

N85-29572

ROCKWELL EXPERIENCE
APPLICATIONS TO AMES SPACE STATION MOCKUP
HABITABILITY/PRODUCTIVITY STUDIES

PRESENTATION TO NASA
AMES RESEARCH CENTER
MOFFET FIELD, CALIFORNIA
MARCH 2, 1984

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CREW/HABITATION GROUP
SYSTEMS ENGINEERING
SPACE STATION PROGRAM

PURPOSE OF BRIEFING

- ASSIST NASA/AMES RESEARCH CENTER WITH PLANNING FOR SPACE STATION MOCKUP STUDIES
- REVIEW MOCKUP LESSONS FROM ROCKWELL SPACECRAFT STUDIES
 - APOLLO-LEM THROUGH SPACE SHUTTLE
 - EARLY SPACE STATION
- ILLUSTRATE TYPICAL AND UNIQUE MOCKUP TECHNOLOGY APPLICATIONS

POTENTIAL USES FOR SPACE STATION MOCKUPS

- VERIFY REQUIREMENTS DURING DESIGN
- DEVELOP NEW REQUIREMENTS (BEFORE IMMERSION AND PARABOLIC FLIGHTS)

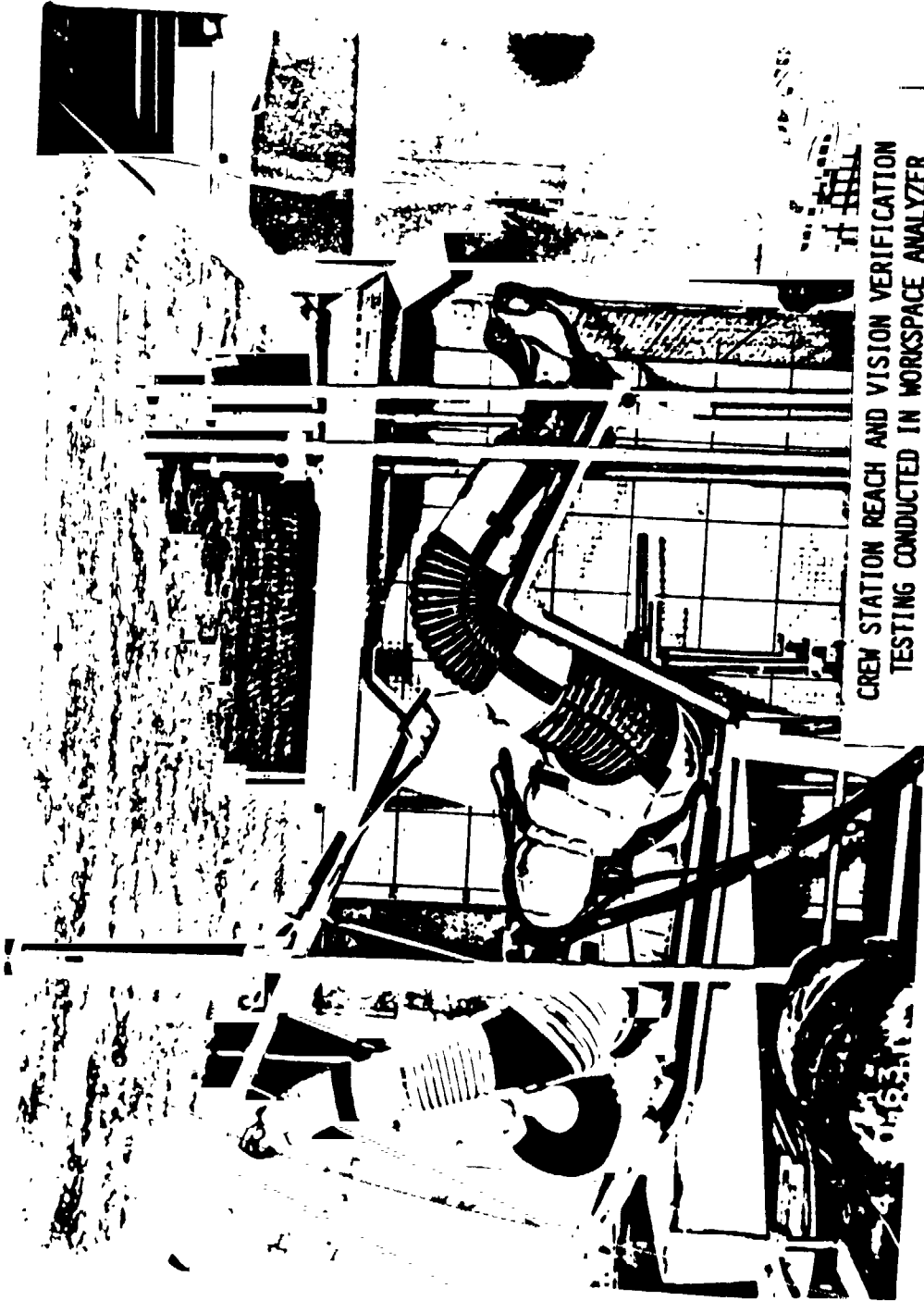
-OR-

<u>AREAS OF CONCERN</u>	<u>CONTRACTOR</u>	<u>AGENCY</u> NASA/AMES
□ CONTROL/DISPLAY LAYOUTS, FORMATS	•	•
□ WORK STATION DESIGN—REACH, CLEARANCE, FORCE	•	•
□ ADEQUATE LIGHTING, MARKINGS, COLOR	•	•
□ REFINE REACH, VISION, CLEARANCE MODELS FOR DRAWINGS/ COMPUTER ANALYSIS	•	•
□ INGRESS/EGRESS PATHWAYS, AIDS	•	•
□ HABITABILITY/PRODUCTIVITY STUDIES (LONG TERM)	•	•
□ MAINTENANCE AND PARTS EXCHANGE	•	•
□ INTERFERENCES—CORRECTIONS	•	•
□ NEW DETAILS, COMPLEX SHAPE DEVELOPMENTS	•	•
□ WIRING AND DUCTING ROUTINGS DEVELOPMENT	•	•
□ EMERGENCY OPERATIONS (IVA & EVA)	•	•
▪ PUBLIC AWARENESS SUPPORT— DOCUMENTARY FILMS, VIDEO TAPES, TV INTERVIEWS & NEWS	•	•

RECOMMENDATIONS—GENERAL

- DON'T GET FANCY TOO SOON
 - GROSS WORKSPACE, LOW FIDELITY FIRST ◦ BUILD UP GRADUALLY, CAREFULLY
- BE FLEXIBLE, VARY KEY DIMENSIONS
 - DON'T SETTLE FOR ONE EASY ANSWER—SEEK MINIMUMS
 - DEVELOP A FEW PARAMETRIC DATA POINTS
 - PROVIDE TILT & ROLL CAPABILITY (ZERO-G SIMULATION)
- SEEK LARGE RANGE OF BODY SIZES & SKILLS IN SUBJECT SELECTION
- MEASURE DISTANCE, TIME, ANGLES, FORCES
 - THINK ABOUT DESIGNER NEEDS—CAN SHAPES BE DRAWN?
- EVALUATE VISIBILITY & LIGHTING—CAN INFORMATION BE READ, PARTS BE DISTINGUISHED?
PROVIDE NUMBERS
- EXERCISE THE SPACE; CHECK FOR
 - SAFETY—PROJECTIONS, HAZARDS
 - PRODUCTIVITY—CONVENIENCE, VOLUME, REACH, TIME
 - HABITABILITY—HOW LONG CAN YOU LIVE IN IT?
 - ON-DUTY TIME
 - OFF-DUTY TIME

ORIGINAL PAGE IS
OF POOR QUALITY



CREW STATION REACH AND VISION VERIFICATION
TESTING CONDUCTED IN WORKSPACE ANALYZER

REACH ENVELOPE MEASUREMENTS AND CLEARANCE EVALUATIONS



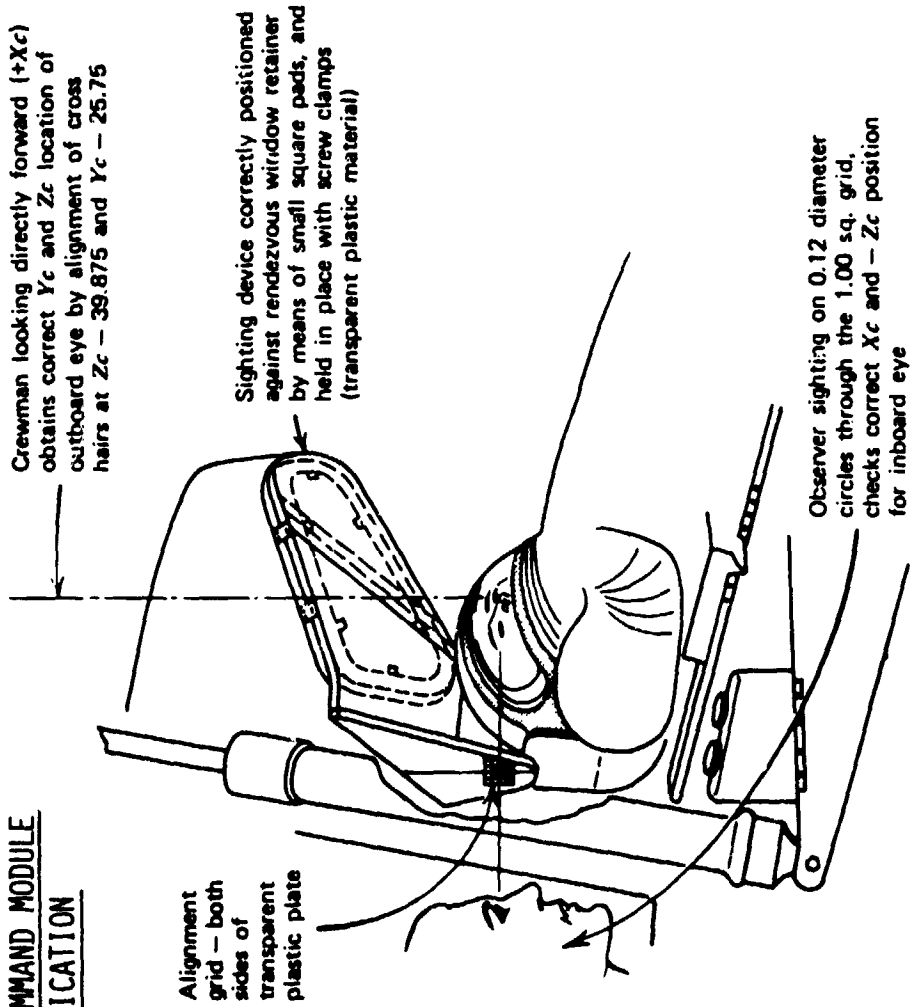
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APOLLO COMMAND MODULE MOCKUP EXAMPLE

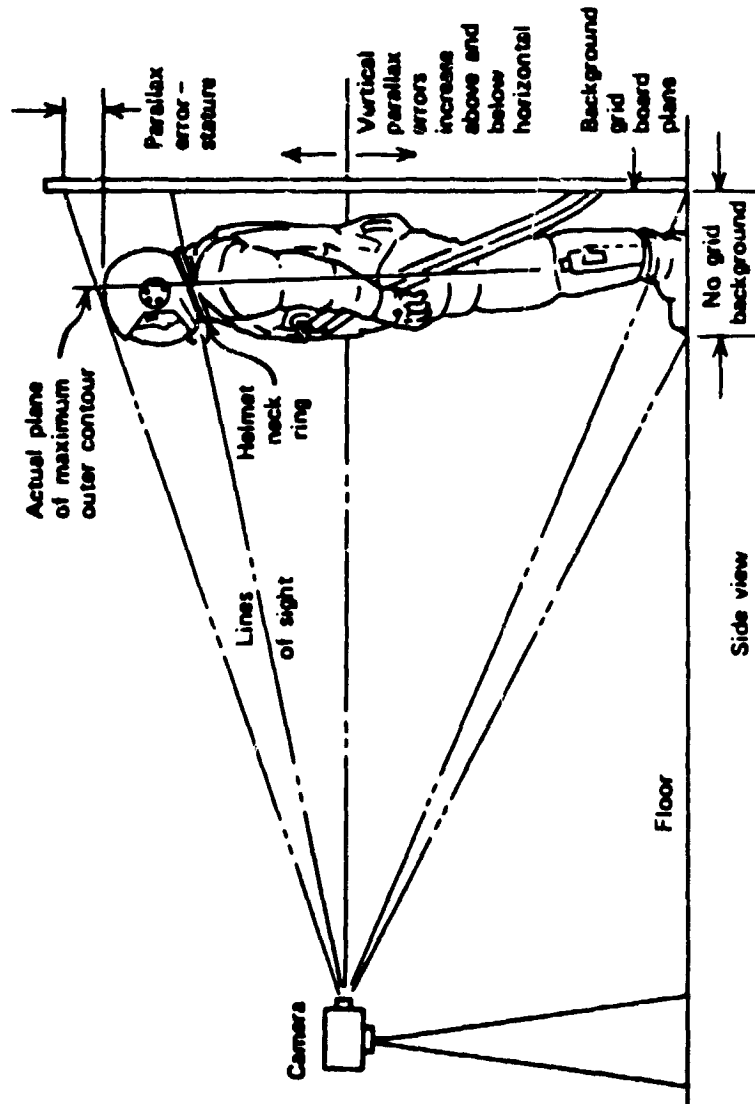
OF POSITION

PARALLEL PLANE GRIDS ON TRANSPARENCY FOR EYE POSITION MEASUREMENTS

APOLLO COMMAND MODULE
APPLICATION



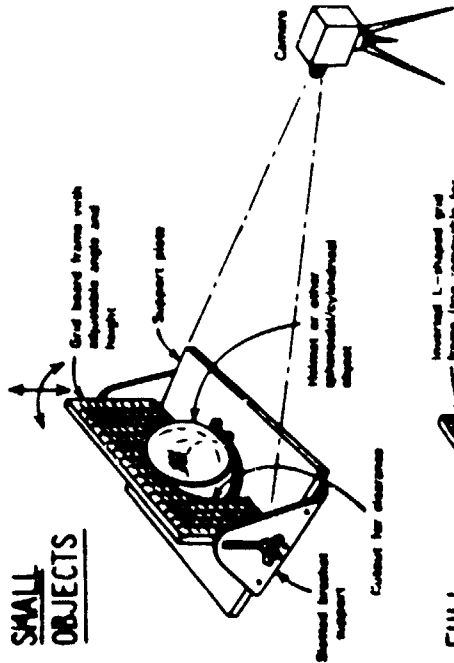
BACKGROUND GRID PARALLAX ERRORS



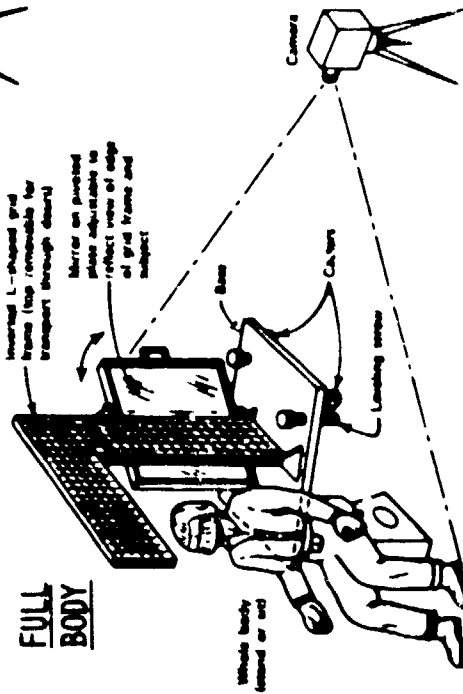
OF POOR QUALITY

LOW-PARALLAX GRID FRAME SYSTEM

SMALL OBJECTS



FULL BODY



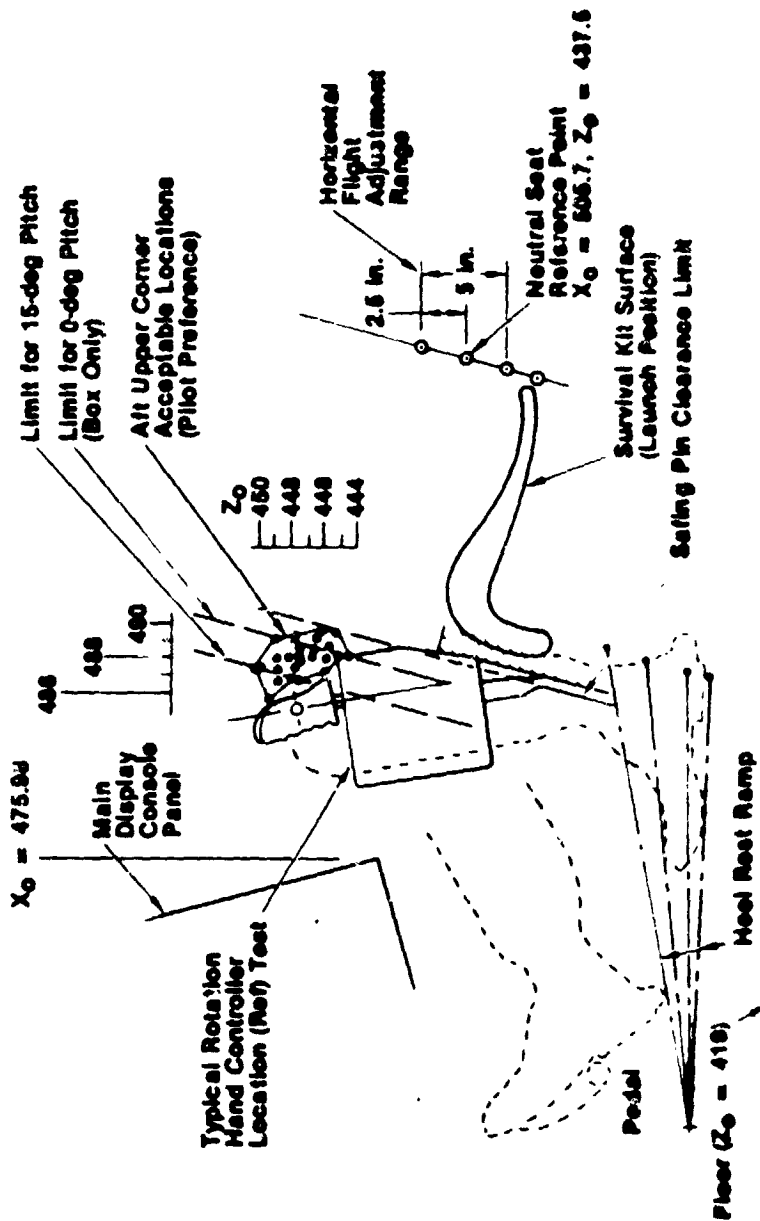
ORIGINAL FACE IS OF POOR QUALITY



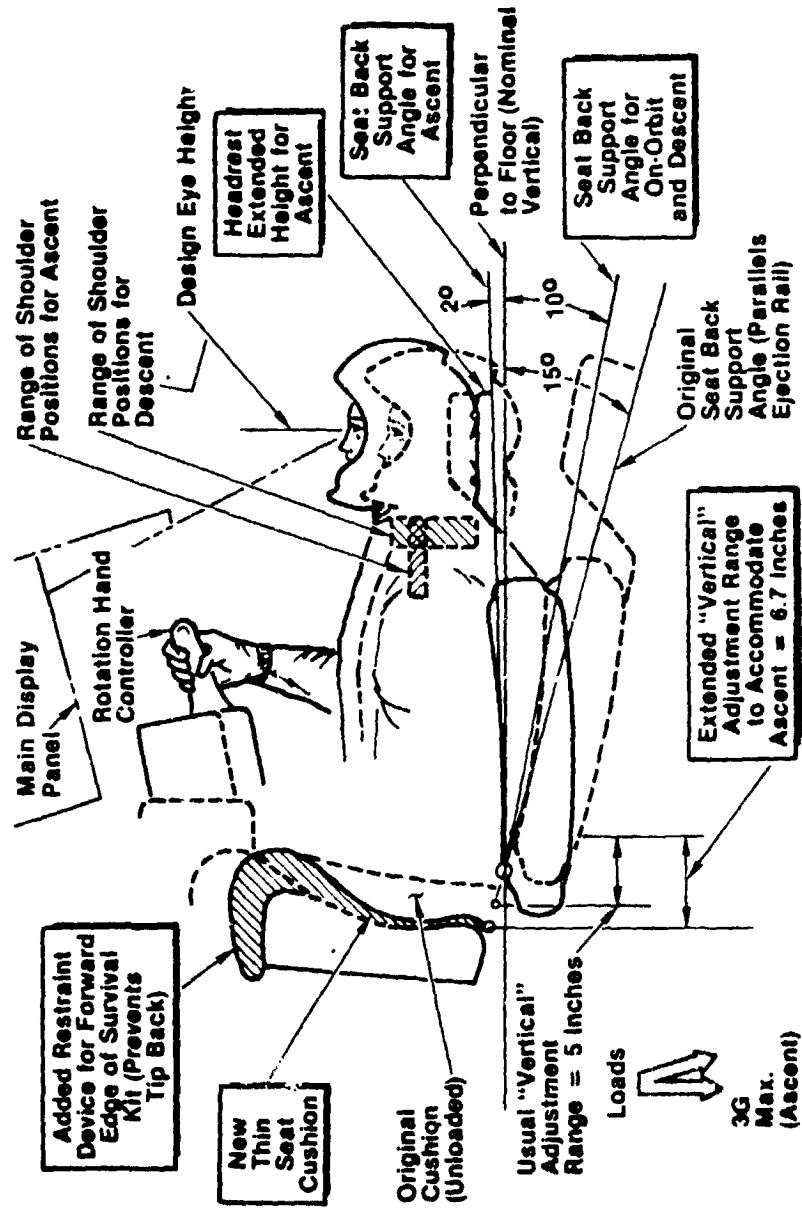
APPLICATION ID
MOCKUP EVALUATION

- GRID ON FOME-COR
- MOUNTED WITH TAPE
- IN PLANES OF MAX. DIAMETERS

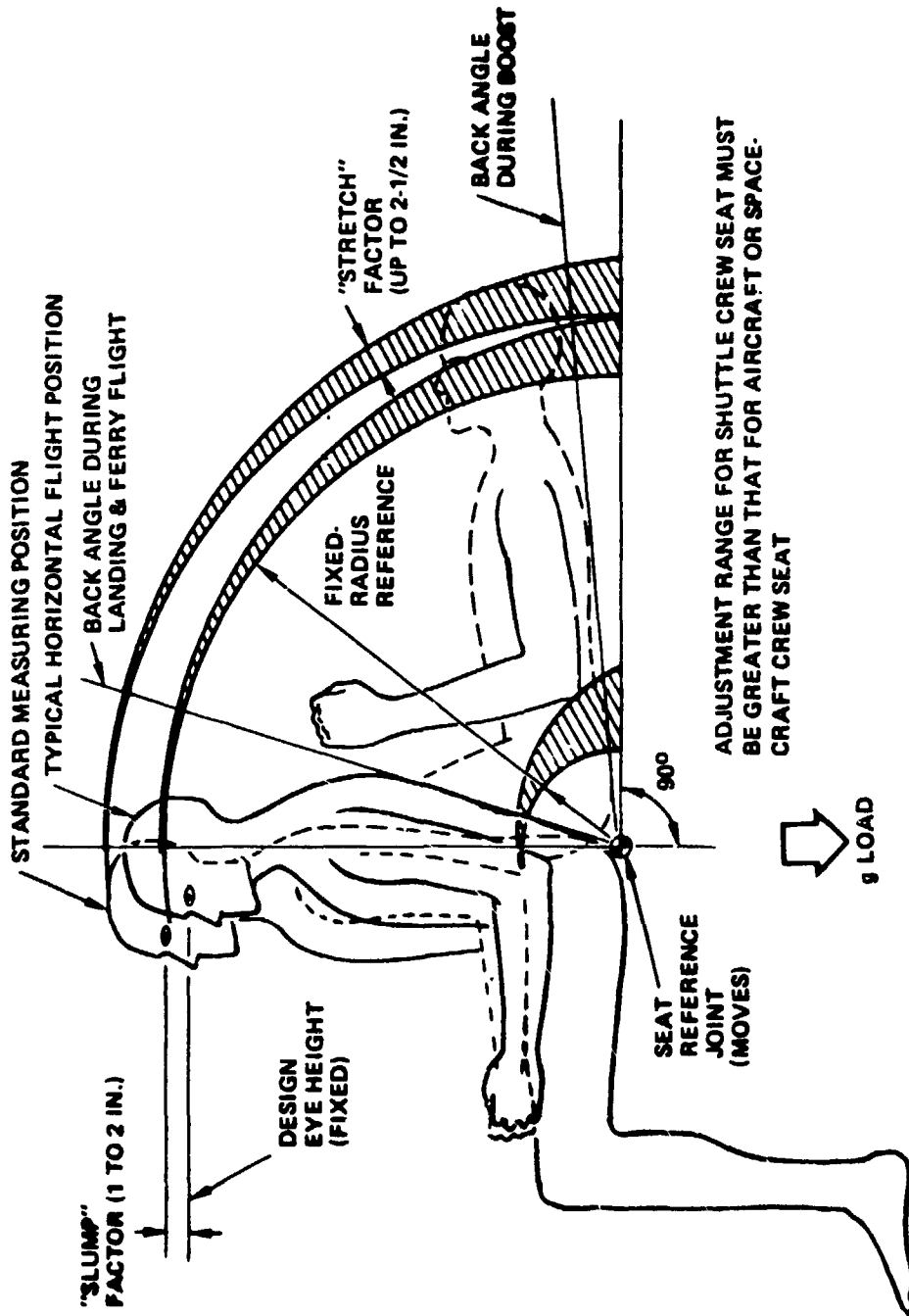
Rotation Hand Controller Adjustment Range



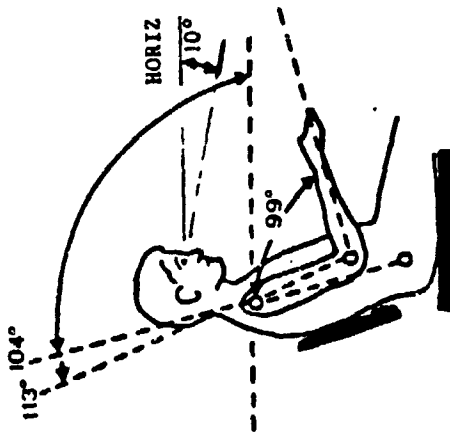
Ejection Seat Modifications for Shuttle Ascent Mode



TRUNK LENGTH AND EYE-TO-SEAT CHANGES WITH BODY ATTITUDE

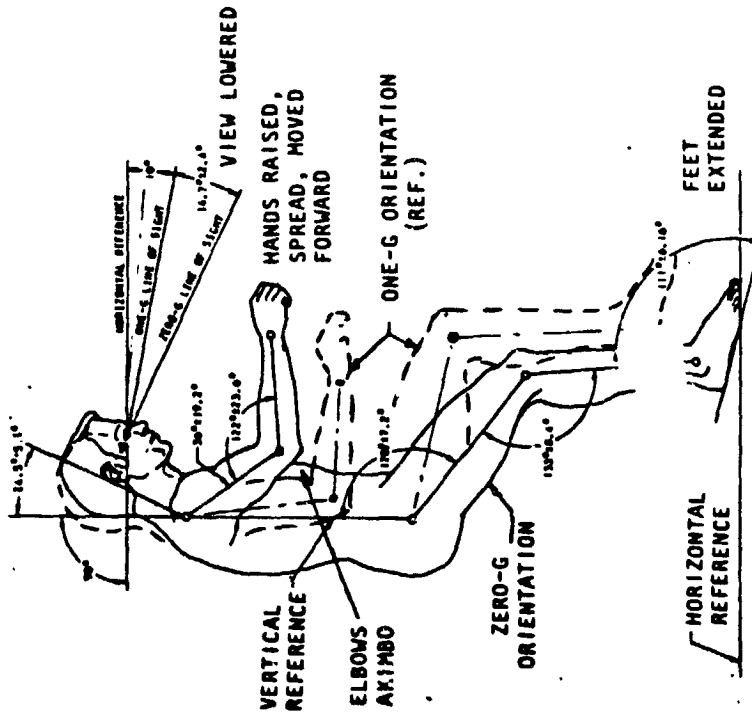


TYPICAL VDT WORKSTATION "MEAN BODY POSTURE"
IN EARTH NORMAL ENVIRONMENT



- SEAT/BACK ANGLES CONDITIONED BY BODY LOADS
- GRAVITY HOLDS ARMS DOWN AGAINST BODY, HANDS LOW - APPROXIMATELY TABLE HEIGHT
- HEAD NEAR VERTICAL FOR MINIMAL EFFORT
- LINE OF SIGHT SLIGHTLY BELOW HORIZON
- NATURAL SEPARATION OF CRT SCREEN AND KEYBOARD OR OTHER CONTROLS
- OPTIMAL WORK STATIONS NOT YET PROVIDED IN MOST INDUSTRY SETTINGS IN SPITE OF MANY STUDIES, FOR EXAMPLE:
 - TYPEWRITER KEYBOARD RECTANGULAR LAYOUT STANDARD (NOT OPTIMUM FOR WRIST ACTION)
 - INSUFFICIENT ADJUSTMENTS

WEIGHTLESSNESS IMPACT ON VDT
WORKSTATION DESIGN REQUIREMENTS



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- NEW PREFERRED ARM ANGLES
- NEW PREFERRED SHOULDER ANGLES
- NEW LINE OF SIGHT REFERENCE
- NEW LEG CLEARANCE REQUIREMENTS
- NEW RESTRAINTS TO BE DETERMINED
 - RESIST PUSH-OFF FORCES ON KEYS
 - NEW CONSTRAINTS ON REACH ENVELOPE
- PROBABLE REORIENTATION OF KEYBOARDS
- POTENTIAL CRT-KEYBOARD INTERFERENCE
- POSSIBLE NEED FOR FINGER GRIPS/GUIDES
- POSSIBLE LIGHTER LOADS ON KEYS/TOUCH SENSORS
 - LIGHT-PEN OPTION

MOCKUP TILT & ROLL BENEFITS EVALUATION

★ ROCKWELL EXPERIENCE HAS VERIFIED VALUE OF 1-G MOCKUP ORIENTATION OPTIONS:

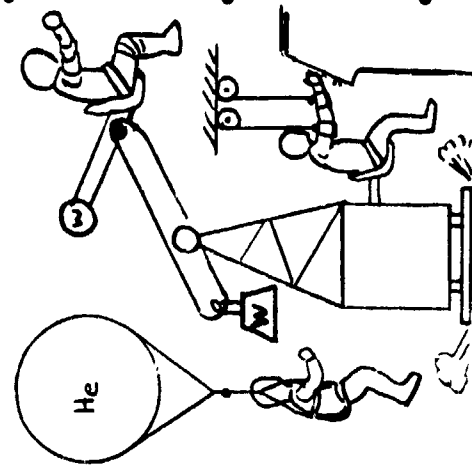
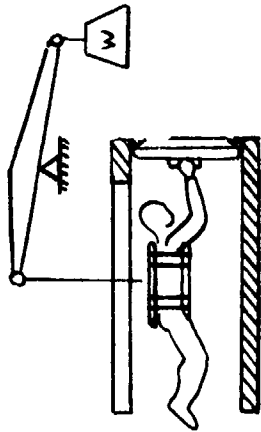
ORIENTATION & PROGRAM APPLICATIONS	BENEFIT
<ul style="list-style-type: none"> • SIMULATE LAUNCH ATTITUDE (NOSE UPWARD)—APOLLO, SHUTTLE CREW COMPARTMENT 	<ul style="list-style-type: none"> • BODY STRETCH: HEAD, HAND & EYE POSITION ACCURACY • INGRESS/EGRESS SIMULATING UNUSUAL POSITION
<ul style="list-style-type: none"> • HORIZONTAL ATTITUDE SIMULATION OF TUNNEL TRANSFER, PARTS HANDLING, POST-LANDING ORBITER EGRESS—NORMAL AND EMERGENCY—APOLLO, SHUTTLE CREW COMPARTMENT, ASTP TRANSFER TUNNEL 	<ul style="list-style-type: none"> • EASE OF HORIZONTAL MOVEMENT, MINIMIZE CONTACTS WITH FLOOR & SIDES (ZERO-G SIM.) • CORRECT ATTITUDE FOR ORBITER EGRESS, RETURN FLIGHT
<ul style="list-style-type: none"> • 360° IN SAGITTAL PLANE—SIMULATION OF BODY MOTION IN STRAPS ON APOLLO COUCH—ROTATION TABLE 	<ul style="list-style-type: none"> • FIRST APPROXIMATION OF HEAD AND KNEE MOTION (ONE-G)
<ul style="list-style-type: none"> • ROTARY SPACE STATION SIMULATION—MOCKUP LIVING QUARTERS ON END OF ARM 	<ul style="list-style-type: none"> • EVALUATE CORIOLIS EFFECTS • EVALUATE VARIABLE G-FIELD EFFECTS

ZERO-G SIMULATION BODY SUPPORTS

- BODY SUPPORTS REQUIRED TO EXPLOIT DIFFERING MOCKUP ORIENTATIONS:

TYPICAL SYSTEMS

- CABLE SUPPORT WITH BODY SANDWICH PANELS, COUNTER WEIGHTS
- APOLLO TUNNEL TRANSFER: HATCH PROBE & DROGUE REMOVAL
- EVA AND IVA SIMULATION
- HELIUM BALLOON AND PARACHUTE HARNESS
- EVA SIMULATION
- NEGATOR SPRINGS, CABLES AND CUFFS ON ARMS
- IVA SIMULATION OF WEIGHTLESSNESS
- AIR-BEARING SUPPORT FLOORS, COUNTER-BALANCED CHAIRS



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SUMMARY

- RECOMMENDED USAGES FOR AMES RESEARCH OFFERED
 - BRIEF SAMPLE OF SPECIAL MOCKUP USAGE TECHNIQUES PRESENTED
 - MOCKUP TECHNOLOGY INVOLVING HUMAN INTERFACES HAS IMPROVED DURING 20 YEARS OF SPACECRAFT EXPERIENCE—NOW AVAILABLE FOR SPACE STATION
 - ✓ APOLLO-LEM
 - ✓ LUNAR FLYER
 - ✓ EARLY SPACE STATION
 - ✓ SHUTTLE
 - ✓ APOLLO-SOYUZ TEST PROGRAM
- } SPACE STATION SYSTEMS
- KEY CONCERNS IN MOCKUP EVALUATIONS
 - COST-EFFECTIVE LEVELS OF FIDELITY
 - VARIABLE VOLUME & SHAPE CAPABILITY
 - MEASUREMENTS WHICH CAN BE USED FOR GRAPHIC ANALYSIS
 - ✓ LAYOUT DRAWINGS
 - ✓ COMPUTER MODELING
 - ✓ TIME DATA
 - ACCURATE, COST-EFFECTIVE MEASUREMENT METHODS AND SUBJECT SELECTION
 - ✓ PHOTOS—GRIDS
 - ✓ HAND MEASURES
 - ✓ VISUAL ALIGNMENT AIDS
 - ✓ DEFINE SUBJECT'S BODY DIMENSIONS & MOBILITY