SHUTTLE HISTORY

• 1952 FULLY REUSABLE LAUNCH VEHICLE CONCEPT DISCUSSED

• 1962 FULLY REUSABLE VEHICLE SERIOUSLY CONSIDERED

• AIR FORCE STUDIED PROJECT DYNASOAR, WHICH WAS CANCELLED IN 1969

• 1969 NASA ADOPTED THE IDEA OF A FULLY REUSABLE SPACE SHIP
TOP LEVEL REQUIREMENTS

• FULLY REUSABLE
• 14 DAY TURN AROUND TO NEXT FLIGHT
• DEPLOY AND RETRIEVE PAYLOADS
• DESIGN, DEVELOPMENT, & TEST PHASE ESTIMATED TO BE 5.1B IN 1971 DOLLARS
• ORIGINAL COST PER FLIGHT FOR 65,000 POUNDS WAS 10.5M PER FLIGHT IN 1971 $ FOR A FLIGHT RATE OF 60 PER YEAR
SHUTTLE STUDIES

• PHASE “A” STUDIES WERE CONDUCTED TO DETERMINE BASIC REQUIREMENTS AND THEIR EFFECT ON DESIGN IN 1969

• PRINCIPAL ISSUES:
  – SIZE AND WEIGHT OF PAYLOAD
  – CROSS RANGE OF THE ORBITER
  – HEAT-RESISTANT STRUCTURE OR REUSABLE INSULATING MATERIAL
SHUTTLE STUDIES

• PRINCIPAL ISSUES:
  – HYPERGOLIC REACTION CONTROL SYSTEM OR LIQUID OXYGEN/HYDROGEN
  – FLY-BY-WIRE FLIGHT CONTROL SYSTEM
  – WIND TUNNEL TESTS TO DETERMINE WING SIZE AND CONFIGURATION
  – AIR BREATHING ENGINES WERE CONSIDERED FOR FLY BACK; LATER WERE DETERMINED TO BE TOO HEAVY
SHUTTLE STUDIES

• PRINCIPAL ISSUES:
  – ENTRY TECHNIQUES
  – LANDING SPEED
  – APPROACH PATTERN
SHUTTLE STUDIES

- PHASE “B” STUDIES WERE PERFORMED IN MID 1970’S TO DETERMINE A PRELIMINARY DESIGN

- RESULTS:
  - FULLY RECOVERABLE ORBITER
  - DISPOSABLE FUEL TANK
  - PARACHUTE-RECOVERABLE SOLID ROCKET BOOSTERS
  - HIGH PERFORMANCE HYDROGEN-OXYGEN ENGINES PLACED IN THE ORBITER TO BE RECOVERED
RESULTS OF STUDIES

• FULLY REUSABLE WITH FLY-BACK BOOSTER WAS GREATER THAN 5.1B.
• MANY CONFIGURATIONS WERE STUDIED (EXAMPLES)
• TURN AROUND TIME REQUIRED LANDING A WINGED VEHICLE ON A RUNWAY
• PAYLOAD DEPLOYMENT AND RETRIEVAL REQUIREMENT DETERMINED LOCATION OF ORBITER ON LAUNCH CONFIGURATION
MAJOR SHUTTLE CONFIGURATION DECISIONS

• HYDROGEN/OXYGEN MAIN ENGINES
• THIS SIZED THE LIQUID OXYGEN/HYDROGEN TANK, WHICH IS NOT REUSABLE
• SOLID ROCKET BOOSTERS PROVIDED THE ADDITIONAL PROPULSION REQUIRED TO GET THE ORBITER INTO EARTH ORBIT
• SOLID ROCKET BOOSTERS DESIGNED TO BE RECOVERED AND RE-USED
ORBITER DECISIONS

• ORBITER ENTRY CROSS RANGE REQUIRED DELTA WINGS
• DELETION OF AIR BREATHING ENGINES FOR MOVING ORBITER REQUIRED THE BOEING 747 TO CARRY THE ORBITER
• FO/FS GUIDANCE, NAVIGATION, AND CONTROL SYSTEM
• FLY- BY- WIRE WITH A DIGITAL AUTO PILOT
ORBITER DECISIONS

• SIZE OF PAYLOAD BAY 60 FEET LONG BY 15 FEET DIAMETER
• SIZE OF CREW CABIN DEFINED TO BE OVER 2600 CUBIC FEET
• PAYLOAD 65,000 POUNDS AT LIFT OFF AND 35,000 POUNDS AT LANDING
• THE ORBITER IS A LAUNCH VEHICLE, A SPACE CRAFT, AND AN AIRCRAFT
ORBITER SUB-SYSTEMS

- THERMAL PROTECTION SYSTEM
- GUIDANCE, NAVIGATION, AND CONTROL
- HYDRAULIC
- AUXILIARY POWER UNIT
- LANDING SYSTEM
- CREW CABIN
- ELECTRICAL POWER
- ORBITAL MANEUVERING SYSTEM
- REACTION CONTROL SYSTEM
- COMMUNICATIONS
- ENVIRONMENTAL CONTROL AND LIFE SUPPORT
- PAYLOAD DEPLOYMENT AND RETRIEVAL
- STRUCTURES
ORBITER SUB-SYSTEMS

• MAJOR ISSUES
  – FUNCTIONS THAT ARE REQUIRED TO BE PERFORMED (FUNCTIONAL REQUIREMENTS)
  – PERFORMANCE THAT IS REQUIRED (PERFORMANCE REQUIREMENTS)
  – WEIGHT
  – INTERFACES
  – AVAILABLE TECHNOLOGY
  – SCHEDULE
  – COST