model to be used in shading.

    <u>OR:</u>

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of
           attachment, the man-model appears superimposed in
           the drawing as a wire-frame model with the tool,
           connected to the point of attachment, in his hand.
           A "TASK COMPLETED" message appears in the upper
           left-hand corner of the window. If the reach is
           unsusuccessful because the distance between the man-
           model/tool and the point of attachment is too
           great, the man-model is displayed attempting to
           perform the reach. The missed distance appears in
           the top left-hand corner of the window. If the
           reach is unsuccessful because there are too many
           obstacles in the man-model/tool's reach path,
           arrows will indicate points of interference and a
           "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF
           INTERFERENCE" message appears in top left-hand
           portion of window. A new prompt and a new CADAM-
           supplied menu appear.

     Figure 3.22 diagrams the flow of actions necessary to
execute a tool analysis for pliers.

     To continue the analysis, the user will generally select
/RECOVER/ from the bottom of the window. Another option is also
available to the user. If /KEEP/ is selected, the drawing
OVERLAY becomes the active drawing.

3.1.5   Miscellaneous Tools

     This classification of tools includes the following:
hammer, chisel/hammer, file, scraper, hacksaw, drill, nutdriver
and sander. For this example, begin by selecting the Tool
Selection menu (see Figure 3.2) from the Task Analysis menu
(see Figure 3.1).
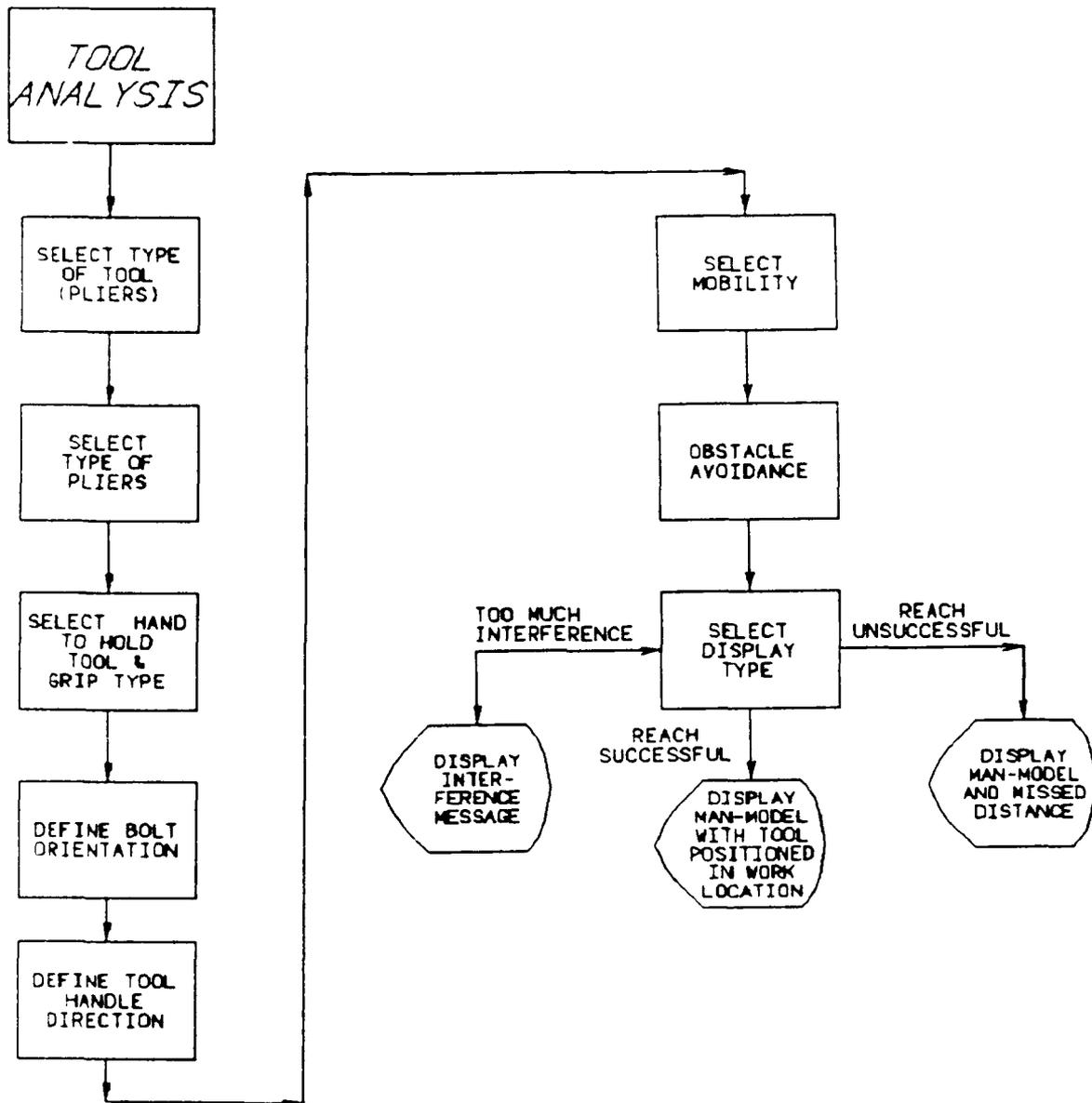
Figure 3.22.   Tool Analysis Flow Diagram for Pliers.

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PROMPT: SELECT TOOL CLASS

     ACTION: Select the type of tool to be used in the analysis
               (see Figure 3.2).   (See Appendix D for a
               discussion of hand tools.)

     EXAMPLE: Select **MISCELLANEOUS**.

     RESULT: New prompt and a new menu appear.

PROMPT: SELECT MISCELLANEOUS TOOLS

     ACTION: Select the type of miscellaneous tool to be used
               (Figure 3.23).

     EXAMPLE: Select **HAMMER**.

     REUSLT: New prompt and menu appear.

     If the tool select had been a NUTDRIVER, then the user
would be prompted to SELECT BOLT DIAMETER and to SELECT GRIP
TYPE.   The prompt SELECT CHISEL is only for the selection of a
hammer.   As a result of choosing of HAMMER the user receives the
following prompt.

PROMPT: SELECT CHISEL

     ACTION: Select to include chisel or not to include chisel.

     EXAMPLE: Select **NO CHISEL**.

     RESULT: New prompt and menu appear.
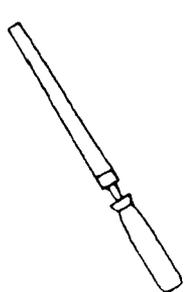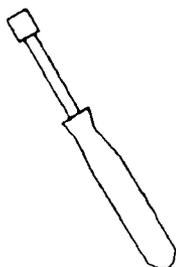
METAL FILE   NUTDRIVER   SCRAPER
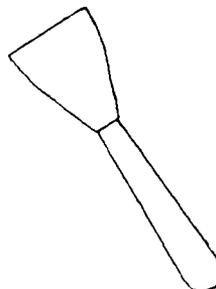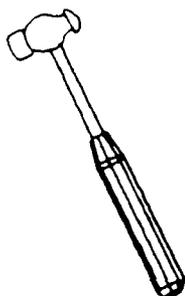
HAMMER
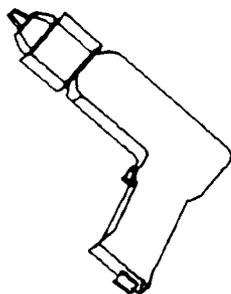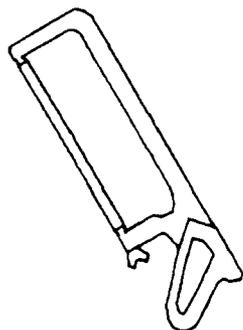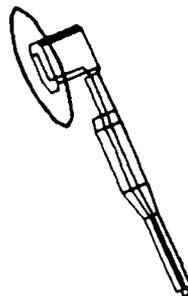
DRILL   HACKSAW   SANDER

Figure 3.23.   Miscellaneous Tool Selection Menu.

PROMPT: SELECT HAND TO BE USED DURING TASK

    ACTION: Select in which hand the tool will be positioned (see Figure 3.17). If hammer, nutdriver, hacksaw, drill or scraper is the tool selected for the analysis, it may be placed in either the right hand or in the left hand. No selection for hand to hold tool is given for the file or sander because both hands are automatically used for both.

    EXAMPLE: Select **RIGHT HAND** .

    RESULT: New prompt appears.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Define the location of the head point of the attach vector (point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

    • Select an existing 3-D point to define the location of head point of attach vector.

    OR:

    • Key in the X,Y,Z coordinates of the location of head point of attach vector <**CR**>.

    EXAMPLE: Key in **27, 163, 40** <**CR**>.

    RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

     ACTION: Define the tail point of attach vector (to
                determine the direction of the point of attach-
                ment) by selecting an existing target 3-D point or
                by keying in the X,Y,Z coordinates of the point.

        •   Select an existing 3-D point to define the
            tail point of attach vector.

    OR:

        •   Key in the X,Y,Z coordinates which define the
            tail point of attach vector <CR>.

    EXAMPLE: Key in **35, 163, 40** <CR>.

    RESULT: New prompt appears.

PROMPT: DEFINE DIRECTION OF TOOL HANDLE

     ACTION: Define the direction that the tool handle points
                away from the point of attachment. The tool
                handle direction is needed only for the hammer,
                scraper, hacksaw, drill, and sander. If the file
                or nutdriver had been selected then this prompt
                would not have appeared.

        •   Select an existing point in the drawing.

    OR:

        •   Key in the X,Y,Z coordinates of the tool handle
            direction point <CR>.

    EXAMPLE: Key in **35, 170, 40** <CR>.

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING ANALYSIS

    ACTION: Select one of the mobility types to be used during
                the REACH analysis.

- Select **ARM-SHOULDER** to allow movement of arms
  and shoulders only.

   OR:

- Select **UPPER BODY** to allow movement from waist
  up; includes arm/shoulder mobility.

   OR:

- Select **FULL BODY** to allow movement of all body
  joints; includes upper body mobility.

    EXAMPLE: Select **UPPER BODY**.

    RESULT: New prompt and menu appear.

]PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include
  obstacle avoidance during REACH analysis;
  execution time is increased.

   OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

EXAMPLE: Select **OBSTACLE AVOIDANCE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-and the point of attachment

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is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful be.ause there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.24 diagrams the flow of actions 'ecessary to execute a tool analysis for all Miscellaneous Tools.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another option is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2 MATERIALS HANDLING ANALYSIS FUNCTION

This function will be used for analysis pertaining to the handling of objects in the workplace. The function will consider such factors as the ability to do one- and two-handed reaches to an object, and strength capabilities related to lift, move, and position of objects in the location of work relative to the man-model's position and posture, and to the location of the object in the workplace.

To use the Materials Handling function, have the CREW CHIEF Main Programs menu activated (see Figure 1.3). Selecting the TASK ANALYSIS icon causes the CREW CHIEF Task Analysis Function menu to appear (see Figure 3.1).
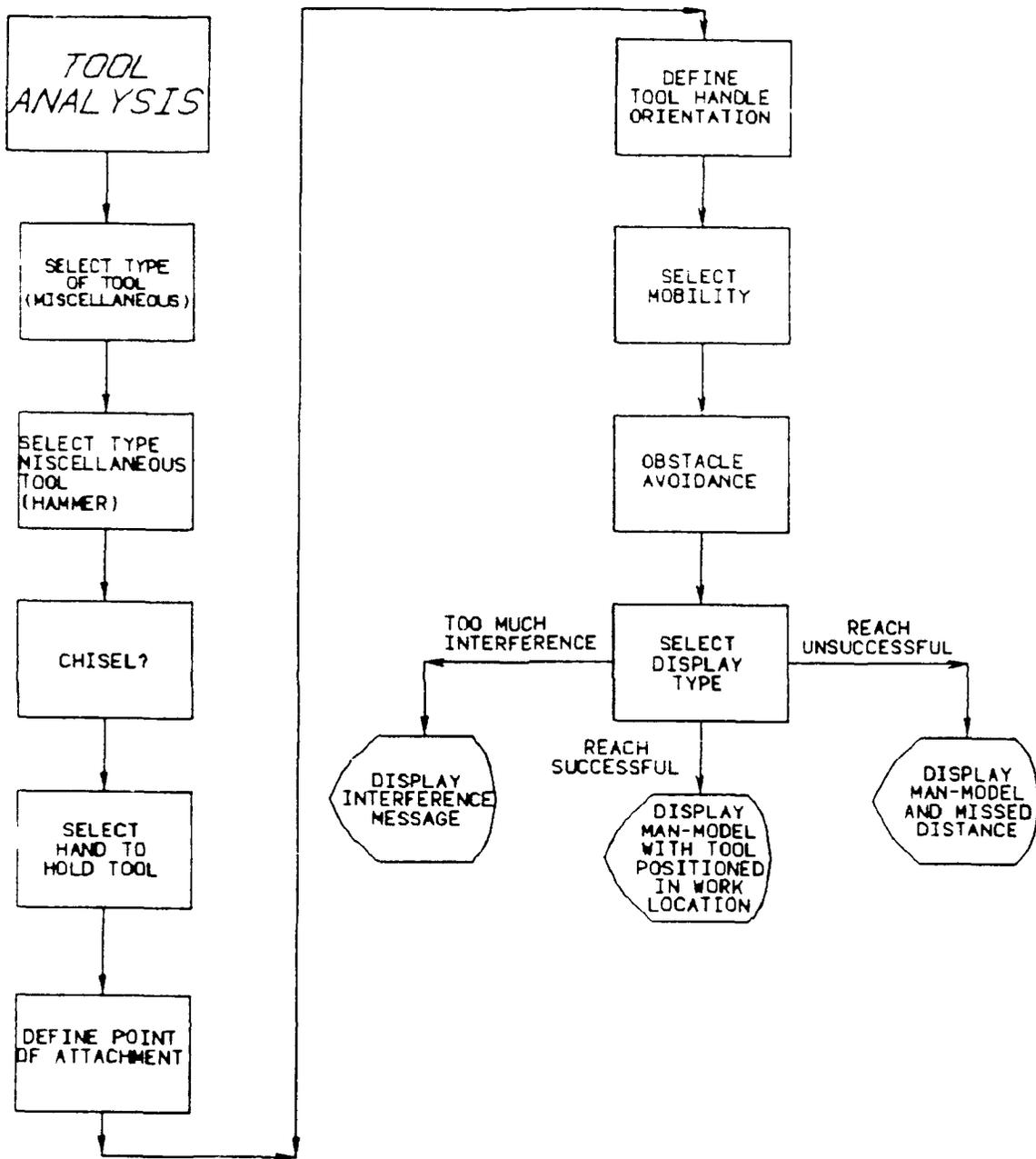
Figure 3.24. Tool Analysis Flow Diagram for Miscellaneous Tools.

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PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

      ACTION: Select the Task Analysis function to be performed
              (see Figure 3.1).

      EXAMPLE: Select the **MATERIALS HANDLING icon.**

      RESULT: The Materials Handling Task menu is displayed
              (Figure 3.25).

3.2.1   CARRY

CARRY is the first of the six materials handl.-., tasks
and is selected when the man-model transports an object while
supporting the object's weight from one horizontal location to
another. For this example, begin by selecting the Materials
Handling Task menu (Figure 3.25) from the Task Analysis menu
(see Figure 3.1).

Note that the CARRY Task will automatically change the
current man-model posture based on the input ceiling height.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

     ACTION: Select the name of the task to use for the
             analysis (see Figure 3.25).

     EXAMPLE: Select the **CARRY icon.**

     RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

     ACTION: Depress the **Y/N** function key to execute the Carry
             Task.

MATERIALS HANDLING

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CARRY

HOLD
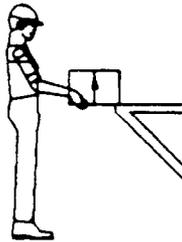
LIFT
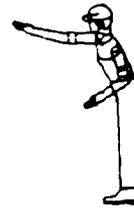
REACH
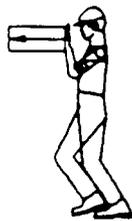
PUSH
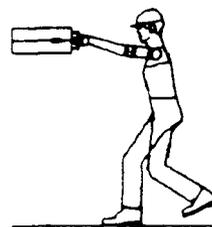
PULL

/ FWD/ BACK/   /RETURN/

Figure 3.25.   Materials Handling Tasks Menu.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM CRYUSR EXECUTING appears and
           then a new prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select one of the handle choices to determine
           whether or not handles will be used (Figure
           3.26).

- Select **NO HANDLES** to indicate that no handles
  are to be used during the CARRY task.

OR:

- Select **ONE HANDLE** to indicate that one handle
  is to be used during the CARRY task. The man-model
  will only perform CARRY Tasks with handles when
  the ceiling height is below 50 percent of the
  current man-model stature.

OR:

- Select **TWO HANDLES** to indicate that two handles
  are to be used during the CARRY task. The man-model
  will only perform CARRY Tasks with handles when
  the ceiling height is below 50 percent of the
  current man-model stature.

EXAMPLE: Select **NO HANDLES**.

RESULT: New prompt and menu appear.
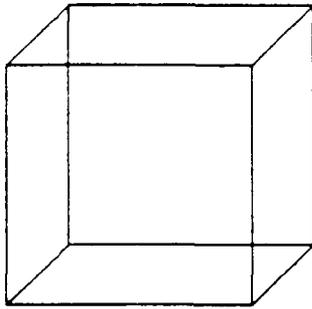
NO HANDLES TO BE USED   ONE HANDLE TO BE USED
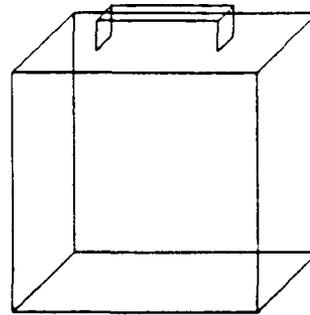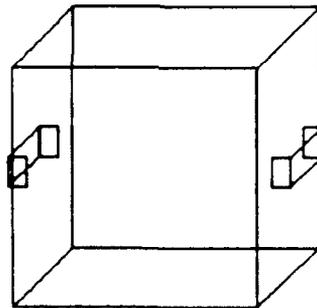
TWO HANDLES TO BE USED

Figure 3.26.   Handles Selection Menu (NO HANDLES, ONE
               HANDLE, and TWO HANDLES).

If ONE HANDLE had been chosen, the user would next be prompted to SELECT ARM TO BE USED DURING TASK. As a result of selecting NO HANDLES, the following prompt appears.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR CEILING
         DEFINITION

    ACTION: Select the mode for defining the ceiling height.

- Choose **SELECT ELEMENT TO DETERMINE CEILING HEIGHT** to allow selection of an element from the screen.

    <u>OR:</u>

- Choose **KEY IN CEILING HEIGHT** to allow the ceiling height to be entered at the ANKB.

    EXAMPLE: Select **KEY IN CEILING HEIGHT.**

    RESULT: New prompt appears.

If SELECT ELEMENT TO DETERMINE CEILING HEIGHT is chosen, the user would be prompted to SELECT CEILING HEIGHT from the screen. As a result of selecting **KEY IN CEILING HEIGHT**, as the example, the following prompt will appear on the screen.

PROMPT: KEY IN CEILING HEIGHT

    ACTION: Key in value to represent ceiling height **<CR>**.

    EXAMPLE: Key in **80 <CR>**.

    RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in a value to represent the height of the
              object to be carried <CR>.

    EXAMPLE: Key in **12.34** <CR>.

    RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in a value to represent the width of the
              object to be carried <CR>.

    EXAMPLE: Key in **20.2** <CR>.

    RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in a value to represent the depth of the
              object to be carried <CR>.
    EXAMPLE: Key in **18** <CR>.

    RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a point on the window to approximately
              position the center of the strength table upon
              completion of a successful reach.

    RESULT: A new prompt appears.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

  ACTION: Select one of the obstacle avoidance choices.

    • Select **OBSTACLE AVOIDANCE** to include obstacle avoidance during CARRY analysis; execution time is increased.

   <u>OR:</u>

    • Select **NO OBSTACLE AVOIDANCE** to omit obstacle avoidance.

  EXAMPLE: Select **NO OBSTACLE AVOIDANCE**.

  RESULT: Prompt remains the same, but new bottom menu appears.

PROMPT: SELECT DESIRED DISPLAY TYPE

  ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definition of WIREFRAME, SURFACED, or PROFILE).

    • Select **WIREFRAME** to display a 3-D wire-frame man-model.

   <u>OR:</u>

    • Select **SURFACED** to display a meshed man-model to be used in shading.

   <u>OR:</u>

    • Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to carry the object
           successfully, the man-model appears superimposed
           in the drawing as a wire-frame model holding the
           object in the final CARRY position, with its hands
           either on the object or on the handle(s). A "TASK
           COMPLETED" message appears in the top left-hand
           corner of the window. If the reach is
           unsuccessful because the distance between the man-
           model and the object is too great, the man-model
           is displayed attempting to perform the task. The
           missed distance appears in the top left-hand
           corner of the window. If the reach is
           unsuccessful because there are too many obstacles
           in the man-model's reach path, arrows will
           indicate points of interference and a "TOO MUCH
           INTERFERENCE. ARROWS INDICATE POINTS OF
           INTERFERENCE" message appears in top, left-hand
           corner of the window. A new prompt and a new
           CADAM-supplied bottom menu appear.

Figure 3.27 diagrams the flow of actions necessary to
execute a CARRY analysis.

To continue an analysis, the user will generally select
/RECOVER/ from the bottom of the window. Another selection is
also available to the user. If /KEEP/ is selected, the drawing
OVERLAY becomes the active drawing.

3.2.2   HOLD

HOLD is the second of the six materials handling tasks, and
is selected when the man-model supports the weight of an object
at a required height. For this example, begin by selecting the
Materials Handling Task menu (see Figure 3.25) from the Task
Analysis menu (see Figure 3.1).

120
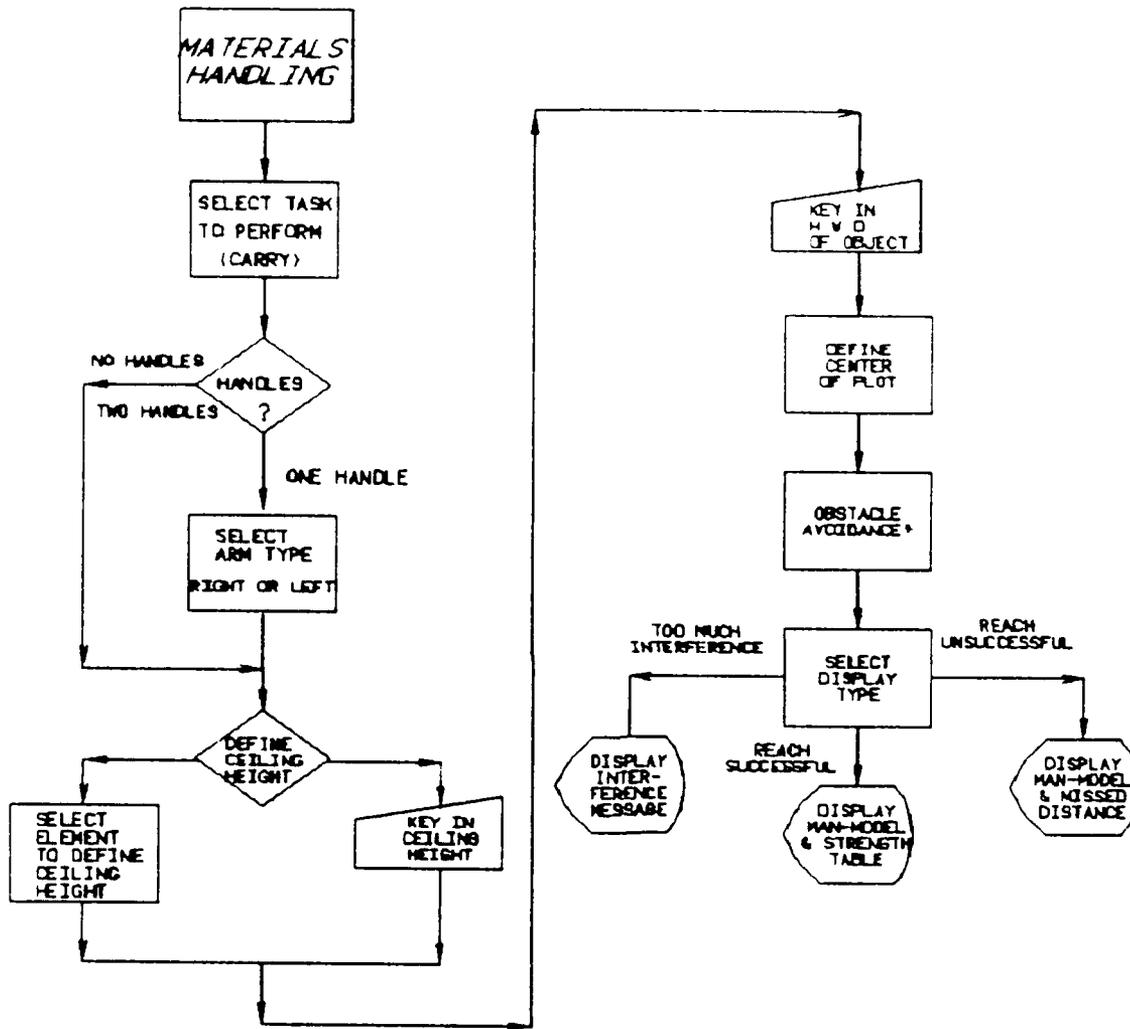
Figure 3.27. Materials Handling Analysis Flow Diagram for
CARRY Task.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

    ACTION: Select the name of the task to use for the
               analysis (see Figure 3.25).

    EXAMPLE: Select the **HOLD icon.**

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

    ACTION: Depress the **Y/N** function key to execute the Hold
               Task.

    EXAMPLE: Depress the **Y/N** function key.

    RESULT: APPLICATION PROGRAM HLDUSR EXECUTING appears and
               then a new prompt and menu appear.

PROMPT: SELECT ARM TO BE USED DURING TASK

    ACTION: Select which arm will hold the object in the
               analysis (Figure 3.28).

    EXAMPLE: Select **RIGHT ARM.**

    RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select mobility type to be used during the reach
               analysis (see Figure 3.7).
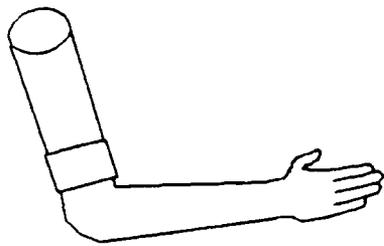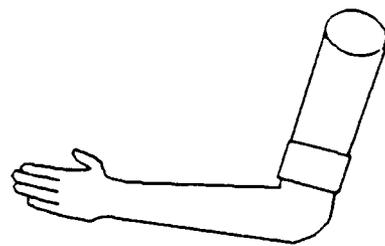
LEFT ARM   RIGHT ARM

Figure 3.28. Arm Selection menu (RIGHT ARM and LEFT ARM).

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY**.

RESULT: New prompt and menu appear.

PROMPT: SELECT TYPE OF SUPPORT OBJECT IS TO BE HELD AGAINST

ACTION: Select Hold Task Type to be used.

EXAMPLE: Select **HOLD AGAINST WALL**.

RESULT: New prompt and menu appear.

If HOLD AGAINST CEILING is chosen as the type of support, the user would select a mode for defining the object (KEY IN or SELECT). Choosing HOLD AGAINST CEILING also automatically defines the top of the object as the ceiling height (see Paragraph .'.2.1). As a result of selecting **HOLD AGAINST WALL** the following prompts will appear on the screen.

PROMPT: SELECT TYPE OF BARRIER INVOLVED IN HOLD TASK

   ACTION: Select one of the barrier types. This action will
             affect the strength values output at the
             completion of a successful task.

   •   Select **NO BARRIER INVOLVED** to indicate a task
       which does not involve any obstructions which
       would keep the man-model from reaching in any
       direction or which would require the man-model to
       bend over due to obstacles.

   OR:

   •   Select **VERTICAL BARRIER BETWEEN OBJECT AND CREW
       CHIEF** to indicate man-model will stand approx-
       imately 15 inches or more away from the object due
       to obstacles in the man-model's reach path.

   OR:

   •   Select **CEILING BARRIER CAU3ED UNUSUAL POSTURE
       DURING TA8K** to indicate an overhead barrier.
       This barrier will cause the man-model to bend over
       to complete the task.

   EXAMPLE: Select **CEILING BARRIER.**

   RESULT: New prompt appears.

     If NO BARRIER or VERTICAL BARRIER is chosen, the
user would be prompted to select the mode for defining the
object (KEY IN or SELECT). (See Paragraph 8.2.2.2.) As a
result of selecting a **CEILING BARRIER,** the following prompt
will appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR CEILING DEFINITION

ACTION: Select the mode for defining ceiling height.

• Choose **SELECT ELEMENT TO DETERMINE CEILING HEIGHT**
  to indicate that a line segment will be selected to
  define the ceiling height.

OR:

• Select **KEY IN CEILING HEIGHT** to indicate the
  ceiling height will be keyed in.

EXAMPLE: Choose **SELECT ELEMENT TO DETERMINE CEILING HEIGHT**.

RESULT: New prompt and menu appear.

If the user selects KEY IN CEILING HEIGHT, the user is
prompted to KEY IN THE CEILING HEIGHT. As a result of choosing
SELECT CEILING HEIGHT, the following prompt appears.

PROMPT: SELECT ELEMENT TO DEFINE CEILING HEIGHT

ACTION: Select a line segment in the drawing to define the
           ceiling height. The line segment selected will be
           used to define the ceiling height by taking the
           intersection of the line segment (which is
           extended as needed to find an intersection) with
           the plane that bisects the man-model into
           symmetric right and left halves. The vertical
           distance between this intersection point and the
           platform becomes the value of the ceiling height.
           Note that it is possible that no intersection can
           be found and the user will be notified later.
           EXAMPLE: Select a line segment which defines the
           ceiling height.

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RESULT: A new prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select the mode (key in or select) for defining
the dimensions (HEIGHT, WIDTH, and DEPTH) of the
object to be held.

- Choose **SELECT OBJECT FROM SCREEN** to allow
selection of elements from screen. The height and
width selections will determine the attach plane
and attach points of the object automatically for
objects held AGAINST WALL. Similarly, the width
and depth selection will determine the attach
plane (i.e., CEILING) and attach points for
objects held AGAINST CEILING.

OR:

- Choose **KEY IN OBJECT DIMENSIONS** to allow dimensions
to be entered at the ANKB.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS**.

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be
prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
/END/ TO FINISH. When these other elements have been defined,
the user would select END from the bottom menu (see Paragraph
8.2.2.2). If the user selects **KEY IN OBJECT DIMENSIONS**, as in
the example, the following prompt will appear on the screen.

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PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

     ACTION: Key in a value to represent the height of the
                object to be held **<CR>**.

     EXAMPLE: Key in **10.31 <CR>**.

     RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

     ACTION: Key in a value representing the width of the
                object to be held **<CR>**.

     EXAMPLE: Key in **15 <CR>**.

     RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

     ACTION: Key in a value representing the depth of the
                object to be held **<CR>**.

     EXAMPLE: Key in **9.5 <CR>**.

     RESULT: New prompt appears.

PROMPT: SELECT LINE DEFINING HEIGHT DIRECTION OF OBJECT

     ACTION: Select an element from the screen which will be
                used to define the plane to which the object will
                be attached. Since the example uses AGAINST WALL,
                the user must select a line which extends in the
                same direction as the height of the object.

RESULT: New prompt appears.

PROMPT: SELECT LINE DEFINING WIDTH DIRECTION OF OBJECT

    ACTION: Select element from screen which will be used to
                define the plane to which the object will be
                attached. Since this example is for an AGAINST
                WALL, the user should select a line which lies
                on the wall (or mounting bracket). This line
                should not lie in the same direction as the line
                selected for the previous prompt. These lines
                determine an attach plane for the created object.
                The back face of the object will be placed flush
                against the plane (or a parallel plane) defined by
                these two lines. Note that this determines the
                directions of the width and depth dimensions of
                the object since the height direction has already
                been defined and the object is assumed
                rectilinear. (All dimensions are assumed to be
                perpendicular to each other.)

    RESULT: New prompt appears.

PROMPT: DEFINE ATTACH POINT OF THE OBJECT ON PLANE OF ATTACHMENT

    ACTION: Define a 3-D point to indicate where the center of
                the back face of the object will be placed on the
                attach plane (wall or bracket the object is to be
                held against).

      •   Select an existing 3-D point from the screen to
            determine the attach point of the object.

    <u>OR:</u>

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- Key in the X,Y,Z coordinates <CR> to determine
  which face of the object will be attached to the
  attach plane.

EXAMPLE: Key in **110.37, 25.80, 15.45** <CR>.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the window to approximately
         position the center of the strength table upon
         completion of a successful reach.

RESULT: A new prompt appears.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include
  obstacle avoidance during REACH analysis; execution
  time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit
  obstacle avoidance.

EXAMPLE: Select **DO NOT PERFORM OBSTACLE AVOIDANCE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display
             icons (see Table 2.1 for definitions of WIREFRAME,
             SURFACED, or PROFILE).

    •   Select **WIREFRAME** to display a 3-D wire-frame man-
        model.

OR:

    •   Select **SURFACED** to display a meshed man-model to
        be used in shading.

OR:

    •   Select **PROFILE** to display profile view of man-
        model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to hold the object
             successfully, the man-model appears superimposed in
             the drawing as a wire-frame model holding the
             object with its hands either on the object or on
             the handle(s) (in the final hold position). A
             "TASK COMPLETED" message appears in the top left-
             hand corner of the window. If the reach is
             unsuccessful because the distance between the man-
             model and the object is too great or because there
             are barriers present, the man-model is displayed
             attempting to perform the task. The missed
             distance appears in the top, left-hand corner of
             the window. If the reach is unsuccessful because
             there are too many obstacles in the man-model's
             reach path, arrows will indicate points of
             interference and a "TOO MUCH INTERFERENCE. ARROWS

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INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand corner of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.29 diagrams the flow of actions necessary to execute a HOLD analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.3   LIFT

LIFT is the third of the six materials handling tasks, and is selected when the man-model transports an object from one vertical location to another. For this example, begin by selecting the Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

    ACTION: Select the name of the task to use for the
               analysis (see Figure 3.25).

    EXAMPLE: Select the **LIFT icon**.

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

    ACTION: Depress the **Y/N** function key to execute the Lift
               Task.

    EXAMPLE: Depress the **Y/N** function key.

132
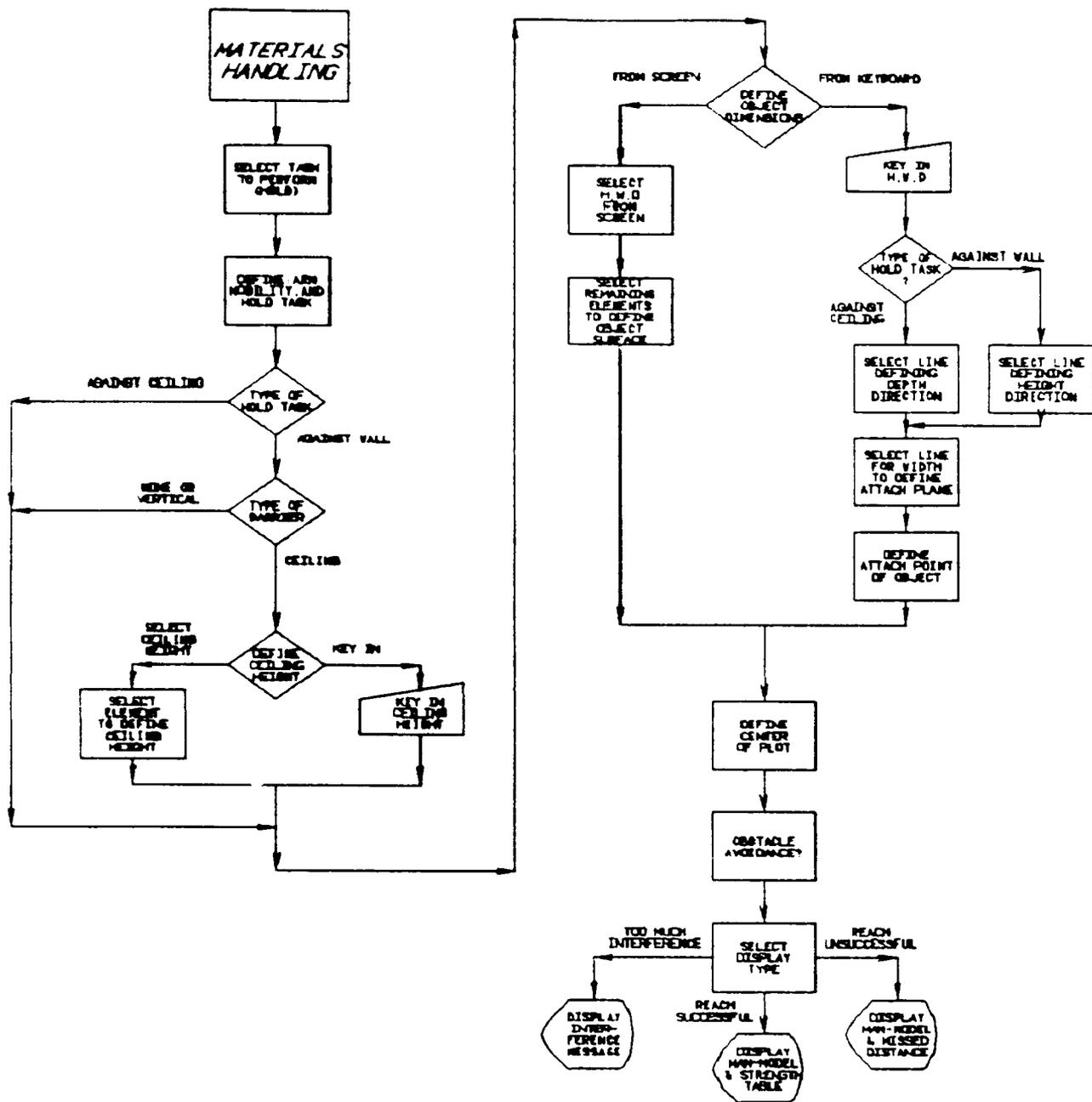
Figure 3.29.   Materials Handling Analysis Flow Diagram for HOLD Task.

RESULT: APPLICATION PROGRAM LFTUSR EXECUTING appears and
           then a new prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

    ACTION: Select number of handles to be used during the
               lift task (Figure 3.30). Currently, the Lift
               task does not have data to support a TWO HAND, ONE
               HANDLE lift combination.

    EXAMPLE: Select **ONE HANDLE**.

    RESULT: New prompt and menu appear.

    If NO HANDLES was selected as the example, the user would
not be prompted to SELECT ARM TO BE USED DURING TASK. The
program assumes both arms will be used to lift the object. By
selecting **ONE HANDLE** the user would receive the following prompt.

PROMPT: SELECT ARM TO BE USED DURING TASK

    ACTION: Select which arm will lift the object in the anal-
               ysis (see Figure 3.28).

    EXAMPLE: Select **RIGHT ARM**.

    RESULT: New prompt and menu appear.

PROMPT: **SELECT MOBILITY TO BE USED DURING THE TASK**

    ACTION: Select mobility type to be used during the reach
               analysis (see Figure 3.7).

134
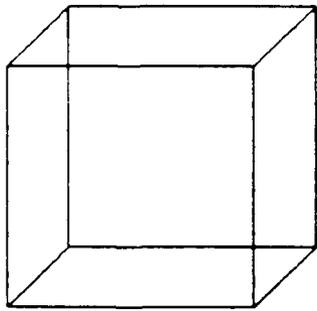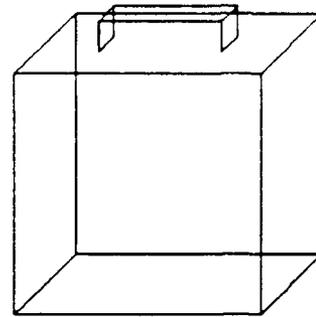
NO HANDLES TO BE USED   ONE HANDLE TO BE USED

Figure 3.30. Handle Selection (NO HANDLES and ONE HANDLE).

- Select UPPER BODY to allow movement from waist up; includes arm/shoulder mobility.

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY**.

RESULT: New prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select the mode (key in or select) for defining the dimensions (HEIGHT, WIDTH, and DEPTH) of the object to be lifted.

- Choose **SELECT OBJECT FROM SCREEN** to allow selection of elements from screen.

OR:

- Choose **KEY IN OBJECT DIMENSIONS** to allow dimensions to be entered at the ANKB.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS**.

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED - /END/ TO FINISH. When these other elements have been defined, the user would select END from the bottom menu. These elements define an irregularly shaped object. If the user had chosen ONE HANDLE, he would then be prompted to DEFINE FIRST ENDPOINT OF HANDLE and DEFINE SECOND ENDPOINT OF FIRST HANDLE. (See Paragraph 8.2.2.3.) If a handle is chosen and the object dimensions are keyed-in, the handle will automatically be placed on top of the object by the program. If the user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

      ACTION: Key in a value representing the height of the
                 object to be lifted **<CR>**.

      EXAMPLE: Key in **12** **<CR>**.

      RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

      ACTION: Key in a value to represent the width of the
                 object to be lifted **<CR>**.

      EXAMPLE: Key in **10.7** **<CR>**.

      RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in a value representing the depth of the
                 object to be lifted **<CR>**.

    EXAMPLE: Key in **5.34 <CR>**.

    RESULT: New prompt appears.

PROMPT: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR
          OBJECT

    ACTION: Select mode for defining the lift distance. This
                 distance is the vertical distance from the man-
                 model's support plane to the final lift height.

       •   Choose **KEY IN OBJECT DISTANCES** to enter value on
           ANKB. This value is the final lift height of the
           object.

   OR:

       •   Choose **SELECT LINE TO DEFINE OBJECT DISTANCES** to
           select an element on the screen which will be the
           shelf onto which the object will be lifted. This
           shelf is the final lift height of the object.

    EXAMPLE: Select **KEY IN OBJECT DISTANCES**.

    RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

    ACTION: Key in the vertical distance to lift the object.

EXAMPLE: Key in **20** <CR>.

RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

   ACTION: Key in the horizontal distance to lift the object.
             This value represents the distance from the man-
             model to the front edge of tne object.

   EXAMPLE: Key in **15** <CR>.

   RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

   ACTION: Indicate a point on the window to approximately
             position the center of the strength table upon
             completion of a successful reach.

   RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

   ACTION: Select one of the obstacle avoidance choices.

   •   Select **PERFORM OBSTACLE AVOIDANCE** to include
       obstacle avoidance during reach analysis;
       execution time is increased.

   OR:

   •   Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit
       obstacle avoidance.

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EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display
          icons (see Table 2.1 for definitions of WIREFRAME,
          SURFACED, or PROFILE).

   • Select **WIREFRAME** to display a 3-D wire-frame
     man-model.

   OR:

   • Select **SURFACED** to display a meshed man-model to
     be used for shading.

   OR:

   • Select **PROFILE** to display profile view of
     man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to lift the object
          successfully, the man-model appears superimposed
          in the drawing as a wire-frame model lifting the
          object with hands either on the object or on the
          handles. A strength table is also displayed.
          A "TASK COMPLETED" message appears in the top
          left-hand corner of the window. If the reach is
          unsuccessful because the distance between the man-
          model and the object is too great, the man-model
          is displayed attempting to perform the task. The
          missed distance appears in the top, left-hand

corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.31 diagrams the flow of actions necessary to execute a LIFT analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.4   PUSH

PUSH is the fourth of the six materials handling tasks, and is selected when the man-model moves an object away from the man-model in a horizontal direction without supporting the weight of the object. The Push task is always performed with both hands. For this example, begin by selecting Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1)

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

   ACTION: Select the name of the task to use for the analysis (see Figure 3.25).

   EXAMPLE: Select the **PUSH icon.**

   RESULT: New prompt appears.
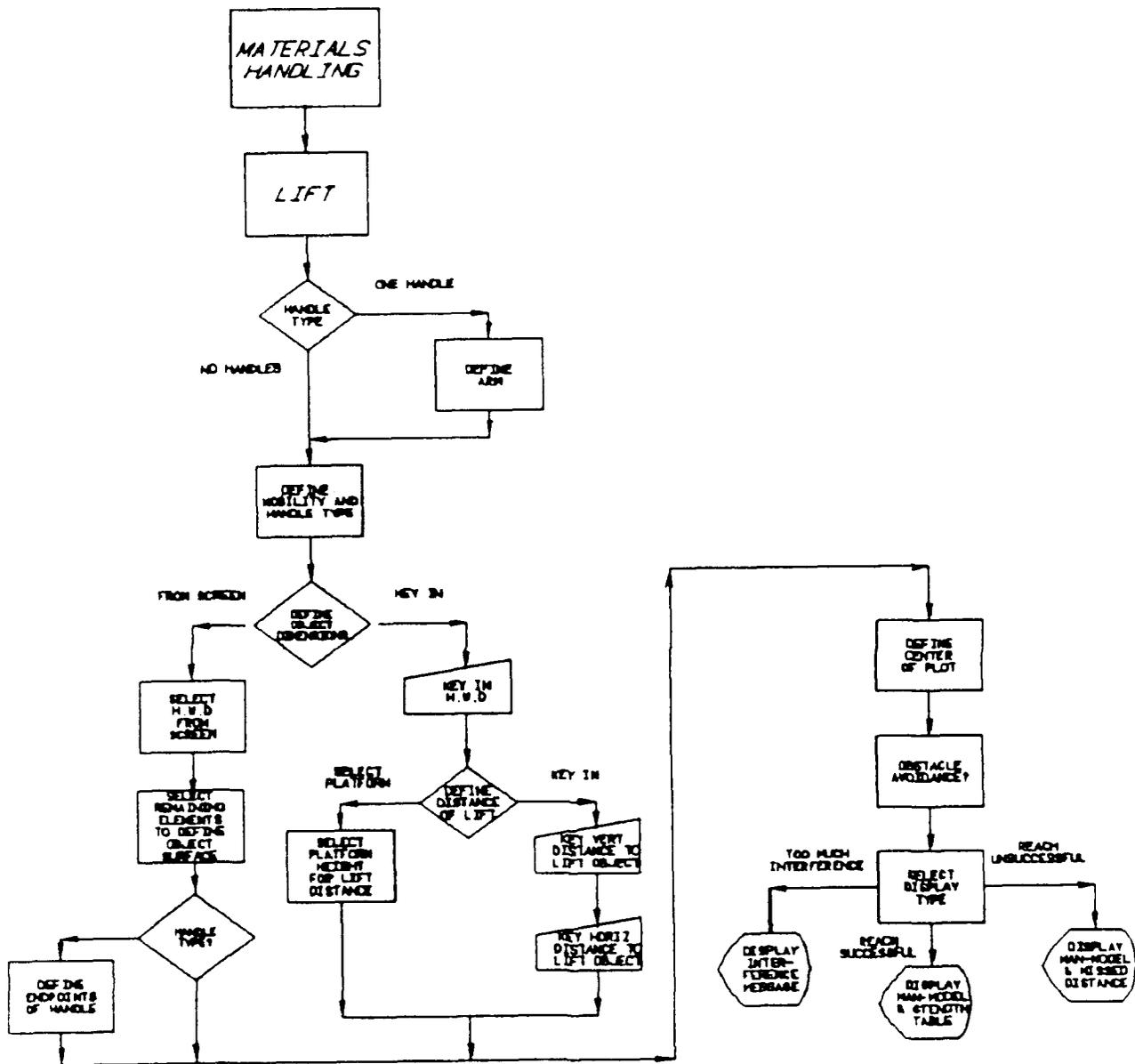
Figure 3.31.   Materials Handling Analysis Flow Diagram for LIFT
Task.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

     ACTION: Depress the **Y/N** function key to execute the Push
                Task.

     EXAMPLE: Depress the **Y/N** function key.

     RESULT: APPLICATION PROGRAM PSHUSR EXECUTING appears and
                then a new prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING THE TASK

     ACTION: Select mobility type to be used during the reach
                analysis (see Figure 3.7).

        •   Select UPPER BODY to allow movement from waist
           up; includes arm/shoulder mobility.

     OR:

        •   Choose **ARM/SHOULDER** to allow movement of arms and
           shoulders only.

     OR:

        •   Choose **FULL BODY** to allow movement of all body
           joints; includes upper body mobility.

     EXAMPLE: Select **FULL BODY**.

     RESULT: New prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

     ACTION: Select handle type to be used (Figure 3.32).
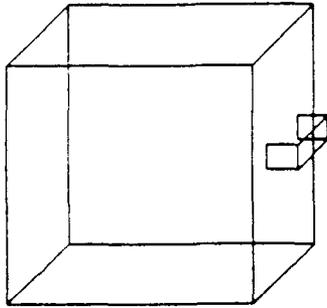
ONE HANDLE TO BE USED
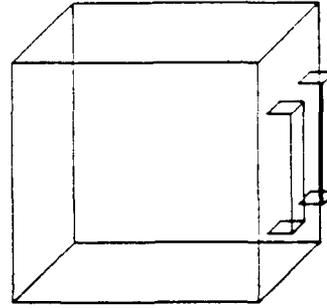
TWO HANDLES TO BE USED
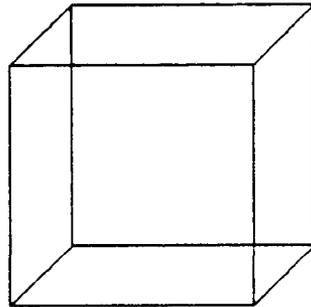
NO HANDLES TO BE USED

Figure 3.32. Handle Selection Menu (NO HANDLES, ONE HANDLE, and TWO HANDLES).

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EXAMPLE: Select **ONE HANDLE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select whether you wish to key in values to define
          the object dimensions, or if you wish to select
          elements from the screen to define the object
          dimensions. If you choose to select elements from
          the screen, only straight lines and two-point
          splines are recognized as valid elements.

- Choose **SELECT OBJECT FROM SCREEN** if the object
  dimensions are to be defined by selecting screen
  elements.

OR:

- Select **KEY IN OBJECT DIMENSIONS** if the object
  dimensions are to be defined by keying in values.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS.**

RESULT   New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be
prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
/END/ TO **FINISH.** When these other elements have been defined,
the user would select END from the bottom menu. These elements
define an irregularly shaped object. If the user had chosen a
handle(s), he would then be prompted to DEFINE FIRST ENDPOINT OF
HANDLE(s) and to DEFINE SECOND ENDPOINT TWO OF HANDLE(s). (See

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Paragraph 8.2.2.3.) If a handle(s) is chosen and the object dimensions are keyed-in, the handle(s) will automatically be placed on top of the object by the program. If the user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

  ACTION: Key in a value **\<CR\>** to define the height of the object.

  EXAMPLE: Key in **10.3 \<CR\>**.

  RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

  ACTION: Key in a value **\<CR\>** to define the width of the object.

  EXAMPLE: Key in **12.0 \<CR\>**.

  RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

  ACTION: Key in a value **\<CR\>** to define the depth of the object.

  EXAMPLE: Key in **12.0 \<CR\>**.

  RESULT: New prompt and menu appear.

PROMPT: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR
        OBJECT

    ACTION: Select whether you wish to key in values to define
        the shelf height and distance of push, or if you
        wish to select an element from the screen to
        define these distances.

    •   Choose **SELECT LINE TO DEFINE OBJECT DISTANCES** if
        the push distances are to be defined by selecting
        an element from the screen.

    OR:

    •   Choose **KEY IN OBJECT DISTANCES** if the push
        distances are to be defined by keying in values.

    EXAMPLE: Select **KEY IN OBJECT DISTANCES**.

    RESULT: New prompt appears.

PROMPT: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

    ACTION: Key in a value **<CR>** to define the vertical
        distance for the push.

    EXAMPLE: Key in **45.0 <CR>**.

    RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

    ACTION: Key in a value **<CR>** to define the horizontal
        push distance.

EXAMPLE: Key in **20.5** **<CR>**.

RESULT: New prompt appears.

PROMPT: KEY IN COEFFICIENT OF FRICTION

ACTION: Key in a value **<CR>** to define the coefficient
           of friction between the man-model's shoes and the
           surface on which he is standing for this analysis.
           For description of values, see Figure 7.3 [HELP
           page].

EXAMPLE: Key in **0.47** **<CR>**.

RESULT: New prompt and menu appear.

PROMPT: SELECT MENU WHICH IDENTIFIES THE NEED FOR OBJECT
         CLEARANCE

ACTION: Select the type of object clearance desired in
           this analysis. Object clearance is the space
           between the object and the inner surfaces of the
           containing area.

    •   Choose **CLEARANCE IS CRITICAL** if the object has a
        tight clearance.

    OR:

    •   Choose **CLEARANCE NOT CRITICAL** if the object will
        easily clear the area into which it will be placed.

EXAMPLE: Select **CLEARANCE IS NOT CRITICAL**.

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach.

    RESULT: New prompt and new menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

    OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit obstacle avoidance.

    EXAMPLE: Select **DO NOT PERFORM OBSTACLE AVOIDANCE**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire frame man-model.

    OR:

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- Select **SURFACED** to display a meshed man-model to be used in shading

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to push the object
           successfully, the man-model appears superimposed
           in the drawing as a wire-frame model pushing the
           object with his hands either on the object or on
           the handles. A "TASK COMPLETED" message appears
           in the top left-hand corner of the window. If the
           reach is unsuccessful because the distance between
           the man-model and the object is too great, the
           man-model is displayed attempting to perform the
           task. The missed distance appears in the top,
           left-hand corner of the window. If the reach is
           unsuccessful because there are too many obstacles
           in the man-model's reach path, arrows will
           indicate points of interference and a "TOO MUCH
           INTERFERENCE. ARROWS INDICATE POINTS OF
           INTERFERENCE" message appears in top, left-hand
           portion of the window. A new prompt and a new
           CADAM-supplied bottom menu appear.

Figure 3.33 diagrams the flow of actions necessary to execute a PUSH analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

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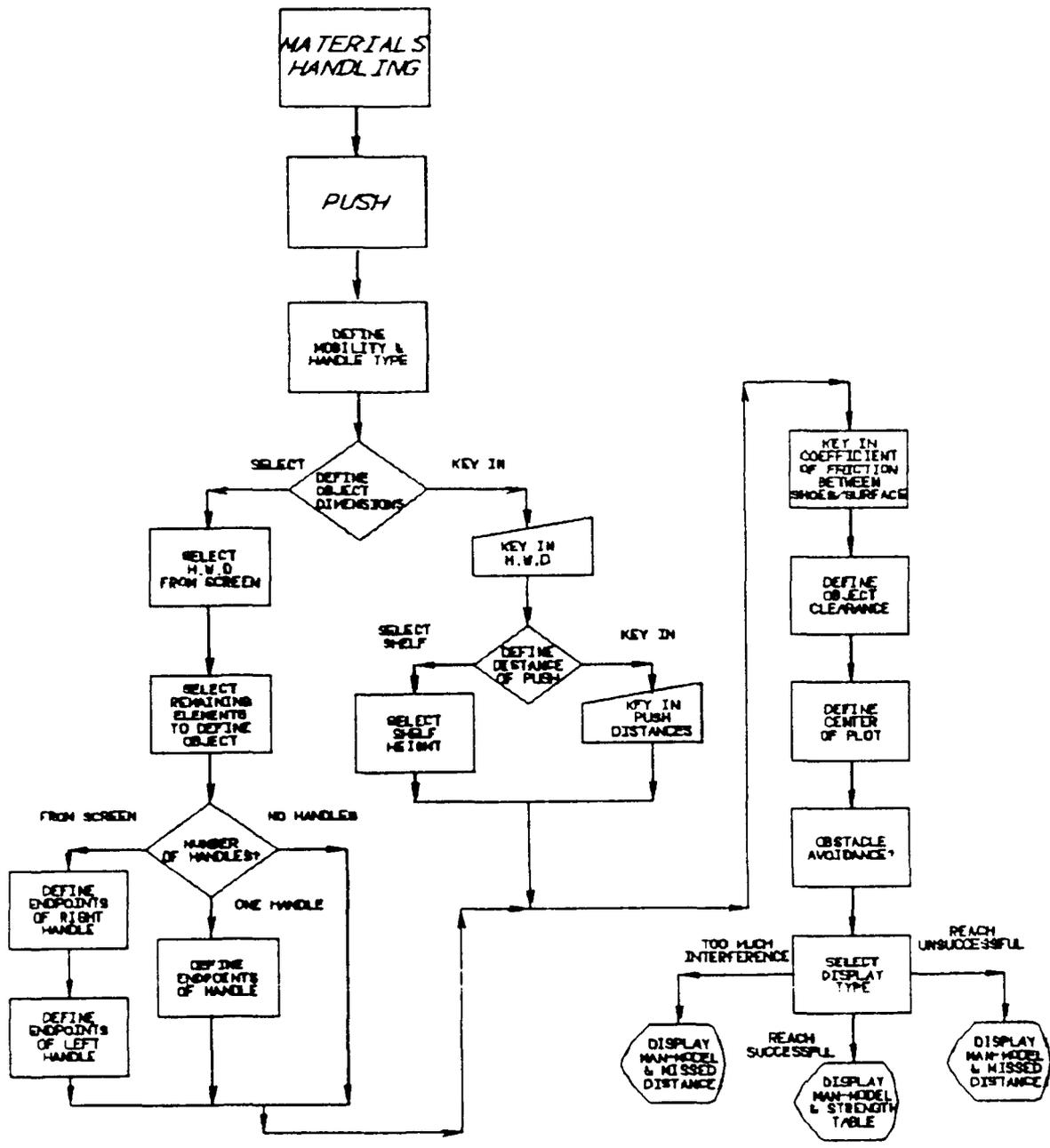
Figure 3.?3. Materials Handling Task Analysis Flow Diagram for
PUSH Task.

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3.2.5 PULL

PULL is the fifth of the six materials handling tasks and is selected when the man-model moves an object toward the man-model in a horizontal direction without supporting the weight of the object. The PULL task is always performed with BOTH HANDS. For this example, begin by selecting Materials Handling Task menu (see Figure 3.25) from the Task Analysis menu (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

    ACTION: Select the name of the task to use for the analysis (see Figure 3.24).

    EXAMPLE: Select the **PULL icon**.

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

    ACTION: Depress the **Y/N** function key to execute the Pull Task.

    EXAMPLE: Depress the **Y/N** function key.

    RESULT: APPLICATION PROGRAM PLLUSR EXECUTING appears and then a new prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING THE TASK

    ACTION: Select mobility type to be used during the reach analysis (see Figure 3.7).

       • Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

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OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only.

<u>OR:</u>

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility.

EXAMPLE: Select **FULL BODY**.

RESULT: New prompt and menu appear.

PROMPT: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

ACTION: Select handle type to be used in the analysis (Figure 3.34).

EXAMPLE: Select **ONE HANDLE**.

RESULT: New prompt and menu appear.

PROMPT: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING OBJECT

ACTION: Select whether you wish to key in values to define the object dimensions, or if you wish to select elements from the screen to define the object dimensions. If you choose to select elements from the screen only straight lines and two-point splines are recognized as valid elements.

- Choose **SELECT OBJECT FROM SCREEN** if the object dimensions are to be defined by selecting screen elements.
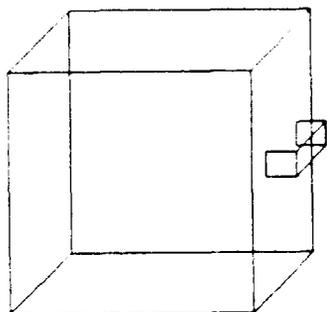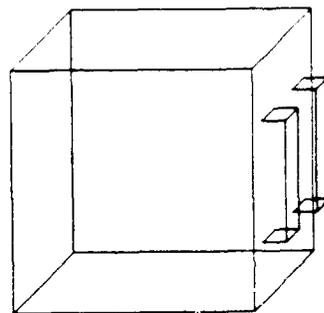
ONE HANDLE TO BE USED   TWO HANDLES TO BE USED

Figure 3.34.   Handle Selection Menu (ONE HANDLE or TWO HANLLES).

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OR:

- Select **KEY IN OBJECT DIMENSIONS** if the object
  dimensions are to be defined by keying in values.

EXAMPLE: Select **KEY IN OBJECT DIMENSIONS**.

RESULT: New prompt appears.

If SELECT OBJECT FROM SCREEN is chosen, the user would be
prompted to (1) SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
OBJECT, (2) SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
OBJECT, (3) SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
OBJECT, and to (4) SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
/END/ TO FINISH. When these other elements have been defined,
the user would select END from the bottom menu. These elements
define an irregularly shaped object. (See Paragraph 8.2.2.3.)
If the object dimensions are keyed-in, the handle(s) will auto-
matically be placed on top of the object by the program. If the
user selects **KEY IN OBJECT DIMENSIONS**, as in the example, the
following prompt will appear on the screen.

PROMPT: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in a value **<CR>** to define the height of
              the object.

    EXAMPLE: Key in **10.3** **<CR>**.

    RESULT: New prompt appears.

PROMPT: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in a value **<CR>** to define the width of
              the object.

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EXAMPLE: Key in **12.0** <**CR**>.

RESULT: New prompt appears.

PROMPT: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in a value <**CR**> to define the depth of
               the object.

    EXAMPLE: Key in **12.0** <**CR**>.

    RESULT: New prompt and menu appear.

PROMPT: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES FOR
        OBJECT

    ACTION: Select whether you wish to key in values to define
               the shelf height and distance of pull, or if you
               wish to select an element from the screen to
               define these distances.

        •   Choose **SELECT LINE TO DEFINE OBJECT DISTANCES** if
            the pull distances are to be defined by selecting
            an element from the screen.

      OR:

        •   Choose **KEY IN OBJECT DISTANCES** if the pull
            distances are to be defined by keying in values.

    EXAMPLE: Select **KEY IN OBJECT DISTANCES**.

    RESULT: New prompt appears.

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PROMPT: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT PLATFORM

    ACTION: Key in a value **<CR>** to define the vertical
              distance for the pull.

    EXAMPLE: Key in **45.0 <CR>**.

    RESULT: New prompt appears.

PROMPT: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-MODEL

    ACTION: Key in a value **<CR>** to define the horizontal
              pull distance.

    EXAMPLE: Key in **20.5 <CR>**.

    RESULT: New prompt appears.

PROMPT: KEY IN COEFFICIENT OF FRICTION

    ACTION: Key in a value **<CR>** to define the coefficient
              of friction between the technicians shoes and
              the surface on which he is standing for this
              analysis. (See Figure 7.3 [HELP page] for
              Coefficient of Friction table.)

    EXAMPLE: Key in **0.79 <CR>**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT MENU WHICH IDENTIFIES THE NEED FOR OBJECT
          CLEARANCE

    ACTION: Select the type of object clearance desired in
              this analysis. Object clearance is the space

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between the object and the inner surfaces of the
containing area.

- Choose **CLEARANCE IS CRITICAL** if the object
  will has a tight clearance.

OR:

- Choose **CLEARANCE NOT CRITICAL** if the object will
  easily clear the area into which it will be placed.

EXAMPLE: Select **CLEARANCE IS CRITICAL.**

RESULT: New prompt appears.

PROMPT: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point on the screen to approximately
           position the center of the strength table upon
           completion of a successful reach.

RESULT: New prompt and menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include
  obstacle avoidance during reach analysis;
  execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit
  obstacle avoidance.

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EXAMPLE: Select **DO NOT PERFORM OBSTACLE AVOIDANCE.**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types from the Display
               icons (see Table 2.1 for definitions of WIREFRAME,
               SURFACED, or PROFILE).

        •   Select **WIREFRAME** to display a 3-D wire-frame man-
            model.

    OR:

        •   Select **SURFACED** to display a meshed man-model to
            be used in shading.

        OR:

        •   Select **PROFILE** to display profile view of man-
            model.

    EXAMPLE: Select **WIREFRAME.**

    RESULT: If the man-model is able to pull the object
               successfully, the man-model appears superimposed
               in the drawing as a wire-frame model pulling the
               object with his hands either on the object or on
               the handles. A "TASK COMPLETED" message appears
               in the top left-hand corner of the window. If the
               reach is unsucessful because the distance between
               the man-model and the object is too great, the
               man-model is displayed attempting to perform the
               task. The missed distance appears in the top,
               left-hand corner of the window. If the reach is

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unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.35 diagrams the flow of actions necessary to execute a PULL analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is also available to the user. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.

3.2.6   REACH

REACH is the last of the materials handling tasks, and is selected when the man-model moves empty hands to a different location. For this example, begin by selecting Materials Handling Task menu (see Figure 3.25) from the Task Analysis Menu (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX/YN EXECUTE

ACTION: Depress the **Y/N** function key to execute the Reach Task.

EXAMPLE: Depress the **Y/N** function key.

RESULT: APPLICATION PROGRAM REAUSR EXECUTING appears and then a new prompt and menu appear.
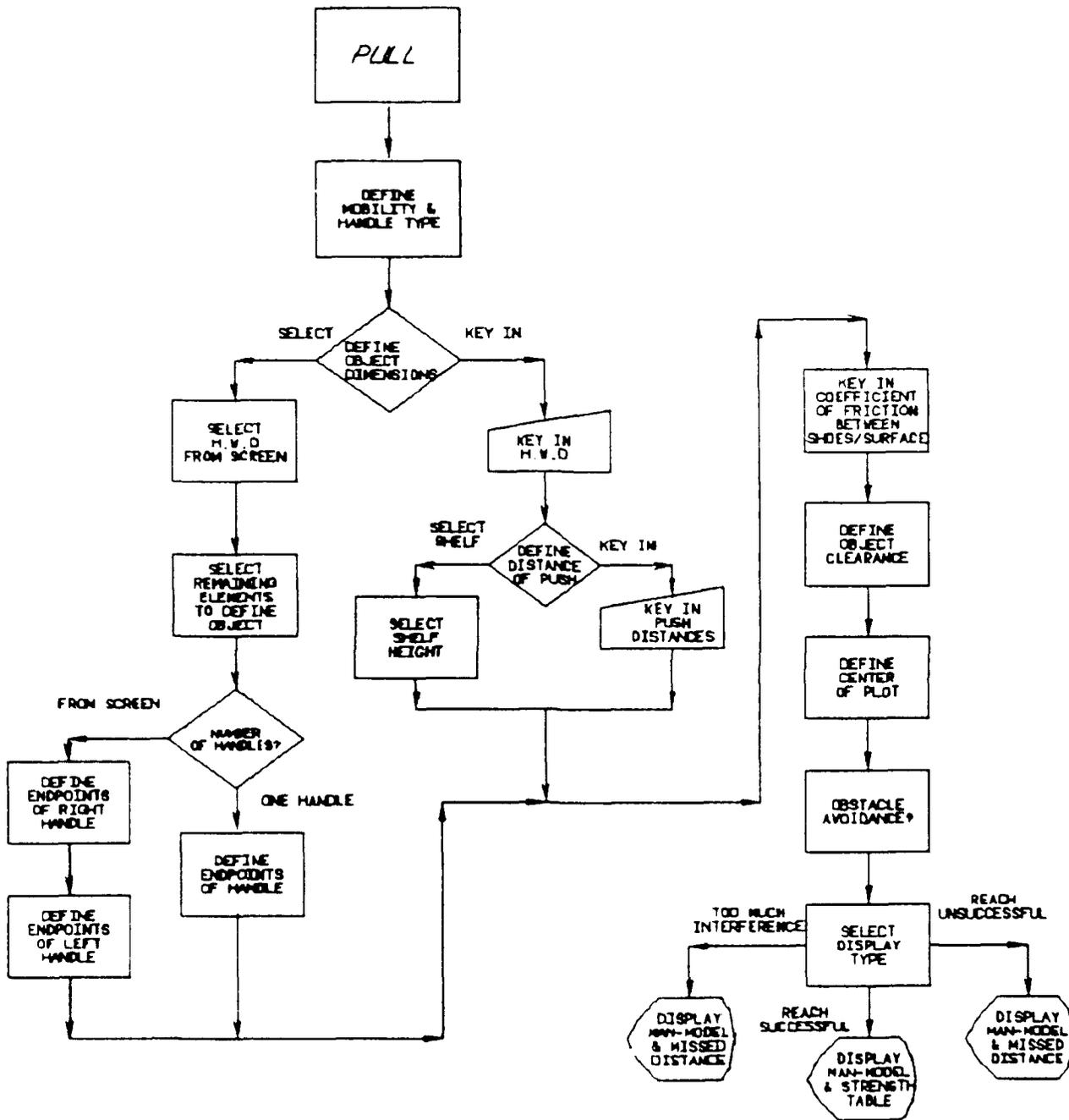
Figure 3.35. Materials Handling Analysis Flow Diagram for PULL Task.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

    ACTION: Select the name of the task to use for the
              analysis (see Figure 3.25).

    EXAMPLE: Select the **REACH icon**.

    RESULT: New prompt appears.

PROMPT: SELECT ARM TO BE USED DURING TASK

    ACTION: Select which arm will be used in the reach
              analysis (Figure 3.36).

    EXAMPLE: Select **LEFT ARM**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select mobility type to use in the reach analysis
              (see Figure 3.7).

- Choose **UPPER BODY** to allow movement from
  waist up; includes arm/shoulder mobility.

   OR:

- Choose **ARM/SHOULDER** to allow movement of arms and
  shoulders only.

   OR:

- Choose **FULL BODY** to allow movement of all body
  joints; includes upper body mobility.

LEFT ARM
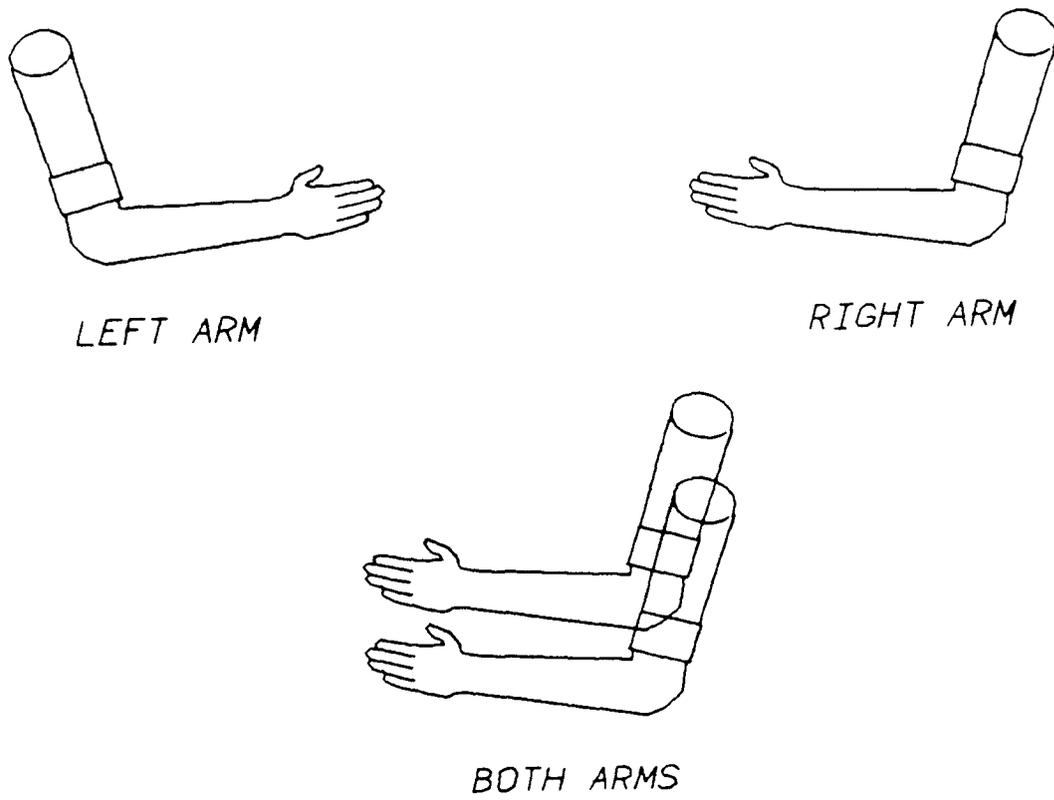
RIGHT ARM

BOTH ARMS

Figure 3.36.   Arm Selection Menu (RIGHT ARM, LEFT ARM, and
               BOTH ARMS).

EXAMPLE: Select **FULL BODY.**

RESULT: New prompt and menu appear.

PROMPT: SELECT REACH EXTENT TO BE USED DURING THE TASK

    ACTION: Select the reach grip type to be used in the
               analysis (Figure 3.37).

    EXAMPLE: Select **FUNCTIONAL.**

    RESULT: New prompt and menu appear.

PROMPT: SELECT REACH POINT FOR LEFT ARM

    ACTION: Define a 3-D point toward which the man-model will
               reach.

    •   Select an existing 3-D point from the screen to
         determine the reach point.

    OR:

    •   Key in the X,Y,Z coordinates **<CR>** to determine
         the reach point.

    EXAMPLE: Key in **26.74, 170, 39.98 <CR>.**

    RESULT: New prompt appears.

    If RIGHT (arm) had been selected the prompts would have
similar. If BOTH (arms) had been selected, the prompt for the
right hand reach point would have appeared, followed by a prompt
for the left hand reach point. (See Paragraph 8.2.2.6.)
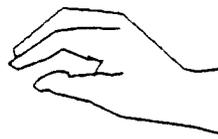
GRIP CENTER REACH   FUNCTIONAL REACH
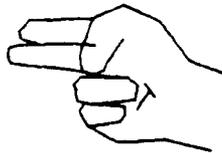
FINGER-TIP REACH

Figure 3.37.   Grip Type Selection Menu for REACH Task.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices.

- Select **PERFORM OBSTACLE AVOIDANCE** to include obstacle avoidance during reach analysis; execution time is increased.

OR:

- Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit include obstacle avoidance.

EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE**.

RESULT: New prompt and menu appear.

PROMPT: *SELECT DESIRED DISPLAY TYPE*

ACTION: Select one of the display types from the Display icons (see Table 2.1 for definitions of WIREFRAME, SURFACED, or PROFILE).

- Select **WIREFRAME** to display a 3-D wire-frame man-model.

OR:

- Select **SURFACED** to display a meshed man-model to be used in shading.

OR:

- Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the point
            successfully, the man-model appears superimposed
            in the drawing as a wire-frame model in the final
            reach position. A "TASK COMPLETED" message
            appears in the top left-hand corner of the window.
            If the reach is unsuccessful because the distance
            between the man-model and the reach point is too
            great, the man-model is displayed attempting to
            perform the task. The missed distance appears in
            the top, left-hand corner of the window. If the
            reach is unsuccessful because there are too many
            obstacles in the man-model's reach path, arrows
            will indicate points of interference and a "TOO
            MUCH INTERFERENCE. ARROWS INDICATE POINTS OF
            INTERFERENCE" message appears in top, left-hand
            portion of the window. A new prompt and a new
            CADAM-supplied bottom menu appear.

Figure 3.38 diagrams the flow of actions necessary to
execute a REACH task.

To continue an analysis, the user will generally select
/RECOVER/ from the bottom of the window. Another selection is
also available to the user. If /KEEP/ is selected, the drawing
OVERLAY becomes the active drawing.

3.3   CONNECTOR ANALYSIS FUNCTION

The Connector Analysis function evaluates the strength
capability of the technician to mate an electrical connector at a
specified location.   This evaluation is given in a table of
strength capability related to grip used and size of connector.

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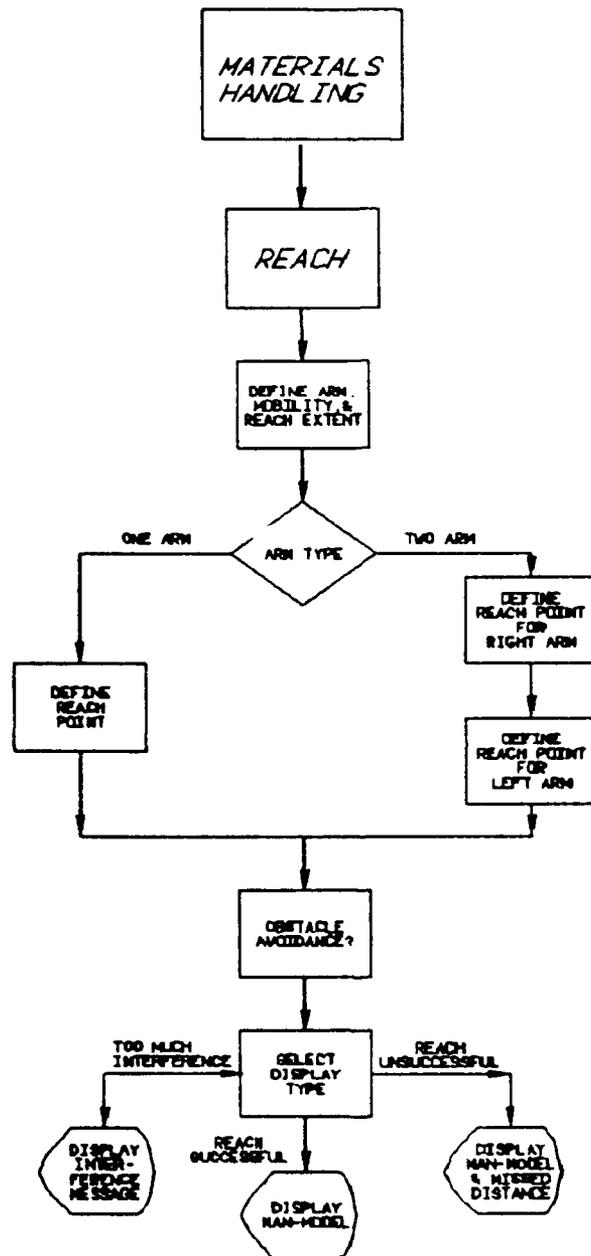
Figure 3.38.   Materials Handling Analysis Flow Diagram for REACH Task.

To use the Connector Analysis function, choose the TASK ANALYSIS from the CREW CHIEF Main Programs menu (see Figure 1.3) which will cause the CREW CHIEF Task Analysis menu to appear on the screen (see Figure 3.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY INDEX

    ACTION: Select the Task Analysis function to be performed (see Figure 3.1).

    EXAMPLE: Select the **CONNECTOR icon**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT GRIP TO BE USED DURING TASK

    ACTION: Select the grip type (Figure 3.39).

    EXAMPLE: Select **GRIP CENTER**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT CONNECTOR SIZE TO BE USED DURING TASK

    ACTION: Select the connector size (diameter of lock ring) to be used in the analysis (Figure 3.40).

    EXAMPLE: Select **2.0 INCHES**.

    RESULT: New prompt and menu appear.

GRIP CENTER REACH   FUNCTIONAL REACH

Figure 3.39. Grip Type Selection Menu for Connector.

0.9 INCHES   1 5 INCHES   2 INCHES
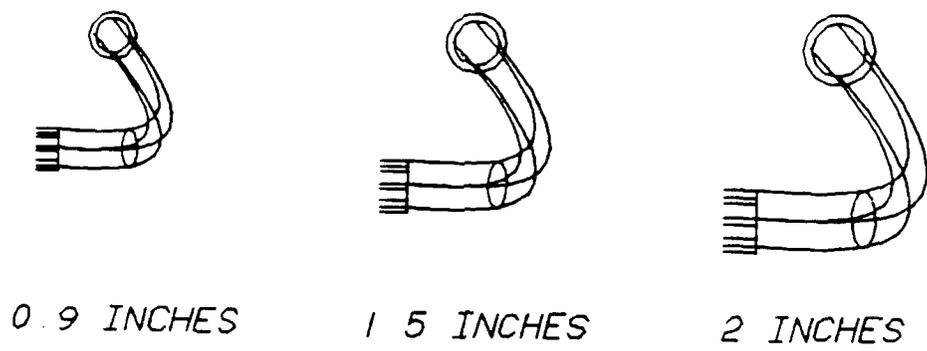
Figure 3.40.   Connector Size Menu.

PROMPT: DEFINE HEAD POINT OF ATTACH VECTOR

      ACTION: Define a 3-D point that defines at which point the man-model grips the connector.

- Select an existing 3-D point from the screen to determine where the man-model will grip the connector.

OR:

- Key in the X,Y,Z coordinates which represent where the man-model will grip the connector <CR>.

      EXAMPLE: Key in **28, 218, 44.75** <CR>.

      RESULT: New prompt appears.

PROMPT: DEFINE TAIL POINT OF ATTACH VECTOR

      ACTION: Define a 3-D point that (along with the head point, or the point at which the man-model grips the connector) defines the direction from which the man-model will reach the connector.

- Select an existing 3-D point from the screen to define the axis of the connector and the direction the man-model will reach.

OR:

- Key in the X,Y,Z coordinates which will define the axis of the connector and the direction the man-model will reach <CR>.

      EXAMPLE: Key in **28, 221, 44.75** <CR>.

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RESULT: New prompt and menu appear.

PROMPT: SELECT HAND TO BE USED DURING TASK

    ACTION: Select which arm will reach to the connector (see Figure 3.17).

    EXAMPLE: Select **LEFT HAND.**

    RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types to be used in the reach analysis (see Figure 3.7).

- Select **ARM-SHOULDER** to allow movement of arms and shoulders only.

    <u>OR:</u>

- Select **UPPER BODY** to allow movement from waist up; includes arm/shoulder mobility.

    <u>OR:</u>

- Select **FULL BODY** to allow movement of all body joints; includes upper body mobility.

    EXAMPLE: Select **UPPER BODY.**

    RESULT: New prompt appears.

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PROMPT: INDICATE CENTER OF PLOT

    ACTION: Indicate a point on the window to approximately
                     position the center of the strength-related
                     measurements upon completion of a successful
                     reach.

    RESULT: New prompt and new bottom menu appear.

PROMPT: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices.

        •   Select **PERFORM OBSTACLE AVOIDANCE** to include
           obstacle avoidance during reach analysis;
           execution time is increased.

      OR:

        •   Select **DO NOT PERFORM OBSTACLE AVOIDANCE** to omit
           obstacle avoidance.

    EXAMPLE: Select **PERFORM OBSTACLE AVOIDANCE**.

    RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types from the Display
                     icons (see Table 2.1 for definitions of WIREFRAME,
                     SURFACED, or PROFILE).

        •   Select **WIREFRAME** to display a 3-D wire-frame man-
           model.

<u>OR:</u>

• Select **SURFACED** to display a meshed man-model to be used in shading.

<u>OR:</u>

• Select **PROFILE** to display profile view of man-model.

EXAMPLE: Select **WIREFRAME**.

RESULT: If the man-model is able to reach the connector, the man-model appears superimposed in the drawing as a wire-frame model holding the connector. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. A table of strength-related measurements is displayed. If the reach is unsuccessful because the distance between the man-model and the connector is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.41 diagrams the flow of actions necessary to execute the connector analysis.

To continue an analysis, the user will generally select **/RECOVER/** from the bottom of the window. Another selection is

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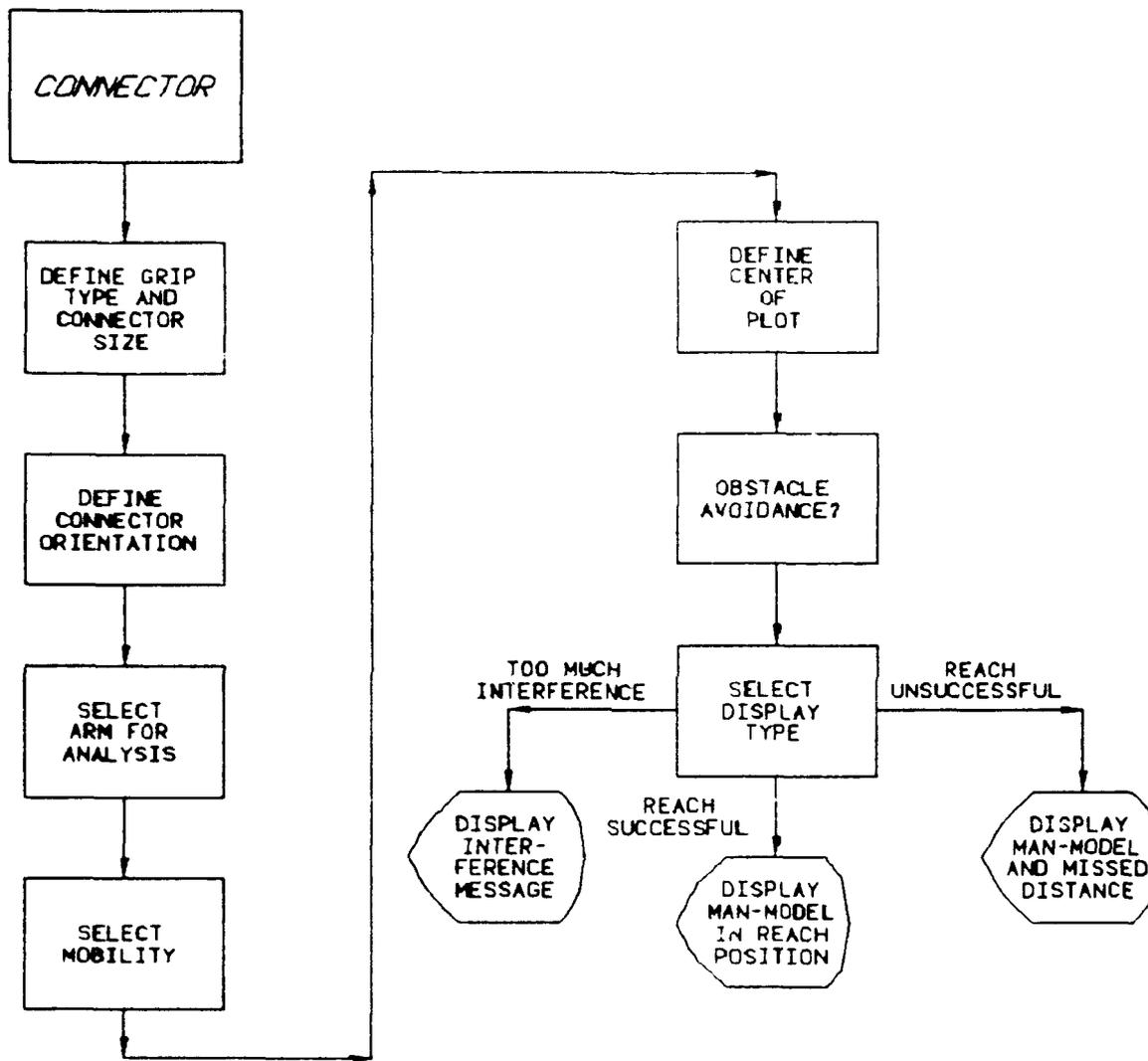
Figure 3.41. Materials Handling Task Analyses Flow Diagram for Connector.

also available to the user. If /KEEP/ is selected, the drawing
OVERLAY becomes the active drawing.

SECTION 4
VISIBILITY ANALYSIS FUNCTION

4.1 INTRODUCTION TO VISIBILITY ANALYSIS

The Visibility Analysis Function program plots a map of visual azimuth and elevation line-of-sight (LOS) angles to work station components in the drawing. The plot is rectilinear, and depicts the visual field as seen by the CREW CHIEF man-model in its current posture, or as seen from a user-chosen, arbitrary viewpoint. The plot is presented on-screen and a hard copy can be obtained using the CADAM Plot Function.

The vision limits will be presented for the baseline condition, which is unrestricted, and for restrictions due to clothing or personal protective equipment such as the Chemical Defense mask. These restrictions will be available as overlays in the program.

4.2 USING THE VISIBILITY ANALYSIS FUNCTION

The first step in using the Visibility Analysis function is to call the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **VISIBILITY icon**

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

      ACTION: Depress the Y/N function key to execute the
                    Visibility Analysis Function

      EXAMPLE: Depress the **Y/N** function key

      RESULT: APPLICATION PROGRAM VISUSR EXECUTING appears and
                    then a new prompt and menu appear.

PROMPT: SELECT VIEWPOiNT OPTION

      ACTION: Select the viewpoint that depicts the visual
                    field as seen by the man-model or as seen from a
                    user-defined, arbitrary viewpoint.

        •   Select **CREW CHIEF'S** to view the
            visual field as seen by the man-model from his
            current position and posture

    <u>OR:</u>

        •   Select **USER DEFINED** to establish an arbitrary
            line-of-sight

      EXAMPLE: Select **CREWCHIEF'S**

      RESULT: New prompt appears.

    If USER-DEFINED had been selected as the EXAMPLE, then the
user would be prompted to DEFINE EYE LOCATION POINT from which
the man-model will view the work location and to DEFINE EYE
TARGET POINT which defines the man-model's line-of-sight. Next
the user would be prompted to DEFINE CENTER OF PLOT for the
visibility plot. (See Paragraph 8.3.) The following prompt
appears as a result of selecting **CREW CHIEF'S**.

PROMPT: SELECT INCLUDE/EXCLUDE MAN-MODEL OPTION

    ACTION: Select from the menu whether to include or exclude
               the man-model. Body parts of the man-model which
               are within the visual field of the man-model will
               or will not be included in the final visibility
               plot depending on this selection.

        •   Select **INCLUDE MAN** to include the body parts
            of the man-model which are within the visual field
            of the man-model in the final visibility plot

    OR:

        •   Select **EXCLUDE MAN** to not include the body parts
            of the man-model which are within the visual field
            of the man-model in the final visibility plot

    EXAMPLE: Select **INCLUDE MAN**

    RESULT: New prompt appears.

PROMPT: DEFINE CENTER OF PLOT

    ACTION: Indicate a 2-D point to determine where the center
               of the visibility plot will appear on the screen

    EXAMPLE: Indicate a point on the screen

    RESULT: Plot appears on screen at specified center of plot
               location. New menu appears.

    Figures 4.1 through 4.3 are examples of vision outlines;
the vision outline which appears is dependent upon the clothing
type selected during CREW CHIEF Initialization. The bareheaded

Figure 4.1.   An Example of the Vision Outline Which is Shown When
the Fatigues or the Fatigues with Jacket Clothing
Type is Selected. "BH" Represents the Bareheaded
Visual Field.

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Figure 4.2.   An Example of the Vision Outline Which is Shown When
               the Arctic Clothing Type is Selected. "PA" Represents
               the Visual Field with Fur-Trimmed Edge of the Parka
               Hood Pulled Away from the Face; "PB" Indicates the
               Visual Field with Fur Edge of Hood Pushed Toward the
               Face. "BH" Shows the Bareheaded Visual Field.

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WINDOW
      VIEW PV   SCL 1.000 WDO 1.355.0
    IND SIZE/KEY SIZE/KEY X.Y.SIZE/SEL ANY TO MOVE/YN SIZE=1
DET DIR   SIZE= 1.35497

BH - BAREHEADED

CM - CHEMICAL DEFENSE MASK (M17)

ELEVATION

AZIMUTH

-180   -120   -60   0   60   120   180

/ MOVE/ SIZE/ BOX/ ROT/ TRUE/ ISO/ OVRLY/ SET// 1/ 2/ 3/ 4/ PLOT/ RESET/
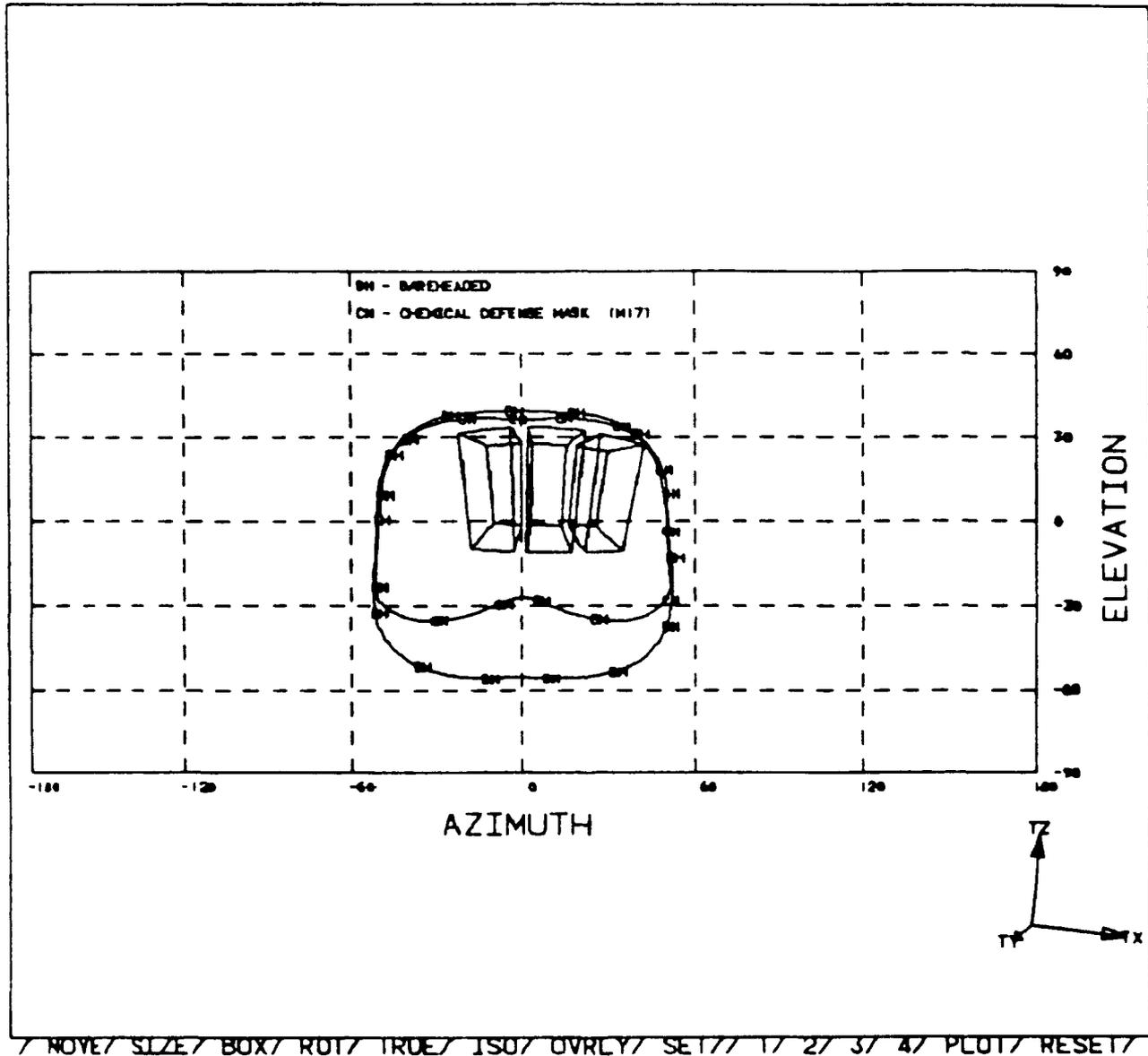
Figure 4.3. An Example of the Vision Outline Which is Shown When the Chemical Defense Clothing Type is Selected. "CM" Represents the Visual Field with Chemical Defense Mask. "BH" Shows the Bareheaded Visual Field.

vision outline, shown by a solid contour and the letters "BH" (see Figure 4.1, i.e., the result of choosing fatigues or fatigues with jacket), is plotted regardless of the clothing type selected.

When the arctic ensemble is selected, two dashed contours appear (see Figure 4.2). The outline labeled "PA" represents the visual field of the man-model wearing the parka hood with the fur-trimmed edge pulled away from the face. The outline labeled "PB" denotes the visual field with the parka hood fur edge pushed toward the face (in the snorkel opening position). The bareheaded vision outline, as described previously, is also displayed.

If the chemical defense ensemble is selected, the dashed contour labeled "CM" appears (see Figure 4.3). Again, the bareheaded vision outline described previously is also displayed.

After the plot appears on the screen, it may be necessary to increase the size of the plot to be viewed correctly. This can be accomplished by depressing CADAM's window function key and using the appropriate menu items to view the plot. After the user has viewed the plot, he/she should depress the Macro Geometry function key to continue any analysis.

Figure 4.4 diagrams the flow of action necessary to execute a visibility analysis.

To continue the analysis, the user will generally select /RECOVER/ from bottom of screen to return to CREW CHIEF Main Programs menu. If /KEEP/ is selected, the drawing OVERLAY becomes the active drawing.
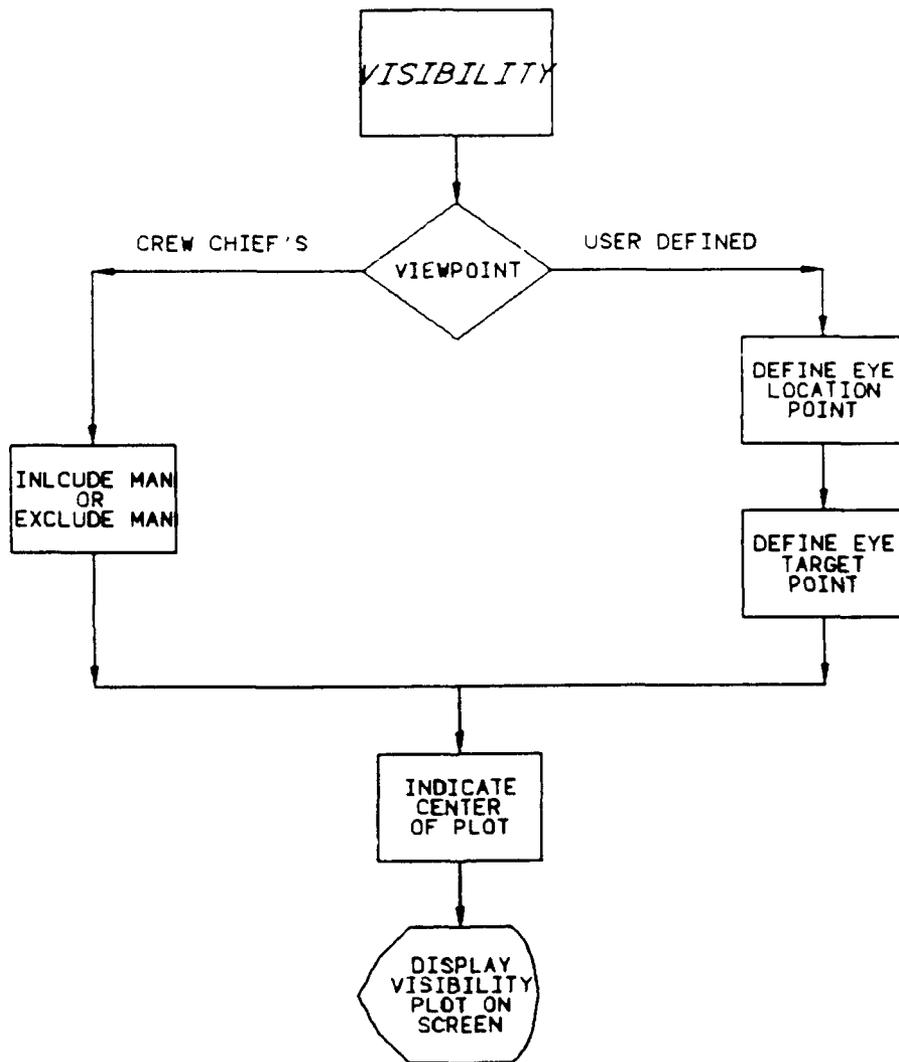
Figure 4.4. Visibility Analysis Flow Diagram.

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SECTION 5

ACCESSIBILITY ANALYSES FUNCTION

The Accessibility Analyses function is provided to perform analyses concerning interference between elements of the CREW CHIEF technician model and elements of the drawing depicting the location of work. The function is broken into two areas: Interference Analysis, which checks interference between the man-model and drawing elements in a static condition, and Work Envelope Analysis, which is a quasi-dynamic interference check. Work Envelope presents a graphic display of the volume of space required to operate a tool or the movement of an object, such as a component to be removed or installed, in the work area.

Interference can be observed on the screen by viewing both the drawing and the man-model from different perspectives. In some cases this is the easiest and quickest way for the user to check for interference.

The Accessibility Analysis function is initiated from the CREW CHIEF Main Program Menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the analysis to be performed

EXAMPLE: Select the **ACCESSIBILITY icon** (Figure 5.1).

Choose the desired Accessibility Analysis function by selecting the **INTERFERENCE** or **WORK ENVELOPE** icon.

PAGE 4
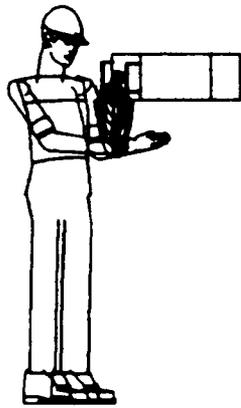
ACCESSIBILITY
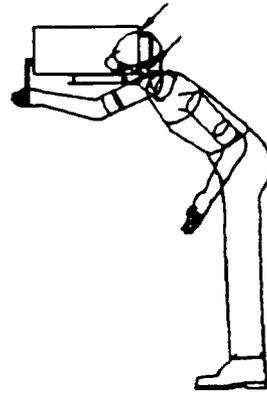
WORK ENVELOPE   INTERFERENCE

RETURN TO
CREW CHIEF
MAIN MENU

/ FWD/ BACK/   /RETURN/

Figure 5.1.   CREW CHIEF Accessibility Analyses Menu.

5.1   CREW CHIEF INTERFERENCE ANALYSIS FUNCTION

5.1.1   Introduction to Interference Analysis

Interference checking of a complex drawing is generally a time-consuming process. For this reason, the user should employ the "NO-SHOW" capabilities of CADAM to temporarily remove drawing elements that are obviously out of the interference range of the man-model elements.

The CREW CHIEF program also allows the user to check inter- ference for the whole body or portions of the body (with or without a tool). The user can check interference for the shoulders, arms and hand, or the upper torso which includes all body elements from the waist up, or the whole body. A tool will be included if a tool was used in the previous analysis. By using the "NO-SHOW" capabilities of CADAM, the program only has to check the "shown" drawing elements and the designated body/tool elements for interference, a task which significantly reduces computer processing time.

Interference checking is performed using the current posture configuration and position of the man-model. Thus, before performing any Interference Analysis, the man-model must be generated and placed in the desired posture and position using the Initialization, Reposition, and/or Task Analysis functions. The program searches for interference between the man-model and drawing elements, displays CADAM 3-D arrows indicating points of interference, and indicates at the top of the screen whether or not interference is found.

5.1.2   Using the Interference Analysis Function

To use the Interference Analysis function, select ACCESSIBILITY icon from the CREW CHIEF Main Programs menu (see Figure 1.3) which will display the CREW CHIEF Accessibility Analysis menu (see Figure 5.1).

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PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **INTERFERENCE icon**

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the Y/N function key to execute the
                 Interference Analysis Function.

    EXAMPLE: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM ITFUSR EXECUTING appears and
                 then a new prompt and menu appear.

PROMPT: SELECT LEVEL OF INTERFERENCE TO BE CHECKED

    ACTION: Select the level of interference checking to be
                 used (Figure 5.2). The level of interference
                 checking chosen determines which body parts will
                 be included during interference checking. The
                 more body parts contained in the level, the more
                 execution time is required to evaluate the
                 interference. Also execution time of the
                 interference analysis will decrease if elements
                 that definitely do not interfere with the man-
                 model are "NO-SHOWED" before the analysis.

        •   Select **ARMS ONLY** to include only the arms, hands,
           and tool (if applicable) for possible interference
           between the man-model and the elements in the drawing

PROCESS ARMS ONLY

PROCESS ARMS
AND UPPER BODY

PROCESS WHOLE BODY
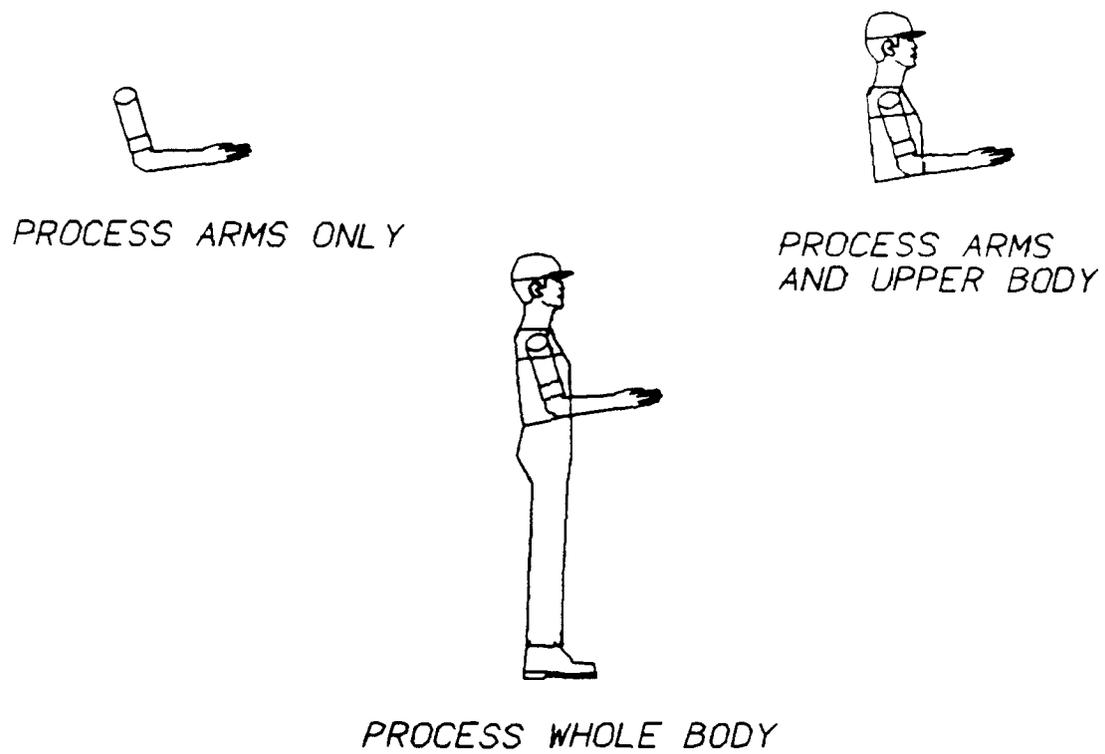
Figure 5.2. Level of Interference Checking Menu.

OR:

- Select **ARMS AND UPPER TORSO** to include all body
  elements from the waist up for possible interference
  between the man-model and the elements in the drawing

OR:

- Select **FULL BODY** to include the whole body for
  possible interference between the man-model and
  the elements in the drawing

EXAMPLE: Select **ARMS AND UPPER TORSO**

RESULT: New prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the display
           icons (see Table 2.1 for definitions of WIREFRAME,
           SURFACED, or PROFILE)

- Select **WIREFRAME** to display a 3-D wire-frame
  man-model

OR:

- Select **SURFACED** to display a meshed man-model to be
  used in shading

OR:

- Select **PROFILE** to display profile view of
  man-model

EXAMPLE: Select **WIREFRAME**

RESULT: The man-model will appear in the drawing as a
          wire-frame model. If interference was found, 3-D
          arrows indicate the points where the man-model
          (depending on level of interference chosen) inter
          sects with elements in the drawing. The message
          "ARROWS BELOW INDICATE POINT OF INTERFERENCE" is
          displayed. If no interference is found, then the
          message "NO INTERFERENCE FOUND IN UPPER BODY
          LEVEL" is displayed (this message will change
          depending on level of interference selected).

Figure 5.3 diagrams the flow of actions necessary to
execute an Interference Analysis.

To continue the analysis, the user will generally
select **/RECOVER/** from bottom of screen. Another selection is
available to the user. If /KEEP/ is selected, OVERLAY becomes
the active drawing.

5.2   WORK ENVELOPE ANALYSIS FUNCTION

Prior to using the Work Envelope Analysis function, the
user will be required to perform a Task Analysis to establish the
parameters for the volume required for using a tool or handling
an object.

5.2.1   Introduction to Work Envelope Analysis

The work envelope analysis currently evaluates the volume
of space that is available for the operation of a tool task. The
function requires that a successful obstacle avoidance tool reach
was previously performed. The work envelope is defined relative
to the location of the tool as defined in the Tool Analysis
function (see Paragraph 3.1), and can be greatly affected by the
handle direction chosen.
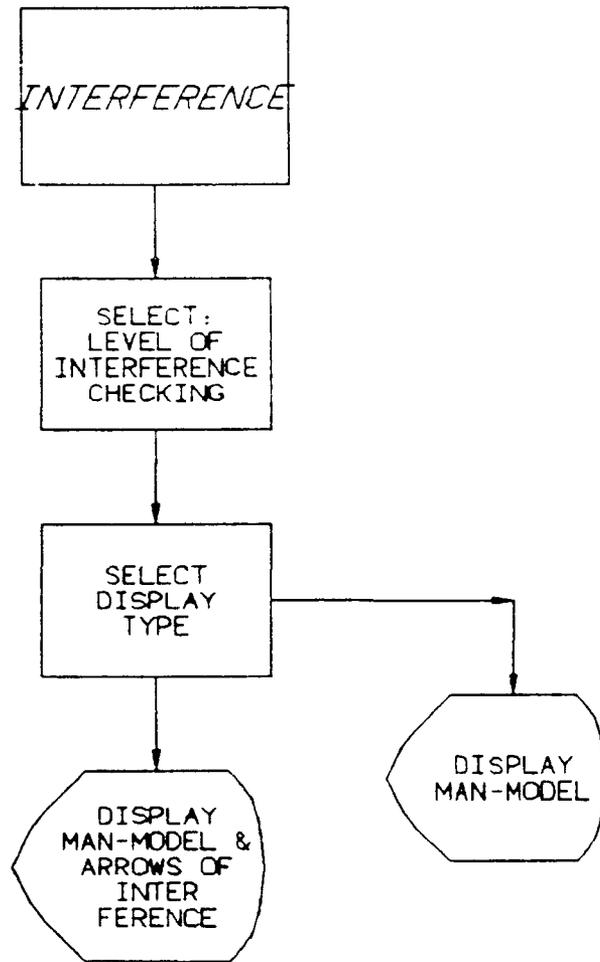
Figure 5.3. Interference Analysis Flow Diagram.

The Work Envelope evaluates three types of envelopes. In the first type of envelope, a full sweep of the tool handle can be viewed. This evaluation does not take into account obstructions in the work place or the ability of the man-model to reach the tool handle for the full sweep. In the second type of envelope, a tool envelope can be evaluated. This considers obstructions that will affect the sweep of the tool, but reach is not evaluated. The third type of envelope is the work envelope. This evaluates the ability of the man-model to reach the handle of the tool during the sweep of the tool, and also takes into account obstacles in the work place. The work envelope can be very time-consuming, depending upon the reach interval increment given and the number of obstacles near the tool.

Several tools available in the Tool Analysis function have undefined envelopes: hammer, scraper, and safety wire pliers. Also several tools do not have an envelope: drill, chisel, sander, combination pliers, needlenose pliers, wire cutters, nutdriver, flat bladed screwdrivers, and when using long end allen wrenches.

5.2.2   Using the Work Envelope Analysis Function

To use the Work Envelope Analysis function, select the ACCESSIBILITY icon from the CREW CHIEF Main Programs menu (see Figure 1.3) which will display the CREW CHIEF Accessibility Analysis menu (see Figure 5.1).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **WORK ENVELOPE icon**

    RESULT: New prompt appears.

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PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

>   ACTION: Depress the Y/N function key to execute the
               Work Envelope Analysis Function.

>   EXAMPLE: Depress the **Y/N** function key

>   RESULT: APPLICATION PROGRAM WRKUSR EXECUTING appears and
               then a new prompt and menu appear.

PROMPT: SELECT WORK ENVELOPE TO BE OUTPUT

>   ACTION: Select one of the envelope types to be evaluated
               (Figure 5.4). The envelope type chosen will
               affect the execution time of the analysis. The
               sweep volume will require the least amount of time
               since reach and obstacles are not considered. The
               work envelope will require the greatest amount of
               time, because it considers the number of obstacles
               near the tool and the ability to reach the tool
               handle during the sweep of the tool.

>   •   Select **SWEPT VOLUME** to evaluate the sweep of the
          tool handle (ability to reach the tool handle and
          obstacles in the reach path are not considered)

>   OR:

>   •   Select **TOOL ENVELOPE**, to evaluate the sweep
          of the tool handle considering obstacles in the
          sweep path [tool handle position will effect this
          envelope (Figure 5.5)]

>   OR:

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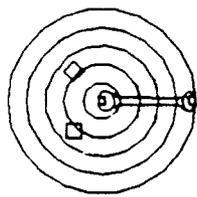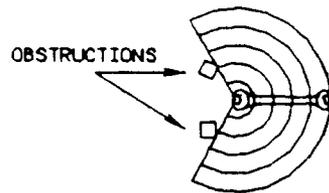
FULL SWEEP   TOOL ENVELOPE   WORK ENVELOPE
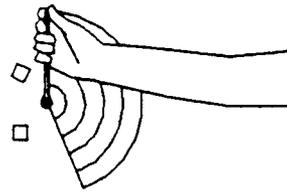
Figure 5.4.   Types of Work Envelopes Menu.

OBSTRUCTIONS

OBSTRUCTIONS
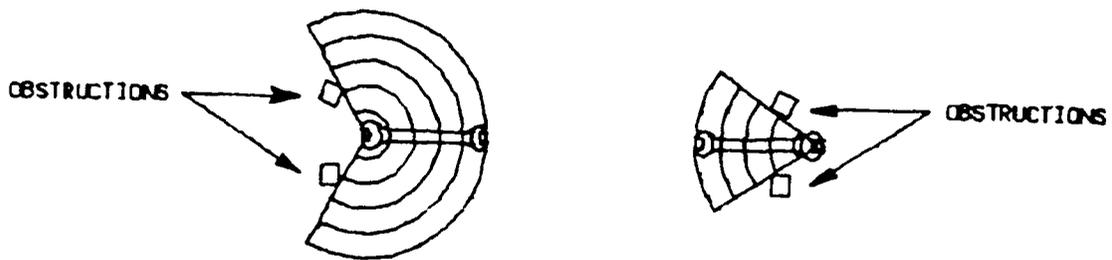
Figure 5.5.   The Work Envelope, Defined Relative to the Location
of the Tool, is Greatly Affected by the Chosen Handle
Direction.   To Change Handle Direction, User Must
Rerun the Tool Analysis.

- Select **WORK ENVELOPE** to evaluate the sweep of the tool handle considering the ability of the man-model to reach the handle and any obstacles that are in the sweep path [tool handle position will effect this envelope (see Figure 5.5)]

EXAMPLE: Select **WORK ENVELOPE**

RESULT: New prompt and menu appear.

If the example chosen had been either SWEPT VOLUME or TOOL ENVELOPE, the user would next select a DISPLAY TYPE and the final results of the analysis would appear on the screen. As a result of selecting **WORK ENVELOPE**, the following prompt must be considered.

PROMPT: KEY IN WORK ENVELOPE REACH INCREMENT, MUST BE >0

ACTION: Determine the reach increment to be used by keying the value <CR>. The reach increment is the increment used for the sweep of the tool handle. The ability of the man-model to reach the handle at each of these increments (along with obstacles) is evaluated.

NOTE: The reach increment must be equal to or greater than 0.5 inches.

EXAMPLE: Key in **1.5** **<CR>**

RESULT: New prompt and menu appear.

PROMPT: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select one of the mobility types to be used in the
reach analysis

- Select **ARM/SHOULDER** to allow movement of arms and
shoulders only

<u>OR:</u>

- Select **UPPER BODY** to allow movement from waist
up; includes arm/shoulder mobility

<u>OR:</u>

- Select **FULL BODY** to allow movement of all body
joints; includes upper body mobility

EXAMPLE: Select **UPPER BODY**
RESULT: A new prompt and menu appear.

PROMPT: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types from the Display
icons (see Table 2.1 for definitions of WIREFRAME,
SURFACED, or PROFILE)

- Select **WIREFRAME** to display a 3-D wire-frame man-
model

<u>OR:</u>

- Select **SURFACED** to display a meshed man-model to
be used in shading man-model

<u>OR:</u>

- Select **PROFILE** to display profile view of man-model

EXAMPLE: Select **WIREFRAME**

RESULT: If the envelope type chosen was WORK ENVELOPE, the man-model appears in the drawing with the tool(s) attached as it was in the previous tool analysis. The sweep demarcation lines, which are dependent upon the ability of the man-model to reach the tool(s) during the handle sweep and the obstacles that would possibly prevent a full sweep of the tool, appear. If the envelope type chosen was either SWEPT VOLUME or TOOL ENVELOPE, only the sweep demarcation lines and the tool(s) appear. For SWEPT VOLUME, these lines indicate a full sweep of the tool handle without any restrictions. For TOOL ENVELOPE, these lines indicate the handle sweep possible if obstacles are considered (see Figure 7.8).

NOTE: If the display of the envelope is from a rotational type tool (e.g., wrenches), then the lines displayed represent the clockwise and counterclockwise angle (in degrees) with relation to the initial tool position. The direction of clockwise angles is in the same direction of a right-threaded screw or bolt. Likewise, counterclockwise is in the opposite direction. If the enveloped displayed represents a translation type tool (hacksaw, file, etc.), then the lines represent the distance that the tool can travel in a forward direction (in user-defined units).

Figure 5.6 diagrams the flow of actions necessary to execute a Work Envelope Analysis.

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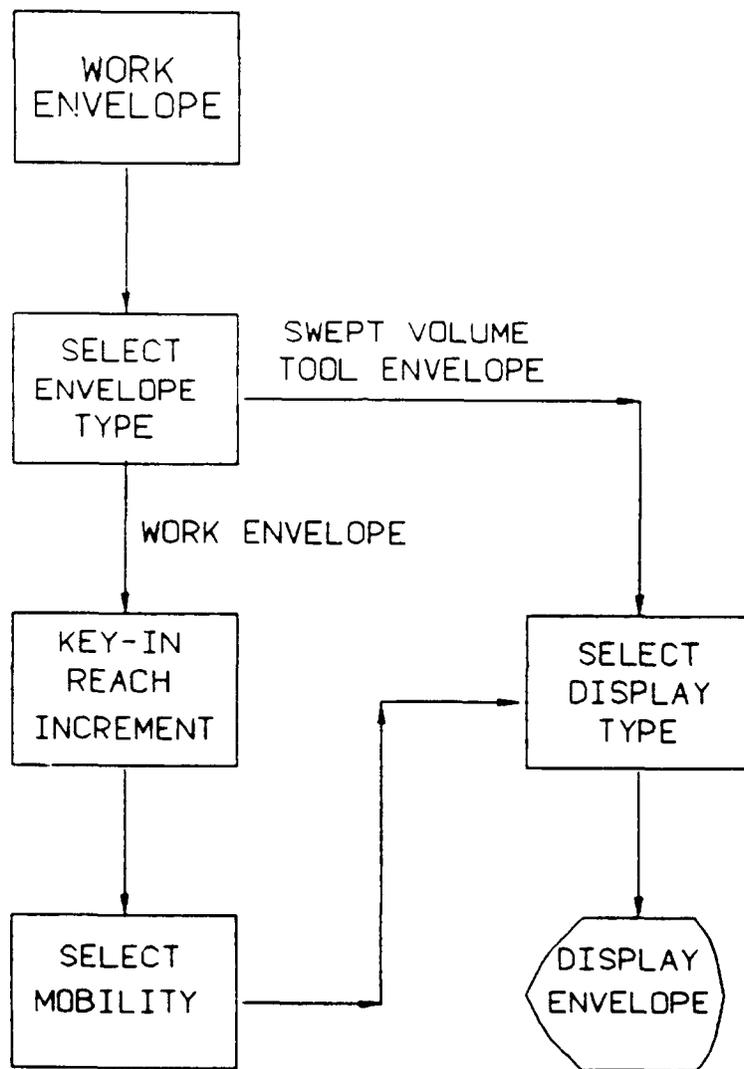
Figure 5.6.   Work Envelope Analysis Flow Diagram.

To continue the analysis, the user will generally select **/RECOVER/** from the bottom of the screen. Another selection is available to the user. If /KEEP/ is selected, OVERLAY becomes the active drawing.

SECTION 6
DISPLAY CURRENT CREW CHIEF DATA FUNCTION

6.1   INTRODUCTION TO DISPLAY CURRENT CREW CHIEF DATA FUNCTION

The Display Current CREW CHIEF Data function displays the selected or default values of the parameters used in the execution of the CREW CHIEF functions. Figure 6.1 shows the format.

6.2   USING THE DISPLAY CURRENT CREW CHIEF FUNCTION

To use the Display Current CREW CHIEF Data function, select the CONFIGURATION icon from the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the function to be performed

    EXAMPLE: Select the **CONFIGURATION icon**

    RESULT: New prompt appears.

PROMPT: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/KEY PAGE

    ACTION: Depress the Y/N function key to execute the
             Configuration function

    EXAMPLE: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM CFGUSR EXECUTING appears and
             then a new prompt appears.

CURRENT CREW CHIEF DATA SHEET

PERCENTILE AND GENDER: 50TH PERCENTILE FEMALE

CLOTHING TYPE: JACKET

POSTURE: KNEEL 2 (ON TWO KNEES)

LOCATION OF WORK: (30.00   ,0.00   ,0.00   )

DIRECTON FROM WORK: (5.00   ,0.00   )

DISTANCE OF MAN-MODEL FROM WORK PLANE: 12.00

SUPPORT PLATFORM HEIGHT: 30.00

TOOL SELECTED FOR:

     RIGHT HAND: NONE

     LEFT HAND: NONE

/ MOVE/ SIZE/ BOX/ ROT/ TRUE/ ISO/ OVRLY/ SET// 1/ 2/ 3/ 4/ PLOT/ RESET/

Figure 6.1.   Current CREW CHIEF Data Sheet.

PROMPT: DEFINE CENTER OF DATA SHEET

    ACTION: Indicate a 2-D point to determine where the center
                of the current CREW CHIEF data sheet will appear
                on the screen

    RESULT: The current CREW CHIEF data sheet appears on the
                screen.

After the data sheet appears on the screen, it may be
necessary to increase the size of the data sheet to be viewed
correctly. This can be accomplished by depressing CADAM's window
function key and using the appropriate menu items to view the
data sheet. After the user has viewed the plot, he/she should
depress the ACCESS PFK to continue any analysis.

Figure 6.2 diagrams the actions necessary to execute a
display of the current CREW CHIEF data.

To continue the analysis, the user will generally select
/RECOVER/ from bottom of screen. The CREW CHIEF Main Programs
menu will appear. Another option is also available to the user.
If /KEEP/ is selected, OVERLAY becomes the active drawing.
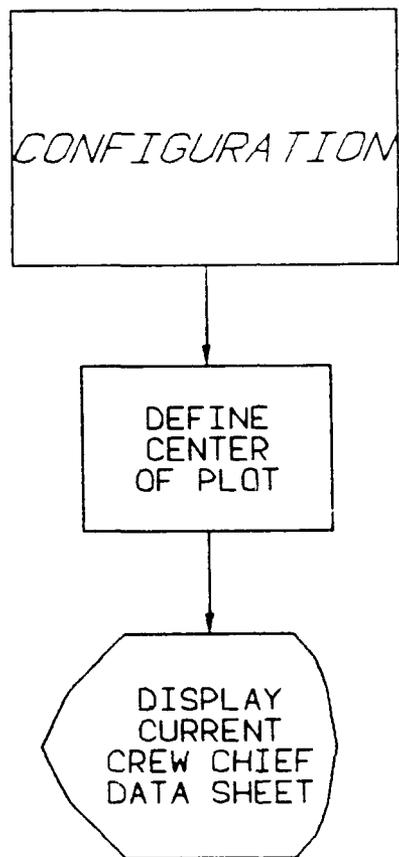
Figure 6.2. Current CREW CHIEF Data Flow Diagram.

SECTION 7

INTERACTIVE HELP CAPABILITIES

7.1 INTRODUCTION TO INTERACTIVE HELP CAPABILITIES

Each CREW CHIEF function includes a series of callable HELP pages, displayed on the screen, to assist in operating the function. These pages give reminders on how to use the function and suggestions concerning the selections to be made, but do not take the place of this user's guide.

The HELP pages cannot be called at will when executing the function. Help is available once a particular CREW CHIEF function is being executed. They can only be called when /HELP/ is displayed in the CADAM-supplied bottom menu.

Once **/HELP/** has been selected, the user will select the **/PAGE FORWARD/** option from the bottom CADAM supplied menu until the desired information is displayed on the screen. To exit HELP the user selects **/EXIT HELP/** from the bottom menu. The CADAM HELP capability has one drawback: the user cannot go directly to the desired HELP page, but instead must wait while each page is sequentially displayed on the screen.

7.2 USING THE INTERACTIVE HELP CAPABILITIES

To call the set of HELP pages for any function:

PROMPT: (These vary from function to function, and always appear at the top of the window.)

 ACTION: Select **/HELP/**, when it is available, from the CADAM-supplied bottom menu. It is available once a particular CREW CHIEF function is being activated.

RESULT: First page of HELP available for a particular
           function is displayed.

   To view the next page:

PROMPT: SEL MENU (These vary from function to function and
         prompt appears at top of page)

   ACTION: Select **/PAGE FORWARD/** from the bottom menu

   RESULT: Subsequent page is displayed.

   Each succeeding page is accessed by selecting **/PAGE
FORWARD/**. When the last page is reached, the /PAGE FORWARD/
selection will display the index page and the order of HELP pages
will begin again. The user exits the HELP mode by selecting
/EXIT HELP/ from the bottom menu. The program returns the user
back to his/her previous location in the interface of the
particular function. Figures 7.1 through 7.7 are typical
examples of HELP pages.
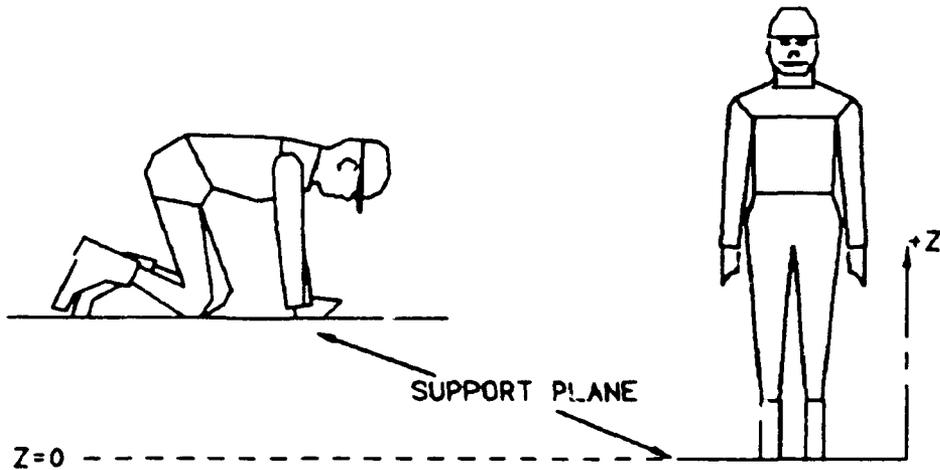
Figure 7.1.   CREW CHIEF Initialization Help Page.

ATTACH VECTOR AND
TOOL HANDLE DIRECTION VECTOR   PAGE 2
- -

ATTACH VECTOR: DEFINES THE POINT OF ATTACHMENT
                OF THE TOOL IN THE WORKPLACE

DIRECTION VECTOR: DEFINES THE DIRECTION THAT
                   THE MAJOR AXIS OF THE TOOL
                   IS TO POINT

          NOTE: THE TAIL POINT FOR THE
          DIRECTION VECTOR IS THE SAME AS
          THAT OF THE ATTACH VECTOR

TAIL POINT OF
ATTACH VECTOR AND
TOOL HANDLE
DIRECTION VECTOR
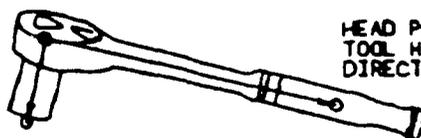
                              HEAD POINT FOR
                              TOOL HANDLE
                              DIRECTION VECTOR

     HEAD POINT OF
     ATTACH VECTOR
     (LOCATION OF NUT/BOLT)

Figure 7.2.   CREW CHIEF Tool Analysis Help Page.

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COEFFICIENT OF FRICTION
BETWEEN SHOES AND SURFACE

SURFACE 1	SURFACE 2	μ
RUBBER	RUBBER (WET)	0.5-0.9
RUBBER	RUBBER (DRY)	0.7-1.0
LEATHER	WOOD	0.2-0.5
LEATHER	METAL	0.3-0.6

MORE HELP AVAILABLE ON NEXT PAGE.

Figure 7.3.   Coefficient of Friction Help Page.

OBJECT DIMENSIONS:

HEIGHT:

OBJECT'S DIMENSION PERPENDICULAR TO THE
SUPPORT PLANE

WIDTH:

OBJECT'S HORIZONTAL DIMENSION PARALLEL
TO THE CREW CHIEF'S BODY

DEPTH:

OBJECT'S DIMENSTON PERPENDICULAR TO THE
CREW CHIEF'S BODY

•• NOTE: FOR IRREGULAR OBJECTS. OTHER ELEMENTS
BESIDES HEIGHT. WIDTH. & DEPTH MAY BE
NEEDED TO DEFINE THE OBJECT'S SURFACE.

MORE HELP AVAILABLE ON NEXT PAGE.

Figure 7.4. Materials Handling Help Page.

VIEWPOINT:

CREWCHIEF'S: VIEW THE WORK STATION FROM
CREW CHIEF'S ORIENTATION

INCLUDE MAN/EXCLUDE MAN: CHOOSE THIS TO CHECK
FOR BODY PART INTERFERENCE IN THE
VIEWING PROCESS.

MORE HELP AVAILABLE ON NEXT PAGE

Figure 7.5. CREW CHIEF Visibility Analysis Help Page.

CENTER OF PLOT

2-DIMENSIONAL CADAM POINT DEFINING WHERE
THE CENTER OF THE STRENGTH TABLE WILL
APPEAR ON THE SCREEN.

DISPLAY TYPE

WIRE: WIRE FRAME MODEL WILL BE DISPLAYED.

FRONT: WIRE FRAME MODEL WITH BACK FACES REMOVED.

PROFILE: WIRE FRAME MODEL WITH BACK FACES AND

             INTERIOR LINES REMOVED.

REPOSITION: WIRE FRAME MODEL WITH EXTRA LINE SEGMENTS

             TO AID REPOSITIONING PROCESS.

END OF HELP FOR CONNECTOR ANALYSIS

Figure 7.6.   Connector Analysis Help Page.

DESCRIPTION OF ENVELOPE TYPES:

SWEPT VOLUME - FULL SWEEP OF TOOL HANDLE
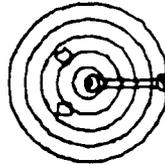
TOOL ENVELOPE - OBSTRUCTED SWEEP OF TOOL HANDLE

OBSTRUCTIONS
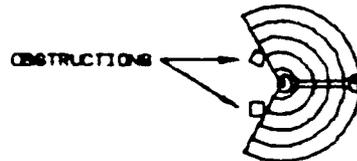
WORK ENVELOPE - PORTION OF TOOL ENVELOPE WITHIN
REACH OF MAN-MODEL

ARM FULLY EXTENDED
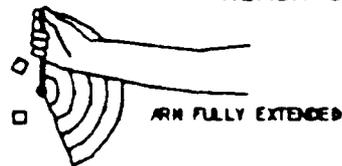
DEFAULT ENVELOPE TYPE IS TOOL ENVELOPE.
MORE HELP AVAILABLE ON NEXT PAGE.

Figure 7.7.   Work Envelope Help Table Depicting Difference
Between Work Envelope Types.

SECTION 8

QUICK REFERENCE

This Quick Reference Section is provided as an outline of the actions which can be taken for any given function. The Section is divided into each of the eleven different functions. All function prompts begin from the CREW CHIEF Main Programs menu (Figure 1.3). All prompts appear at the top of the window and all menus appears either on the screen or at the bottom of the window.

8.1 CREW CHIEF GENERATION FUNCTIONS

8.1.1 CREW CHIEF Initialization Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **GENERATION icon**

    RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **INITIALIZATION icon**

    RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM INIUSR EXECUTING appears and then the Body Size menu appears (Figure 2.2).

PROMPT 4: SELECT DESIRED BODY SIZE

    ACTION: Select the icon representing the body size and gender of the man-model (see Appendix A)

    RESULT: Clothing menu appears (Figure 2.3).

PROMPT 5:   SELECT DESIRED CLOTHING TYPE

    ACTION: Select the icon representing the type of
                  clothing to be worn by the man-model (see
                  Appendix B)
    RESULT: Posture menu appears (Figure 2.4).

PROMPT 6:   SELECT DESIRED POSTURE

    ACTION: Select the icon representing the starting
                  posture of the man-model (see Appendix C).

    RESULT: Position mode menu appears.

PROMPT 7:   SELECT DESIRED POSITION MODE

    ACTION 1:   Select **NEW POSITION AND ORIENTATION** to
                  define the man-model at a new position and
                  orientation

    RESULT: Prompt to define location of work appears.

    ACTION 2:   Select **OLD POSITION AND ORIENTATION** to place
                  the man-model in the same location and
                  orientation as previously defined during
                  Initialization.

    RESULT: Display Type Selection menu appears (Go to
                  Prompt 14).

    ACTION 3:   Select **CURRENT POSITION AND ORIENTATION** to
                  redisplay the man-model in the current saved
                  position and orientation.

    RESULT: Display Type Selection menu appears (Go to
                  Prompt 14).

PROMPT 8:   DEFINE POINT FOR LOCATION OF WORK

    ACTION: Select an existing 3-D point of the location
                  of work <u>or</u> key in the X,Y,Z coordinates of
                  the location of work **<CR>**

    RESULT: Prompt for direction of man-model to work
                  appears.

PROMPT 9: DEFINE POINT FOR DIRECTION FROM WORK

    ACTION: Select an existing point to define the
                  direction point <u>or</u> key in the X,Y,Z
                  coordinates of the direction point <CR>

    RESULT: Prompt to key in distance from work appears.

PROMPT 10: KEY IN DISTANCE FROM WORK

    ACTION: Key in distance from work <CR>

    RESULT: Menu for defining mode to input platform
                  height appears.

PROMPT 11: SELECT PLATFORM INPUT MODE

    ACTION 1: Choose **SELECT WORK PLATFORM POINT** to define
                  an existing 3-D point in the drawing.

    RESULT: Prompt to select platform height from
                  drawing appears.

    ACTION 2: Select **KEY IN PLATFORM HEIGHT** to key in the
                  height of the support platform.

    RESULT: Prompt to key in platform height appears
                  (Go to Prompt 13).

PROMPT 12: DEFINE POINT ON PLATFORM

    ACTION: Select an existing 3-D point (Z coordinate).

    RESULT: Display Type menu appears (Go to Prompt 14).

PROMPT 13: KEY IN PLATFORM HEIGHT

    ACTION: Key in platform height (Z coordinate) <CR>.

    RESULT: Display Type menu appears.

PROMPT 14: SELECT DESIRED DISPLAY TYPE

    ACTION: Select a display type (see Table 2.1)

    RESULT: Man-model appears superimposed on the drawing
                  in size-gender, posture, clothing, and
                  display type chosen; a CADAM menu appears.

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PROMPT 15: SEL MENU

    ACTION: Select **/RECOVER/** to return to the CREW
                  CHIEF Generation Functions menu (Figure 2.1)

    RESULT: Program returns to CREW CHIEF Generation
                  Functions menu (Figure 2.1).

8.1.2   <u>CREW CHIEF Regeneration Function</u>

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **GENERATION icon**

    RESULT: CREW CHIEF Generation Functions menu (Figure
                  2.1) is displayed.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **REGENERATION icon**

    RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM REGUSR EXECUTING appears
                  and then the Display Type menu appears.

PROMPT 4: SELECT DESIRED DISPLAY TYPE

    ACTION: Select a display type (see Table 2.1)

    RESULT: Man-model appears on the drawing in the
                  display type chosen and as it did in the last
                  successful generation; a CADAM menu appears.

PROMPT 5: SEL MENU

    ACTION: Select **/RECOVER/** to return to the CREW CHIEF
                  Generation Functions menu (Figure 2.1)

    RESULT: Program returns to CREW CHIEF Generation
                  Functions menu (Figure 2.1).

8.1.3   CREW CHIEF Reposition Function

PROMPT 1:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **GENERATION icon**

    RESULT: The CREW CHIEF Generation Functions menu is
              displayed (see Figure 2.1).

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **REPOSITION icon**

    RESULT: New prompt appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM RPNUSR EXECUTING appears,
              man-model is initialized in the last successful
              positioning and appears in the drawing, and
              then a new prompt appears.

PROMPT 4:   SELECT THE OPTION YOU WISH TO USE

    ACTION 1: Select **REORIENT A MAN-MODEL SEGMENT** to rotate
             and/or twist specific segments of the man-
             model

    RESULT: Prompt to select man-model segment to reorient
              appears.

    ACTION 2: Select **DEFINE NEW POSITION REFERENCE POINT**
             to define a new position reference point on
             the man-model. Figure 2.6 defines the
             position reference point for each posture.

    RESULT: Prompt to define new position reference point
              appears   (Go to Prompt 11).

    ACTION 3: Select **REORIENT THE ENTIRE MAN-MODEL** to
             define a new support platform or rotate
             entire man-model.

    RESULT: Menu to tilt support or rotate the entire man-
              model appears   (Go to Prompt 12).

    ACTION 4: Select **SQUAT FROM AN UPRIGHT POSTURE** to
             allow the man-model to be positioned in a
             squat posture.

RESULT: Prompt to key in angle of knees appears
           (Go to Prompt 16).

PROMPT 5:   SELECT MAN-MODEL SEGMENT YOU WISH TO REORIENT

    ACTION: Select the body segment you wish to to flex
               or twist. The user may select one of the
               options from the bottom menu at any time.

    RESULT 1: Menu to select option for flexing or
               twisting selected segment appears.

    RESULT 2: New main menu appears (Result of choosing
               /TO PREVIOUS MENU/ from bottom menu. The
               man-model has been repositioned at this
               time) (Go to Prompt 9).

    RESULT 3: Main menu appears (Result of choosing /TO
               PREVIOUS MENU/ from bottom menu without
               repositioning the man-model) (Go to Prompt
               4).

PROMPT 6:   SELECT THE OPTION YOU WISH TO USE

    ACTION: Select option whether to flex or twist the
               selected segment. If the user is satisfied
               with the location of a specified segment he
               may select one of the options from the
               bottom menu.

    RESULT 1: Prompt to key in the angle of flexion appears
               (Result of choosing FLEX).

    RESULT 2: Prompt to key in the angle of twist appears
               (Result of choosing TWIST) (Go to Prompt
               10).

    RESULT 3: Prompt to select man-model to reorient
               appears (Result of choosing /TO PREVIOUS
               MENU/ from bottom menu) (Go to Prompt 5).

PROMPT 7:   KEY IN INCREMENT FOR FLEXED ANGLE IN DEGREES

    ACTION: Key in the angle of flexion in degrees <CR>.
               The default is ten degrees and can be
               obtained by <CR>.

    RESULT: Man-model reappears on screen with selected
               body segment flexed by amount of degrees
               specified. Then prompt to key in new angle
               appears.

PROMPT 8:   KEY IN INCREMENT FOR THE FLEXED ANGLE IN DEGREES

       ACTION: Key in a new angle of flexion or rotation or
                        <CR> for same angle. If the user is
                        satisfied with the location of the body
                        segment, he can select **/TO PREVIOUS MENU/**
                        from the bottom menu. This will return him
                        to a new menu.

       RESULT 1: Man-model reappears on screen with selected body
                        segment flexed or rotated by amount of degrees
                        specified. This same prompt stays active
                        (Result of keying in a new angle). (Go to
                        Prompt 8.)

       RESULT 2: Menu to select Flex or Twist man-model
                        segment appears (Result of choosing /TO
                        PREVIOUS MENU/ from bottom menu) (Go to
                        Prompt 6).

PROMPT 9:   SELECT THE OPTION YOU WISH TO USE

       ACTION 1: Select **ABORT CURRENT MAN-MODEL AND RECOVER**
                        to recover position of man-model before last
                        save command was given

       RESULT: Main menu appears (Go to Prompt 4).

       ACTION 2: Select **REORIENT A MAN-MODEL SEGMENT** to
                        rotate and/or flex specific segments of the
                        man-model

       RESULT: Prompt to select man-model segment to
                        reorient appears. (Go to Prompt 5).

       ACTION 3: Select **DEFINE NEW POSITION REFERENCE POINT**
                        to define a new position reference point on
                        the man-model. Figure 2.6 defines the
                        position reference point for each posture.

       RESULT: Prompt to define new position reference
                        point appears (Go to Prompt 11).

       ACTION 4: Select **REORIENT THE ENTIRE MAN-MODEL** to
                        define a new support platform or rotate
                        entire man-model.

       RESULT: Menu to tilt support or rotate the entire
                        man-model appears (Go to Prompt 12).

ACTION 5: Select **SQUAT FROM AN UPRIGHT POSTURE** to allow the man-model to be positioned in a squat posture.

RESULT: Prompt to key in angle of knees appears (Go to Prompt 16).

ACTION 6: Select **/EXIT FUNCTION/** from bottom menu to exit Reposition function.

RESULT 1: Menu option to save current man-model or exit function without saving appears (Result of repositioning the man-model) (Go to Prompt 17).

RESULT 2: CADAM menu appears (Result of not repositioning the man-model after saving) (Go to Prompt 18).

PROMPT 10: KEY IN INCREMENT FOR TWISTED ANGLE IN DEGREES

ACTION: Key in the angle of twist in degrees **<CR>**. The default is ten degrees and can be obtained by **<CR>**. If the user is satisfied with the location of the body segment he can select /TO PREVIOUS MENU/ from the bottom menu

RESULT 1: Man-model reappears on screen with selected body segment twisted by amount of degrees specified. This same Prompt stays active (Result of keying in new angle) (Go to Prompt 10).

RESULT 2: Menu to select flex or twist man-model segment appears (Result of choosing /TO PREVIOUS MENU/ from bottom screen) (Go to Prompt 6).

PROMPT 11: DEFINE NEW POSITION REFERENCE POINT

ACTION: Select an existing 3-D point to define the new position reference point or key in the X,Y,Z coordinates to define the new position reference point **<CR>**. If the user is satisfied with the position reference point, he can select /TO PREVIOUS MENU/ from the bottom menu

RESULT 1: Man-model reappears moved to the new position reference point. Same prompt appears. (Go to prompt 11).

RESULT 2: New main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu. The man-model has been repositioned at this time) (Go to Prompt 9).

RESULT 3: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model) (Go to Prompt 4).

PROMPT 12: SELECT OPTION YOU WISH TO USE

ACTION 1: Select **TILT THE SUPPORT PLATFORM**

RESULT: Prompt to select the tilting axis appears.

ACTION 2: Select **ROTATE THE ENTIRE MAN-MODEL**

RESULT: Prompt to key in angle to rotate man-model appears. (Go to prompt 15.)

ACTION 3: Select /TO PREVIOUS MENU/ to return to previous menu

RESULT 1: New Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu. The man-model has been repositioned at this time) (Go to Prompt 9).

RESULT 2: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model (Go to Prompt 4).

PROMPT 13: SELECT THE TILTING AXIS YOU WISH TO USE

ACTION: Select a line segment representing the tilting axis. If the user is satisfied with the tilt of the support platform, he can select to previous menu from the bottom menu.

RESULT 1: Prompt to key in angle to tilt platform appears.

RESULT 2: Menu to tilt the support platform or rotate the entire man-model appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu (Go to Prompt 12).

PROMPT 14: KEY IN INCREMENT FOR TILTED ANGLE IN DEGREES

    ACTION: Key in the angle to tilt the support
platform. The default is 10 degrees and can
be obtained by **<CR>**. If the user is
satisfied with the tilt of the support
platform he can choose /TO PREVIOUS MENU/
from the bottom menu.

    RESULT 1: Man-model reappears moved onto new support
platform. Same prompt appears (Go to
Prompt 14).

    RESULT 2: Prompt to select tilted axis appears (Result
of choosing /TO PREVIOUS MENU/) (Go to
Prompt 13).

PROMPT 15: KEY IN ANGLE TO ROTATE MAN-MODEL IN DEGREES

    ACTION: Key in angle to rotate the man-model. The
default is 10 degrees and can be obtained by
<CR>. If the user is satisfied with the
position of the man-model he can select /TO
PREVIOUS MENU/ from the bottom menu.

    RESULT 1: Man-model is rotated by angle specified.
Same Prompt appears (Go to Prompt 15).

    RESULT 2: Menu to tilt the support platform or rotate
the entire man-model appears (Result of
choosing /TO PREVIOUS MENU/ from bottom
menu) (Go to Prompt 12).

PROMPT 16: KEY IN THE DESIRED KNEE ANGLE IN DEGREES

    ACTION: Key in angle needed for bending the knees.
If the user is satisfied with the position
of the man-model he can select /TO PREVIOUS
MENU/ from bottom menu.

    RESULT 1: This same prompt appears to key in another
angle (Result of keying in another angle).
(Go to Prompt 16.)

    RESULT 2: New main menu appears (Result of choosing
/TO PREVIOUS MENU/ from bottom menu. The
man-model has been repositioned at this
time) (Go to Prompt 9).

RESULT 3: Main menu appears (Result of choosing /TO PREVIOUS MENU/ from bottom menu without repositioning the man-model) (Go to Prompt 4).

PROMPT 17: SELECT THE OPTION YOU WISH TO USE

ACTION 1: Select **SAVE THE MAN-MODEL AND RESUME THE FUNCTION**

RESULT: Main menu appears (Go to Prompt 4).

ACTION 2: Select **SAVE THE MAN-MODEL AND EXIT THE FUNCTION**

RESULT: CADAM menu appears.

ACTION 3: Select **EXIT FUNCTION WITHOUT SAVING**

RESULT: CADAM menu appears

PROMPT 18: SEL MENU

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/RECOVER/** will return the user to the CREW CHIEF Generation Functions

RESULT: Program returns to CREW CHIEF Generation Functions menu.

8.1.4   <u>CREW CHIEF Head Orientation Function</u>

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **GENERATION icon**

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **HEAD ORIENTATION icon**

RESULT: New prompt appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM HDOUSR EXECUTING appears
               and then prompt to define target point
               appears.

PROMPT 4:   DEFINE TARGET POINT

    ACTION: Select an existing 3-D point to define the
               target point <u>or</u> key in X,Y,Z coordinates of
               the target point **<CR>**

    RESULT: Display type menu appears.

PROMPT 5:   SELECT DESIRED DISPLAY TYPE

    ACTION: Select a display type (see Table 2.1)

    RESULT: Man-model appears superimposed in the
               display type chosen, with its head oriented
               toward the target point; CADAM menu appears.

PROMPT 6:   SEL MENU

    ACTION: Select **/RECOVER/** to return to the CREW CHIEF
               Generation Functions menu (Figure 2.1)

    RESULT: Program returns to CREW CHIEF Generation
               Functions menu (Figure 2.1).

8.2   MAINTENANCE TASK ANALYSES

8.2.1   <u>CREW CHIEF Tool Analysis Function</u>

    8.2.1.1   Wrenches Without Sockets: Open End, Combination End,
             Standard Box End, Deep Offset Box End, Ratcheting
             Box End, and Allen

PROMPT 1:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TASK ANALYSIS icon**

    RESULT: CREW CHIEF Task Analyses Function menu
               (Figure 3.1) appears.

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TOOL ANALYSIS icon**

    RESULT: New prompt appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears
             and then Tool Selection menu (Figure 3.2)
             appears.

PROMPT 4:   SELECT TOOL CLASS

    ACTION: Select **WRENCHES** from menu

    RESULT: Wrench Selection menu (Figure 3.3) appears.

PROMPT 5:   SELECT WRENCHES

    ACTION: Select a type of wrench from the menu

    RESULT: Bolt diameter menu appears.

PROMPT 6:   SELECT BOLT DIAMETER

    ACTION: Select the size corresponding to bolt
             diameter to be used in the analysis

    RESULT 1: Hand Selection menu (Figure 3.5) appears
             (Result of selecting a bolt diameter that
             will need a large enough wrench to use one
             or both hands).

    RESULT 2: Hand Selection menu (Figure 3.16) appears
             (Result of selecting a bolt diameter that
             will need a small wrench).

PROMPT 7:   SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool

    RESULT: Grip Selection menu appears.

PROMPT 8:   SELECT GRIP TYPE

    ACTION: Select the grip type to be used

    RESULT: Prompt to define head point of attach vector
                appears.

PROMPT 9:   DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
                bolt head or key in X,Y,Z coordinates which
                define center point of bolt head **<CR>**

    RESULT: Prompt to define tail point of attach vector
                appears.

PROMPT 10: DEFINE TAIL POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
                orientation of bolt axis or key in the X,Y,Z
                coordinates of bolt axis
    RESULT: Prompt to define direction of tool handle
                appears.

PROMPT 11: DEFINE DIRECTION OF TOOL HANDLE

    ACTION: Select an existing 3-D point to define the
                tool handle direction or key in X,Y,Z
                coordinates of handle direction point **<CR>**

    RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 12: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types to be used
                during the Reach analysis

    RESULT 1: Prompt for center of plot appears (Result of
                choosing a wrench that has strength information).

    RESULT 2: Obstacle Avoidance menu appears (Result of
                choosing an allen wrench which has no
                strength information). (Go to Prompt 14.)

PROMPT 13: DEFINE POINT FOR CENTER OF STRENGTH

  ACTION: Indicate a 2-D point to determine where the
       center of the strength-related measurements
       table will appear on the screen.

  RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SELECT OBSTACLE AVOIDANCE DESIRED

  ACTION: Select one of the obstacle avoidance choices

  RESULT: Display Type menu appears.

PROMPT 15: SELECT DESIRED DISPLAY TYPE

  ACTION: Select one of the display types (Table 2.1)

  RESULT 1: If task is successful, man-model appears on
       the drawing performing the task; CADAM menu
       appears.

  RESULT 2: If task is unsuccessful because distance
       from man-model to task is too great, man-
       model appears on drawing attempting to
       perform task; missed distance appears on
       screen; CADAM menu appears.
  RESULT 3: If unsuccessful due to interference, arrows
       are displayed indicating points of
       interference; CADAM menu appears.

PROMPT 16: SEL MENU

  ACTION: Select **/RECOVER/** from bottom menu to continue
       any analysis

  RESULT: Task Analysis Function menu (Figure 3.1)
       appears.

8.2.1.2 Wrenches With Sockets: Breaker Bar, Torque,
     Ratchet, and Speedhandle

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

  ACTION: Select the **TASK ANALYSIS icon**

  RESULT: CREW CHIEF Task Analyses Function menu
       (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TOOL ANALYSIS icon**

    RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears
         and then Tool Selection menu (Figure 3.2)
         appears.

PROMPT 4: SELECT TOOL CLASS

    ACTION: Select **WRENCHES** from menu

    RESULT: Wrench Selection menu (Figure 3.3) appears.

PROMPT 5: SELECT WRENCHES

    ACTION: Select a type of wrench from the menu

    RESULT 1: Extension menu (Figure 3.9) appears (Result
         of selecting ratchet, torque or breaker bar).

    RESULT 2: Socket Selection menu (Figure 3.10) appears
         (Result of selecting speedhandle). (Go to
         Prompt 7.)

PROMPT 6: SELECT EXTENSION

    ACTION: Select desired extension length

    RESULT: Socket Type menu (Figure 3.10) appears.

PROMPT 7: SELECT SOCKET

    ACTION: Select desired socket type

    RESULT: Drive Size menu appears.

PROMPT 8:   SELECT DRIVE SIZE

    ACTION: Select the range corresponding to the bolt
               diameter to be used in the analysis. The
               drive size of the socket may be selected
               instead of the bolt diameter.

    RESULT: Head size selection menu appears.

PROMPT 9:   SELECT HEAD SIZE

    ACTION: Select the size corresponding to the bolt
               head

    RESULT 1: Tool handle selection menu appears.

    RESULT 2: GRIP Type Selection menu appears (Result of
               choosing a speedhandle) (Go to Prompt 12).

PROMPT 10: SELECT HANDLE LENGTH

    ACTION: Select the length of the wrench handle
               (regular or long) to be used in the analysis

    RESULT: Hand Type Selection menu (Figure 3.5)
               appears.

PROMPT 11: SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool
    RESULT: Grip Type Selection menu appears.
PROMPT 12: SELECT GRIP TYPE

    ACTION: Select the grip type to be used

    RESULT: Prompt to define head point of attach vector
               appears.

PROMPT 13: DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
               center point of bolt head or key in X,Y,Z

               coordinates which define center point of bolt
               head **<CR>**

    RESULT: Prompt to define tail point of attach vector
               appears.

PROMPT 14: DEFINE TAIL POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
                orientation of the bolt axis or key in the
                X,Y,Z coordinates to define the orientation
                cf the bolt axis **<CR>**

    RESULT: Prompt to define direction of tool handle
                appears.

PROMPT 15: DEFINE DIRECTION OF TOOL HANDLE

    ACTION: Select an existing 3-D point to define the
                tool handle direction <u>or</u> key in X,Y,Z
                coordinates of the tool handle direction
                point **<CR>**

    RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 16: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of mobility types to be used
                during the Reach analysis

    RESULT 1: Prompt for center of plot appears (Result of
                choosing a wrench which has a torque table
                to be displayed).

    RESULT 2: Menu for obstacle avoidance appears (Result
                of choosing a speed handle). (Go to Prompt
                18.)

PROMPT 17: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a 2-D point to determine where the
                center of the strength-related measurements
                table will appear on the screen

    RESULT: Menu for obstacle avoidance appears.

PROMPT 18: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices

    RESULT: Display type menu appears.

PROMPT 19: SELECT DESIRED DISPLAY TYPE

      ACTION: Select one of the display types (Table 2.1)

      RESULT 1: If task is successful, man-model along with table (if applicable) appears on the drawing performing the task; CADAM menu appears.

      RESULT 2: If task is unsuccessful because the distance from the man-model to the task is too great, then man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

      RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 20: SEL MENU

      ACTION: Select **/RECOVER/** to continue any analysis

      RESULT: Task Analysis Function menu (Figure 3.1) appears.

8.2.1.3 Screwdrivers: Flat Bladed and Offset

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

      ACTION: Select the **TASK ANALYSIS icon**

      RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

      ACTION: Select the **TOOL ANALYSIS icon**

      RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

      ACTION: Depress the **Y/N** function key

      RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears and then Tool Selection menu (Figure 3.2) appears.

PROMPT 4:   SELECT TOOL CLASS

    ACTION: Select **SCREWDRIVERS** from menu

    RESULT: Screwdriver Selection menu (Figure 3.14)
                 appears.

PROMPT 5:   SELECT SCREWDRIVERS

    ACTION1: Select type of screwdriver to be used in the
                 analysis

    RESULT: Blade Length Selection menu appears.

PROMPT 6:   SELECT BLADE LENGTH

    ACTION: Select blade length to be used in the
                 analysis

    RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 7:   SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool

    RESULT: Grip Selection menu appears.

PROMPT 8:   SELECT GRIP TYPE

    ACTION: Select the grip type to be used

    RESULT: Prompt to define head point of attach vector
                 appears.

PROMPT 9:   DEFINE HEAD POINT OF ATTACH VECTOR
    ACTION: Select an existing 3-D point to define the
                 center point of attachment or key in X,Y,Z
                 coordinates which define center point of
                 attachment **<CR>**

    RESULT: Prompt to define tail point of attach vector
                 appears.

PROMPT 10: DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the orientation of the screw axis or key in the X,Y,Z coordinates to define the orientation of the screw axis <CR>

RESULT 1: Mobility Type Selection menu (Figure 3.7) appears (Result of choosing a flat bladed screwdriver). (Go to Prompt 12.)

RESULT 2: Prompt to define direction of tool handle appears (Result of choosing OFFSET screwdriver).

PROMPT 11: DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the direction of tool handle or key in the

X,Y,Z coordinates to define the direction of the tool handle <CR>

RESULT: Mobility Type Selection menu (Figure 3.7) appears.

PROMPT 12: SELECT MOBILITY TO BE USED DURING TASK

ACTION: Select the mobility type to be used during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 13: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display Type menu appears.

PROMPT 14: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)
RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

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RESULT 3: If unsuccessful due to interference, arrows
          are displayed indicating points of
          interference; CADAM menu appears.

PROMPT 15: SEL MENU

    ACTION: Select **/RECOVER/** to continue any analysis

        RESULT: Task Analysis Function menu (Figure 3.1)
        appears.

8.2.1.4 Pliers: Combination, Needle Nose, Safety,
        Adjustable, and Wire Cutters

PROMPT 1:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TASK ANALYSIS icon**

    RESULT: CREW CHIEF Task Analyses Function menu
        (Figure 3.1) appears.

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TOOL ANALYSIS icon**

    RESULT: New prompt appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears
        and then Tool Selection menu (Figure 3.2)
        appears.

PROMPT 4:   SELECT TOOL CLASS

    ACTION: Select **PLIERS** from menu
    RESULT: Pliers Selection menu (Figure 3.19) appears.

PROMPT 5:   SELECT PLIERS

    ACTION: Select the type of pliers to be used in the
        analysis from menu

    RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 6:   SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool

    RESULT: Grip Type Selection menu appears.

PROMPT 7:   SELECT GRIP TYPE

    ACTION: Select the grip type to be used

    RESULT: Prompt to define head point of attach
                appears.

PROMPT 8:   DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
                center point of attachment or key in X,Y,Z
                coordinates which define center point of
                attachment <CR>

    RESULT: Prompt to define tail point of attach vector
                appears.

PROMPT 9:   DEFINE TAIL POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
                direction of the point of attachment or key in
                the X,Y,Z coordinates to define the direction
                of the point of attachment <CR>

    RESULT: Prompt to define direction of tool handle
                appears.

PROMPT 10:   DEFINE DIRECTION OF TOOL HANDLE

    ACTION: Select an existing 3-D point to define the
                direction of tool handle or key in X,Y,Z
                coordinates of the direction of tool handle
                <CR>
    RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 11: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select the mobility type to use during the
                Reach analysis

    RESULT: Menu for obstacle avoidance appears.

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PROMPT 12: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices

    RESULT: Display Type menu appears.

PROMPT 13: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types (Table 2.1)

    RESULT 1: If task is successful, man-model appears on
              the drawing performing task; CADAM menu
              appears.

    RESULT 2: If task is unsuccessful because distance
              from man-model to task is too great, man-
              model appears on drawing attempting to
              perform task; missed distance appears on
              screen; CADAM menu appears.

    RESULT 3: If unsuccessful due to interference, arrows
              are displayed indicating points of
              interference; CADAM menu appears.

PROMPT 14: SEL MENU

    ACTION: Select **/RECOVER/** to continue any analysis

    RESULT: Task Analysis Function menu (Figure 3.1)
              appears.

8.2.1.5 Miscellaneous Tools: Nutdriver, Hammer, File,
          Scraper, Hacksaw, Drill, and Sander

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TASK ANALYSIS icon**

    RESULT: CREW CHIEF Task Analyses Function menu
              (Figure 3.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TOOL ANALYSIS icon**

    RESULT: New prompt appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM TANUSR EXECUTING appears
             and then Tool Selection menu (Figure 3.2)
             appears.

PROMPT 4:   SELECT TOOL CLASS

    ACTION: Select **MISCELLANEOUS** from menu

    RESULT: Miscellaneous Selection menu (Figure 3.22)
             appears.

PROMPT 5:   SELECT MISCELLANEOUS TOOLS

    ACTION: Select the tool to be used in the analysis

    RESULT 1:   Hand selection menu (Figure 3.16) appears
             (Result of choosing scraper, hacksaw, or
             drill).   (Go to Prompt 8.)

    RESULT 2:   Prompt to define head point of attach
             vectors appears (Result of choosing file or
             sander).   (Go to Prompt 10.)

    RESULT 3:   Chisel Selection Menu appears (Result of
             choosing a hammer).

    RESULT 4:   Bolt Diameter Selection menu for nutdriver
             appears (Result of choosing a nutdriver).
             (Go to Prompt 7).

PROMPT 6:   SELECT CHISEL

    ACTION: Select option to decide if chisel is to be
             used with the hammer in the analysis

    RESULT: Hand Selection menu (Figure 3.16) appears.
             (Go to Prompt 8.)

PROMPT 7:   SELECT BOLT DIAMETER

    ACTION: Select the size corresponding to the bolt
             diameter to be used in analysis

    RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 8:   SELECT HAND TO BE USED DURING TASK

    ACTION: Select which hand will hold the tool

    RESULT 1: Prompt for head point of attach vector
          appears.   (Go to Prompt 10.)

    RESULT 2: Grip Type Selection menu for nutdriver
          appears.

PROMPT 9:   SELECT GRIP TYPE

    ACTION: Select the grip to be used in the analysis

    RESULT: Prompt for head point of attach vector
          appears.

PROMPT 10: DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
          center point of attachment or key in X,Y,Z
          coordinates which define center point of
          attachment **<CR>**

    RESULT: Prompt to define tail point of attach vector
          appears.

PROMPT 11: DEFINE TAIL POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point to define the
          direction of the point of attachment or key in
          the X,Y,Z coordinates to define the direction
          of the point of attachment **<CR>**

    RESULT 1: Prompt to define direction of tool handle
          appears.

    RESULT 2: Mobility Type menu (Figure 3.7) appears.
          (Result of choosing a Nutdriver or File).
          (Go to prompt 13.)

PROMPT 12: DEFINE DIRECTION OF TOOL HANDLE

    ACTION: Select an existing 3-D point to define the
          direction of tool handle or key in X,Y,Z coor-
          dinates of the direction of tool handle **<CR>**

    RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 13: SELECT MOBILITY TO BE USED DURING TASK

        ACTION: Select the mobility type to be used during
                      the Reach analysis

        RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SELECT OBSTACLE AVOIDANCE DESIRED

        ACTION: Select one of the obstacle avoidance choices

        RESULT: Display Type menu appears.

PROMPT 15: SELECT DESIRED DISPLAY TYPE

        ACTION: Select one of the display types (Table 2.1)

        RESULT 1: If task is successful, man-model appears on
                    the drawing performing task; CADAM menu appears.

        RESULT 2: If task is unsuccessful because distance
                    from man-model to task is too great, man-
                    model appears on drawing attempting to
                    perform task; missed distance appears on
                    screen; CADAM menu appears.

        RESULT 3: If unsuccessful due to interference, arrows
                    are displayed indicating points of
                    interference; CADAM menu appears.

PROMPT 16: SEL MENU

        ACTION: Select **/RECOVER/** to continue any analysis

        RESULT: Task Analysis Function menu (Figure 3.1)
                      appears.

8.2.2   **Materials Handling Analysis Function**

8.2.2.1   Carry

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

        ACTION: Select the **TASK ANALYSIS icon**

        RESULT: CREW CHIEF Task Analyses Function menu
                      (Figure 3.1) appears.

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **MATERIALS HANDLING icon**

    RESULT: Materials Handling menu (Figure 3.24)
             appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **CARRY icon**

    RESULT: New prompt appears.

PROMPT 4:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM CRYUSR EXECUTING appears
             and then the Handle Selection menu (Figure
             3.25) appears.

PROMPT 5:   SELECT NUMBER OF HANDLES TO BE USED DURING TASK

    ACTION: Select the number of handles to be used

    RESULT 1:   Menu to select process for defining ceiling
             height appears (Result of selecting NO
             HANDLES or TWO HANDLES). (Go to Prompt 7.)

    RESULT 2:   Arm Selection menu (Figure 3.27) appears
             (Result of selecting ONE HANDLE).

PROMPT 6:   SELECT ARM TO BE USED DURING TASK

    ACTION: Select which arm will perform task

    RESULT: Menu to select mode for defining ceiling
             height appears.

PROMPT 7:   SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING
            CEILING DEFINITION

    ACTION: Select mode for defining the ceiling height

    RESULT 1:   Prompt to select ceiling height appears
             (Result of choosing SELECT ELEMENT TO
             DETERMINE CEILING HEIGHT). (Go to Prompt 9.)

    RESULT 2:   Prompt to key in ceiling height appears
             (Result of choosing KEY IN CEILING HEIGHT).

PROMPT 8: KEY IN CEILING HEIGHT

    ACTION: Key in value which represents ceiling height
                \<CR\>

    RESULT: Prompt to key in object height appears. (Go
                to Prompt 10.)

PROMPT 9: SELECT ELEMENT TO DEFINE CEILING HEIGHT

    ACTION: Select element (line or 2-point spline) in
                drawing to represent ceiling height

    RESULT: Prompt to key in object height appears.

PROMPT 10: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in value representing height of object \<CR\>

    RESULT: Prompt to key in object width appears.

PROMPT 11: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in value representing width of object \<CR\>

    RESULT: Prompt to key in object depth appears.

PROMPT 12: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in value representing depth of object \<CR\>

    RESULT: Prompt to indicate Center of Plot Table
                appears.

PROMPT 13: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a point in the drawing to position
                the center of the strength table

    RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices
                from bottom menu

    RESULT: Display type menu appears.

PROMPT 15: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)
            from bottom menu

RESULT 1:   If carry is successful, man-model along with
            strength table appears on the drawing in the
            final carry position; CADAM menu appears.

RESULT 2:   If carry is unsuccessful because the distance
            from the man-model to the object is too great,
            then man-model appears on drawing attempting
            to perform carry; missed distance appears on
            screen; CADAM menu appears.

RESULT 3:   If unsuccessful due to interference, arrows
            are displayed indicating points of
            interference; CADAM menu appears.

RESULT 4:   If the element selected to define a ceiling
            was not a line segment or a two-point
            spline, then the CARRY Task is abandoned and
            the message "ILLEGAL ELEMENT SELECTED" appears.

RESULT 5:   If the line selected to define the ceiling
            height is parallel to the plane which
            bisects the man-model into right and left
            halves, then no intersection point can be
            found, the ceiling height remains undefined,
            the CARRY Task is abandoned, and the message
            "LINE DEFINING CEILING DOES NOT CROSS MAN-
            MODEL PATH" appears.

RESULT 6:   If the object height is greater than the
            ceiling height, then the CARRY Task is
            abandoned and the message "OBJECT DOES NOT
            FIT UNDER CHOSEN CEILING" appears.

RESULT 7:   If the ceiling height is less than thirty
            percent of the current man-model's stature,
            then no data have been gathered for the
            chosen ceiling height and the message
            "CEILING TOO LOW RELATIVE TO CURRENT MAN-
            MODEL SIZE" appears.

PROMPT 16: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials
            Handling Tasks menu

RESULT: Materials Handling Tasks menu (Figure 3.24)
            appears.

8.2.2.2 Hold

PROMPT 1:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **TASK ANALYSIS icon**

    RESULT: CREW CHIEF Task Analyses Function menu
               (Figure 3.1) appears.

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **MATERIALS HANDLING icon**

    RESULT: Materials Handling menu (Figure 3.24)
               appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **HOLD icon**

    RESULT: New prompt appears.

PROMPT 4:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM HLDUSR EXECUTING appears
               and then the Arm Selection menu (Figure
               3.27) appears.

PROMPT 5:   SELECT ARM TO BE USED DURING TASK

    ACTION: Select which arm will hold the object

    RESULT: Mobility Selection menu (Figure 3.7)
               appears.

PROMPT 6:   SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types to be used
               during the Reach Analysis

    RESULT: Menu to select type of support object is to
               be held against appears.

PROMPT 7:   SELECT TYPE OF SUPPORT OBJECT IS TO BE HELD
            AGAINST

        ACTION: Select which Hold Task Type to use during the
                  analysis

        RESULT 1: Menu to define mode for defining object
                  appears (Result of choosing HOLD AGAINST
                  CEILING). (Go to Prompt 12.)

        RESULT 2: Barrier Selection menu appears (Result of
                  choosing HOLD AGAINST WALL).

PROMPT 8:   SELECT TYPE OF BARRIER INVOLVED IN HOLD TASK

        ACTION: Choose a type of barrier

        RESULT 1: Menu to select mode for object dimensions
                  appears (Result of choosing NO BARRIER
                  INVOLVED or VERTICAL BARRIER BETWEEN OBJECT
                  AND CREW CHIEF). (Go to Prompt 12.)

        RESULT 2: Menu to select mode for defining ceiling
                  height appears (Result of choosing CEILING
                  BARRIER CAUSES UNUSUAL POSTURE).

PROMPT 9:   SELECT WHICH TYPE OF PROCESS TO USE FOR CEILING
            DEFINITION

        ACTION: Select process to define ceiling height

        RESULT 1: Prompt to select ceiling height appears.
                  (Result of choosing SELECT ELEMENT TO
                  DETERMINE CEILING HEIGHT). (Go to Prompt 11.)

        RESULT 2: Prompt to key in ceiling height appears
                  (Result of choosing KEY IN CEILING HEIGHT).

PROMPT 10: KEY IN CEILING HEIGHT
        ACTION: Key in value which represents the ceiling
                  height

        RESULT: Menu to select mode for object dimensions
                  appears. (Go to Prompt 12.)

PROMPT 11: SELECT ELEMENT TO DEFINE CEILING HEIGHT

        ACTION: Select element from screen which represents
                  the ceiling height
        RESULT: Menu to select mode for object dimensions
                  appears.

PROMPT 12: SELECT WHICH TYPE OF PROCESS TO USE FOR
DEFINING OBJECT

    ACTION: Choose type of process for defining object
dimensions

    RESULT 1: Prompt to key in object height appears.
(Result of choosing KEY IN OBJECT
DIMENSIONS). (Go to Prompt 17.)

    RESULT 2: Prompt to select object height appears
(Result of choosing SELECT OBJECT FROM
SCREEN).

PROMPT 13: SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
OBJECT

    ACTION: Select element in drawing to represent
object height

    RESULT: Prompt to select object width appears.

PROMPT 14: SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
OBJECT

    ACTION: Select element in drawing to represent object
width

    RESULT: Prompt to select object depth appears.

PROMPT 15: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
OBJECT

    ACTION: Select element in drawing to represent object
depth

    RESULT: Prompt to select any other elements to define
object appears.

PROMPT 16: SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
/END/ TO FINISH

    ACTION: Select other elements in the drawing to
define the object; if and when other elements
have been defined, select /**END**/ from bottom
menu

    RESULT: Prompt to indicate center of plot for
strength table appears. (Go to Prompt 24.)

PROMPT 17: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in value representing height of object
                \<CR\>

    RESULT: Prompt to key in object width appears.

PROMPT 18: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in value representing width of object
                \<CR\>

    RESULT: Prompt to key in object depth appears.

PROMPT 19: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in value representing depth of object
                \<CR\>

    RESULT 1: Prompt to select line defining height
           direction appears. (Result of selecting
           HOLD AGAINST WALL.) (Go to Prompt 21.)

    RESULT 2: Prompt to select line defining depth
           direction appears. (Result of selecting
           HOLD AGAINST CEILING.)

PROMPT 20: SELECT LINE DEFINING DEPTH DIRECTION OF OBJECT

    ACTION: Select a line in the drawing which defines
                the direction of the depth dimension of the
                object

    RESULT: Prompt to select width of attach plane
                appears. (Go to Prompt 22.)

PROMPT 21: SELECT LINE DEFINING HEIGHT DIRECTION OF OBJECT

    ACTION: Select a line in the drawing which defines
                the direction of the height dimension of the
                object

    RESULT: Prompt to select width of attach plane
                appears.

PROMPT 22: SELECT LINE DEFINING WIDTH DIRECTION OF OBJECT

    ACTION: Select element in the drawing to represent
                 second line defining attach plane

    RESULT: Prompt to define attach point of object
                 appears.

PROMPT 23: DEFINE ATTACH POINT OF THE OBJECT ON PLANE OF
                ATTACHMENT

    ACTION: Select an existing 3-D point to define
                 coordinates of the object's attach point, or
                 key in X,Y,Z coordinates of object's attach
                 point **\<CR\>**

    RESULT: Prompt to indicate center of plot for
                 strength table appears.

PROMPT 24: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a point in the drawing to position
                 the center of the strength table

    RESULT: Menu for obstacle avoidance appears.

PROMPT 25: SELECT OBSTACLE AVOIDANCE DESIRED

    `CTION: Select one of the obstacle avoidance choices

    RESULT: Display type menu appears.

PROMPT 26: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types (Table 2.1)

    RESULT 1: If hold is successful, man-model along with
                 strength table appear on the drawing in the
                 final hold position: CADAM-supplied menu
                 appears.
    RESULT 2: If hold is unsuccessful because the distance
                 from the man-model to the object is too
                 great, then the man-model appears on drawing
                 attempting to perform hold; missed distance
                 appears on screen; CADAM-supplied menu
                 appears.

    RESULT 3: If unsuccessful due to interference, arrows
                 are displayed indicating points of interference;
                 CADAM-supplied menu appears.

RESULT 4: If a line segment chosen for defining the ceiling height runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; thus the ceiling height remains undefined and the message "LINE DEFINING CEILING HEIGHT DOES NOT INTERSECT MAN-MODEL PLANE" appears.

RESULT 5: If the ceiling and/or the current posture combination does not relate to the current strength data, the Hold task is abandoned and the message "POSTURE AND OBJECT HEIGHT NOT COMPATIBLE WITH PRESENT DATA" appears.

RESULT 6: If any part of the object lies above the ceiling, then the Hold task is abandoned and the message "TOP OF OBJECT GREATER THAN THE USER INPUT CEILING HEIGHT" appears.

RESULT 7: If any one of the object dimensions input is <1 inch, then the Hold task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR THIS SIZE OBJECT" appears.

RESULT 8: If the user has selected or created an object which is impossible for the man-model to reach, then the Hold task is abandoned and the message "SELECTED OBJECT DEFINES DISTANCES TOO LARGE TO REACH" appears.

RESULT 9: If the user picks two line segments which run in the same direction (or exactly opposite directions) to define the attach plane for the object, then the HOLD Task is abandoned and the message "ATTACH PLANE DEFINED IMPROPERLY" appears.

PROMPT 27: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials Handling menu

RESULT: Materials Handling menu (Figure 3.24) appears.

8.2.2.3 Lift

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

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PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **MATERIALS HANDLING icon**

    RESULT: Materials Handling menu (Figure 3.24)
                appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **LIFT icon**

    RESULT·   New prompt appears.

PROMPT 4:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM LFTUSR EXECUTING appears
                and then the Handle Selection menu (Figure
                3.25) appears.

    RESULT: Handle Type Selection menu (Figure 3.29) appears.

PROMPT 5:   SELECT NUMBER OF HANDLES TO BE USED DURING TASK

    ACTION: Select number of handles during lift task

    RESULT 1:   Arm Selection Menu (Figure 3.27) appears
                (Result of choosing ONE HANDLE).

    RESULT 2:   Mobility Type Selection menu (Figure 3.7)
                appears (Result of choosing NO HANDLES).
                (Go to Prompt 7.)

PROMPT 6:   SELECT ARM TO BE USED DURING TASK

    ACTION: Select which arm will lift the object

    RESULT: Mobility Type Selection menu (Figure 3.7)
                appears.

PROMPT 7.   SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types to be used
                during the Reach analysis

    RESULT: Menu for process to define object appears.

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PROMPT 8:   SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING
            OBJECT

     ACTION: Select mode for defining the dimensions of
                the object

     RESULT 1: Prompt to key in object height appears
                (Result of choosing KEY IN OBJECT
                DIMENSION). (Go to Prompt 13.)

     RESULT 2: Prompt to select object height appears
                (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 9:   SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
            OBJECT

     ACTION: Select element in drawing to represent object
                height

     RESULT: Prompt to select object width appears.

PROMPT 10: SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
            OBJECT

     ACTION: Select element in drawing to represent
                object width

     RESULT: Prompt to select object depth appears.

PROMPT 11: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
            OBJECT

     ACTION: Select element in drawing to represent object
                depth

     RESULT: Prompt to select any other elements to define
                object appears.

PROMPT 12: SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
            /END/ TO FINISH

     ACTION: Select other elements in the drawing to
                define the object; if and when other elements
                have been defined, select **/END/** from bottom
                menu

     RESULT 1: Prompt to define first endpoint of handle
                appears (Result of choosing ONE HANDLE).
                (Go to Prompt 20.)

     RESULT 2: Prompt to indicate Center of Plot Table
                appears. (Go to Prompt 22.)

PROMPT 13: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in value representing height of object
             <CR>
             RESULT: Prompt to key in object width
             appears.

PROMPT 14: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in value representing width of object **<CR>**

    RESULT: Prompt to key in object depth appears.

PROMPT 15: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in value representing depth of object **<CR>**

    RESULT: Menu for selecting mode to define lift
             distance appears.

PROMPT 16: SELECT MENU TO DETERMINE HOW TO DEFINE DISTANCES
          FOR OBJECT

    ACTION: Select mode for defining the lift distance.

    RESULT 1: Prompt to key in lift distance appears
          (Result of choosing KEY IN OBJECT
          DISTANCES). (Go to Prompt 18.)

    RESULT 2: Prompt to select lift distance from screen
          appears (Result of choosing SELECT LINE TO
          DEFINE OBJECT DISTANCES).

PROMPT 17: SELECT LINE TO DETERMINE DISTANCES OF OBJECT

    ACTION: Select element from the screen which will
             represent the shelf onto which the object
             will be lifted

        RESULT: Prompt to indicate center of plot for
        strength table appears. (Go to Prompt 22.)

PROMPT 18: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT
          PLATFORM

    ACTION: Key in value which represents the shelf
             height onto which the object will be lifted
             <CR>

    RESULT: Prompt to key in distance object is in front
             of man-model appears.

PROMPT 19:   KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-
               MODEL

     ACTION: Key in value which represents the distance
               from the man-model to the front edge of the
               object <CR>.

     RESULT: Prompt to indicate center of plot for
               strength table appears. (Go to Prompt 22.)

PROMPT 20: DEFINE FIRST ENDPOINT OF FIRST HANDLE

     ACTION: Select an existing 3-D point to define
               End Point of handle or key in X,Y,Z
               coordinates of handle End Point <CR>

     RESULT: Prompt to define second End Point of handle
               appears.

PROMPT 21: DEFINE SECOND ENDPOINT OF FIRST HANDLE

     ACTION: Select an existing 3-D point to define
               coordinates of handle End Point 2
               or key in X,Y,Z coordinates of handle End
               Point 2 <CR>

     RESULT: Prompt to indicate center of plot for
               strength table appears.

PROMPT 22:   DEFINE POINT FOR CENTER OF STRENGTH

     ACTION: Indicate a point in the drawing to position
               the center of the strength table

     RESULT: Menu for obstacle avoidance appears.

PROMPT 23:   SELECT OBSTACLE AVOIDANCE DESIRED

     ACTION: Select one of the obstacle avoidance choices
               from bottom menu

     RESULT: Display type menu appears.

PROMPT 24:   SELECT DESIRED DISPLAY TYPE

     ACTION: Select one of the display types (Table 2.1)
               from bottom menu

     RESULT 1: If lift is successful, man-model along with
               strength table appears on the drawing
               performing the lift; CADAM menu appears.

RESULT 2: If lift is unsuccessful because the distance
from the man-model to the object is too great,
then man-model appears on drawing attempting
to perform lift; missed distance appears on
screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows
are displayed indicating points of
interference; CADAM menu appears.

RESULT 4: If the current posture is neither stand,
sit, squat, kneeling on one knee, nor
kneeling on two knees, then the LIFT Task
is abandoned and the message "NO STRENGTH
DATA AVAILABLE FOR SELECTED POSTURE" appears.

RESULT 5: If the line segment selected to define the
vertical and horizontal distances is
parallel to the plane bisecting the man-
model into two halves, then both distances
remain undefined, the LIFT Task is abandoned
and the message "LINE DEFINING DISTANCES
DOES NOT CROSS MAN-MODEL PATH" appears.

RESULT 6: If the user picks a two hand lift with one
handle, then the LIFT Task is abandoned and
the message "LIFT WITH 1 HANDLE AVAILABLE
FOR 1 ARM LIFT ONLY" appears.

RESULT 7: If the selected line defining the distances
on the keyed distances for the LIFT task are
definitely out of the man-model reach, then
the LIFT Task is abandoned and the message
"SELECTED LINE DEFINES DISTANCES TOO LARGE
FOR REACH" appears.

PROMPT 25: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials
Handling Tasks menu

RESULT: Materials Handling Tasks menu (Figure 3.24)
appears.

8.2.2.4 Push

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu
(Figure 3.1) appears.

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PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **MATERIALS HANDLING icon**

    RESULT: Materials Handling menu (Figure 3.24)
            appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **PUSH icon**

    RESULT: New prompt appears.

PROMPT 4: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM PSHUSR EXECUTING appears
            and then the Mobility Selection menu (Figure
            3.7) appears.

PROMPT 5: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types to be used
            during the Reach analysis

    RESULT: Handle Selection menu (Figure 3.31) appears.

PROMPT 6: SELECT NUMBER OF HANDLES TO BE USED DURING TASK

    ACTION: Select number of handles to be used

    RESULT: Menu for selecting process to define object
            appears

PROMPT 7: SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING
           OBJECT

    ACTION: Select process for defining object.

    RESULT 1: Prompt to key in object height appears
            (Result of choosing KEY IN OBJECT
            DIMENSIONS). (Go to Prompt 12.)

    RESULT 2: Prompt to select object height appears
            (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 8:   SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
            OBJECT

    ACTION: Select element in drawing to represent object
               height

    RESULT: Prompt to select object width appears.

PROMPT 9:   SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
            OBJECT

    ACTION: Select element in drawing to represent object
               width

    RESULT: Prompt to select object depth appears.

PROMPT 10: SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
            OBJECT

    ACTION: Select element in drawing to represent object
               depth

    RESULT: Prompt to select any other elements to define
               object appears.

PROMPT 11: SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
            /END/ TO FINISH

    ACTION: Select other elements in the drawing to
               define the object; if and when other elements
               have been defined, select **/END/** from bottom
               menu

    RESULT 1: Prompt to key in coefficient of friction
               appears (Result of selecting NO HANDLES).
               (Go to Prompt 23.)

    RESULT 2: Prompt to define first endpoint of first handle
               appears (Result of selecting HANDLES).   (Go
               to Prompt 19.)

PROMPT 12: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in value representing height of object
               <CR>

    RESULT: Prompt to key in object width appears.

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PROMPT 13: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in value representing width of object
                \<CR>

    RESULT: Prompt to key in object depth appears.

PROMPT 14: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in value representing depth of object
                \<CR>

    RESULT: Menu to select process for defining Push
                distances

PROMPT 15: SELECT MENU TO DETERMINE HOW TO DEFINE
            DISTANCES FOR OBJECT

    ACTION: Select mode for defining Push distances

    RESULT 1: Prompt to key in height object is from the
                support platform appears (Result of choosing
                KEY IN OBJECT DISTANCES). (Go to Prompt 17.)

    RESULT 2: Prompt to select line to define object
                distances appears (Result of choosing SELECT
                LINE TO DEFINE OBJECT DISTANCES).

PROMPT 16: SELECT LINE TO DETERMINE DISTANCES FOR OBJECT

    ACTION: Select element from screen which represents
                the shelf height where the object will be
                pushed

    RESULT: Prompt to key in coefficient of friction
                appears. (Go to Prompt 23.)

PROMPT 17: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT
            PLATFORM

    ACTION: Key in value which represents the shelf
                height where the object will be pushed **\<CR>**

    RESULT: Prompt to key in distance object is forward
                of man-model appears.

PROMPT 18:   KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-
             MODEL

     ACTION: Key in a value that represents the distance
                      for the push. **<CR>**

     RESULT: Prompt to key in coefficient of friction
                      appears. (Go to Prompt 23.)

PROMPT 19: DEFINE FIRST ENDPOINT OF FIRST HANDLE

     ACTION: Select an existing 3-D point to define
                      coordinates of handle of End Point 1 or key in
                      X,Y,Z coordinates of handle End Point 1 **<CR>**

     RESULT: Prompt to define End Point 2 of right handle
                      appears.

PROMPT 20: DEFINE SECOND ENDPOINT OF FIRST HANDLE

     ACTION: Select an existing 3-D point to define
                      coordinates of handle of End Point 2 or key in
                      X,Y,Z coordinates of handle End Point 2 **<CR>**

     RESULT 1: Prompt to key in coefficient of friction
                      appears. (Go to Prompt 23.)

     RESULT 2: Prompt to define first endpoint of second
                      handle appears (Result of choosing TWO HANDLES).

PROMPT 21: DEFINE FIRST ENDPOINT OF SECOND HANDLE

     ACTION: Select an existing 3-D point to define coordinates
                      of right handle of End Point 1 or key in X,Y,Z
                      coordinates of left handle End Point 1 **<CR>**

     RESULT: Prompt to define second End Point of second
                      handle appears.

PROMPT 22: DEFINE SECOND ENDPOINT OF SECOND HANDLE

     ACTION: Select an existing 3-D point to define
                      coordinates of handle of End Point 2 or key in
                      X,Y,Z coordinates of handle End Point 2 **<CR>**

     RESULT: Prompt to key in coefficient of friction
                      appears.

PROMPT 23: KEY IN COEFFICIENT OF FRICTION

    ACTION: Key in value to define coefficient of
                  friction between man-model's shoes and the
                  surface on which he is standing <CR>

    RESULT: Menu to determine object clearance appears.

PROMPT 24: SELECT MENU WHICH IDENTIFIES THE NEED FOR
                OBJECT CLEARANCE

    ACTION: Select type of object clearance from bottom
                  menu

    RESULT: Prompt to indicate center of plot for
                  strength table appears.

PROMPT 25: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a point in the drawing to position
                  the center of the strength table

    RESULT: Menu for obstacle avoidance appears.

PROMPT 26: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices

    RESULT: Display type menu appears.

PROMPT 27: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types (Table 2.1)
    RESULT 1: If push is successful, the man-model and
                strength table appear on the drawing
                performing the push; CADAM menu appears.

    RESULT 2: If push is unsuccessful because the distance
                from the man-model to the object is too
                great, then the man-model appears on drawing
                attempting to perform push; missed distance
                appears on screen; CADAM menu appears.

    RESULT 3: If unsuccessful due to interference, arrows
                are displayed indicating points of
                interference; CADAM menu appears.

    RESULT 4: If the selected posture does not relate to
                the current strength data, the push task is
                abandoned and the message "NO STRENGTH DATA
                AVAILABLE FOR SELECTED POSTURE" appears.

Presently only the stand and sit postures have strength data.

RESULT 5: If a line segment chosen for defining the push distance runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; consequently the push distance remains undefined and the "LINE DEFINING DISTANCES DOES NOT CROSS THE MAN-MODEL PATH" appears.

RESULT 6: If the coefficient of friction entered is less than 0.00001, then the coefficient of friction remains undefined and the message "INVALID COEFFICIENT OF FRICTION -- < 0.00001" appears.

RESULT 7: If the selected handle endpoints are the same, then the PUSH Task is abandoned and the message "INVALID HANDLES -- ENDPOINTS ARE THE SAME" appears.

RESULT 8: If any one of the object dimensions input is less than one inch, then the PUSH Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR OBJECT DIMENSIONS DEFINED" appears.

RESULT 9: If the user has selected a push distance that is impossible for the man-model to reach, the PUSH Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 28: SEL MENU

ACTION: Select /RECOVER/ to return to the Materials Handling menu

RESULT: Materials Handling menu (Figure 3.24) appears.

8.2.2.5 Pull

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the TASK ANALYSIS icon

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **MATERIALS HANDLING icon**

    RESULT: Materials Handling menu (Figure 3.24)
           appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **PULL icon**

    RESULT: New prompt appears.

PROMPT 4:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM PLLUSR EXECUTING appears
           and then the Mobility Selection menu (Figure
           3.7) appears.

PROMPT 5:   SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types to be used
           during the Reach analysis

    RESULT: Handle Selection menu (Figure 3.33) appears.

PROMPT 6:   SELECT NUMBER OF HANDLES TO BE USED DURING TASK

    ACTION: Select handle type to be used

    RESULT: Menu for selecting process to define object
           appears.

PROMPT 7:   SELECT WHICH TYPE OF PROCESS TO USE FOR DEFINING
          OBJECT

    ACTION: Select mode for defining object dimensions

    RESULT: Prompt to key in object height appears
           (Result of choosing KEY IN OBJECT
           DIMENSIONS). (Go to Prompt 18.)

    RESULT: Prompt to select object height appears
           (Result of choosing SELECT OBJECT FROM SCREEN).

PROMPT 8:   SELECT ELEMENT ON OBJECT WHICH DEFINES HEIGHT OF
             OBJECT

    ACTION: Select element in drawing to represent object
               height

    RESULT: Prompt to select object width appears.

PROMPT 9:   SELECT ELEMENT ON OBJECT WHICH DEFINES WIDTH OF
             OBJECT

    ACTION: Select element in drawing to represent object
               width

    RESULT: Prompt to select object depth appears.

PROMPT 10:   SELECT ELEMENT ON OBJECT WHICH DEFINES DEPTH OF
             OBJECT

    ACTION: Select element in drawing to represent object
               depth

    RESULT: Prompt to select any other elements to define
               object appears.

PROMPT 11:   SELECT REMAINING OBJECT ELEMENTS AS NEEDED -
             /END/ TO FINISH

    ACTION: Select other elements in the drawing to
               define the object; if and when other elements
               have been defined, select **/END/** from bottom
               menu

    RESULT: Prompt to define first endpoint of a handle
               appears.

PROMPT 12:   DEFINE FIRST ENDPOINT OF FIRST HANDLE

    ACTION: Select an existing 3-D point to define
               coordinates of handle of End Point 1 or key in
               X,Y,Z coordinates of handle End Point 1 **<CR>**

    RESULT: Prompt to define second endpoint of handle
               appears.

PROMPT 13: DEFINE SECOND ENDPOINT OF FIRST HANDLE

    ACTION: Select an existing 3-D point to   fine
                    coordinates of handle of End Point 2 or key in
                    X,Y,Z coordinates of handle End Point 2 **<CR>**

    RESULT 1: Prompt to key in coefficient of friction
                    appears. (Go to Prompt 23.)

    RESULT 2: Prompt to define first endpoint of second
                    handle appears (Result of choosing TWO
                    HANDLES).

PROMPT 14: DEFINE FIRST ENDPOINT OF SECOND HANDLE

    ACTION: Select an existing 3-D point to define
                    coordinates of handle of End Point 1 or key in
                    X,Y,Z coordinates of handle End Point 1 **<CR>**

    RESULT: Prompt to define second End Point of handle
                    appears.

PROMPT 15: DEFINE SECOND ENDPOINT OF SECOND HANDLE

    ACTION: Select an existing 3-D point to define
                    coordinates of handle of End Point 2 or key in
                    X,Y,Z coordinates of handle End Point 2 **<CR>**

    RESULT: Prompt to key in coefficient of friction
                    appears (Go to Prompt 23).

PROMPT 16: KEY IN HEIGHT DIMENSION OF OBJECT

    ACTION: Key in value which represents the height
                    of the object **<CR>**
    RESULT: Menu to select mode for object dimensions
                    appears.

PROMPT 17: KEY IN WIDTH DIMENSION OF OBJECT

    ACTION: Key in value representing width of object
                    <CR>

    RESULT: Prompt to key in object depth appears.

PROMPT 18: KEY IN DEPTH DIMENSION OF OBJECT

    ACTION: Key in value representing depth of object
               <CR>

    RESULT: Menu to select process to define pull
               distances appears.

PROMPT 19: SELECT MENU TO DETERMINE HOW TO DEFINE
           DISTANCES FOR OBJECT

    ACTION: Select process to define pull distances.

    RESULT 1: Prompt to key in vertical distance for pull
               appears (Result of choosing KEY IN OBJECT
               DISTANCES).   (Go to Prompt 21.)

    RESULT 2: Prompt to select shelf to define pull
               distance appears (Result of choosing SELECT
               LINE TO DEFINE OBJECT DISTANCES).

PROMPT 20: SELECT LINE TO DEFINE OBJECT DISTANCES

    ACTION: Select element from screen which represents
               the shelf height where the object will be
               pulled

    RESULT: Prompt to key in coefficient of friction
               appears. (Go to Prompt 23.)

PROMPT 21: KEY IN HEIGHT OBJECT IS FROM THE SUPPORT
           PLATFORM

    ACTION: Key in value which represents the shelf
               height where the object will be pulled **<CR>**

    RESULT: Prompt to key in distance object is in front
               of man-model

PROMPT 22: KEY IN DISTANCE OBJECT IS FORWARD OF THE MAN-
           MODEL

    ACTION: Key in a value that represents the distance
               for the pull. **<CR>**

    RESULT: Prompt to key in coefficient of friction
               appears.

PROMPT 23: KEY IN COEFFICIENT OF FRICTION

ACTION: Key in value to define coefficient of
           friction between man-model's shoes and the
           surface on which he is standing <CR>

RESULT: Menu to determine object clearance appears.

PROMPT 24: SELECT MENU WHICH IDENTIFIES THE NEED FOR
           OBJECT CLEARANCE

ACTION: Select type of object clearance

RESULT: Prompt to indicate center of plot for
           strength table appears.

PROMPT 25: DEFINE POINT FOR CENTER OF STRENGTH

ACTION: Indicate a point in the drawing to position
           the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 26: SELECT OBSTACLE AVOIDANCE DESIRED

ACTION: Select one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 27: SELECT DESIRED DISPLAY TYPE

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If pull is successful, the man-model and
           strength table appear on the drawing
           performing the pull; CADAM menu appears.

RESULT 2: If pull is unsuccessful because the distance
           from the man-model to the object is too
           great, then the man-model appears on drawing

           attempting to perform pull; missed distance
           appears on screen; CADAM menu appears.

RESULT 3: If pull is unsuccessful due to interference,
           arrows are displayed indicating points of
           interference; CADAM menu appears.

RESULT 4: If the selected posture does not relate to
           the current strength data, the PULL Task is
           abandoned and the message "NO STRENGTH DATA

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AVAILABLE FOR SELECTED POSTURE" appears.
Presently only the stand and sit postures
have strength data.

RESULT 5: If a line segment chosen for defining the
pull distance runs parallel to the plane
bisecting the man-model into right and left
halves, then no intersection can be found;
consequently the pull distance remains
undefined and the "LINE DEFINING DISTANCES
DOES NOT CROSS THE MAN-MODEL PATH" appears.

RESULT 6: If the coefficient of friction entered is
less than 0.00001, then the coefficient of
friction remains undefined and the message
"INVALID COEFFICIENT OF FRICTION --
< 0.00001" appears.

RESULT 7: If the selected handle endpoints are the
same, then the PULL Task is abandoned and
the message "INVALID HANDLES -- ENDPOINTS
ARE THE SAME" appears.

RESULT 8: If any one of the object dimensions input is
less than one inch, then the PULL Task is
abandoned and the message "NO STRENGTH DATA
AVAILABLE FOR OBJECT DIMENSIONS DEFINED"
appears.

RESULT 9: If the user has selected a push distance
that is impossible for the man-model to
reach, the PULL Task is abandoned and the
message "SELECTED LINE DEFINES DISTANCES TOO
LARGE FOR REACH" appears.

PROMPT 28: SEL MENU

ACTION: Select **/RECOVER/** to return to the Materials
Handling menu

RESULT: Materials Handling menu (Figure 3.22)
appears.

8.2.2.6 Reach

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

ACTION: Select the **TASK ANALYSIS icon**

RESULT: CREW CHIEF Task Analyses Function menu
(Figure 3.1) appears.

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PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

     ACTION: Select the **MATERIALS HANDLING icon**

     RESULT: Materials Handling menu (Figure 3.24)
                 appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

     ACTION: Select the **REACH icon**

     RESULT: New prompt appears.

PROMPT 4:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

     ACTION: Depress the **Y/N** function key

     RESULT: APPLICATION PROGRAM REAUSR EXECUTING appears
                 and then the Arm Selection menu (Figure
                 3.35) appears.

PROMPT 5:   SELECT ARM TO BE USED DURING TASK

     ACTION: Select which arm will perform the reach

     RESULT: Mobility Selection menu (Figure 3.7) appears.

PROMPT 6:   SELECT MOBILITY TO BE USED DURING TASK

     ACTION: Select one of the mobility types to be used
                 during the Reach analysis

     RESULT: Grip Type Selection menu for Reach (Figure
                 3.36) appears.

PROMPT 7:   SELECT REACH EXTENT TO BE USED DURING THE TASK

     ACTION: Select the grip to be used in the task

     RESULT 1: Prompt to select reach point for right hand
                 appears (Result of selecting RIGHT or BOTH ARMS)

     RESULT 2: Prompt to select reach point for left hand
                 appears (Result of selecting LEFT ARM)

PROMPT 8:   DEFINE REACH POINT FOR RIGHT ARM

    ACTION: Select an existing 3-D point from the screen
            to define Reach Point or key in the X,Y,Z
            coordinates of Reach Point **<CR>**

    RESULT 1: Obstacle Avoidance Selection menu appears.
            (Go to Prompt 10.)

    RESULT 2: Prompt to define reach point for left arm
            appears (Result of choosing BOTH ARMS).

PROMPT 9:   DEFINE REACH POINT FOR LEFT ARM

    ACTION: Select an existing 3-D point from the screen
            to define Reach Point for Left Arm or key in
            the X,Y,Z coordinates of Left Arm Reach
            Point **<CR>**

    RESULT: Obstacle Avoidance Selection menu appears

PROMPT 10: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices

    RESULT: Display type menu appears.

PROMPT 11: SELECT DESIRED DISPLAY TYPE

    ACTION: Select display type (See Table 2.1)

    RESULT 1: If reach is successful, man-model appears on
            drawing performing Reach; CADAM menu appears.

    RESULT 2: If reach is unsuccessful because the
            distance from the man-model to the reach
            point is too great, the man-model appears
            on the drawing attempting to perform the
            reach; missed distance appears on screen;
            CADAM menu appears.

    RESULT 3: If unsuccessful due to interference, arrows
            are displayed indicating points of
            interference; CADAM menu appears.

    RESULT 4: If a two hand reach was chosen and both
            reach points are the same, then the REACH
            Task is abandoned and the message "--
            ERROR CANNOT REACH WITH 2 HANDS TO ONE
            POINT" appears.

PROMPT 12: SEL MENU

>   ACTION: Select **/RECOVER/** to return to the Materials
>   Handling menu
>
>   RESULT: Materials Handling menu (Figure 3.22) appears.

8.2.3   <u>Connector Analysis Function</u>

>   PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE
>
>   ACTION: Select the **TASK ANALYSIS icon**
>
>   RESULT: CREW CHIEF Task Analyses Function menu
>   (Figure 3.1) appears.
>
>
>   PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE
>
>   ACTION: Select the **CONNECTOR icon**
>
>   RESULT: New prompt appears
>
>
>   PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE
>
>   ACTION: Depress the **Y/N** function key
>
>   RESULT: APPLICATION PROGRAM CTRUSR EXECUTING appears
>   and then the Grip Selection menu (Figure
>   3.38) appears.
>
>
>   PROMPT 4: SELECT GRIP TO BE USED DURING TASK
>
>   ACTION: Select the grip type to be used
>
>   RESULT: Connector Size menu (Figure 3.39) appears.
>
>
>   PROMPT 5: SELECT CONNECTOR SIZE TO BE USED DURING TASK
>
>   ACTION: Select the connector size to be used
>
>   RESULT: Prompt to define head point of attachment
>   appears.

PROMPT 6: DEFINE HEAD POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point which defines
                the point at which the man-model grips the
                connector or key in X,Y,Z coordinates to
                define the point at which the man-model grips
                the connector **<CR>**

    RESULT: Prompt to define tail point of attachment
                appears.

PROMPT 7: DEFINE TAIL POINT OF ATTACH VECTOR

    ACTION: Select an existing 3-D point which defines the
                direction at which the man-model will reach the
                connector or key in X,Y,Z coordinates to
                define the direction at which the man-model
                will reach the connector **<CR>**

    RESULT: Hand Selection menu (Figure 3.16) appears.

PROMPT 8: SELECT HAND TO BE USED DURING TASK

    ACTION: Select hand will reach for the connector

    RESULT: Mobility Type Selection menu (Figure 3.7)
                appears.

PROMPT 9: SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select the mobility type to use during the
                Reach analysis

    RESULT: Prompt to define Center of Strength table
                appears.

PROMPT 10: DEFINE POINT FOR CENTER OF STRENGTH

    ACTION: Indicate a 2-D point in the drawing to
                position the center of the strength table

    RESULT: Menu for obstacle avoidance appears.

PROMPT 11: SELECT OBSTACLE AVOIDANCE DESIRED

    ACTION: Select one of the obstacle avoidance choices

    P℟SULT: Display Type menu appears.

PROMPT 12: SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types (Table 2.1)
                 from bottom menu

    RESULT 1: If task is successful, the man-model and
                 strength table appear on the drawing
                 performing a task; CADAM menu appears.

    RESULT 2: If task is unsuccessful because the distance
                 from the man-model to the connector is too
                 great, the man-model appears on drawing
                 attempting to perform task; missed distance
                 appears on screen; CADAM menu appears.

    RESULT 3: If unsuccessful due to interference, arrows
                 are displayed indicating points of inter-
                 ference; CADAM menu appears.

PROMPT 13: SEL MENU

    ACTION: Select **/RECOVER/** to continue any analysis

    RESULT: Task Analysis menu (Figure 3.1) appears.

8.3   VISIBILITY ANALYSIS FUNCTION

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **VISIBILITY icon**

    RESULT: New prompt appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM VISUSR EXECUTING appears
                 and then the menu to select viewpoint as
                 seen by man-model or as user-defined
                 arbitrary point.

PROMPT 3: SELECT VIEWPOINT OPTION

    ACTION 1: Select **CREWCHIEF'S** to see the work place
                 from the man-model's viewpoint

    RESULT: Menu to include or exclude man-model appears

ACTION 2:   Select **USER DEFINED** to define viewpoint

RESULT: Prompt to define eye location point appears
            (Go to Prompt 5.)

PROMPT 4:   SELECT INCLUDE/EXCLUDE MAN-MODEL OPTION

ACTION: Select from menu whether to include or
            exclude the man-model during visual analysis

RESULT: Prompt to define center of visibility plot
            appears. (Go to Prompt 7.)

PROMPT 5:   DEFINE EYE LOCATION POINT

ACTION: Select an existing 3-D point to define the
            eye location or key in the X,Y,Z coordinates
            to define the eye location point **<CR>**

RESULT: Prompt to define eye target point appears.

PROMPT 6:   DEFINE EYE TARGET POINT

ACTION: Select an existing 3-D point to define the
            eye target point or key in the X,Y,Z
            coordinates to define the eye target point <CR>

RESULT: Prompt to define center of visibility plot
            appears.

PROMPT 7:   DEFINE CENTER OF PLOT

ACTION: Indicate a 2-D point to determine where the
            center of visibility plot will appear on screen

RESULT: Plot appears on screen as specified by center
            of plot location.

PROMPT 8:   SEL MENU

ACTION: Select **/RECOVER/** to continue any analysis

RESULT: CREW CHIEF Main Programs menu (Figure 1.3)
            appears.

8.4 ACCESSIBILITY ANALYSES FUNCTION

8.4.1 CREW CHIEF Interference Analysis Function

PROMPT 1: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **ACCESSIBILITY icon**

    RESULT: CREW CHIEF Accessibility Analyses menu (Figure 5.1) appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **INTERFERENCE icon**

    RESULT: New prompt appears.

PROMPT 3: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM ITFUSR EXECUTING appears and then the Level of Interference Checking menu (Figure 5.2) appears.

PROMPT 4: SELECT LEVEL OF INTERFERENCE TO BE CHECKED

    ACTION: Select the level of interference to be used in the analysis

    RESULT: Display type menu appears.

PROMPT 5: SELECT DESIRED DISPLAY TYPE

    ACTION: Select a display type (see Table 2.1)

    RESULT: Man-model appears superimposed on drawing and, if interference found, 3-D arrows indicating points of interference between the man-model and elements in the drawing are displayed.

PROMPT 6: SEL MENU

    ACTION: Select **/RECOVER/** to return to the CREW CHIEF Accessibility Functions menu (Figure 5.1)

    RESULT: Program returns to the CREW CHIEF Accessibility Functions menu (Figure 5.1).

8.4.2 Work Envelope Analysis Function

PROMPT 1:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **ACCESSIBILITY icon**

    RESULT: CREW CHIEF Accessibility Analyses menu
                (Figure 5.1) appears.

PROMPT 2:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **WORK ENVELOPE icon**

    RESULT: New prompt appears.

PROMPT 3:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

    ACTION: Depress the **Y/N** function key

    RESULT: APPLICATION PROGRAM WRKUSR EXECUTING appears
                and then the types of Work Envelope menu
                (Figure 5.4) appears.

PROMPT 4:   SELECT WORK ENVELOPE TO BE OUTPUT

    ACTION 1: Select **FULL SWEPT** to determine full sweep of
                tool handle

    RESULT: The tool appears in the drawing attached as
                it was in the previous tool analysis. The
                full sweep of the tool handle is displayed
                (END OF WORK ENVELOPE).

    ACTION 2: Select **TOOL ENVELOPE** to determine obstructed
                sweep of handle

    RESULT: Prompt to key in increment for tool envelope
                appears.

    ACTION 3: Select **WORK ENVELOPE** to determine
                obstructed sweep of handle with reach limits

    RESULT: Prompt to key in Work Envelope reach
                increment appears. (Go to Prompt 6).

PROMPT 5:   KEY IN INCREMENT FOR TOOL ENVELOPE, MUST >0

    ACTION: Key in the tool envelope increment <CR> or
                accept the default.

    RESULT: The tool appears in the drawing with the
                tool attached as it was in the previous tool
                analysis. The sweep of the tool handle, as
                obstacles will allow, is displayed on the
                screen (END OF WORK ENVELOPE).

PROMPT 6:   KEY IN WORK ENVELOPE REACH INCREMENT TO BE USED
           FOR ANALYSIS

    ACTION: Key in the reach increment <CR> or accept
                the default value

    RESULT: Mobility Type menu (Figure 3.7) appears.

PROMPT 7:   SELECT MOBILITY TO BE USED DURING TASK

    ACTION: Select one of the mobility types

    RESULT: Display Type menu appears.

PROMPT 8:   SELECT DESIRED DISPLAY TYPE

    ACTION: Select one of the display types (Table 2.1)
                from bottom menu

    RESULT: The man-model appears in the drawing with
                the tool attached as it was in the previous
                tool analysis. The sweep of the tool
                handle, as reach and obstacles will allow,
                is displayed on the screen.

PROMPT 9: SEL MENU

    ACTION: Select **/RECOVER/** to return to the
                Accessibility Analysis menu
    RESULT: Accessibility Analysis menu (Figure 5.1)
                appears.

8.5   DISPLAY CURRENT CREW CHIEF DATA FUNCTION

PROMPT 1:   SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE

    ACTION: Select the **CONFIGURATION icon**

    RESULT: New prompt appears.

PROMPT 2: SEL MENU/SEL PGM/SEL PGM INDEX/KEY PAGE/YN EXECUTE

ACTION: Depress the **Y/N** function key

RESULT: APPLICATION PROGRAM CFGUSR EXECUTING appears
and then Prompt to define center of plot
appears.

PROMPT 3: DEFINE CENTER OF DATA SHEET

ACTION: Indicate a point on the screen to determine
where the center of the CREW CHIEF data sheet
will appear

RESULT: The current CREW CHIEF data sheet appears on
the screen.

PROMPT 4: SEL MENU

ACTION: Select **/RECOVER/** to return to the CREW CHIEF
Main Programs menu (Figure 1.3)

RESULT: Program returns to the CREW CHIEF Main
Programs menu (Figure 1.3).

REFERENCES

1. CADAM Geometry Interface Installation Guide, #C-200-050-I, Burbank, CA: CADAM, Inc., 1 Dec 1984.

2. CADAM Interactive User Reference Manual (Vol. 2), #C-200-020-URM, Burbank, CA: CADAM, Inc., 1 Dec 1984.

3. Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

4. Ayoub, M.M., Denardo, J.D., Smith, J.L., Bethea, N.J., Lambert, B.K., Alley, L.R., & Duran, B.S., Establishing Physical Criteria for Assigning Personnel to Air Force Jobs, Lubbock, TX: Institute for Ergonomic Research, Texas Tech University, Sept 1982.

5. CADAM Geometry Interface, User Reference Manual, #C-200-050-5, Burbank, CA: CADAM, Inc., 16 Aug 1984.

APPENDIX A

GENERATION OF THE PHYSICAL CHARACTERISTICS
AND CAPABILITIES OF THE MAN-MODEL

APPENDIX A

GENERATION OF THE PHYSICAL CHARACTERISTICS
AND CAPABILITIES OF THE MAN-MODEL

The primary purpose of the CREW CHIEF system of programs is to improve maintainability during the design process by assessing the interactions of the physical characteristics and capabilities of the maintenance technician and the work station. MIL-STD-1472C, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities," (Reference A.1), and changes thereto, establishes general human engineering criteria for military systems, subsystems, equipment, and facilities.

Paragraph 5.6.1 states: "Generally, design limits shall be based upon a range from the 5th percentile female to the 95th percentile male values for critical body dimensions, as appropriate. For any body dimension, the 5th percentile value indicates that five percent of the population will be equal to or smaller than that value, and 95 percent will be larger; conversely, the 95th percent value indicates that 95 percent of the population will be equal to or smaller than that value, and five percent will be larger. Therefore, use of a design range from the 5th to 95th percentile will theoretically provide coverage for 90 percent of the user population for that value."

Paragraph 5.6.3.2 states: "Clearance dimensions (e.g., for passageways and access), which must accommodate or allow passage of the body, or parts of the body, shall be based upon the 95th percentile values for body dimensions."

Paragraph 5.6.3.3 states: "Limiting dimensions (reaching distance, control movement, displays, test points, handrails, etc.) which restrict, or are limited by, extensions of the body shall be based upon the 5th percentile values for applicable body dimensions."

The CREW CHIEF programs must work within the design criteria stated here. Thus the range of operator sizes must necessarily include, as a minimum, the range of 5th percentile female through 95th percentile male. The program includes the 1st, 5th, 50th, 95th, and 99th percentile body sizes for both male and female; thus there is a range of 1st percentile female through 99th percentile male. Pending changes to Military Standards and Specifications are expected to require this range in some applications. This appendix addresses the body size of the technician model as a function of the skeletal link system, enfleshment, and clothing bulk.

Since maintenance technicians work in a wide range of postures, the joint mobility of the skeletal link system is a vital consideration to the development of the model. Additionally, the effect of body/body segment mass and center of gravity must be considered in establishing joint mobility limits. A maintenance technician must be able to maintain balance while performing a task. Thus, individual joint mobility limits may vary with differing body segment relationships for changes in posture.

The ability of the technician to see the task object is another area of concern. This appendix also addresses the data bases and derivation of the visual analysis function of the programs.

The ability to apply force in a specific manner to a task-related object is another physical capability that is addressed in the CREW CHIEF programs. The development of the strength data bases will also be discussed.

A.1   CREW CHIEF MODEL SKELETAL LINK SYSTEM AND ENFLESHMENT

The model used in the CREW CHIEF system of programs is based on a 36-link skeletal system. These links connect the major points of rotation of body segments and are used to

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graphically display the model in different postures. The lengths of the links are calculated by regression from 13 readily measured anthropometric variables (e.g., stature, sitting height, weight, etc.).

The 1965 Survey of US Air Force Male Personnel (Reference A.2) was used as the basis for the male calculations. This survey includes 3869 subjects. Officer subjects were discarded, as were those subjects not meeting current weight restrictions of Air Force Regulation (AFR) 160-43. The remaining 2084 subjects were used for the regression equation data pool.

The 1968 Survey of US Air Force Women (Reference A.3) and the 1977 Survey of US Army Women (Reference A.4) were purged of data of subjects not meeting the weight limits of AFR 160-43. The remaining 3037 subjects from the two surveys were used for the regression equation data pool for females.

The 1981 Study of Weight Lifting Capabilities of Air Force Basic Trainees (Reference A.5) was selected as the best reflection of the current Air Force maintenance technician population. This survey had only two relevant anthropometric measures, stature and weight. The regression equations calculated from the 1965 US Air Force Male Personnel, 1968 US Air Force Women, and 1977 US Army Women surveys were applied to the variables (stature and weight) from the 1981 survey of Air Force Basic Trainees to calculate the remaining 11 anthropometric variables required to generate the 36 internal links and the enfleshment of the CREW CHIEF man-model.

The enfleshment of the CREW CHIEF man-model is based on a modeling technique to define three-dimensional (3-D) coordinates of solid objects. Solid objects, such as hand forms, head forms, and boots, are divided into triangular facets with the vertices and edges of the triangles identified for tracking. A sonic digitizer is used to define the local X, Y, and Z coordinates of the vertices. A series of sorting routines to identify

coincidental edges and points; to convert local X,Y,Z coordinates to the CREW CHIEF coordinate system; and to determine the display lines are used to provide the desired graphic presentation.

Ellipses are placed about major joint centers. The ellipses are connected, and the modeling technique for solid objects is used to determine the display lines for the body enfleshment. Multiple ellipses are placed at the joint centers, e.g., the knees, elbows, and shoulders, which exhibit high compressibility. The body is divided into 13 semi-unique sets of ellipses. These are the lower and upper trunk, head, lower and upper arms (left and right), hands (left and right), and lower and upper legs (left and right), with the lower legs including the feet. These sets are classified as semi-unique in that a main ellipse may be contained in different sets. For example, the lower and upper arm sets each contain the main ellipse at the elbow.

To increment the nude enfleshment radii to portray clothing bulk, subjects were measured both nude and in the four clothing configurations (fatigues, fatigues with jacket, arctic, and chemical defense).

A.2 CREW CHIEF MODEL JOINT MOBILITY

Joint mobility is the movement at the skeletal links which defines and portrays the various postures of the technician model. Posture includes the variations in positioning of body segments, such as arms, legs, and trunk segments, to properly position the technician model in relation to the task object. Two aspects must be considered: first, the limits of motion (joint mobility limits) around an individual joint; and second, the stability (balance) of the technician model when in a specific posture in relation to the task object.

Joint mobility limits are based, at present, upon previous range of motion studies. The mobility limits data are being

updated as a result of recent research and will be included in future CREW CHIEF releases. Future mobility limits will also address out-of-balance conditions.

A.3   CREW CHIEF MODEL VISUAL ANALYSIS

The techniques for displaying the field-of-view of the technician model are relatively simple and already exist. Existing vision data bases are primarily concerned with peripheral vision. A maintenance technician man-model must be concerned with visual acuity rather than with peripheral vision. Data bases for visual acuity (field-of-focus) must be generated. Planning to collect the data for these data bases is in progress.

A.4   CREW CHIEF MODEL STRENGTH CAPABILITIES

The strength capabilities of the CREW CHIEF man-model are divided into two areas.

(1)   Torque: the ability to apply a force to:

(a) a tool, primarily a wrench, that results in a torque value that can be applied to a fastener. See Appendix C for those tools which will have torque values in the program.

(b) an electrical connector, with the hand alone, in a clockwise or counter-clockwise direction.

(2)   Materials Handling: related to moving, lifting, carrying, pushing, pulling, positioning, and holding objects.

Strength, in general, is not highly correlated to body size. Thus, in the CREW CHIEF man-model, the percentile values are based on strength capabilities across a population, not on the percentile value of the body size. Strength data bases for CREW CHIEF were created from ergonomics studies specifically

designed to simulate aircraft maintenance tasks. Strength data from test subjects were related to the aircraft technician population through a series of strength tests that had been previously administered to Air Force personnel. Since there are few restrictions on the assignment of Air Force personnel to maintenance AFSCs, these subjects were deemed to be representative of the Air Force maintenance technician population. During the data collection phase of Torque and Materials Handling data bases, subjects performed 1 to 7 of the same strength tests. Regressors from the cited study are used to distribute the predictions from the Torque and Materials Handling data bases across the maintenance population.

A.4.1   TORQUE

Data bases providing the information required to predict the force a maintenance technician can exert on a wrench, or electrical connector, were not available when CREW CHIEF program development was begun. A series of tests using torque measuring devices was implemented. The basic variables in the wrench torque studies include posture; bolt elevation as a percentage of the finger tip vertical reach for a given posture; distance of the body from the bolt head; wrench handle orientation (selected position around the 360-degree circle of the bolt axis); bolt orientation (relative to the mid-sagittal plane of the body); type wrench (ratchet with socket, open end, box end, etc.); and the reach around and over obstacles to the wrench handle.

Experiments were performed to develop the data bases for the prediction of force that can be applied to an electrical connector. The variables considered in the electrical connector experiments were: connector diameter (three sizes); type of grip (two types); hand covering (bare and two types of glove); direction of torque (clockwise and counter-clockwise); work height (as a percentage of subject's finger tip vertical reach);

direction of approach (front, back and side); and distance of
connector from other connectors above, below, or to the side of
the task connector.

A.4.2   MATERIALS HANDLING

A series of experiments is being conducted to develop the
Materials Handling data bases. The lifting phases of the
experiments are done in various postures (kneeling, standing,
sitting, supine and prone). Lifting tasks are one- or two-
handed. Various size boxes are used for the different tasks, and
the weight can be adjusted. The subject could request the
experimenter to add or remove weight until the subject reached
his maximum without straining himself. (The weights were not
individually marked, so the subject did not know the weight
lifted.)

A common task in system maintenance is to position an
object and hold it in place with one hand while securing it with
the other hand. Hold/Position studies are based on posture,
target height (expressed as a percentage of the subject's finger-
tip vertical reach for the posture used in the exertion),
barriers (used above and in front of the target to simulate
working conditions), and the weight of the object (variable
from 10 to 110 pounds). The object is positioned with both hands
and, once positioned, is held in place with the left hand. The
time the object is held within the confines of the target is
measured up to a maximum of 60 seconds. Sixty subjects, 30
female and 30 male, participated in the experiment.

Experiments were performed to collect data for Push/Pull
capabilities. This study was divided into three phases, with a
total of 230 exertions performed by 20 female and 20 male
subjects. Subjects were selected on the basis of age (18 to 30
years), body size and weight limits within the limits of AFR
160-43, and their abilities to lift 40 pounds to 6 feet on a
weight lift machine (attainment of a Factor-X Score of 3).

Variables for the exertions included five postures, two
directions (push and pull), handle position (distance above the
support platform), foot position (distance from the handle
expressed as percentage of vertical reach), and angle of the
elbow (straight or bent). Exertions were also performed in two
methods (freestyle and controlled). In freestyle, the subject
was allowed to push or pull to attain the maximum horizontal
force. In controlled, the subject was required to keep the
vertical force less than 10% of the maximum horizontal force. A
sonic digitizer was used to digitize 14 points on the body during
each exertion and to relate body angles to force data.

APPENDIX B

CLOTHING ENSEMBLE DESCRIPTIONS

APPENDIX B

CLOTHING ENSEMBLE DESCRIPTIONS

B.1   FATIGUES, WITHOUT JACKET

The fatigues ensemble (see Figure B.1) is the normal work clothing for maintenance technicians and is worn in shops and on the flight line during moderate to hot temperatures. The shirt has long or short sleeves. The shoes are rubber-soled work shoes or flight boots. The fatigue cap is part of the ensemble, but is often removed during maintenance activities.

B.2   FATIGUES, WITH JACKET

This uniform consists of the basic fatigues ensemble with a jacket added. It is used at cooler temperatures on the flight line and in unheated shops (see Figure B.2).

B.3   ARCTIC

The arctic clothing ensemble adds a parka with fur-lined hood, insulated trousers, and mittens to the fatigue ensemble for protection in cold temperatures. The mukluk replaces the work shoes or flight boots. Under wet conditions, the work shoes or flight boots may be worn, because the mukluks are not water-resistant. Due to their inhibition of manual dexterity, the mittens are normally replaced with the work glove while performing maintenance, so they are not included in the graphic display of the technician model. The parka hood over the head can restrict the technician's vision. During maintenance activities, if the hood interferes with the technician's vision, it is laid back on the shoulders (see Figure B.3).

Figure B.1.   Photograph Showing Fatigues Ensemble:
(a) Side View, and (b) Front View.

Figure B.2.   Photograph Showing Fatigues Ensemble With
Jacket Added: (a) Side View, and (b) Front
View.

Figure B.3.   Photograph of Man Wearing Arctic Clothing
Ensemble: (a) Side View, and (b) Front View.

B.4   CHEMICAL DEFENSE

The chemical defense ensemble (see Figure B.4) is worn over fatigues and consists of a mask, over-garment, hood, over-boots, and rubber gloves. Both cotton and rubber gloves are worn under the leather work gloves. This ensemble is used when the technician is threatened with hazardous chemical/biological agents.

Figures B.5 through B.8 show the man-model as it appears in each of these clothing ensembles. Default clothing type is fatigues (Figure B.5).

Figure B.4.   Photograph of Man Wearing Chemical Defense Ensemble:
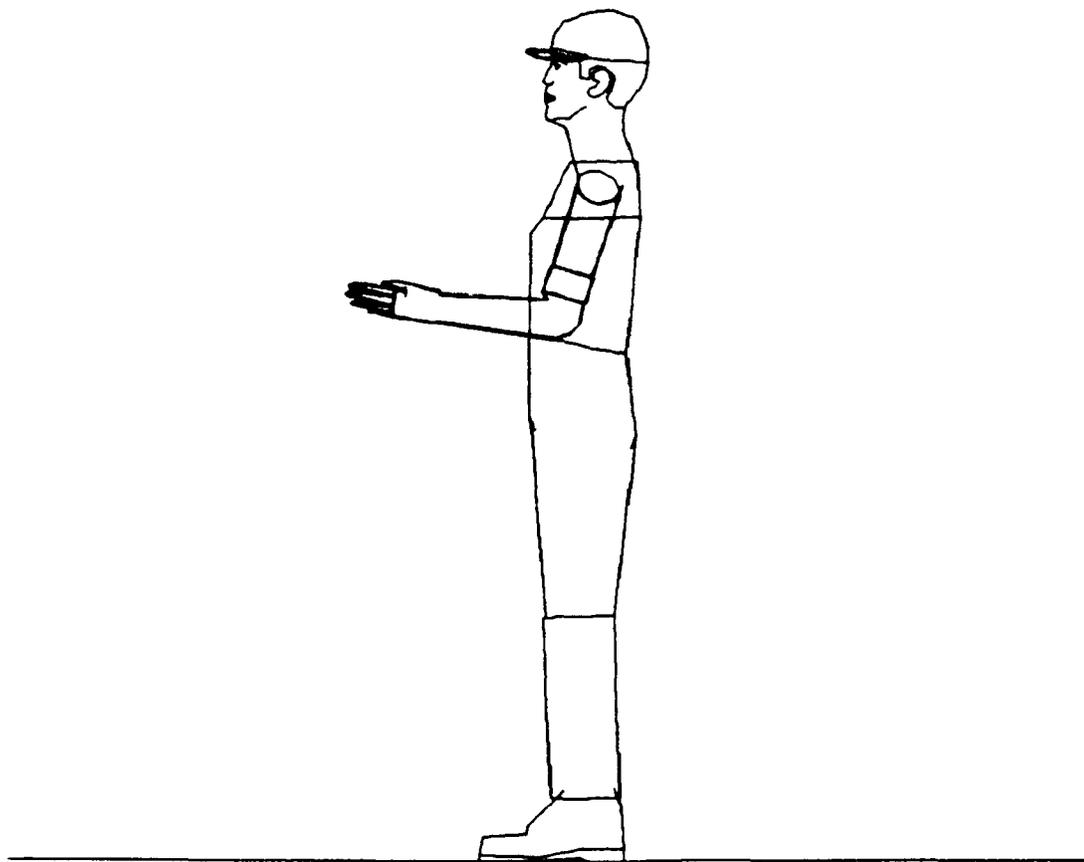(a) Right View, (b) Front View, and (c) Left View.
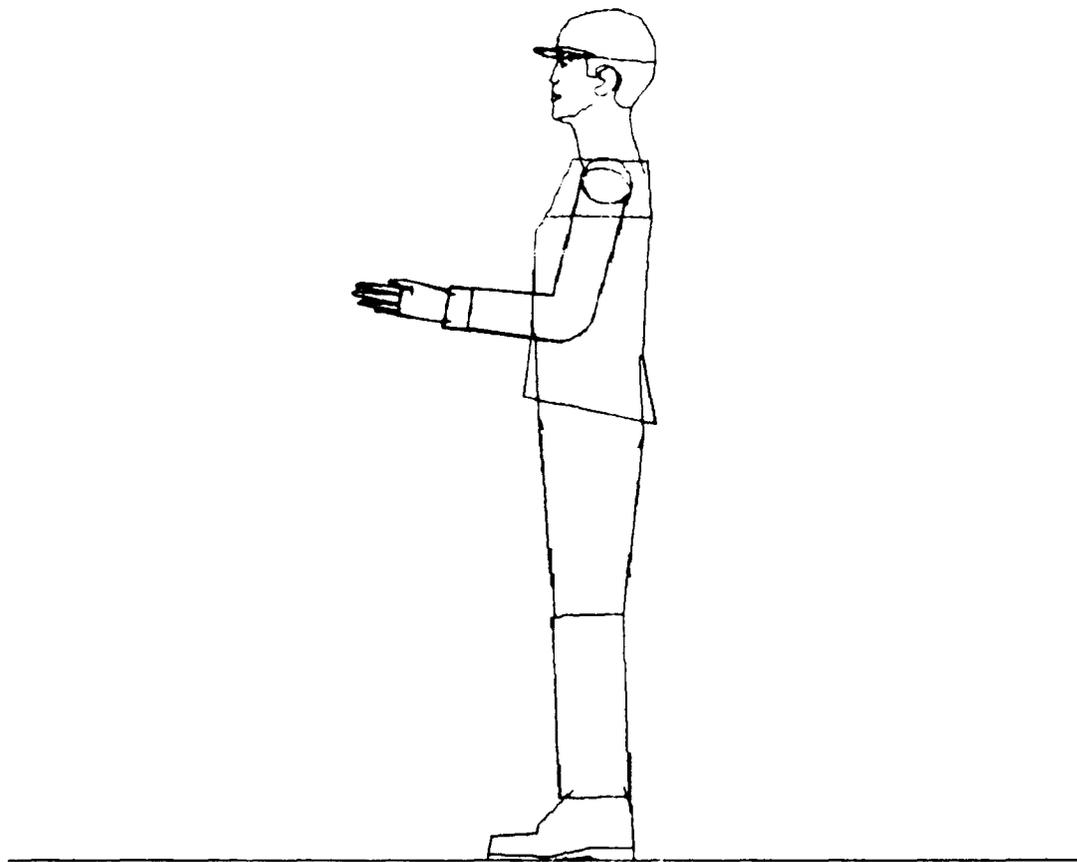
Figure B.5. Fatigues, Without Jacket.
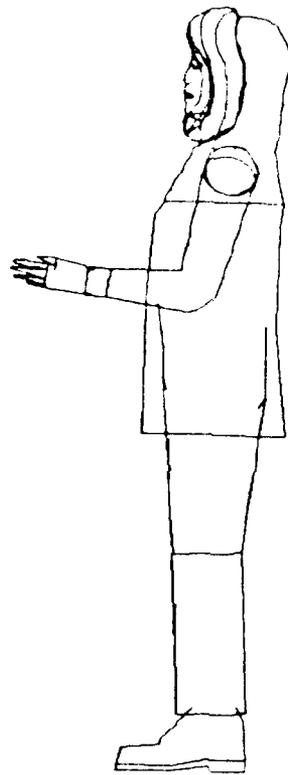
Figure B.6.   Fatigues, With Jacket.

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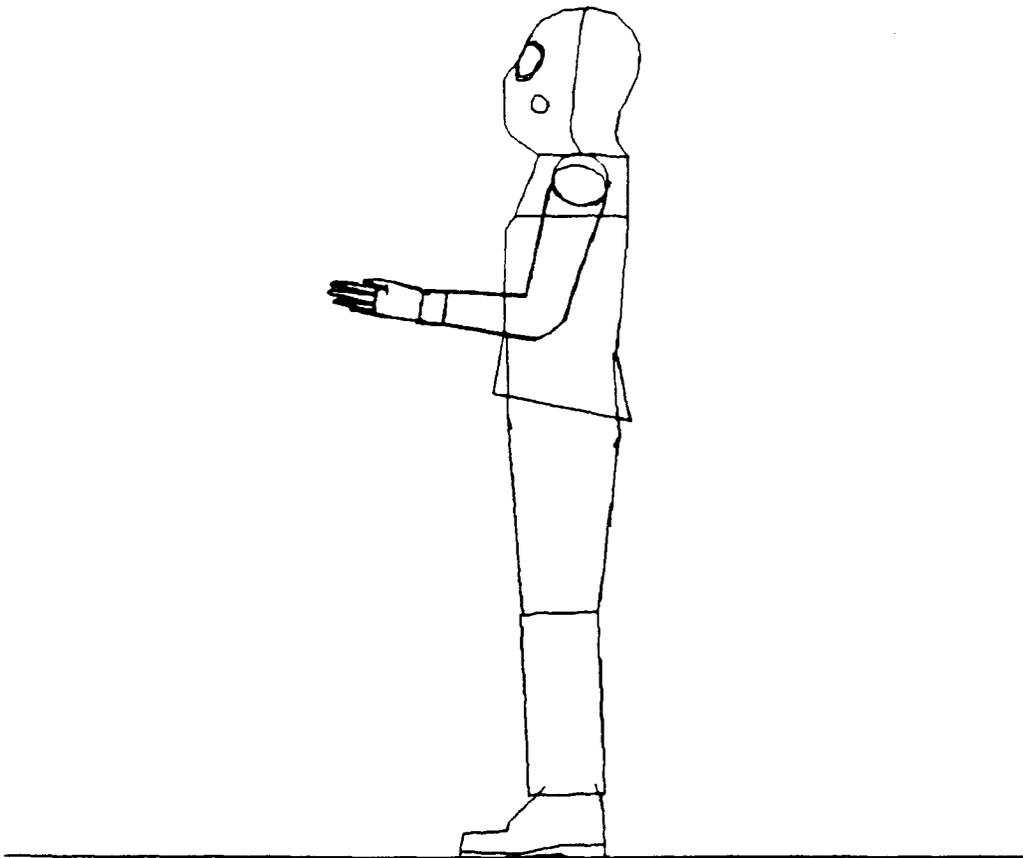Figure B.7.   Arctic Ensemble.

Figure B.8. Chemical Defense Ensemble.

APPENDIX C

BODY POSTURES

APPENDIX C
BODY POSTURES

The twelve postures represent common postures found in a maintenance environment. These postures allow initial generation of the man-model in a posture which closely approximates the one desired. The initial postures can be further modified manually (using the Reposition Function), or automatically by the Task Analysis functions. The twelve postures available in the Initialization Function can be seen in Figures C.1 through C.12. Standing posture is the default.
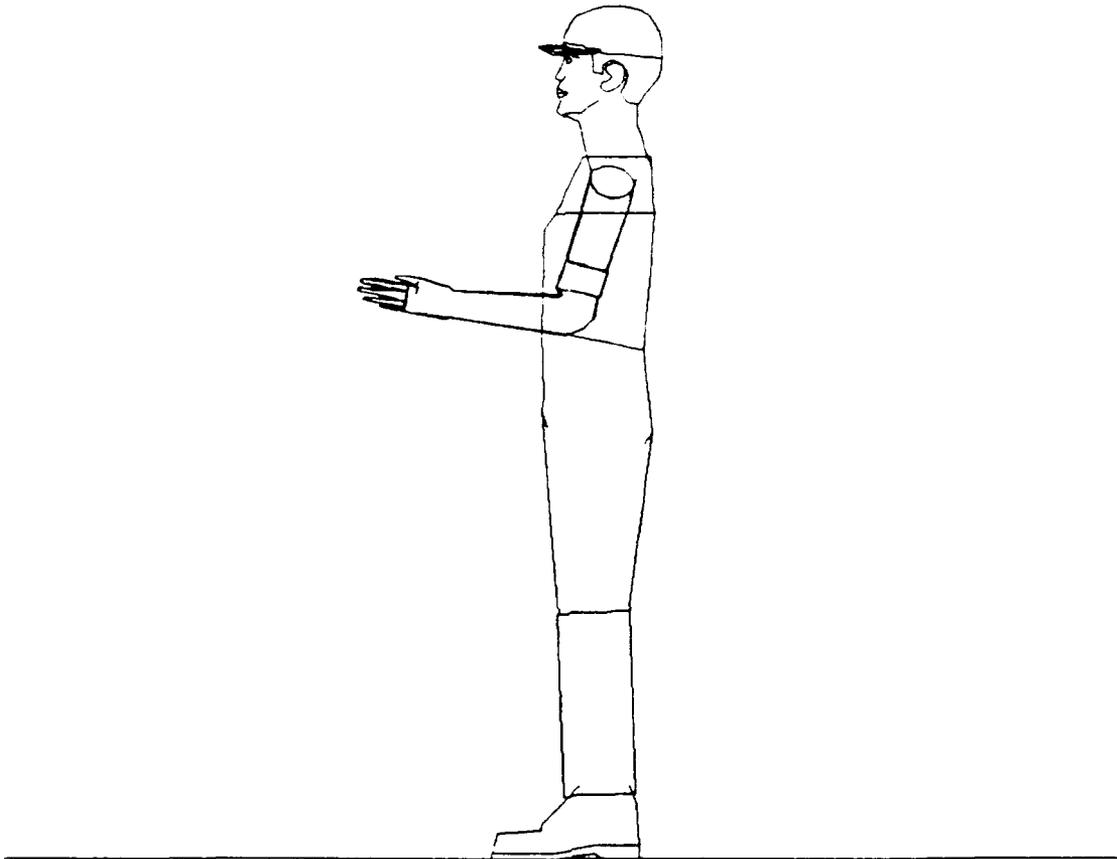
Figure C.1. Initial Stand Posture, with Position
Reference Point on Platform and Centered
Between the Ankles.
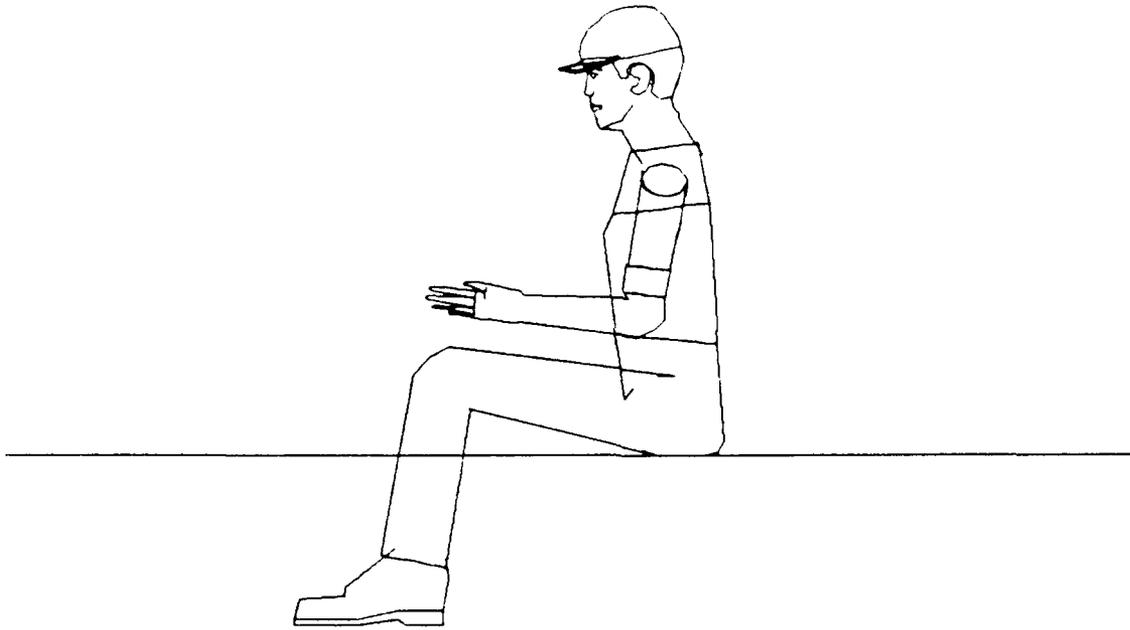
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Figure C.2.   Initial Sitting Posture, with Position
             Reference Point at Center of Seat Pan.
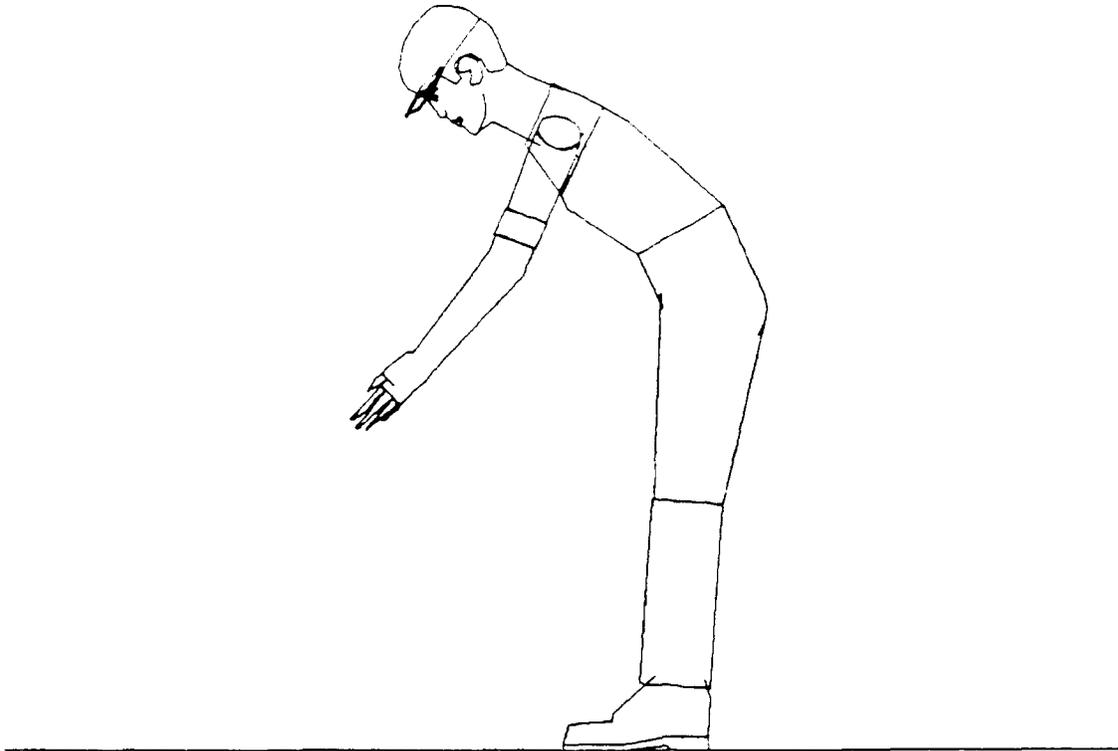
Figure C.3. Initial Bend Posture, with Position
            Reference Point on Platform and
            Centered Between the Ankles.

Figure C.4.   Initial Supine Posture, with Position
               Reference Point on Platform and
               Centered Between Shoulders.

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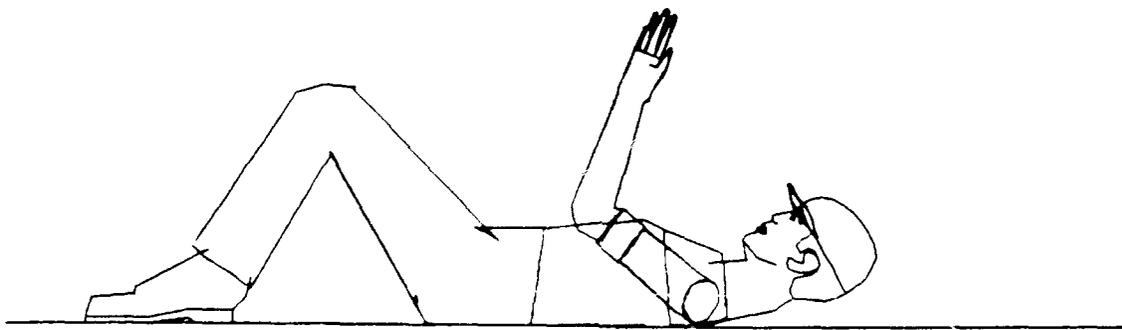
Figure C.5. Initial Prone Posture, with Position
Reference Point on Platform and
Centered Between Shoulders.

Figure C.6.   Initial Side Posture, with Position
             Reference Point on Platform and
             Centered Between Shoulders.

Figure C.7. Initial Kneel Posture, One Knee, with
Position Reference Point on Platform and
Centered Between Left Knee and Right Foot.

Figure C.8.   Initial Kneel Posture, Two Knees, with
              Position Reference Point on Platform and
              Centered Between Knees.

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Figure C.9.   Initial Squat Posture, with Position
              Reference Point on Platform and
              Centered Between the Ankles.

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Figure C.10.   Initial Walk Posture, with Position
                Reference Point on Platform and
                Centered Between the Feet.
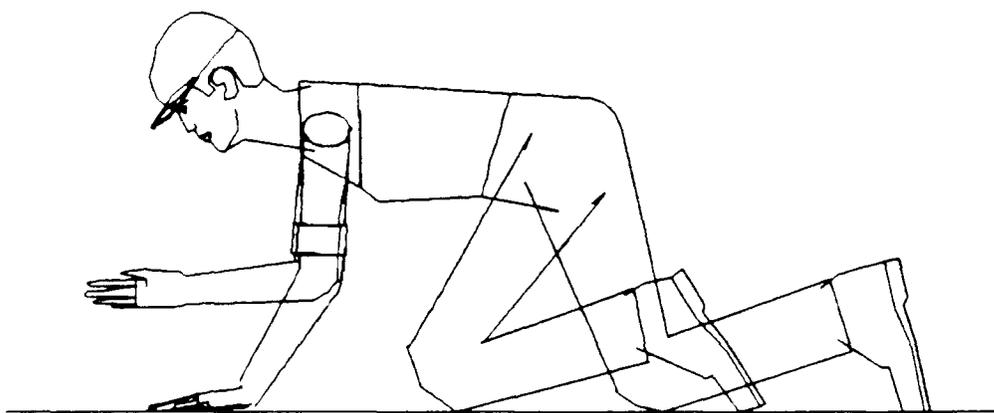
Figure C.11.   Initial Crawl Posture, with Position
              Reference Point on Platform and
              Centered Between Knees.

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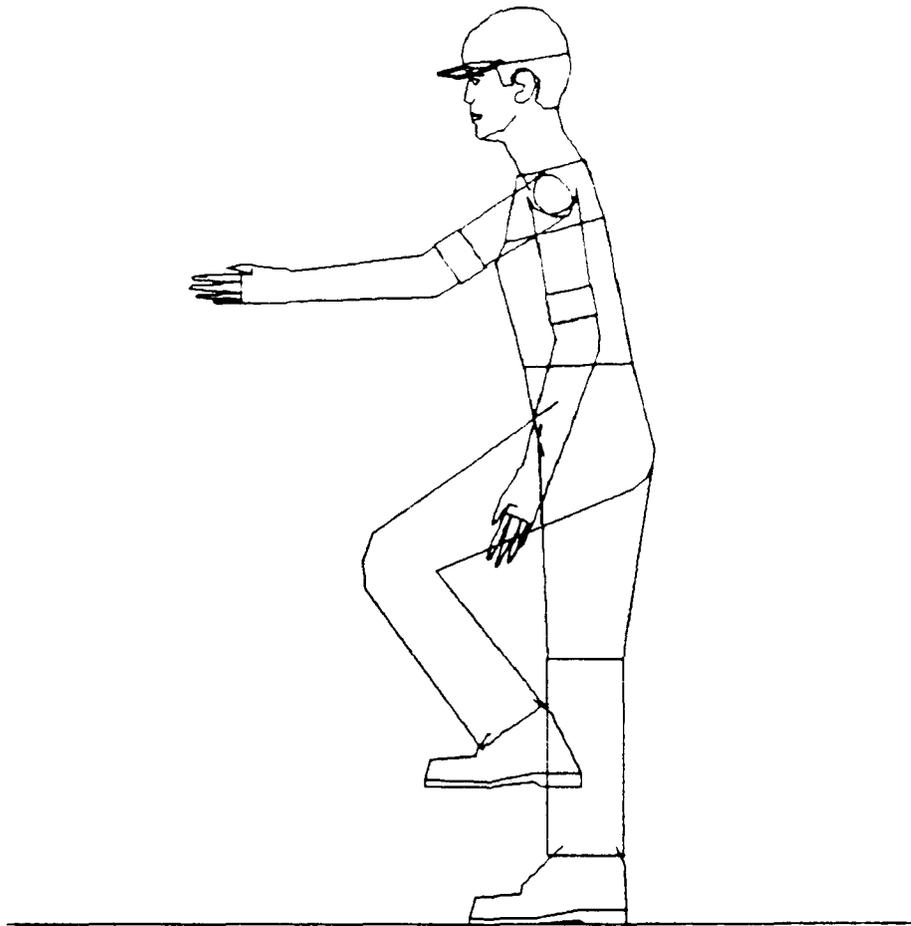
Figure C.12.   Initial Climb Posture, with Position
             Reference Point on Platform and
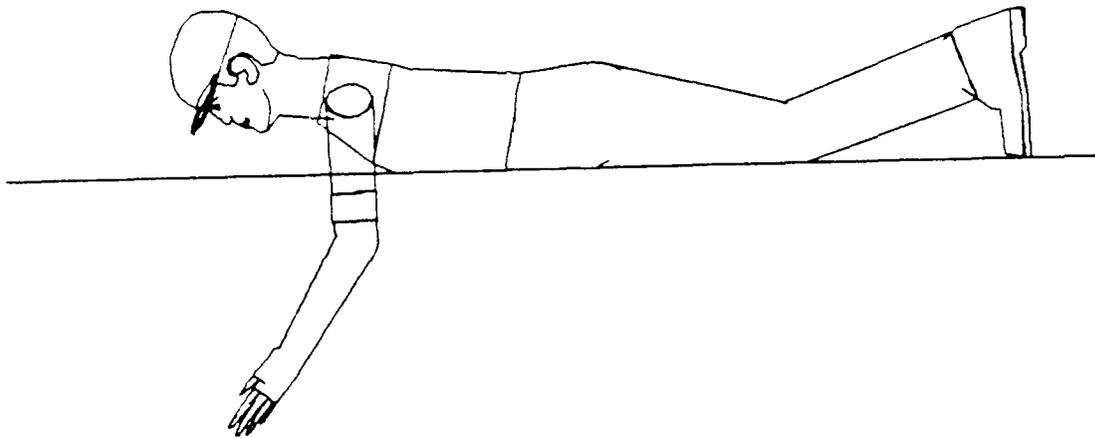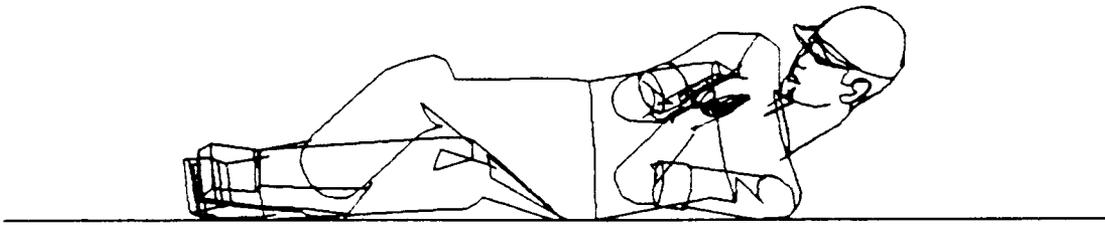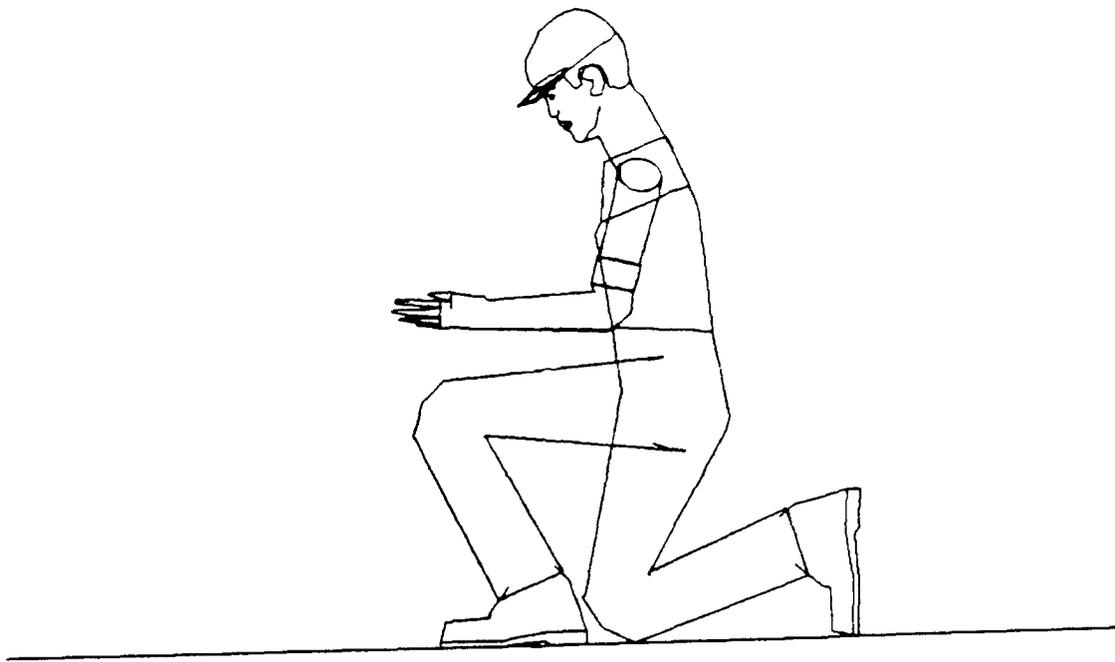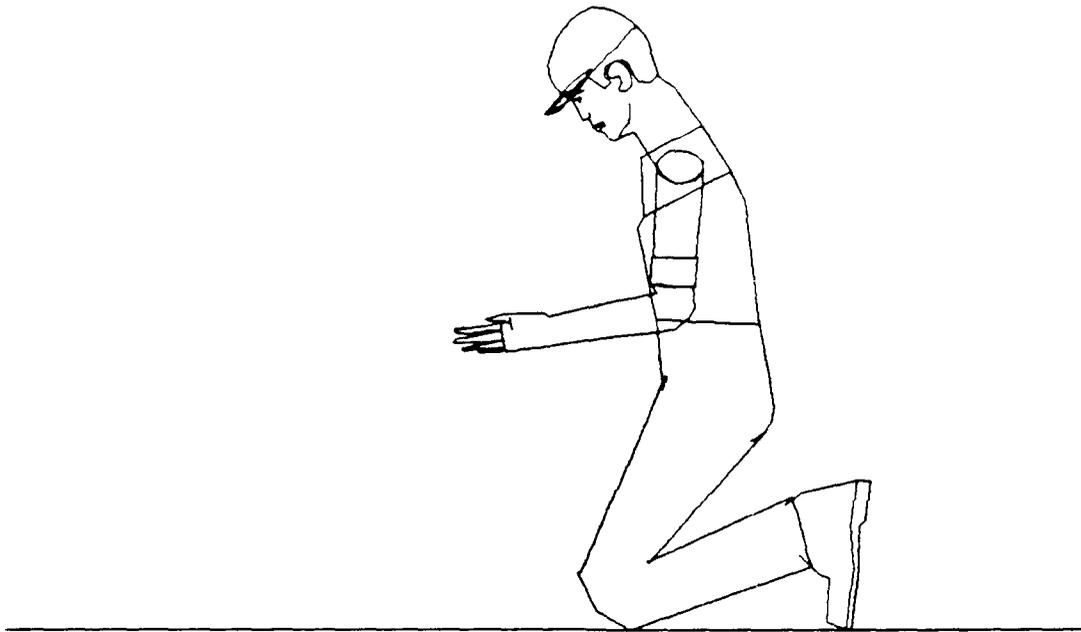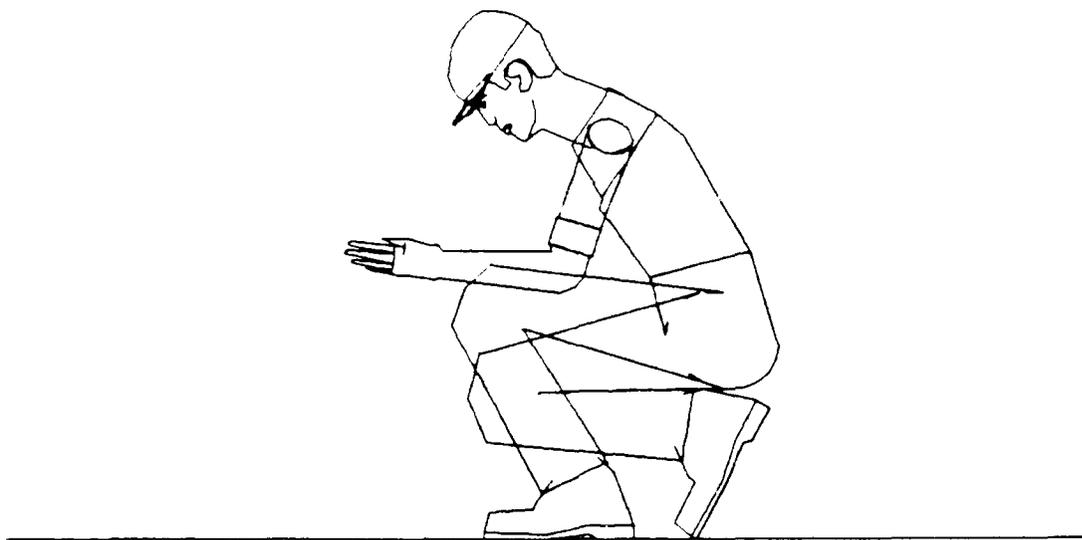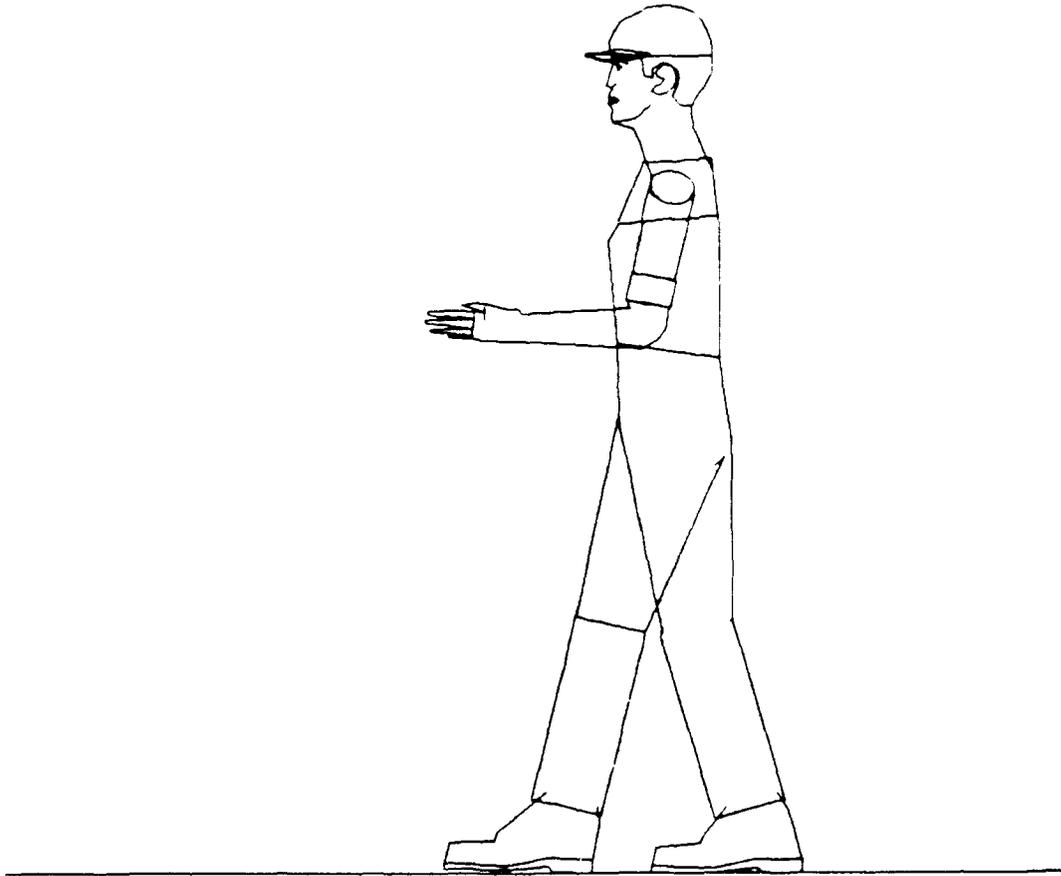   Centered Between the Feet.

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APPENDIX D

HAND TOOLS IN CREW CHIEF

APPENDIX D
HAND TOOLS IN CREW CHIEF

D.1 INTRODUCTION

Hand tools commonly used in aircraft maintenance have been
included in CREW CHIEF. Evaluations using tools include accessi-
bility (reach interference, work envelope, and visibility) and
strength (torque). All tools included in the program are
standard tools. Standard tools are defined in MIL-STD 1472C
(Reference C.1) as tools (normally hand tools) used for the
assembly, disassembly, inspection, servicing, repair, and
maintenance of equipment, and which are manufactured by two or
more recognized tool manufacturing companies and listed in those
companies' catalogs. The appropriateness of the list of tools
was verified through interviews with aircraft maintenance
managers and technicians at several operational Air Force Bases.
Sizing of the tools was based on information in tool catalogs for
manufacturers participating in the Air Force warranted tool
program.

Tools available for selection are:

ACCESSIBILITY AND TORQUE STRENGTH

Torque Wrench	Deep Offset Box End
Ratchet Wrench	Ratcheting Box End
Breaker Bar	Open End
Standard Box End	Combination End

Wrenches listed here are shown in Figures D.1 and D.2.
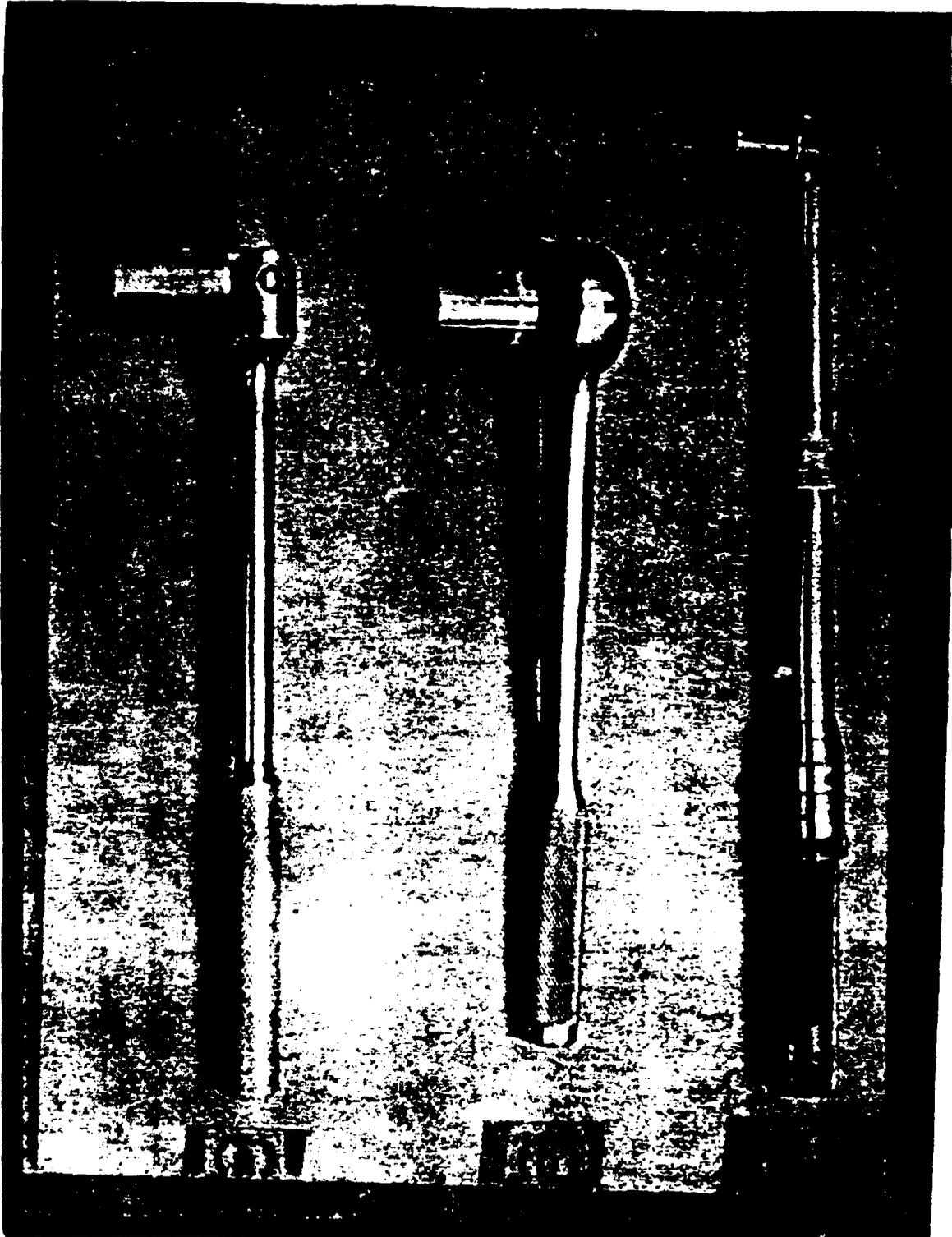
Figure D.1. Socket-Type Wrenches With Strength Analyses
Include (a) Breaker Bar, (b) Ratchet Wrench,
and (c) Torque Wrench.
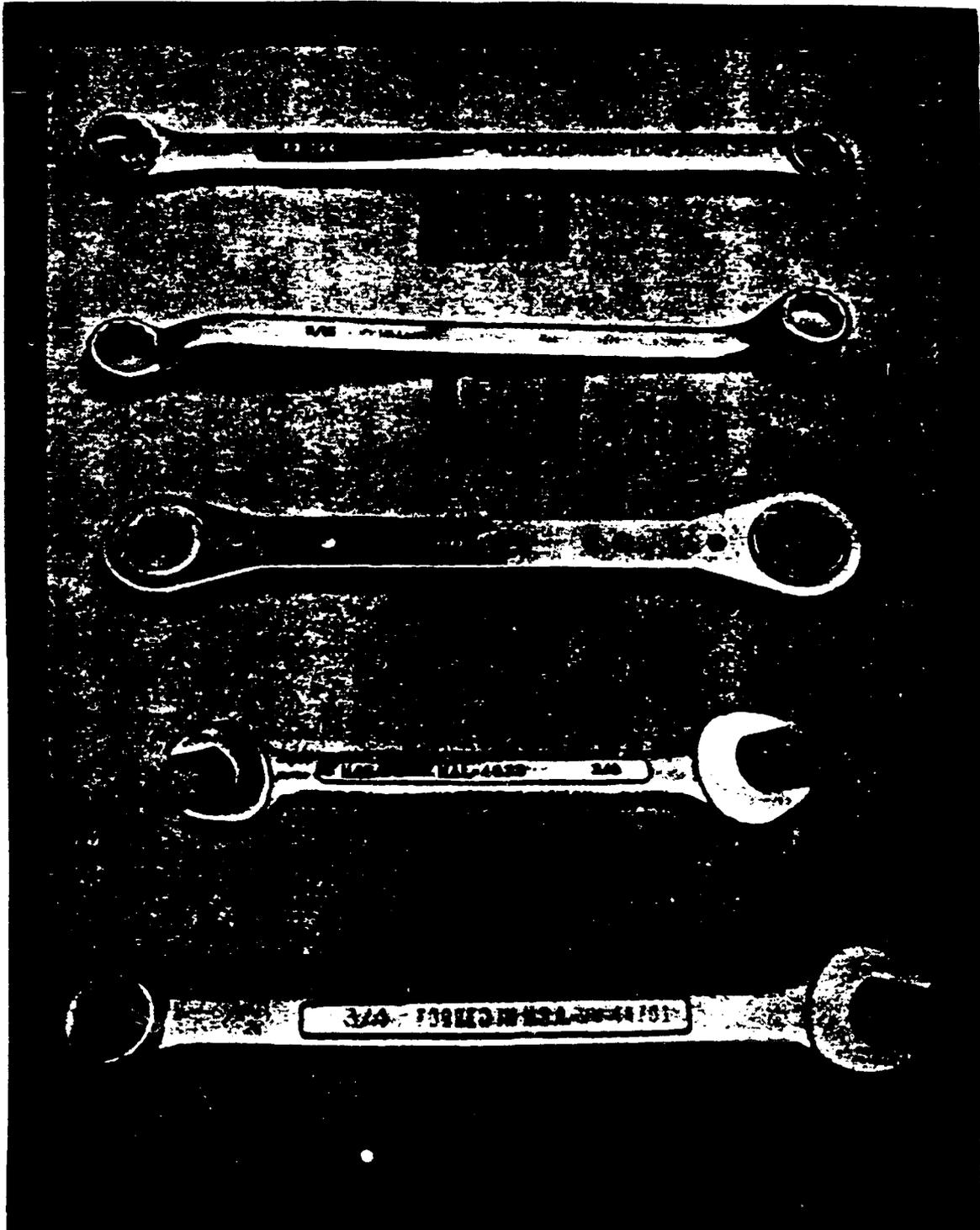
Figure D.2.   Common Wrenches With Strength Analyses Include
               (a) Standard Box End, (b) Deep-Offset Box End,
               (c) Ratcheting Box End, (d) Open End, and
               (e) Combination End.

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ACCESSIBILITY ONLY

Speed Handle	Hammer with Chisel
Allen Wrench	File
Pliers	Scraper
Screwdriver	Hacksaw
Nutdriver	Power Drill
Hammer	Power Sander

The tools listed here are illustrated in Figures D.3, D.4, D.5, D.6, D.7, and D.8.

D.1.1   WRENCHES

There   a direct relationship between bolt shank diameter and bolt head size. The table below indicates this relationship. Bolts with diameters of less than 3/16 inch are referred to as numbered screws. *Dimensions are in inches.*

NUMBERED SCREWS		BOLTS	
Diameter	Head Size	Diameter	Head Size
1, 2	1/8	3/16	3/8
3, 4, 5	3/16	1/4	7/16
6, 8	1/4	5/16	1/2
10	5/16	3/8	9/16
		7/16	5/8
		1/2	3/4
		9/16	13/16
		5/8	15/16
		3/4	1-1/4
		7/8	1-5/16
		1	1-1/2
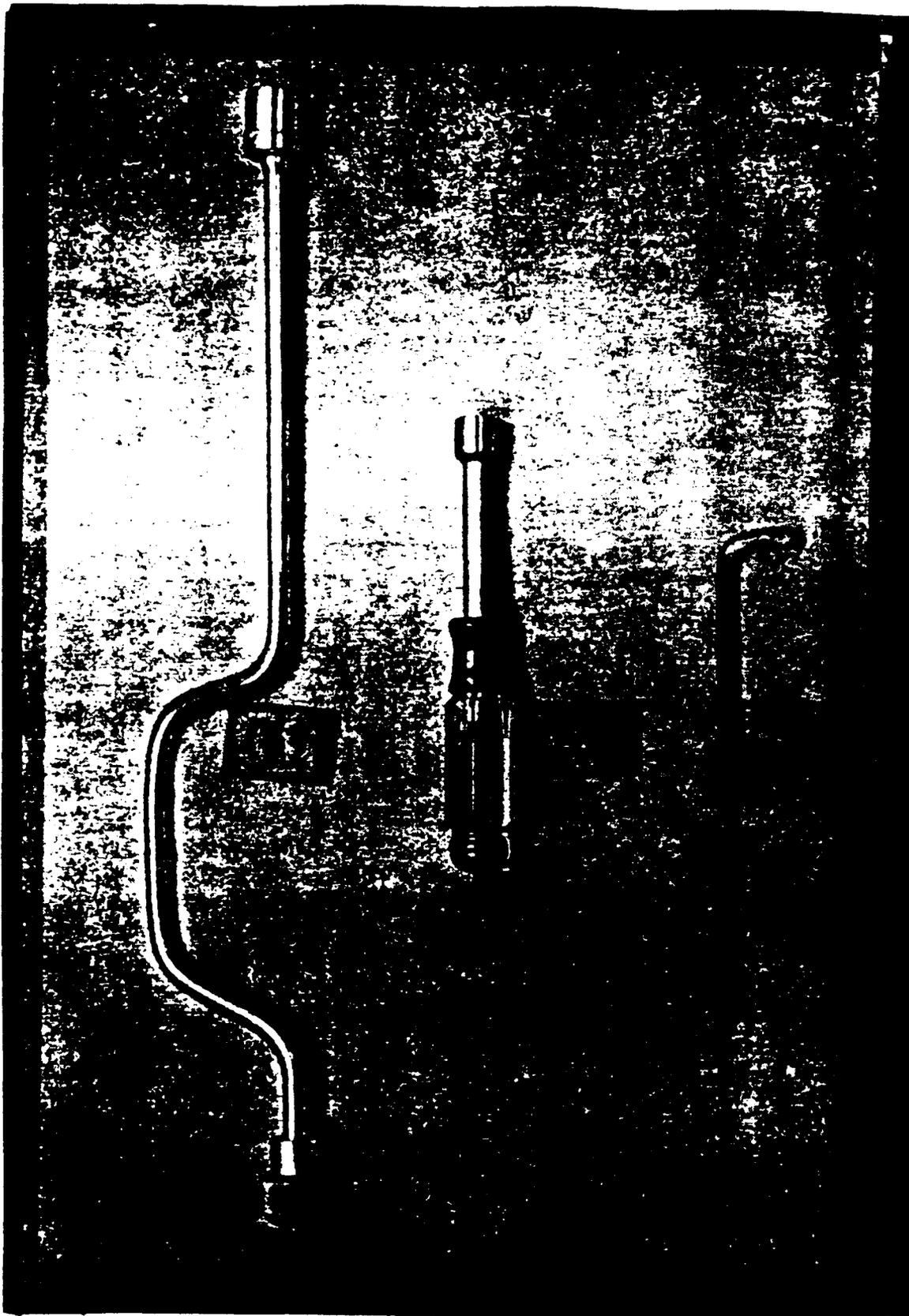
Figure D.3.   Wrenches Without Strength Analyses Include
              (a) Speed Handle, (b) Nutdriver, and (c) Allen
              Wrench.

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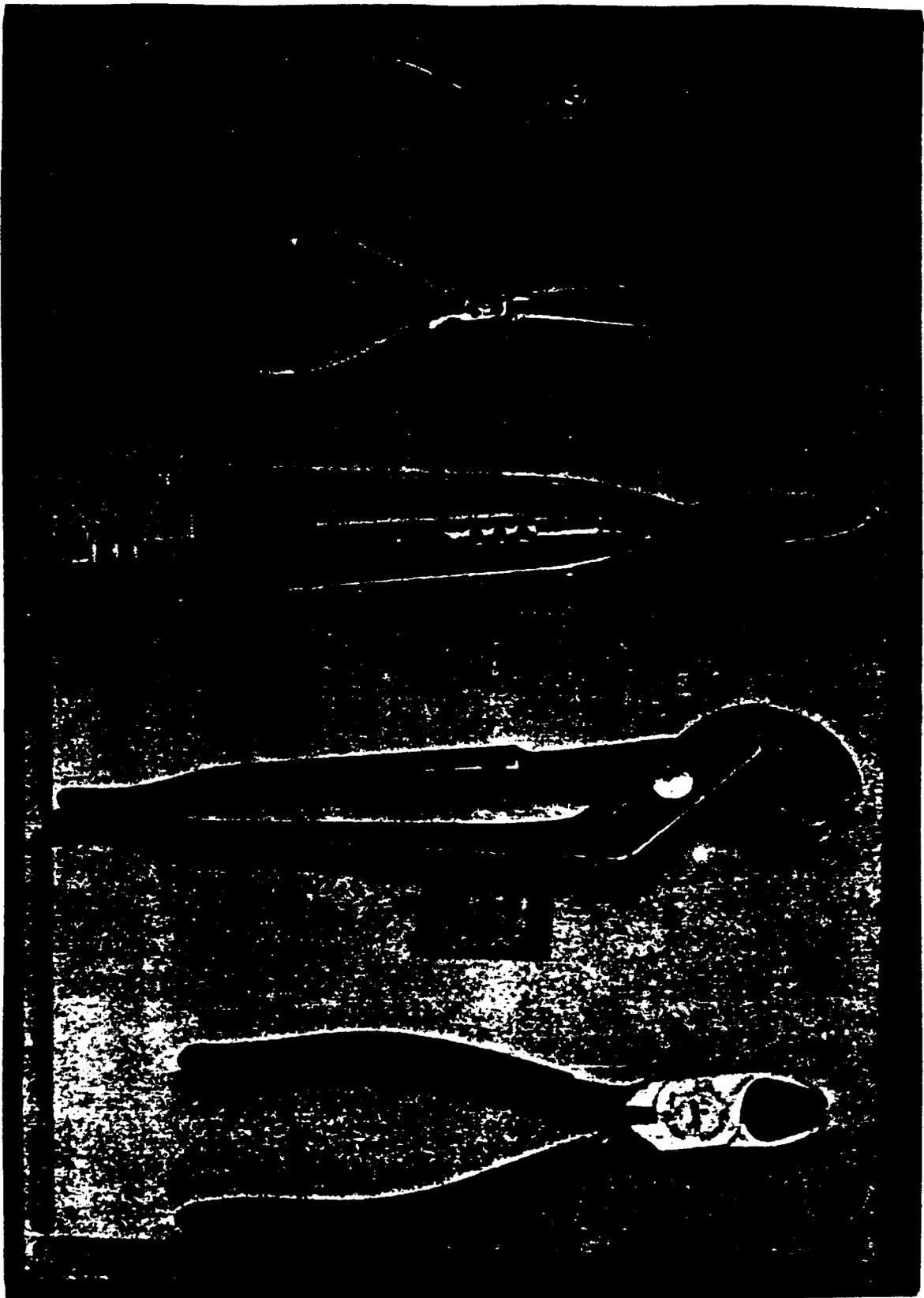
Figure D.4. Plier-Type Tools Include (a) Combination,
(b) Needle Nose, (c) Safety Wire,
(d) Adjustable Joint, and (e) Wire Cutters.
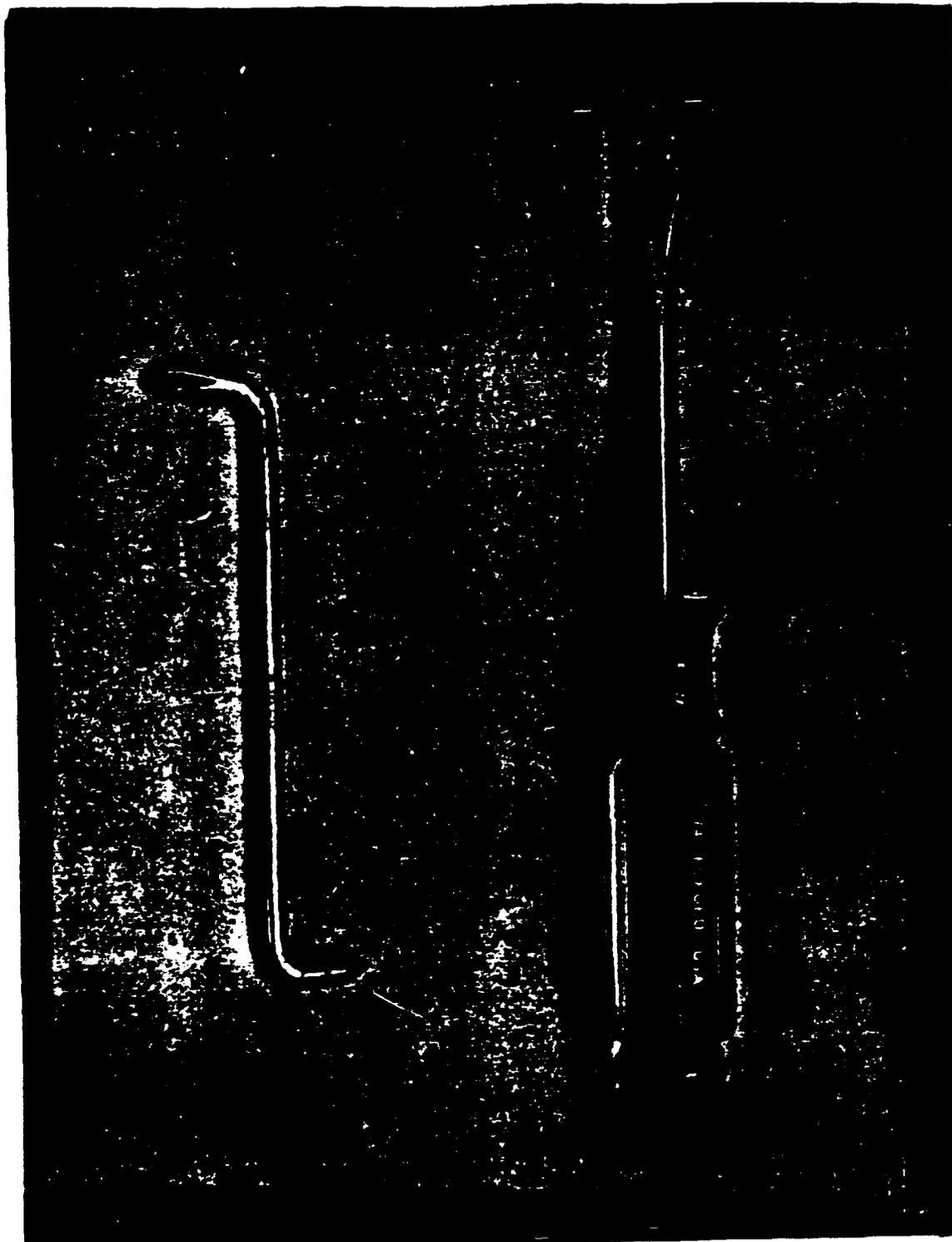
Figure D.5.   Screwdrivers Include (a) Offset and (b) Regular.
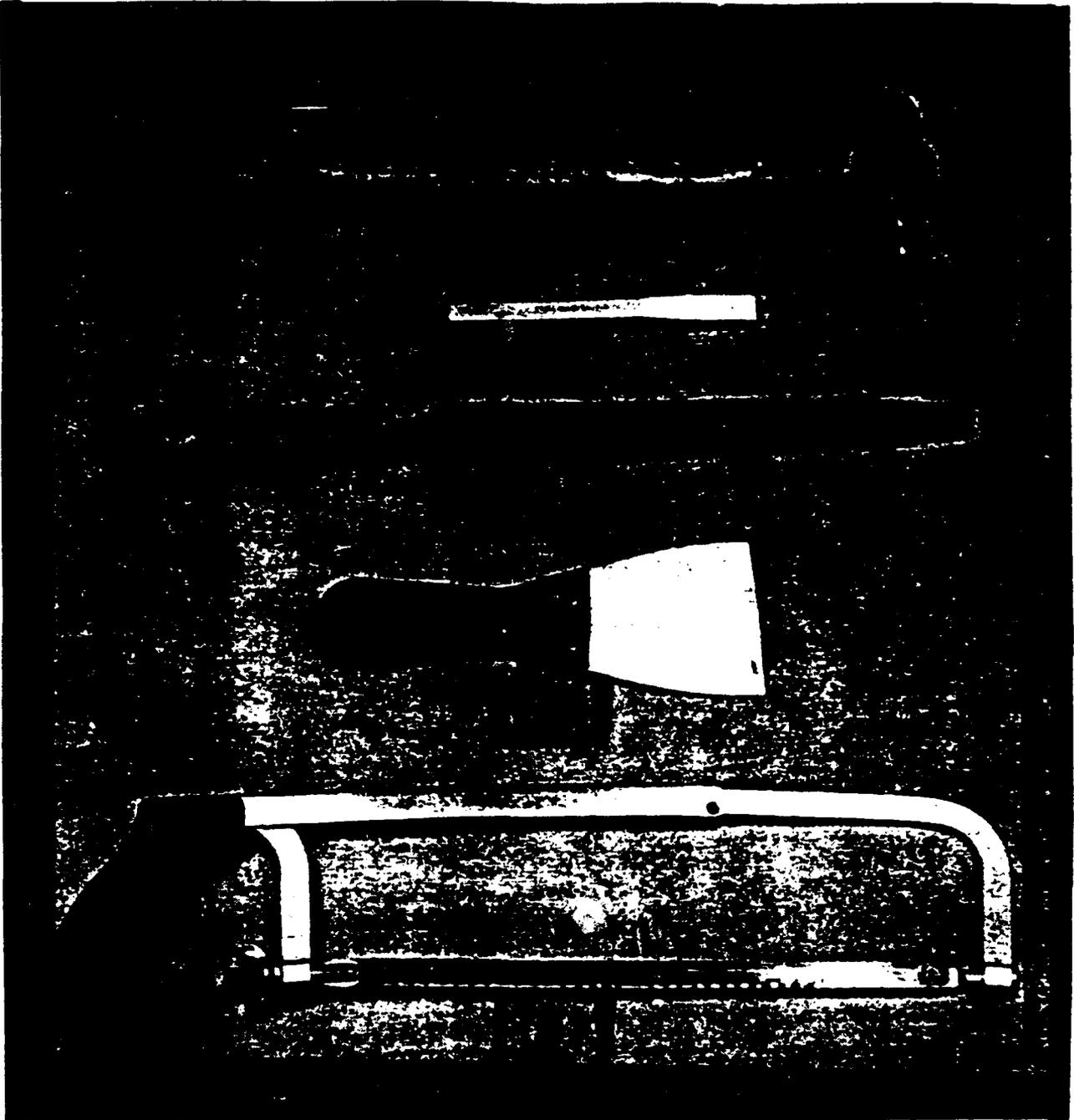
Figure D.6.   Miscellaneous Tools Include (a) Hammer,
               (b) Chisel, (c) File, (d) Scraper, and
               (e) Hacksaw.
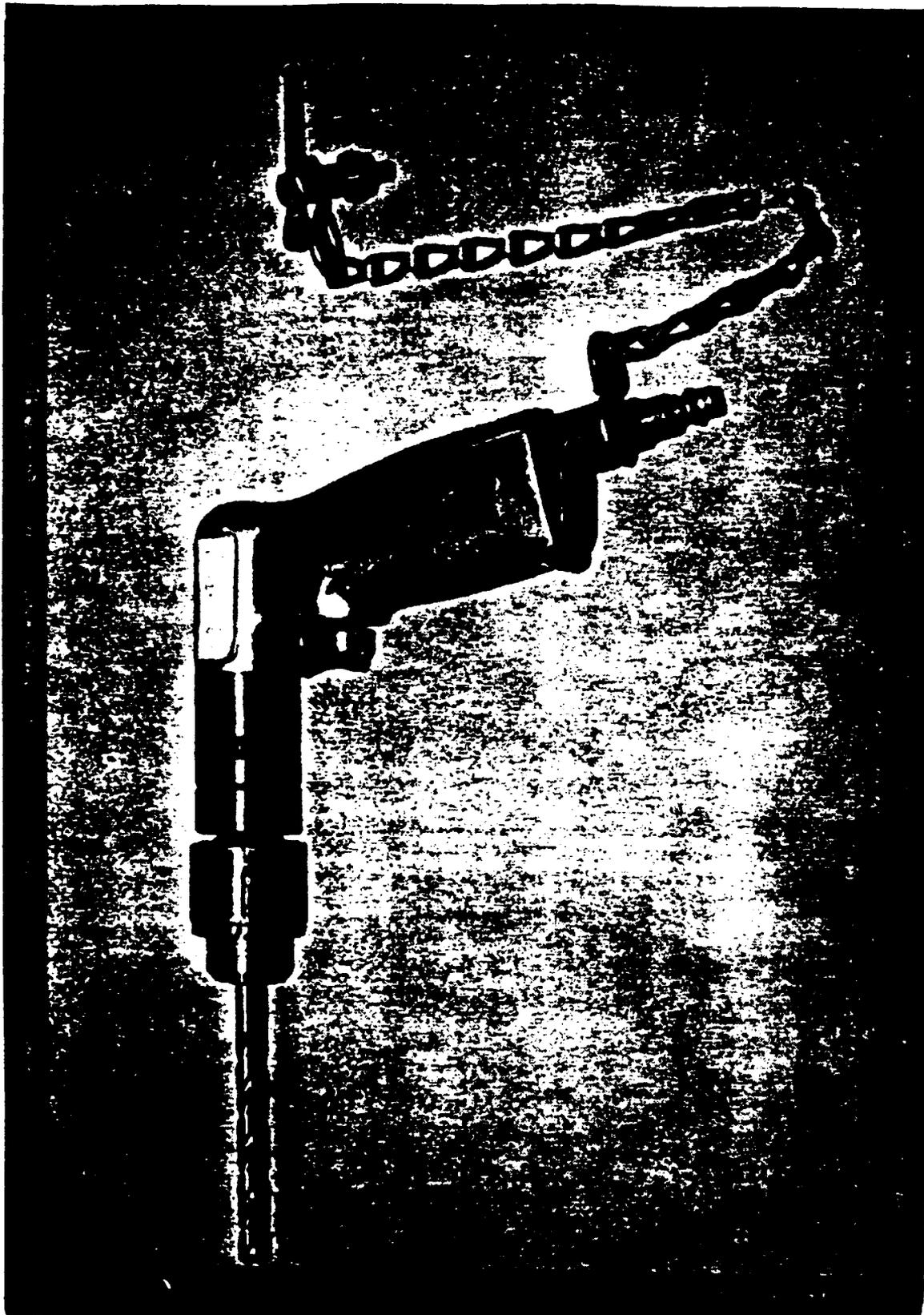
Figure D.7.   Power Drill.
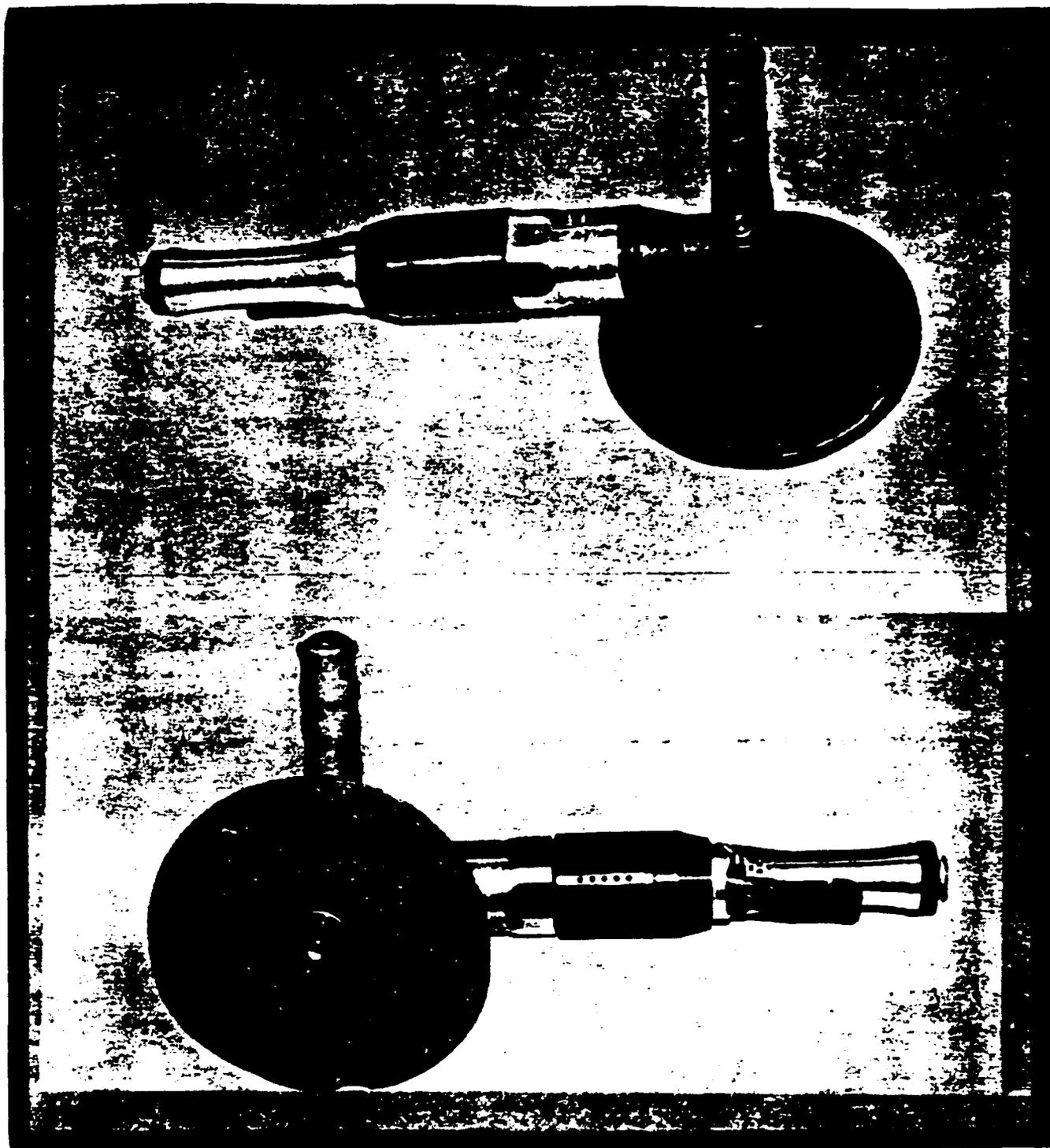
Figure D.8. Power Sander.

In general, the larger the bolt to be turned, the larger the wrench used for the task. For this reason, the wrench sizes in CREW CHIEF are a function of the diameter of the bolt being evaluated.

D.1.1.1 Wrenches with Sockets

For the torque wrench, ratchet wrench, breaker bar, speed handle, and nutdriver (those tools that use sockets) the bolt diameter dictates the tool drive size (1/4, 3/8, or 1/2 inch), and handle lengths in CREW CHIEF correspond to those common for that drive size. Bolt diameters that correspond to each drive size are:

BOLT DIAMETER	DRIVE SIZE
Numbered Screws 1-10	1/4 inch
3/16 to 1/2 inch	3/8 inch
9/16 to 1 inch	1/2 inch

Handle lengths in CREW CHIEF, in inches, are:

	1/4-INCH DRIVE		3/8-INCH DRIVE		1/2-INCH DRIVE	
	Standard	Long	Standard	Long	Standard	Long
Torque Wrench	6.0	9.5	9.5	14.5	20.8	36.0
Ratchet Wrench	5.4	6.5	7.5	10.3	10.3	15.0
Breaker Bar	6.0	9.5	9.5	11.5	15.0	24.0
Speed Handle (Sweep)	3.0	N/A	3.3	N/A	4.1	N/A

D.1.1.1.1   Extensions

Extensions may be used with torque wrenches, ratchet wrenches, and breaker bars to improve accessibility. Extensions of 3, 6, and 12 inches are available in CREW CHIEF. An extension is shown in Figure D.9(a).

D.1.1.1.2   Sockets

Four types of sockets are included in CREW CHIEF:

1. Regular
2. Deep
3. Universal
4. Hex Drive.

Sockets are shown in Figure D.9(b-e).

D.1.1.2   Wrenches Without Sockets

Bolt diameter dictates the wrench head size for the standard box end, deep offset box end, ratcheting box end, open end, combination end, allen wrenches, and nutdriver. (The nutdriver in CREW CHIEF is a one-piece tool.) CREW CHIEF automatically selects the handle length appropriate for the wrench head size for the type of wrench selected by the user. CREW CHIEF selects the handle length for the allen wrench that is appropriate for the grip selected by the user.
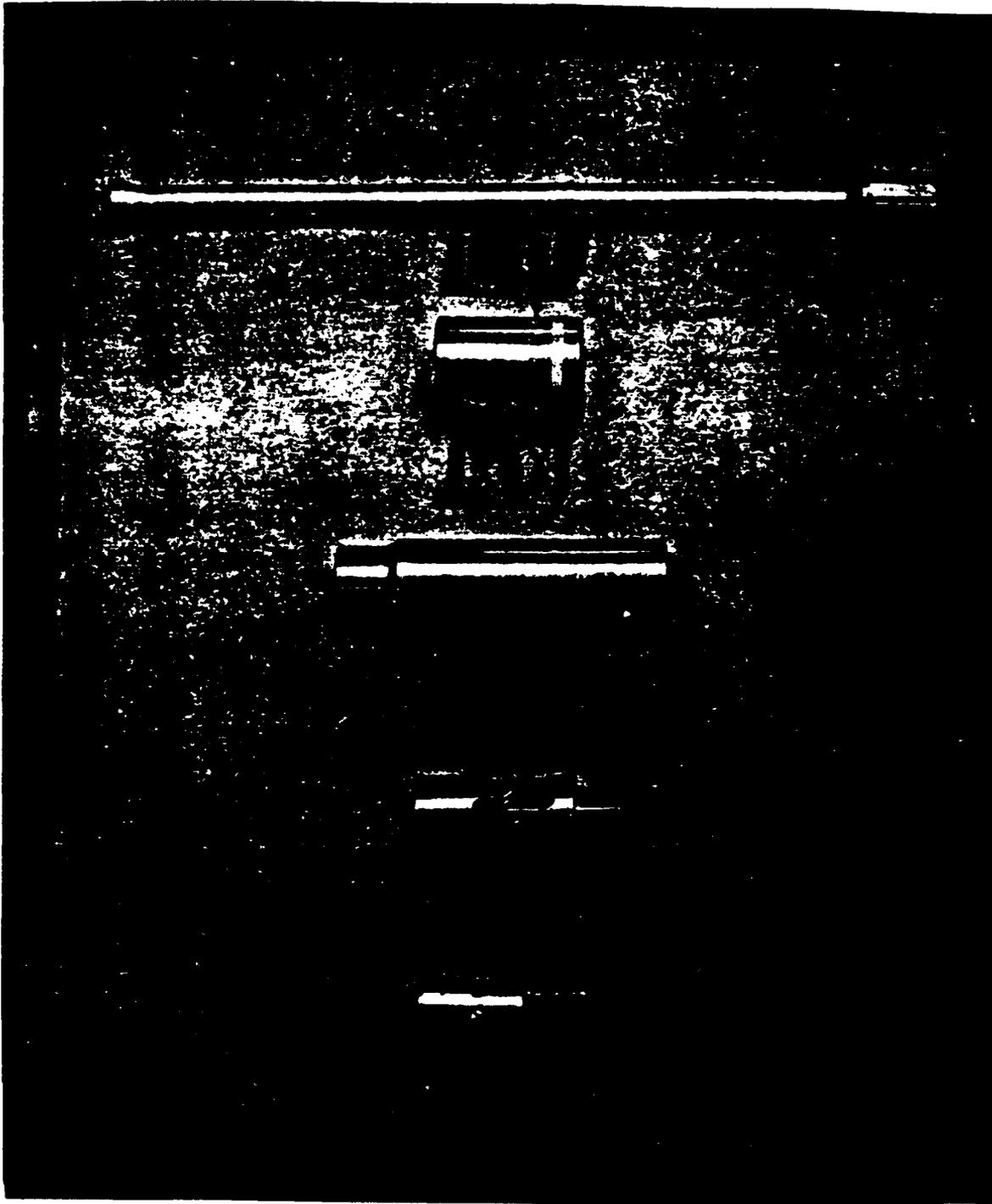
Figure D.9. Extensions and Sockets Include (a) Extension,
(b) Regular Socket, (c) Deep Socket, (d) Universal
Joint, and (e) Hex Drive.

Handle lengths in CREW CHIEF, in inches, are:

STANDARD BOX END

Bolt Diameter	Length
#4, 5,	2.8
#6, 8, 10	3.6
3/16 - 1/4	7.6
5/16 - 3/8	8.8
7/16 - 15/32	10.0
1/2 - 9/16	11.1
19/32 - 5/8	12.8
21/32 - 11/16	13.6
>11/16	16.0

DEEP OFFSET BOX END

Bolt Diameter	Length
#6, 8, 10	4.2
3/16 - 1/4	7.5
5/16 - 3/8	8.5
7/16 - 15/32	9.5
1/2 - 9/16	10.5
19/32 - 5/8	12.2
>5/8	13.1

RATCHETING BOX END

Bolt Diameter	Length
#6, 8, 10	4.3
3/16 - 1/4	5.5
5/16 - 3/8	7.0
7/16 - 15/32	7.0
1/2 - 9/16	7.8
19/32 - 5/8	8.7
21/32 - 11/16	10.0
>11/16	12.8

OPEN END

Bolt Diameter	Length
#4, 5	2.8
#6, 8, 10	4.0
3/16 - 1/4	5.3
5/16 - 3/8	6.5
7/16 - 15/32	7.7
1/2 - 9/16	9.3
19/32 - 5/8	10.8
21/32 - 11/16	11.6
>11/16	13.9

COMBINATION END

Bolt Diameter	Length
#6, 8, 10	4.7
3/16 - 5/16	7.3
3/8 - 7/16	8.3
15/32	9.0
1/2	10.0
9/16 - 19/32	11.3
5/8	13.0
11/16	14.0
>11/16	16.9

ALLEN WRENCH

Bolt Diameter	Short	Long
#1, 2, 3	0.6	1.5
#4 - 10	0.9	2.3
3/16 - 3/8	1.3	3.3
7/16 - 5/8	1.9	4.8
>5/8	2.7	6.8

NUTDRIVER

BOLT DIAMETER	LENGTH
#1-10	6.6
3/16-7/16	7.3

D.1.2   SCREWDRIVERS

Screwdrivers in CREW CHIEF include regular and offset.
No distinction is made between standard and crosspoint
screwdrivers. Regular screwdrivers are available with the
following blade lengths: 1.5, 3, 4, 6, 8, 10 and 12 inches. Two
lengths of offset screwdrivers are included: 4.5 and 6 inches.

D.1.3   PLIER-TYPE TOOLS

There are five plier-type tools included in CREW CHIEF:

1. Combination
2. Needle nose
3. Safety wire
4. Adjustable joint
5. Wire cutters.

One size of each of these pliers is included.
Therefore, selecting the type of pliers defines the tool size and
no other definition is necessary.

D.1.4   MISCELLANEOUS TOOLS

The hammer (ball peen), hammer with chisel, file,
scraper, hacksaw, power drill, and power sander are limited to
one size each in CREW CHIEF. Therefore, a selection of any of
these tools completely defines the tool and no other selections
are necessary.

D.2 SELECTING THE PROPER TOOL

When evaluating maintenance tasks that require a tool, the user is faced with choosing the tool that is most appropriate. Often the choice will be evident because the function of the tool is unique in the program, that is, no other tool will do the job. For example, if the task to be evaluated involves determining whether the design provided sufficient space to properly safety-wire an aircraft part, the obvious choice would be the safety wire pliers. At times, however, the choice may not be so clear. A bolt or nut can be torqued with any of several tools included in the program. Likewise, screwdrivers of different lengths may be used with equal success for the same task. The following information and recommendations should make the choice easier.

D.2.1 TOOLS WITH STRENGTH EVALUATION

Strength analyses with tools are available for wrenches only. No other tool strength limitations are considered pertinent to maintainability problems caused by design. Torque capabilities are available with eight of the tool types in CREW CHIEF. These eight tools are used to apply high torque to nuts and bolts.

D.2.1.1 Torque Wrench

The torque wrench must be used when a bolt or nut must be torqued to a specific value dictated by the specific aircraft maintenance technical order. Likewise, this tool is never used if a specific torque value is not required by this technical order. Generally, specific values will be designated if they are critical to safety or proper aircraft operation. Use of a universal joint produces erroneous torques on the bolt, and therefore, the use of the universal is disallowed with the torque wrench.

D.2.1.2   Other Wrenches with Strength Evaluation

The seven other wrenches with strength analyses in the program can be used whenever a specific torque value is not required by the specific aircraft technical order. In these cases, general torque recommendations based on bolt and nut types and sizes can be found in the USAF Technical Order 1-1A-8, "Aircraft and Missile Repair - Structural Hardware" (Reference D.2). These seven wrenches are often chosen by the maintenance technician according to personal preference and/or the tool's accessibility traits in relation to the task. The following is a recommended order of preference for the selection of these seven wrenches.

1. Ratchet
2. Ratcheting box end
3. Breaker bar
4. Combination end
5. Standard box end
6. Deep offset box end
7. Open end (NOTE: It should be obvious that only the open end wrench can be used on tasks involving connections for various lines such as fuel and hydraulic lines.)

D.2.2   TOOLS WITHOUT STRENGTH EVALUATION

D.2.2.1   Wrenches

Three wrenches are included in the CREW CHIEF Program that do not have strength analyses available. Lack of technician's strength while using these tools is not a common maintenance problem.

SPEED HANDLE: As its name implies, the shape of the speed handle allows the technician to turn fasteners at a rapid rate. For this reason, it is used for tasks that require removal

or installation of numerous bolts or screws. The prime example is an aircraft access panel that has bolts/screws along its entire perimeter. The speed handle is not useful for applying high torque because of the short moment arm of the sweep.

ALLEN WRENCH: This tool is used on light tasks that require tightening and loosening of internal hex head fasteners. Selection of this tool in the program should be apparent by the task to be evaluated.

NUTDRIVER: This tool is used on small bolts/nuts that are easily turned and especially in recessed areas that do not allow the use of other wrenches. It is commonly used in avionics and electrical system maintenance.

D.2.2.2   Plier-Type Tools

The five types of pliers included in the program (combination, needle nose, safety wire, adjustable joint, and wire cutters) are very common and the appropriate selection of each should be fairly evident to the user based upon the task to be evaluated.

COMBINATION PLIERS: These are the most common pliers. They are used as gripping tools. They should be selected in preference to the other plier-type tools for general gripping tasks. The other four have specific functions and should only be selected if the task corresponds to that specific function.

NEEDLE NOSE PLIERS: These pliers have jaws that are long and slender. They are designed for gripping small objects and for use in areas of restricted access.

ADJUSTABLE JOINT PLIERS: These pliers have jaws that will open wide and are designed for gripping larger objects than can be gripped with the combination pliers. They tend to be large overall and are not useful in areas of limited access.

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WIRE CUTTERS: This tool is used only for cutting elec-
trical wire. No other tool in CREW CHIEF should be selected for
this function.

SAFETY WIRE PLIERS: This tool has a very specific
purpose. It is used only for twisting wire during safety wiring
tasks. No other tool should be selected for this task.

D.2.2.3 Screwdrivers

There are two types of screwdrivers in the program:
regular and offset. Regular screwdrivers include standard and
crosspoint; that is, no distinction is made in the point types.
Regular screwdrivers should be selected in preference to offset
screwdrivers. The offset screwdriver is normally used only if
necessary because of lack of access with regular screwdrivers.
Regular screwdrivers are selected in the program by blade length
(1.5, 3, 4, 6, 8, 10, and 12 inches). It is recommended that the
user first select the median length (6 inches) as the preferred
length and subsequently choose shorter or longer blades as the
design dictates.

D.2.2.4 Miscellaneous Tools

All other tools in the CREW CHIEF Program (hammer,
hammer with chisel, file, scraper, hacksaw, drill, and sander)
have unique functions and their appropriate selection should be
evident by the task to be evaluated.

APPENDIX E

ANTHROPOMETRIC DATA BASE MAINTENANCE PROGRAM (AMPREG)

APPENDIX E

ANTHROPOMETRIC DATA BASE MAINTENANCE PROGRAM (AMPREG)

The human model used in CREW CHIEF is based on the anthro-
pometry of Air Force maintenance technicians. However, the CREW
CHIEF program has applications in many areas of maintenance, and
so need not be restricted to representing a single population.
These additional populations may be created and stored in the
Anthropometry/Regression data base, and then used during a CREW
CHIEF analysis.

This data base can be accessed through a data base
maintenance program, AMPREG, which allows for general data
management of the Anthropometry/Regression Data Base. AMPREG
allows a CREW CHIEF user to add virtually any population to this
data base, compress the data base, and generate reports on the
data base.

There are three anthropometric variables which are crucial
to maintainability analysis :

- Stature,
- Weight, and
- Arm Length

Stature and Weight are standard anthropometric variables
found in most surveys. Arm Length is defined by three other
anthropometric variables found in most surveys.

Arm Length = Acromion-Radiale + Radiale-stylion +
Hand Length

These three variables are used as a basis for calculating 10
additional variables which, along with stature and weight, are
used for defining the human model skeletal system and
enfleshment. AMPREG allows the user to represent a population by
altering either the data for these three variables, or the

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equations used to calculate the data for the 10 variables. Note that the Arm Length must be calculated for each individual, and then the overall percentiles determined from this set of Arm Lengths. A 5th percentile length is **not** the sum of the 5th percentile values of the Acromion-Radiale, Radiale-Stylion and Hand Length.

Data for the three anthropometric variables can be altered by adding an Anthropometric Member to the data base. This member will contain data defining the percentile data for each of the three variables. Each Anthropometric Member must reference a set of regression equations from which data for the 10 additional variables can be calculated.

Regression equations are stored in a second type of data base member, called a Regression Member. These equations further define the CREW CHIEF model, and may vary from population to population. When referencing a Regression Member from an Anthropometric Member, the AMPREG user should take care that the regression equations will accurately represent a desired population. For instance, a subpopulation of Japanese pilots would not be well represented by referencing regression equations based on an American population. They would be represented much better by referencing regression equations based on the general Japanese population. Of course, the best representation of a subpopulation would be to reference regression equations based on the same subpopulation.

E.1   AMPREG CONTROL STATEMENTS

All data base management is performed through control statements input through the //USRINPT DD statement in the AMPREG execution JCL. While processing a control statement, AMPREG assumes that the //DATABAS DD statement points to the location of the data base. This section discusses each of these control statements in detail.

- FORMAT <u>BASTTL</u>

The FORMAT control statement formats a NEW data base prior to adding any members. **CAUTION:** If the FORMAT control card is input for an existing data base, all members in that data base will be lost.

FORMAT: (A10,1X,A32)

BASTTL- Title of new Anthropometry/Regression data base (contained in a field of 32 characters).

- ADD <u>TYPE   MBRTTL</u>

The ADD control statement is used to add a member to the data base. This control statement must always be followed by a DATA control statement (see below) which defines the location of the data. Both Regression and Anthropometric Members are entered using this control statement, as specified by the TYPE variable.

FORMAT: (A10,1X,A14,1X,A32)

TYPE - Type of member to be entered
        = 'ANTHROPOMETRIC', Anthropometric Member.
        = 'REGRESSION', Regression Member.

MBRTTL- Title of member. Note: the title of each member must be unique within that type. For instance, there can be only one Anthropometric Member entitled "Japanese Maintenance Technicians." However, a Regression Member may have the same name as a Anthropometric Member.

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- ERASE <u>TYPE   MEMBER</u>

The ERASE control statement allows the user to delete a member from the data base.

FORMAT: (A10,1X,A14,1X,A32)

TYPE -   Type of member to be erased.
MEMBER - The name of the member to be erased.

- COPY <u>TYPE   MEMBER</u>

The COPY control statement is used t copy a member from one Anthropometry/Regression data base to another. This function can be used to merge data bases, or to selectively copy members from one or more data bases. The COPY control statement must be followed by a DATA control statement defining the DDNAME of the data base from which you are copying. The member will be copied into the database pointed to by the //DATABAS DD statement.

FORMAT(A10,1X,A14,1X,A32)

TYPE -   Type of member to be copied.
MEMBER - The name of the member to be copied.

- REPORT <u><TYPE>   <MEMBER></u>

The REPORT control statement prints out general infor- mation on the Anthropometry/Regression data base. If no member is specified, general information on the entire data base is output. Otherwise, a somewhat more detailed report for the specified member is output.

FORMAT: (A10,1X,A14,1X,A32)

<TYPE>:   The type of member whose report is
           desired (OPTIONAL OPERAND).

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<MEMBER>: The name of the member whose report is
         desired (OPTIONAL OPERAND).

- PRINT <u><TYPE>   <MEMBER></u>

The PRINT control statement can be used to obtain a
complete print-out of data for the member specified or, alter-
nately, for all members in the data base.

FORMAT: (A10,1X,A14,1X,A32)

<TYPE>:   Type of member to be printed
<MEMBER>: The name of the member to be printed
         (OPTIONAL OPERAND).

- DATA <u>DDNAME</u>

The DATA control statement is used to indicate the
location of input data for the Anthropometric and Regression
Members. Rather than placing these data in-stream, AMPREG uses
this statement to locate a file containing the data. Note that
each ADD control statement must be followed by a DATA control
statement.

FORMAT: (A10,1X,A8)

DDNAME - The name of the data definition JCL statement which
         points to the dataset containing the input data.

E.2 EXECUTING THE AMPREG PROGRAM

Figure E.1 shows sample JCL for executing the AMPREG
program. This example formats a new database, and then adds a
Regression Member and an Anthropometric Member.

The first control statement under the //USRINPT DD statement
(line #6000) requests that the database be formatted, and given

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the name "SAMPLE DATABASE." The next record (line #6100) requests that a new Regression Member, called "SAMPLE REGRESSION MEMBER," be added to the database. The DATA control statement immediately following the ADD statement specifies that the input data for the Regression Member can be found in the data set pointed to by the //REGIN DD statement (line #4500).

The next control statement (line #6300) requests that a new Anthropometric Member, called "SAMPLE ANTHROPOMETRIC MEMBER," be added to the database. The DATA control statement immediately following this ADD statement specifies that the input data for the member can be found in the data set pointed to by the //ANTHIN DD statement (line #3600).

Note that in this example, if the new Anthropometric Member is to reference the new Regression Member, the Regression Member must be added first. Note also that the the input data for the two new members need not necessarily reside in the same Partitioned Dataset.

E.3   DATA INPUT FORMATS

The dataset pointed to by the DATA control statement contains specific information needed for defining a member. The necessary information is different for Regression Members and Anthropometric Members, so input formats vary between the two.

E.3.1   Anthropometric Data Input Format

The first portion of the anthropometry input dataset contains general information for the member. The first record contains,

```
00100 //jobname   JOB account_number,programmer_name,CLASS=A,MSGCLASS=A
00200 //*****************************************************************
00300 //*                                                               *
00400 //*                     PROGRAM AMPREG                            *
00500 //*                                                               *
00600 //*---- -------------------------------------------------------- *
00700 //*    THIS IS SAMPLE JCL FOR EXECUTING THE CREW CHIEF DATABASE   *
00800 //* MAINTENANCE PROGRAM AMPREG, WHICH ALLOWS THE CREW CHIEF USER TO *
00900 //* DEFINE BODY SIZES BASED ON A POPULATION OTHER THAN THE AF     *
01000 //* MAINTENANCE TECHNICIAN POPULATION.  THIS JCL ASSUMES THE      *
01100 //* FOLLOWING:                                                    *
01200 //*                                                               *
01300 //*         1. THE USER WANTS TO CREATE A NEW CREW CHIEF DATABASE IN *
01400 //*            THE DATA SET 'CREW.CHIEF.SAMPLE.ANTHREG.DATA'.      *
01500 //*         2. THE INPUT DATA FOR THE ANTHROPOMETRIC AND REGRESSION *
01600 //*            MEMBERS CAN BE FOUND IN 'CREW.CHIEF.SAMPLE.SOURCE'. *
01700 //*                                                               *
01800 //*****************************************************************
01900 //*
02000 //AMPREG    EXEC PGM=AMPREG
02100 //STEPLIB  DD   DSN=CREW.CHIEF.CADAM.LOAD,DISP=SHR,LABEL=(,,,IN)
02200 //*
02300 //* +++ THE NEW DATABASE IS POINTED TO BY THE //DATABAS DD
02400 //* +++ STATEMENT.  ALL AMPREG CONTROL STATEMENTS ACT ON THE
02500 //* +++ DATA SET POINTED TO BY THIS DD.
02600 //*
02700 //DATABAS DD   DSN=CREW.CHIEF.SAMPLE.ANTHREG.DATA,DISP=(NEW,CATLG),
02800 //          SPACE=(???,(???,???)),UNIT=DISK,VOL=SER=CCFDSK
02900 //*
03000 //* +++ THE ANTHROPOMETRIC MEMBER INPUT DATA IS POINTED TO BY
03100 //* +++ THE //ANTHIN DD STATEMENT.  THIS DD STATEMENT WAS SPECIFIED
03200 //* +++ BY THE 'DATA' CONTROL STATEMENT FOLLOWING THE 'ADD'
03300 //* +++ ANTHROPOMETRIC MEMBER CONTROL STATEMENT IN THE //USRINPT
03400 //* +++ DD.
03500 //*
03600 //ANTHIN   DD   DSN=CREW.CHIEF.SAMPLE.SOURCE(ANTHIN),DISP=SHR,
03700 //          LABEL=(,,,IN)
03800 //*
03900 //* +++ THE REGRESSION MEMBER INPUT DATA IS POINTED TO BY
04000 //* +++ THE //REGIN DD STATEMENT.  THIS DD STATEMENT WAS SPECIFIED
04100 //* +++ BY THE 'DATA' CONTROL STATEMENT FOLLOWING THE 'ADD'
04200 //* +++ REGRESSION MEMBER CONTROL STATEMENT IN THE //USRINPT
04300 //* +++ DD.
04400 //*
04500 //REGIN    DD   DSN=CREW.CHIEF.SAMPLE.SOURCE(REGIN),DISP=SHR,
04600 //          LABEL=(,,,IN)
04700 //*
04800 //* +++ THE //USRINPT DD STATEMENT CONTAINS THE CONTROL STATEMENTS
04900 //* +++ FOR DRIVING THE AMPREG PROGRAM.  IN THIS EXAMPLE, THE PROGRAM
05000 //* +++ IS TOLD TO:
05100 //* +++
05200 //* +++     1. FORMAT THE DATABASE, AND NAME IT 'SAMPLE DATABASE'
05300 //* +++     2. ADD A REGRESSION MEMBER CALLED 'SAMPLE
05400 //* +++        REGRESSION MEMBER', WHOSE INPUT DATA ARE POINTED TO
05500 //* +++        BY THE DD STATEMENT //REGIN.
05600 //* +++     3. ADD AN ANTHROPOMETRIC MEMBER CALLED 'SAMPLE
05700 //* +++        ANTHROPOMETRIC MEMBER', WHOSE INPUT DATA ARE
05800 //* +++        POINTED TO BY THE DD STATEMENT //ANTHIN.
05900 //USRINPT DD *
06000 FORMAT      SAMPLE DATABASE
06100 ADD         REGRESSION    SAMPLE REGRESSION MEMBER
06200 DATA        REGIN
06300 ADD         ANTHROPOMETRIC SAMPLE ANTHROPOMETRIC MEMBER
06400 DATA        ANTHIN
06500 /*
06600 //
```

Figure E.1: Sample JCL for Executing the AMPREG
            Anthropometry/Regression Database
            Maintenance Program.

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- **NUMCMT GENDR REGNAM**

  FORMAT(I2,1X,A6,1X,A32)

  NUMCMT- Total number of records needed to contain all the general member comments.

  GENDR - Gender indicator.
  - = 'NONE', if not gender-specific.
  - = 'MALE', if male population.
  - = 'FEMALE', if female population.
  - = 'BOTH', if member contains both male and female data.

  REGNAM- The name of the reference regression data base. Note that if a particular Anthropometric Member contains both male and female data (GENDR= 'BOTH'), then the referenced Regression Member must also contain data for both.

The next set of records contain informational text on the origins of the member. This block may contain information on data editing, data validity, or any other type of historical information.

- **COMENT**

  FORMAT(A72)

  COMENT- Informational text.

The remainder of the dataset contains percentile data for each of the five variables. Each set of variable data is input using two lines, one defining the type of data, and one defining the actual data, itself.

- <u>VARNAM   GENDR</u>

  FORMAT(A20,1X,A6)

  > This record defines _he name of the variable for which data is being input. The variable name must be input exactly as seen in Table E.1. The next field, separated by a blank from the first, specifies the gender which the data describes. The gender need be specified only when the member is to contain both male and female data.

- <u>(PCTVAL(I), I=1,5)</u>

  FORMAT(F10.4,4(2X,F10.4))

  > This record contains the percentile data for the variable described in the preceding record. The data is ordered according to increasing percentile (i.e., PCTVAL(1) contains the data for the 1st percentile, PCTVAL(2) contains the data for the 5th percentile, etc.).

The above two records must be input for each of the five variables used to generate the human model. In addition, if the member is to contain both genders, each variable must be entered twice-- once for males and once for females.

E.3.2   <u>Example Anthropometric Member Addition</u>

Figure E.2 shows a partial listing of typical input for creating an Anthropometric Member. These data are contained in the data set pointed to by the DD statement specified in the DATA control statement following the ADD control statement under the //USRINPT DD statement (recall Figure 1). The first line of data in Figure 2 (line # 100) specifies that there are 12 lines of comments following the first record, that the new Anthropometric

TABLE E.1

VARIABLES USED FOR DEFINING CREW CHIEF

VARIABLE NAME	REGRESSED FROM
SITTING HEIGHT	STATURE
ACROMION HEIGHT/SITTING	STATURE
KNEE HEIGHT/SITTING	STATURE
BUTTOCK-KNEE LENGTH	STATURE, WEIGHT
BIACROMIAL BREADTH	STATURE, WEIGHT
HIP BREADTH	STATURE, WEIGHT
CHEST DEPTH	STATURE, WEIGHT
FOOT LENGTH	STATURE
SHOULDER-ELBOW LENGTH	ARM LENGTH[*]
ELBOW-WRIST LENGTH	ARM LENGTH[*]

[*] ARM LENGTH= (ACROMION-RADIALE) + (RADIALE-STYLION) + (HAND LENGTH).

COLUMN NUMBERS

```
       10        20        30        40        50        60
xxxxxx----+---- |----+ -- |----+---- |----+---- |----+---- |----+---- |
```

00100 12 BOTH   SAMPLE REGRESSION MEMBER

00200

00300   THIS ANTHROPOMETRIC MEMBER IS BASED ON THE ANTHROPOMETRY OF

00400 AIR FORCE MAINTENANCE TECHNICIANS.   THE BASIS FOR MALE ANTHROPOMETRY

00500 WAS THE 1965 SURVEY OF AIR FORCE MALE PERSONNEL, WHICH WAS EDITED

00600 ACCORDING TO AFR 160-43.   IN ADDITION, ONLY THOSE PERSONNEL AT THE

00700 MASTER SERGEANT LEVEL OR BELOW WERE INCLUDED, SINCE THOSE OF HIGHER

00800 RANK WOULD NOT TYPICALLY BE PERFORMING MAINTENANCE.

00900   THE BASIS OF THE FEMALE ANTHROPOMETRY WAS THE 1968 SURVEY OF

01000 AIR FORCE WOMEN, WHICH WAS EDITED USING THE SAME STANDARDS AS THE

01100 MALES.

01200   BOTH SETS OF DATA WERE ADJUSTED, USING A CALCULATED GROWTH

01300 FACTOR, BASED ON DATA FROM THE AIR FORCE'S ESTABLISHING PHYSICAL

01310 CRITERIA FOR ASSIGNING PERSONNEL TO AIR FORCE JOBS STUDY.

01400

01500 STATURE   MALE

01600   63.2   64.8   69.1   73.8   76.1

01700 STATURE   FEMALE

01800   59.2   60.4   64.3   68.5   70.3

01900 WEIGHT   MALE

02000   110.6   122.9   154.7   194.7   207.4

02100 WEIGHT   FEMALE

02200   96.2   103.8   126.8   146.6   157.4

02300   .

02400   .

02500   .

Figure E.2: Example Input for Creating a New
            Anthropometric Member.
```

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Member will contain both male and female data, and that the Regression Member to be used for calculating data for the 10 additional variables is 'SAMPLE REGRESSION MEMBER.'

Lines #200 through #1400 contain comments on the methods used to generate this set of data. These comments are stored directly in the database, and will be printed out whenever a REPORT control statement is encountered.

The remainder of the data set consists of data for each of the five base variables used in defining the man-model. Lines #1500 & #1600 contain the percentile data for stature of the male portion of the population, in order of increasing percentile. Lines #1700 and 1800 contain the percentile data for stature of the female portion of the population. The remainder of the data set follows the same format, until data for all five variables have been defined for both genders.

E.3.3    Regression Data Input Format

Regression Members contain the data necessary to "flesh out" the man-model anthropometry. This type of member defines the regression equations for calculating dependent variable values.

The first record contains general information for the regression member.

• NUMCMT GENDR

FORMAT(I2,1X,A6)

NUMCMT- Number of records used for describing the origins of this member. This space can be used for historical recording of the location of the original data, as well as any editing procedures on it.

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```
GENDR  - Gender indicator
       = 'NONE'  , if not gender-specific.
       = 'MALE'  , if male population.
       = 'FEMALE', if female population.
       = 'BOTH'  , if population is both male and female.
```

The next NUMCMT records are used to input the historical comments. Each record is formatted as

- **COMENT**

FORMAT(A72)

COMENT- Informational text.

A regression member contains the data needed to calculate the dependent variables from the input set of independent variables. These calculations are usually performed as linear regressions, where the variable to be calculated, say v_{dep}, is expressed as a linear function

$$v_{dep} = a_1 * v_{ind} + b_1,$$

where v_{ind} is one of the five base variables; and a_1 and b_1 are the regression coefficients. Note that this equation is easily extended to any number of independent variables. Table I also shows which combinations of the five variables are used to calculate each of the additional ten needed. Note also that more than one anthropometric member can reference a single regression member.

- **VARNAM   GENDR**

FORMAT(A20,1X,A6)

This record defines the name of the variable for which a regression equation is being input. The variable name must be

input exactly as seen in table I. The next field, which begins
in column 22, specifies the gender which the data describes. The
gender need be specified only when the member is to contain both
male and female data. The next record defines the actual
regression equation for calculating the variable specified above.
The regression coefficients are input in the same order they are
listed in Table E.1.

- XCEPT, REGCF1, REGCF

    FORMAT(3(F10.4,1X))

    XCEPT -   The intercept term for the regression
               equation.
    REGCF1 -   The regression coefficient for the first
               regressor.
    REGCF2 -   The regression coefficient for the second
               regressor (if needed).

The regression data must be input for each of the ten
variables listed in Table I. In addition, if a particular
Regression Member contains both male and female data (GENDR=
'BOTH', each variable must be input twice-- once for each gender.

E.3.4   Example Regression Member Addition

    Figure E.3 shows an example of the format used to input
data for a new Regression Member. The first line (#100)
specifies that 19 lines of comments follow the first record, and
that the new Regression Member will contain equations for both
males and females. The next 19 records (lines #200 through
#2000) contain the historical comment data.

    The remainder of the data set is used to define the
regression equations needed to calculate the 10 additional
variables, for both male and females. The first equation entered
(lines #2100 & #2200) provides the coefficients for calculating
Sitting Height for males as a function of Stature (see Table E.1):

355

COLUMN NUMBERS

```
           10        20        30        40        50        60
xxxxxx----+----|----+----|----+----|----+----|----+----|----+----|

00100  19 BOTH
00200
00300     THIS REGRESSION  MEMBER  IS BASED  ON THE  ANTHROPOMETRY   OF
00400  AIR FORCE MAINTENANCE  TECHNICIANS.   THE BASIS  FOR MALE  ANTHROPOMETRY
00500  WAS THE 1965 SURVEY  OF AIR FORCE MALE PERSONNEL,  WHICH WAS  EDITED
00600  ACCORDING  TO AFR 160-43.   IN ADDITION,  ONLY THOSE  PERSONNEL   AT THE
00700  MASTER  SERGEANT  LEVEL OR BELOW WERE INCLUDED,  SINCE THOSE OF HIGHER
00800  RANK WOULD NOT TYPICALLY  BE PERFORMING  MAINTENANCE.
00900     THE BASIS OF THE FEMALE ANTHROPOMETRY  WAS THE 1968 SURVEY OF
01000  AIR FORCE WOMEN,  WHICH WAS EDITED USING THE SAME STANDARDS  AS THE
01100  MALES.
01200     BOTH SETS OF DATA WERE ADJUSTED,  USING A CALCULATED  GROWTH
01300  FACTOR,  BASED ON DATA FROM THE AIR FORCE'S ESTABLISHING   PHYSICAL
01310  CRITERIA  FOR ASSIGNING  PERSONNEL  TO AIR FORCE JOBS STUDY.
01400     FOR THE MALE POPULATION,  THE REGRESSION  EQUATIONS  CALCULATED
01500  HERE ARE ALL BASED ON THE EDITED 1965 SURVEY.   FOR THE FEMALE
01600  POPULATION,  ALL EXCEPT ONE OF THE EQUATIONS  ARE BASED ON THE
01700  1968 SURVEY.   KNEE HEIGHT/SITTING  WAS NOT AVAILABLE  IN THE '68
01800  SURVEY,  SO REGRESSION  EQUATIONS  FOR THAT VARIABLE  ARE BASED ON
01900  SIMILARLY  EDITED DATA FROM THE 1977 SURVEY OF ARMY WOMEN.
02000
02100  SITTING HEIGHT          MALE
02200       8.7153       0.3956
02300  BIACROMIAL  BREADTH     MALE
02400       9.1140       0.0638       0.0140
02500  BUTTOCK-KNEE   LENGTH   FEMALE
02600       3.9225       0.2397       0.0267
02700                     .
02800                     .
02900                     .
```

Figure E.3: Example Input for Creating a new Regression
            Member.

SITTING HEIGHT= 8.7153 + (.3956)*(STATURE).

The next two records (lines #2300 and #2400) define male Biacromial Breadth as a function of Stature and Weight (see Table E.1):

BIACROMIAL BREADTH= 9.1140 + (.0638)*(STATURE) +
                    (.0140)*(WEIGHT

Finally, the last two records shown in Figure E.3 define female Buttock-Knee Length as a function of Stature and Weight:

BUTTOCK-KNEE LENGTH= 3.9225 + (.2397)*(STATURE) +
                     (.0267)*(WEIGHT).

The remainder of the data set follows the same format, defining the regression equations for each of the 10 additional variables, for each gender.

APPENDIX F

TOOL DATABASE MAINTENANCE PROGRAM (TOLMNT)

APPENDIX F
TOOL DATABASE MAINTENANCE PROGRAM (TOLMNT)

The Air Force design philosophy is to design systems that can be maintained with standard hand tools. Due to performance and space considerations, it is sometimes required that special tools be used for some applications. Also, there are cases where a standard tool is required for a specific task, which is not included in the CREW CHIEF tool box. To provide the CREW CHIEF users the capability to make tool analyses with special tools, or standard tools not included in the tool box, this program has been developed to allow the user to add such tools to the tool box.

There are several basic requirements for adding a tool to the tool box. Characteristics of the tool which must be defined include:

Bulk and shape of the tool (tool enfleshment)
Grip type used for the tool
Hand(s) used to grip the tool
Point where the tool is gripped
How the tool is used
Parameters of the required space for the working envelope
and interference checking cylinder dimensions).

Two files are required, the drawing file establishing the tool enfleshment, and the Tool Maintenance Control file. The tool maintenance control file is the user's input vehicle for intangible characteristics such as, how the tool may be held, how it is used, and clearances parameters for checking interference.

CREATING A TOOL MODEL

- Tool Enfleshment

    The tool enfleshment is designed on the host CADAM
system as a CADAM Finite Element model (FEM), or as surfaces
which are converted to FEM using the CADAM-supplied Access
function "MESH". Once the tool is represented as a CADAM FEM
drawing, the user may need to create additional mesh points for
use as input for the Tool Maintenance Control file.

    After a complete FEM representation is created, the
user converts this drawing to a NASTRAN file using the CADAM
supplied conversion programs. The first jobstep in the sample
JCL provided with the distribution tape creates the mesh file.
The second jobstep in the sample JCL provided to the user creates
the NASTRAN file. The final jobstep in the tool creation job
uses the NASTRAN file output from the MFTN program as input (for
FORTRAN unit 10).

- Tool Maintenance Control File

    Exterior bulk shape (tool enfleshment) do not determine
all the information necessary to accurately model a tool. Many
intangible characteristics, such as, how the tool may be held, or
how it is used, cannot be determined from a simple FEM model.
Such characteristics must be input by the user, and are done so
through the Tool Maintenance Control file.

    The Tool Maintenance Control file is input through
FORTRAN file 10 in the third jobstep in the sample JCL. The
input is in card-image format, and is described below.

    A.   <u>TOOL TYPE</u> - Indicates the Type of the tool being added
to the tool database. Under the current version of the
tool Database Maintenance program users can only add

"MAIN" type tools. The only value for TOOL TYPE is:

1 - Main Type

B.   TOOL CLASS - Indicates the CLASS of the tool being added. For this version of the program users may only tools in the "USER DEFINED" class. The only value for TOOL CLASS is:

8 - User Defined Class

C.   MODEL NAME - Any 28 alphanumeric string describing the tool name.

D.   EXTENSIONS FLAG - This flag defines whether or not extensions are to be included as accessories for the new tool. When the flag is set to include extensions, all the existing models of extensions (2" through 10") are associated with the new tool. Possible values are:

Y - Include extensions as accessories

N - No extensions as accessories

E.   SOCKETS FLAG - This flag defined whether or not sockets are to be included as accessories for the new tool. When the flag is set to include sockets, all existing models of sockets are available for use with the tool. Possible values are:

Y - Include sockets as accessories

N - No sockets as accessories

F.   RIGID GRIP FLAG - This defines whether or not the tool can rotate in the hand. Non-rigid grip allows the tool handle to rotate in the hand as it is commonly used, such as when using a ratchet wrench. Rigid grips do

not allow the tool handle to rotate in the hand as it is commonly used, such as when using pliers. Possible values are:

0 - Non-rigid grip type tools

1 - Rigid grip type tools

G.   SECOND HAND REACH TYPE - Defines how the second hand may reach and be placed on the tool. The possible values are:

1 - With the palm flat against the tool with the fingers curled around the tool head.

2 - With the palm flush against the tool surface and the hand extended

3 - The second hand may grasp a section of the tool as if it were a handle

H.   HAND GRIPS PERMITTED - A tool may be held in one of three initial orientations in the hand (Figure F.1). The REGULAR grip has the point of application for the tool above the thumb, an the tool handle perpendicular to the hand. The REVERSE grip has the point of application for the tool below the Metacarpal V, and the tool handle perpendicular to the hand. The ALTERNATE grip positions the tool handle parallel to the hand. The possible values are:

1 - Regular

2 - Reverse

3 - Alternate

REGULAR

REVERSE

ALTERNATE

Figure F.1. Hand Grip Types

4 - Regular and Reverse

5 - Regular and Alternate

6 - Reverse and Alternate

7 - Regular, Reverse, and Alternate

I.   HAND HOLDING TOOL - defines the hand that is used to hold the tool. Possible values are:

0 - Non-reachable

1 - Right hand only

2 - Left hand only

3 - Both hands

4 - Right hand, or Left hand

5 - Right hand, Left hand, or Both hands

J.   HAND ATTACH POINT - The tool may attach to the hand at either the grip center or functional grip center location (Figure F.2). Possible values are:

1 - Grip center

2 - Functional grip center

K.   HANDLE RADIUS - A real number describing the radius of the handle.

L.   CYLINDER HEIGHT - A real number describing the height of the cylinder used to exclude any geometry inside the cylinder when calculating interference.

GRIP CENTER   FUNCTIONAL

Figure F.2. Grip Center and Functional Grip Center Locations

M.   <u>CYLINDER RADIUS</u> - A real number describing the radius of the cylinder used to exclude any geometry inside the cylinder when calculating interference.

After the user drawing is converted into a mesh file using the CADAM provided utility (CTFM), all nodes and triangles in the user drawing are assumed to be integral members of the mesh model describing the tool. they can be referred to directly by specifying a node number or a triangle number. The remaining values input by the user make reference to the node identification number used to define the following information.

N.   <u>ATTACH NODE OF THE TOOL</u> - Node that attaches the tool to the work place.

O.   <u>ATTACH DIRECTION NODE</u> - Node that defines the attach direction of the tool.

P.   <u>FIRST NODE PRIMARY HAND CENTERLINE</u> - Node that defined the beginning of the centerline of the handle grasped by the primary hand.

Q.   <u>SECOND NODE PRIMARY HAND CENTERLINE</u> - Node that defines the end of the centerline of the handle grasped by the primary hand.

R.   <u>FIRST NODE SECONDARY HAND CENTERLINE</u> - Node that defines the beginning of the centerline of the handle grasped by the secondary hand.

S.   <u>SECOND NODE SECONDARY HAND CENTERLINE</u> - Node that defines the end of the centerline of the handle grasped by the secondary hand.

T.   <u>FIRST NODE MESH ELEMENT</u> - Node that defines the mesh element against which the secondary hand may be placed.

U.   SECOND NODE MESH ELEMENT - Node that defines the mesh
     hand element against which the secondary may be placed.

V.   THIRD NODE MESH ELEMENT - Node defining the mesh
     element against which the secondary hand may be placed.

     Entries N through V are required except in the
following cases.

1.   The definition of centerline for the secondary hand or
     mesh element for the secondary hand are only needed if
     the hand holding the tool includes both hands (i.e.,
     only when HAND HOLDING TOOL value is set at 3
     or 5).

2.   The definition of the centerline for the secondary hand
     is mutually exclusive with the definition of the mesh
     element for the secondary hand (i.e., define either
     right or left, not both). The criteria used to decide
     which should be defined is as follows:

     a.   The centerline for the secondary hand (both
          beginning and ending nodes) is needed only
          when the value for HAND HOLDING TOOL is set
          at 3 or 5, and the SECOND HAND REACH TYPE
          value is set at 3.

     b.   The mesh element (all three nodes) is needed
          only when the value set for HAND HOLDING TOOL
          is set at 3 or 5, and the SECOND HAND REACH
          TYPE value is set different from at 1 or 2.

     Those entries that are not required should be input
with a value of 9999. These values are ignored by the
maintenance program and are not subject to validation. Notice
that the first 24 characters in each line of the user defined
input are used for documentation purposes. The maintenance
program ignores these characters. Although values in these

columns are not required, we recommend using meaningful character strings describing the contents and format of each line as shown in Figure F.3.

RUNNING THE TOOL MAINTENANCE PROGRAM

Once the drawing of the tool to be added is completed, and all the user defined data is created, the user is ready to run the maintenance program by submitting the JCL named 'CREW.CHIEF.PRODJCL(MAKETOOL)'. This JCL takes the user drawing and converts it into a NASTRAN file. By reading both the NASTRAN file and the user defined information, the tool is created in the tool database.

The user needs to modify line number 36 to include the name of the drawing being used to create the tool. Once this change has been made, the user can submit the above JCL and the tool will be created. If errors are found in the user's input data, the maintenance program will print an error message and stop execution before the database has been updated, thereby not corrupting the database. Once the errors are corrected, the user can re-submit the maintenance program until it executes successfully.

```
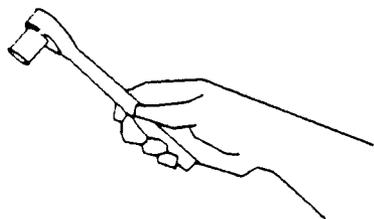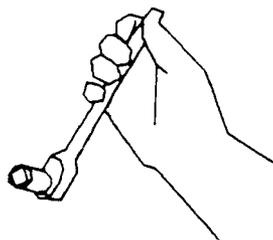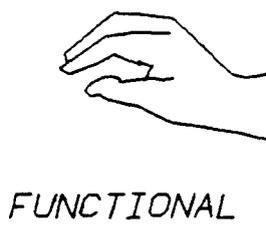TYPE:                      1
CLASS:                     8
MODEL NAME:           USER OPEN END
EXTENSIONS:                Y
SOCKETS:                   Y
RIGID GRIP FLAG:           0
SECOND HAND REACH:         1
HAND GRIPS PERMITTED:      4
HAND HOLDING TOOL:         4
HAND ATTACH POINT:         2
HANDLE RADIUS:           0.85
CYLINDER HEIGHT:         1.00
CYLINDER RADIUS:         1.00
ATTACH NODE:               1
ATTACH DIRECTION:          2
NODE 1 CT LINE(HAND1):     3
NODE 2 CT LINE(HAND1):     4
NODE 1 CT LINE(HAND2):     5
NODE 2 CT LINE(HAND2):     6
NODE 1 MESH EL(HAND2):     7
NODE 2 MESH EL(HAND2):     8
NODE 3 MESH EL(HAND2):     9
```

Figure F.3.   Sample of Contents and Format of Character String

APPENDICES' REFERENCES

A.1   "Human Engineering Design Criteria for Military Systems, Equipment, and Facilities," MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

A.2   Churchill, E., Kikta, P., & Churchill, T., The AMRL Anthropometric Data Bank Library: Vols. I-V, AMRL-TR-77-1, Wright-Patterson Air Force Base, OH: Aerospace Medical Research Laboratory, Aerospace Medical Division, Air Force Systems Command, Oct. 1977. (pp. 105-137).

A.3   Churchill, E., et. al, pp. 33-63.

A.4   McDaniel, J.W., Skandis, R.J., & Madole, S.W., Weight Lift Capabilities of Air Force Basic Trainees, AFAMRL-TR-83-0001, Wright-Patterson Air Force Base, OH: Air Force Aerospace Medical Research Laboratory's Workload Ergonomics Branch, Aerospace Medical Division, Air Force Systems Command, May 1983.

A.5   The AFAMRL Anthropometric Data Bank Library: Vol. IX - 1977 Survey of Army Women, Computer Tape AD-A086-302, May 1980.

A.6   Ayoub, M.M., Denardo, J.D., Smith, J.L., Bethea, N.J., Lambert, B.K., Alley, L.R., & Duran, B.S., Establishing Physical Criteria for Assigning Personnel to Air Force Jobs, Lubbock, TX: Institute for Ergonomic Research, Texas Tech University, Sept 1982.

C.1   Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

C.2   Aircraft and Missile Repair Structural Hardware, Tech. Order 1-1A-8, U.S. Government Printing Office: U.S. Air Force, 1 Sept 1980.