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SPACE DEVELOPMENT FOR THE FUTURE OF MANKIND

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THE DECADE OF THE 60's WITNESSED THE FLOURISHING OF THE EXPLORATION OF SPACE. THIS EXPLORATION ENCOMPASSED MANY AREAS OF SCIENCE AND APPLICATIONS, AND MAN'S OWN VOYAGES AWAY FROM EARTH. THIS DECADE OF EXCITING AND FRUITFUL OPERATIONS IN SPACE WAS CLIMAXED BY MANNED MISSIONS TO THE LUNAR SURFACE. (1)

SPACE ACTIVITIES OF THE SEVENTIES EXHIBITED SOMEWHAT DIFFERENT CHARACTERISTICS. THE EXPLORATION OF THE PLANETS HIGHLIGHTED THIS PERIOD RESULTING IN A RUSH OF NEW KNOWLEDGE ABOUT MARS, JUPITER, SATURN, AND OTHER PLANETS. SCIENTIFIC PROBES PROVIDED NEW DISCOVERIES, AND COMMUNICATION AND WEATHER SATELLITES BECAME 'COMMON-PLACE' IN THE PUBLIC MIND. SATELLITE SURVEYS OF THE EARTH AND ATMOSPHERE CONTINUED AND EXPANDED, WITH IMPORTANT PROGRESS BEING MADE IN THE APPLICATION OF A GREAT FLOOD OF SATELLITE DATA. (2) (3) (4) (4A)

OF EQUAL SIGNIFICANCE TO THE TECHNICAL ACCOMPLISHMENTS WAS THE INCREASE IN THE NUMBER OF NATIONS PARTICIPATING IN SPACE ACTIVITIES. MAN'S ACTIVITIES IN SPACE INCLUDED COMPLETION OF THE LUNAR PROGRAM; THE APOLLO-SOYUZ COOPERATIVE PROGRAM CONDUCTED BY THE UNITED STATES AND THE U.S.S.R.; AND THE LONG DURATION SPACE STATION MISSIONS IN NEAR EARTH ORBIT. THE ACCOMPLISHMENTS OF SKYLAB WERE COMPLEMENTED AND EXTENDED WITH THE OUTSTANDING ACHIEVEMENTS OF THE SOYUZ-SALYUT PROGRAM. THEY ALL REPRESENTED SOLID PROGRESS IN MANNED SPACE EXPLORATION. (5)

IN SUMMARY, THE 20 YEARS OF THE SPACE PROGRAM HAS BEEN A PERIOD OF INTENSIVE AND EXTENSIVE TECHNOLOGY DEVELOPMENT, HAVING APPLICATION FAR BEYOND THE SPACE PROGRAM. COMMUNICATIONS SATELLITES AND LUNAR SCIENCE PACKAGES HAVE OPERATED RELIABLY FOR YEARS WITHOUT MAINTENANCE; MICROWAVE COMMUNICATIONS ARE CONDUCTED OVER MILLIONS OF MILES TO THE PLANETS; NEW ENERGY SYSTEMS SUCH AS SOLAR CELLS AND FUEL CELLS HAVE BEEN BROUGHT INTO EFFICIENT OPERATION; LAUNCH VEHICLES HAVE BEEN DEVELOPED TO LIFT AS MUCH AS 120-TON PAYLOADS TO SPACE; MAN HAS OPERATED 240,000 MILES AWAY FROM EARTH; AND HE HAS SHOWN HIS ABILITY TO LIVE AND WORK FOR LONG PERIODS IN NEAR SPACE. IN ADDITION, AND EQUALLY IMPORTANT, METEOROLOGICAL, EARTH SURVEY, AND SCIENTIFIC SATELLITES HAVE PROVIDED A WIDE VARIETY OF INFORMATION FOR MANY EARTH USES AND INTERESTS. (6)

FOLLOWING THE SUCCESSFUL COMPLETION OF THE APOLLO PROGRAM IN 1972, VERY CAREFUL STUDIES WERE CONDUCTED TO DETERMINE WHAT MAJOR STEP THE U.S. SHOULD UNDERTAKE TO MOST EFFECTIVELY FURTHER THE MANNED EXPLORATION OF SPACE. A PERMANENT MANNED SPACE STATION IN LOW EARTH ORBIT WAS FAVORED BY MANY. IT WAS DECIDED HOWEVER, THAT A DESIRABLE PREREQUISITE TO LONG TERM MANNED OPERATIONS IN SPACE WAS A CONVENIENT TRANSPORTATION SYSTEM; CONSEQUENTLY, THE DECISION WAS MADE TO DEVELOP THE SPACE SHUTTLE TRANSPORTATION SYSTEM. CONSIDERABLE EFFORT HAS BEEN DIRECTED TOWARDS BRINGING THIS SYSTEM INTO BEING OVER THE PAST SIX YEARS. THE REQUIREMENT THAT IT FLY AS A LAUNCH VEHICLE, A SPACE SHIP, AND AN AIRPLANE OVER A FAR GREATER RANGE OF SPEEDS THAN ANY PREVIOUS MACHINE HAS ALREADY REQUIRED GREAT TECHNOLOGICAL ADVANCEMENTS. A BASIC OBJECTIVE OF THE PROGRAM WAS TO REDUCE THE COST OF GOING INTO SPACE. THE GOAL WAS TO REDUCE THE COST FROM THOUSANDS OF DOLLARS A POUND TO HUNDREDS OF DOLLARS A POUND. THE KEY TO THIS REDUCTION IS RECOVERABILITY AND REUSABILITY. THE REUSABILITY FEATURE WILL ALSO GREATLY IMPROVE OUR ACCESSIBILITY TO SPACE, WHILE AFFORDING THE OPPORTUNITY FOR LARGER AND MORE VARIED GROUPS OF INDIVIDUALS TO WORK IN SPACE. THE SHUTTLE HAS, AND WILL, MAKE POSSIBLE COOPERATIVE EFFORTS BETWEEN NATIONS ON A LARGE SCALE, AND IN SO DOING ENCOURAGE THE FURTHER DEVELOPMENT OF SPACE CAPABILITIES THROUGHOUT THE WORLD.

(7)

(8)

THE SHUTTLE WILL BE USED IN MANY WAYS. IT WILL DEPLOY MANY TYPES (9)
OF SATELLITES IN SPACE, UTILIZING SOPHISTICATED MANIPULATORS
DEVELOPED IN CANADA. THIS INITIAL ROLE OF DEPLOYMENT WILL BE
QUICKLY FOLLOWED BY THE INSPECTION, RETRIEVAL, AND SERVICING OF
FREE-FLYING SATELLITES. THE SPACE TELESCOPE IS AN INITIAL SYSTEM (10)
BEING DESIGNED FOR SUCH SERVICING BY THE SHUTTLE SYSTEM.

COMPLEMENTING THE TRANSPORTATION FUNCTION OF THE SHUTTLE SYSTEM IS
THE SPACELAB, BEING DEVELOPED BY THE EUROPEAN SPACE AGENCY. IT WILL (11)
ALLOW MEN TO CONDUCT A VARIETY OF EXPERIMENTS AND INVESTIGATIONS IN (11A)
THE WEIGHTLESS ENVIRONMENT OF SPACE. THE SCOPE OF CAPABILITIES AND
THE REUSABILITY OF THE MANNED SPACELAB OFFERS A NEW DIMENSION FOR
SPACE INVESTIGATIONS. THE INTRIGUING POSSIBILITIES OF THE SPACE
PROCESSING OF MATERIALS IS ONLY ONE OF THE INVESTIGATIONS PLANNED (11B)
FOR THE SPACELAB. THE SPACELAB WILL OPERATE WITH THE SHUTTLE,
HOWEVER THE SUCCESS OF ITS EXPERIMENTAL PROGRAMS WILL HELP TO DEFINE
THE NEED AND APPROACH TO LONGER DURATION MANNED LABORATORIES.

ON STILL OTHER MISSIONS, THE SHUTTLE'S LARGE PAYLOAD CAPABILITY OF (12)
30 TONS, COUPLED WITH ITS CREW AND FACTORY-SIZED WORK AREA, WILL
ENABLE THE DEVELOPMENT OF TECHNIQUES FOR THE CONSTRUCTION OF SYSTEMS
IN SPACE SO LARGE AND OF SUCH LIGHT WEIGHT THAT THEY COULD NOT BE
CONSTRUCTED AND PACKAGED ON EARTH FOR DELIVERY TO SPACE.

AS WE LOOK TOWARD THE 80's, THEREFORE, PLANS FOR THE LAUNCHING OF SATELLITES FROM THE SHUTTLE AND INITIAL SPACE LABORATORY EXPERIMENTS ARE WELL DEFINED, AND HARDWARE IS BEING DEVELOPED. MORE ADVANCED CONCEPTS FOR THE USE OF THE SHUTTLE SYSTEM ARE BEGINNING TO EVOLVE. AN OPTIONAL SOLAR ARRAY TO EXTEND ON-ORBIT STAY TIME AND PROVIDE ADDITIONAL POWER FOR EXPERIMENTATION IS WELL ADVANCED IN DEFINITION AND PLANNING. THE AFOREMENTIONED SATELLITE SERVICES AND THE SPECIFIC FORM THEY SHOULD TAKE ARE NOW UNDER STUDY AND TECHNOLOGICAL DEVELOPMENT. IN SUMMARY THE SHUTTLE WILL PROVIDE US WITH A VERSATILE TOOL IN THE 80's TO FURTHER THE EXPLORATION OF SPACE IN A VARIETY OF WAYS.

NEXT, LET US CONSIDER WHAT WILL BE THE PROGRAMS OF THE FUTURE. THERE WILL CERTAINLY BE A CONTINUATION OF PROGRAMS FOR METEOROLOGY, EARTH SURVEY, AND SCIENTIFIC PROBES. THESE SATELLITES WILL INCREASE IN TECHNICAL EFFECTIVENESS AND IN THEIR CONTRIBUTION TO NEW KNOWLEDGE AND LIFE HERE ON EARTH. I WOULD DIRECT MY REMARKS PRIMARILY, HOWEVER, TO THE NEXT MAJOR STEP IN MAN'S EVOLVING CAPABILITY TO EXPLORE AND OPERATE IN SPACE.

EARLIER I NOTED THAT THE DEVELOPMENT OF THE SHUTTLE TRANSPORTATION WAS CONSIDERED A DESIRABLE PRECURSOR TO A PERMANENT, MANNED OPERATION IN SPACE. AT THAT TIME IT WAS ANTICIPATED THAT THE PRIMARY USE OF A PERMANENT MANNED FACILITY WOULD BE TO CONDUCT SCIENTIFIC EXPERIMENTS AND TO PROVIDE A PLATFORM FOR DATA GATHERING SENSORS.

OVER THE PAST DECADE, HOWEVER, THINKING ON THIS SUBJECT HAS MODIFIED IN SEVERAL WAYS. FIRST THERE APPEARS TO BE GOOD TECHNICAL REASONS FOR ACCOMPLISHING MUCH OF THE LONG DURATION SCIENTIFIC AND APPLICATION PROGRAMS UTILIZING AUTOMATED PLATFORMS. THESE PLATFORMS WOULD BE DEPLOYED AND SUBSEQUENTLY RETRIEVED BY THE SHUTTLE FOR SERVICING OR REFURBISHMENT. CONSEQUENTLY THERE MAY BE LESS OF A REQUIREMENT FOR A PERMANENT, MANNED FACILITY FOR THIS TYPE OF PROGRAM.

(15B)

CONCURRENTLY, NEW AND DIFFERENT NEEDS FOR MANNED FACILITIES HAVE EVOLVED. THESE NEEDS ARE ASSOCIATED WITH THE CONSTRUCTION IN SPACE OF LARGE SYSTEMS. THE LARGE VOLUME AND LOW DENSITY OF THESE SYSTEMS PRECLUDES THEIR CONSTRUCTION ON EARTH FOR TRANSPORT TO SPACE.

TWO AREAS WHICH I BELIEVE OFFER PARTICULAR OPPORTUNITY FOR THE FUTURE, AND CONSEQUENTLY SHOULD GUIDE OUR ACTIONS, ARE SOLAR POWER SATELLITES AND LARGE COMMUNICATIONS PLATFORMS. I WOULD LIKE TO COMMENT BRIEFLY ON EACH OF THESE AREAS.

THE SOLAR POWER SATELLITE CONCEPT WAS FIRST PRESENTED IN 1968 BY DR. PETER GLASER OF THE A. D. LITTLE ENGINEERING FIRM. THE BASIC CONCEPT IS STRAIGHTFORWARD. IT INVOLVES PLACING A LARGE SOLAR COLLECTOR AT GEOSYNCHRONOUS ORBIT. THE COLLECTED SOLAR ENERGY IS TRANSMITTED TO AN EARTH RECEIVER UTILIZING MICROWAVE TECHNIQUES.

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THE LOCATION OF THE COLLECTOR IN GEOSYNCHRONOUS ORBIT PROVIDES ACCESS TO THE SUN'S ENERGY NEARLY 100 PERCENT OF THE TIME, AND THE MICROWAVE TRANSMISSION ALLOWS THE IMMEDIATE AND CONTINUOUS TRANSFER OF ENERGY TO EARTH. THE ADVANTAGES OF THE CONCEPT LIE IN ITS ABILITY TO COLLECT MORE SOLAR ENERGY FOR A GIVEN AREA OF COLLECTOR OVER A GIVEN TIME THAN ON EARTH, AND TO PROVIDE ENERGY CONTINUOUSLY TO EARTH WITHOUT REGARD TO THE DAY-NIGHT CYCLE AND CLOUD COVER. THE IMPLEMENTATION OF THESE LARGE SATELLITES WOULD INVOLVE THE DEVELOPMENT OF MANY TYPES OF HIGH PERFORMANCE, LOW COST COMPONENTS HERE ON EARTH; LARGER AND MORE COST EFFECTIVE SPACE TRANSPORTATION SYSTEMS; AND SPACE BASES WHICH SUPPORT CONSTRUCTION EQUIPMENT AND HUNDREDS OF WORKERS. (17)

FOR THE PAST SEVERAL YEARS, I HAVE OBSERVED WITH CONSIDERABLE INTEREST AND ENTHUSIASM THE RESULTS OF DETAILED STUDIES OF THIS CONCEPT WHICH HAVE BEEN CONDUCTED BY A NUMBER OF GOVERNMENT AND INDUSTRIAL ORGANIZATIONS. WHILE INTRIGUED BY THE CONCEPT, I AM ALSO VERY CONSCIOUS OF THE MAGNITUDE AND DIFFICULTY OF SUCH AN UNDERTAKING; THE COMPLEXITY OF THE OVERALL ENERGY SITUATION; AND THE CARE WHICH MUST BE EXERCISED IN SELECTING AND COMMITTING TO MAJOR COURSES OF ACTION TO DEVELOP NEW ENERGY SYSTEMS. HOWEVER, NO OTHER SPACE CONCEPT HAS BEEN PRESENTED THAT OFFERS REWARDS OF SUCH MAGNITUDE AND IMPORTANCE.

I FULLY REALIZE THAT THERE ARE BOTH PROPONENTS AND OPPONENTS OF THE CONCEPT. THE POSITIONS OF THESE TWO GROUPS, IN THE EXTREME, RANGE FROM COMPLETE ABANDONMENT OF THE CONCEPT BECAUSE THEY BELIEVE IT NOT TO BE VIABLE, TO IMMEDIATE DEVELOPMENT OF FULL-SCALE ENERGY-PRODUCING SATELLITES. NO ONE WHO HAS STUDIED THE CONCEPT CAREFULLY BELIEVES THAT THERE SHOULD BE AN IMMEDIATE COMMITMENT TO BUILD FULL-SCALE SOLAR POWER SATELLITES. BUT RATHER WE SHOULD CONDUCT THOSE ACTIVITIES WHICH WILL LET US FULLY EVALUATE THE CONCEPT. MUCH OF THE IMMEDIATE WORK REQUIRED CAN AND SHOULD BE CONDUCTED IN EARTH BASED LABORATORIES. THIS WORK INCLUDES SUCH ACTIVITIES AS THE DEVELOPMENT AND DEMONSTRATION OF LOW COST SOLAR CELL PRODUCTION TECHNIQUES. THERE IS, HOWEVER, A COMPLEMENTARY SPACE ACTIVITY REQUIRED TO FULLY EVALUATE THE SOLAR POWER SATELLITE CONCEPT. THIS INVOLVES THE DEVELOPMENT OF THE TECHNIQUES FOR THE CONSTRUCTION OF LARGE SYSTEMS IN SPACE, AND THE ASSOCIATED CAPABILITY FOR OPERATING PERMANENT FACILITIES IN SPACE WITH LARGE CREWS CONDUCTING A VARIETY OF FUNCTIONS.

AS COMPARED TO THE POTENTIAL OF SOLAR POWER SATELLITES, COMMUNICATIONS SATELLITES HAVE BEEN ESTABLISHED AS A KEY LINK IN THE WORLD COMMUNICATIONS SYSTEMS. THE SUCCESS OF THE COMMUNICATIONS SATELLITE PROGRAM HAS RESULTED IN AT LEAST TEN SYSTEMS INVOLVING 30 SEPARATE SATELLITES. AS COMMUNICATIONS TRAFFIC INCREASES, BOTH THE NUMBER AND CAPACITY OF THE SATELLITES WILL INCREASE. BY THE 1990's, THE NEED FOR SATELLITES IN THE UNIQUE GEOSYNCHRONOUS ORBIT WILL RESULT IN A CROWDING OF THAT ORBIT. THE PROBABLE SOLUTION TO THIS PROBLEM IS TO DEVELOP A SMALLER NUMBER OF VERY LARGE SATELLITES WHICH WILL SERVE MULTIPLE FUNCTIONS.

IN THIS CASE, THE LARGE SATELLITE IS BEING USED TO SOLVE THE CROWDING PROBLEM. LARGE SATELLITES, OF DIFFERENT MECHANIZATION, WILL ALLOW A SIGNIFICANT EVOLUTION IN COMMUNICATIONS SATELLITE TECHNOLOGY. TO DATE, SATELLITE ANTENNAS HAVE BEEN FAIRLY SMALL, REQUIRING LARGE AND COSTLY RECEIVING ANTENNAS ON THE GROUND. EVOLVING TECHNOLOGY AND LARGE ANTENNAS WILL ALLOW THE REVERSAL OF THIS ARRANGEMENT. A LARGE SATELLITE IN SPACE WILL BE ABLE TO COMMUNICATE WITH MANY SMALL, INEXPENSIVE ANTENNAS ON EARTH. BOTH OF THESE APPROACHES WILL REQUIRE SATELLITES OF A SIZE THAT WILL PROBABLY REQUIRE CONSTRUCTION IN SPACE. CONSTRUCTION IN SPACE IS ACTUALLY THE KEY TO OUR FUTURE NEEDS.

(22)

THIS LINE OF REASONING HAS LED US TO THE IDENTIFICATION OF A PERMANENT MANNED FACILITY IN LOW EARTH ORBIT TO DEVELOP THE TECHNIQUES AND CAPABILITIES FOR THE CONSTRUCTION OF LARGE SPACE SYSTEMS. WE HAVE IDENTIFIED THIS FACILITY AS A SPACE OPERATIONS CENTER.

(23)

THE SPACE OPERATIONS CENTER WOULD ALSO PROVIDE OTHER MAJOR CAPABILITIES OF A COMPLEMENTARY NATURE, SUCH AS THE EQUIPMENT FOR THE ON-ORBIT ASSEMBLY, LAUNCH, RECOVERY, AND SERVICING OF SPACE VEHICLES.

THE ON-ORBIT ASSEMBLY OF SPACE VEHICLES MAKES HIGHER ENERGY MISSIONS FOR LARGER PAYLOADS POSSIBLE, THEREBY EFFECTIVELY ENHANCING LAUNCH VEHICLE PERFORMANCE. THE NOMINAL SHUTTLE PAYLOAD CAPABILITY IS 65,000 LBS TO LOW EARTH ORBIT AND A PAYLOAD OF 5,000 LBS TO GEOSYNCHRONOUS ORBIT WHEN THE IUS SOLID STAGE IS EMPLOYED. THE USE OF MULTIPLE SHUTTLE FLIGHTS AND ASSEMBLY ON-ORBIT COULD INCREASE THIS GEOSYNCHRONOUS PAYLOAD BY A FACTOR OF FOUR OR MORE, IT COULD ALSO SUPPORT MANNED ORBITAL MISSIONS TO GEOSYNCHRONOUS ORBIT WHICH REQUIRE THE LAUNCH OF A SYSTEM FROM LOW EARTH ORBIT WEIGHING ON THE ORDER OF 125,000 POUNDS. CONSEQUENTLY, MULTIPLE SHUTTLE FLIGHTS AND AN ASSEMBLY BASE COULD PROVIDE THE OPPORTUNITY TO EFFECT SUCH MISSIONS. IT IS POSSIBLE THAT EARLY VEHICLE ASSEMBLY IN ORBIT OPERATIONS COULD BE CONDUCTED WITHOUT AN ASSEMBLY BASE; HOWEVER, IT IS BELIEVED THAT FULL EXPLOITATION OF THIS TECHNIQUE WILL REQUIRE SUCH A CENTER, ESPECIALLY IF THE CONCEPT OF RECOVERY AND REUSABILITY OF SPACE VEHICLES IS INCLUDED.

A MORE SUBTLE AND GENERAL OBJECTIVE OF THE SPACE OPERATIONS CENTER (24)
WOULD BE TO REDUCE THE DEPENDENCE FOR RESUPPLY AND EARTH BASED
MISSION CONTROL. REDUCED RESUPPLY FROM EARTH WOULD HAVE DESIGN
IMPLICATIONS SUCH AS REQUIREMENTS FOR CONTINUOUS POWER GENERATION
SYSTEMS; THE RECYCLING OF AIR AND WATER; A DEGREE OF ONBOARD HEALTH
MAINTENANCE; AND COMPREHENSIVE EMERGENCY CONSIDERATIONS. IN ORDER
TO REDUCE DEPENDENCE ON EARTH MONITORING AND CONTROL, THE SPACE (25)
SYSTEM WOULD HAVE TO PROVIDE A SIGNIFICANT CAPABILITY FOR DETAILED
SYSTEMS MONITORING, FAULT ISOLATION AND FAILURE ANALYSIS, AND THE
ABILITY TO REPLACE THE FAILED EQUIPMENT. SPACE CONTROL WOULD ALSO
INVOLVE ONBOARD GUIDANCE AND NAVIGATION; THE ABILITY TO STORE
EXTENSIVE SETS OF DATA; AND THE ONBOARD CAPABILITY FOR MISSION
PLANNING, MUCH OF WHICH IN THE PAST HAS BEEN CARRIED OUT ON THE
GROUND.

WHILE THE SPACE OPERATIONS CENTER, AS ITS NAME IMPLIES, IS OPERATIONALLY
ORIENTED, IT DOES NOT PRECLUDE THE SUPPORT FOR SCIENCE AND APPLICATIONS
PROJECTS. THIS MAY BE ACCOMPLISHED BY THE ATTACHMENT OF SPECIAL
PURPOSE MODULES. AN OBVIOUS CANDIDATE IS A LIFE SCIENCE MODULE.
ALTERNATELY, THE CENTER MAY SUPPORT AND SERVICE FREE-FLYING PLATFORMS
OPERATING NEARBY. THIS APPROACH PROVIDES THE FREE-FLYER WITH THE
LOWER-G, CONTAMINATION-FREE ENVIRONMENT DESIRED, WHILE STILL
AFFORDING CONVENIENT REFURBISHING AND MAINTENANCE SERVICES.

MUCH STUDY WILL BE REQUIRED TO DEFINE A SPACE OPERATIONS CENTER OPTIMIZED TO ACCOMPLISH THE OBJECTIVES WE HAVE DISCUSSED. PRELIMINARY REQUIREMENTS HAVE BEEN DEVELOPED AND INCORPORATED INTO CONCEPTUAL DESIGNS.

THE ELEMENTS OF THE CENTER WOULD BE CAPABLE OF BEING LAUNCHED, (26)
AND SUBSEQUENTLY ASSEMBLED, IN MODULAR FASHION. MULTIPLE DOCKING AND BERTHING PORTS WOULD BE PROVIDED TO ALLOW REVISIT, AND THE ADDITION OF SPECIAL PURPOSE MODULES. CONTINUOUS AVAILABILITY OF EARTH RETURN VEHICLES WOULD NOT BE REQUIRED. THIS OBVIOUSLY HAS CONNOTATIONS FOR EMERGENCY PROVISIONS AND SAFETY, INCLUDING REDUNDANT SYSTEMS, DUAL HABITATS AND ACCESS ROUTES, AND EXTENSIVE EMERGENCY PROVISIONS.

OTHER FEATURES OF THE SYSTEM INCLUDE SOLAR ARRAYS, AUGMENTED BY FUEL CELLS OR BATTERIES; REACTIVE CONTROL SYSTEMS FOR STABILIZATION AND ORBIT MAKEUP; AND REDUNDANT SERVICE MODULES HOUSING COMMUNICATIONS, GUIDANCE, NAVIGATION AND COMPUTING EQUIPMENTS. AIRLOCKS WOULD BE PROVIDED FOR CREW EXIT INTO SPACE, AND A LOGISTICS MODULE WOULD BE USED TO RESUPPLY THE CENTER.

THE HABITATION MODULES WOULD PROVIDE MEDICAL, LIVING, AND CONTROL (27)
PROVISIONS. TYPICALLY, ONE AREA WOULD HOUSE THE BASIC CONTROL CENTER, SUBSYSTEMS, AND COMPARTMENTS FOR SUIT STORAGE. A SECOND AREA WOULD INCLUDE HEALTH MAINTENANCE FACILITIES, SHOWER, AND HYGIENE FACILITIES.

A THIRD WOULD PROVIDE A WARD ROOM, A GALLEY, AND SPACE AND EQUIPMENT FOR EXERCISE AND RECREATION; AND A FOURTH WOULD PROVIDE PRIVATE SLEEPING QUARTERS FOR CREWMEN. EACH HABITATION MODULE WOULD BE ABLE TO ACCOMMODATE THE TOTAL CREW FOR AN EXTENDED PERIOD IN AN EMERGENCY.

IN ORDER TO ACHIEVE THE OBJECTIVE OF REDUCED DEPENDENCE ON EARTH, A KEY FACTOR WOULD BE TO REDUCE THE NEED FOR RESUPPLY OF BASIC NEEDS SUCH AS OXYGEN. THE CENTER WOULD INCORPORATE A REGENERATIVE LIFE SUPPORT SYSTEM OR INITIALLY A PARTIAL REGENERATIVE LIFE SUPPORT SYSTEM. THE PRELIMINARY CONCEPT REQUIRES ONLY TWO ITEMS TO BE RESUPPLIED FROM EARTH, -- WET FOOD AND HYDRAZINE. TECHNOLOGY DEVELOPMENT HAS PROCEEDED IN THE LAST TEN YEARS ON REGENERATIVE SYSTEMS, AND CONSIDERABLE PROGRESS HAS BEEN MADE. A MULTITUDE OF OPTIONS ARE POSSIBLE INCLUDING VARIOUS INTEGRATED APPROACHES WITH OTHER SYSTEMS. (28)

THE OBJECTIVE OF DEVELOPING THE CAPABILITIES FOR THE CONSTRUCTION AND CHECKOUT OF LARGE SYSTEMS IN SPACE PROVIDES PARTICULAR REQUIREMENTS ON THE SPACE OPERATIONS CENTER. IT MUST HAVE THE CAPABILITY TO FABRICATE, ASSEMBLE AND JOIN PRIMARY AND SECONDARY STRUCTURES OR ELEMENTS THEREOF. IT MUST ALSO INCLUDE THE TECHNIQUES AND EQUIPMENT FOR THE INSTALLATION, INTEGRATION AND CHECKOUT OF ELECTRONIC AND OTHER SYSTEMS WHICH MUST BE ADDED TO THE STRUCTURES, AND THEN FINALLY IT MUST PROVIDE THE CAPABILITY TO INSTALL PROPULSION ELEMENTS AND LAUNCH THE COMPLETED SYSTEM TO THE ORBIT WHERE THE CONSTRUCTED SYSTEM WOULD DO ITS EXPERIMENTATION OR OPERATION. (29)

THE ON-ORBIT ASSEMBLY, LAUNCH, RECOVERY, AND SERVICING OF SPACE VEHICLES ALSO PLACES UNIQUE REQUIREMENTS ON A SPACE OPERATIONS CENTER. THESE REQUIREMENTS INCLUDE BERTHS FOR THE VARIOUS VEHICLE STAGES, THE MECHANISMS TO ASSEMBLE THE STAGES TOGETHER, EQUIPMENT FOR THE SYSTEMS DIAGNOSTICS AND CHECKOUT AND EQUIPMENT FOR LAUNCH OPERATIONS, TRACKING, AND NAVIGATION. ALSO REQUIRED ARE A COMMUNICATIONS CAPABILITY FOR RENDEZVOUS WITH THE UPCOMING OR RETURNING SPACE VEHICLES, WORK STATIONS AND TOOLS FOR REPLACEMENT OR REPAIR, AND FINALLY AN ON-ORBIT REFUELING CAPABILITY.

CONSEQUENTLY, WHILE WE CONTINUE TO VIEW A PERMANENT MANNED FACILITY IN LOW EARTH ORBIT AS THE MAJOR NEXT STEP IN MANNED SPACE EXPLORATION, THE NATURE AND USE OF THAT STATION HAS EVOLVED DRAMATICALLY. IT HAS CHANGED FROM BASICALLY A SCIENTIFIC LABORATORY TO AN OPERATIONAL FACILITY DESIGNED TO SUPPORT APPLICATIONS AND SCIENCE THROUGH THE CAPABILITY TO CONSTRUCT LARGE APPLICATION SYSTEMS, AND TO MAKE MORE EXTENSIVE SCIENTIFIC INVESTIGATIONS POSSIBLE THROUGH THE ON-ORBIT ASSEMBLY AND LAUNCH.

IN SUMMARY, WE WOULD LOOK FORWARD IN THE 80'S TO THE INITIAL FLIGHTS (31) OF THE SHUTTLE TRANSPORTATION SYSTEM AND ITS SUBSEQUENT EXPLOITATION AS A PAYLOAD CARRIER, A MANNED EXPERIMENT LABORATORY, A SERVICER OF AUTOMATED SATELLITES, AND A PLATFORM FOR DEVELOPING CONSTRUCTION TECHNIQUES. WE WOULD FORESEE AUGMENTING THE SHUTTLE WITH INCREASED ELECTRICAL POWER TO SUPPORT SPACELAB AND OTHER ACTIVITIES.

WE WOULD EXPECT THE DEVELOPMENT OF AUTOMATED PLATFORMS UNIQUELY DESIGNED TO BE RECOVERED, REUSED, OR SERVICED BY THE SHUTTLE. HOPEFULLY WE WOULD SEE THE IDENTIFICATION, DEFINITION, AND DEVELOPMENT OF A MAJOR NEXT STEP IN SPACE EXPLORATIONS INVOLVING A PERMANENT MANNED FACILITY DESIGNED TO SUPPORT OPERATIONS IN SPACE SUCH AS CONSTRUCTION AND SPACE VEHICLE ASSEMBLY, LAUNCHING, AND RECOVERY. IN DOING SO, WE WOULD DEVELOP AN INCREASED CAPABILITY TO OPERATE INDEPENDENTLY OF EARTH CONTROL AND RESUPPLY. WE BELIEVE SUCH AN ENDEAVOR WOULD NOT ONLY BE A FURTHER STEP IN SPACE EXPLORATION BUT WOULD BE A PROGRAM IN WHICH THE PEOPLE OF MANY NATIONS COULD PARTICIPATE IN A VARIETY OF WAYS.

THE COMMENTS I HAVE MADE HERE TODAY REPRESENT MY PERCEPTION OF A PROPER DIRECTION FOR MANNED SPACE ACTIVITIES IN THE FUTURE. I STRONGLY BELIEVE THAT IT IS CRUCIAL FOR OUR COMMUNITY TO IDENTIFY AND DEFINE THE STEPS WE BELIEVE SHOULD BE TAKEN. FURTHERMORE OUR PROPOSALS MUST BE BOLD AND CONSISTENT WITH THE OPPORTUNITIES THAT SPACE AFFORDS US.

FINALLY, I GREATLY APPRECIATE THE OPPORTUNITY TO PROVIDE TO THIS AUDIENCE MY VIEWS ON THE SUBJECT OF SPACE ACTIVITIES OF THE FUTURE. WHILE I AM UNABLE TO PERSONALLY ATTEND THIS CONGRESS BECAUSE OF THE NEEDS OF OUR SPACE SHUTTLE DEVELOPMENT, I EXTEND MY BEST WISHES FOR ITS SUCCESS.