NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-78

PRESS KIT
JUNE 1996

LIFE AND MICROGRAVITY SPACELAB

STS-78 INSIGNIA

STS078-S-001 -- *The STS-78 mission links the past with the present through an insignia influenced by Pacific Northwest Native American art. Central to the design is the space shuttle Columbia, whose shape evokes the image of the eagle, an icon of power and prestige and the national symbol of the United States. The eagle's feathers, representing both peace and friendship, symbolize the spirit of international unity on STS-78. An orbit surrounding the mission number recalls the traditional NASA emblem. The Life Sciences and Microgravity Spacelab (LMS) is housed in Columbia's payload bay and is depicted in a manner reminiscent of totem art. The pulsating sun, a symbol of life, displays three crystals representing STS-78's three high-temperature microgravity materials processing facilities. The constellation Delphinus recalls the dolphin, friend of sea explorers. Each star represents one member of STS-78's international crew including the alternate payload specialists Pedro Duque and Luca Urbani. The colored thrust rings at the base of Columbia signify the five continents of Earth united in global cooperation for the advancement of all humankind.*

The NASA insignia design for space shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize. Public availability has been approved only in the form of illustrations by the various news media. When and if there is any change in this policy, which we do not anticipate, it will be publicly announced.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

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STS-78 Experiments & Activities

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LIFE AND MICROGRAVITY SCIENCES RESEARCH HIGHLIGHT SHUTTLE MISSION STS-78

The flight of Space Shuttle Columbia on Mission STS-78 will utilize an orbiting research laboratory to conduct a diverse slate of experiments on how human beings and other living organisms along with various materials change in a weightless environment.

Launch of Columbia is currently targeted for June 20, 1996 at 10:49 a.m. EDT from Kennedy Space Center's Launch Complex 39-B. The STS-78 mission duration is currently planned for 15 days, 22 hours, 20 minutes. However, Mission Control will be carefully managing and monitoring Columbia's electrical power consumption with an eye towards extending the flight one day so additional science work can be performed. If the extension day happens, the mission duration would become 16 days, 22 hours, 2 minutes and would make the STS-78 flight NASA's longest Shuttle mission to date. An on-time launch and one day mission extension would set Columbia up for a landing on July 7th at 8:51 a.m. EDT at Kennedy Space Center.

The STS-78 crew will be commanded by Terence T. "Tom" Henricks, making his fourth Shuttle flight. Payload Commander and Mission Specialist-2 Susan J. Helms, is making her third flight. The pilot for the mission, Kevin R. Kregel, is making his second flight. There are two other mission specialists assigned to the flight. Richard M. Linnehan, serving as Mission Specialist-1, is making his first flight. Charles E. Brady, serving as Mission Specialist-3, is making his first flight. There also are two payload specialists serving as part of the STS-78 crew. Jean-Jacques Favier from the French Atomic Energy Commission (CEA) and an astronaut of the French Space Agency (CNES) will serve as Payload Specialist-1. Robert Brent Thirsk from the Canadian Space Agency (CSA) will serve as Payload Specialist-2. Both Favier and Thirsk will be making their first space flight.

The flight will involve the Life and Microgravity Sciences (LMS) payload being carried in the pressurized Spacelab module in Columbia's cargo bay and will focus on two main areas. The LMS life science studies will probe the responses of living organisms to the low- gravity environment and highlight musculoskeletal physiology. LMS microgravity experiments will focus on understanding the subtle influences at work during processing of various samples, such as alloy materials, when gravity's effect is greatly reduced. On Earth, gravity distorts scientific results. Materials processed on orbit reveal underlying secrets masked or distorted in ground-based laboratories. Likewise, free from gravity, the human body undergoes changes that can affect astronaut performance. While LMS life sciences information will help prepare crews for longer duration missions, the causes of, and cures for, similar ailments experienced on Earth may be found.

The STS-78 crew also will take on the role of teachers as they educate students in the United States and other countries about their mission objectives. Using the Shuttle Amateur Radio Experiment-II, which is carried aboard the Shuttle on a regular basis, crewmembers will talk with students around the world about what it is like to live and work in space.

STS-78 will be the 20th flight of Columbia and the 78th mission flown since the start of the Space Shuttle program in April 1981.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

NASA Television Transmission

NASA Television is available through the Spacenet-2 satellite system. Spacenet-2 is located on Transponder 5, at 69 degrees West longitude, frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the Orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, TX; and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR at 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is provided daily at noon Eastern time.

Television schedules also may be obtained via the Internet on:

http://www.hq.nasa.gov/office/pao/ntv.html

Status Reports

Status reports on countdown and mission progress, on- orbit activities and landing operations will be produced by the appropriate NASA newscenter.

Briefings

A mission press briefing schedule will be issued prior to launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

Information on STS-78 is available through several sources on the Internet. The primary source for mission information is the NASA Shuttle Web, part of the World Wide Web. This site contains information on the crew and their mission and will be regularly updated with status reports, photos and video clips throughout the flight. The NASA Shuttle Web's address is: **http://shuttle.nasa.gov**

If that address is busy or unavailable, Shuttle information is available through the Office of Space Flight Home Page: **http://www.osf.hq.nasa.gov/**

General information on NASA and its programs is available through the NASA Home Page and the NASA Public Affairs Home Page:

http://www.nasa.gov
http://www.gsfc.nasa.gov/hqpao/hqpao_home.html

Information on other current NASA activities is available through the Today@NASA page:

http://www.hq.nasa.gov/office/pao/NewsRoom/today.html

Status reports, TV schedules and other information is also available from the NASA Headquarters FTP server, ftp.hq.nasa.gov. Log in as anonymous and go to the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

NASA's Spacelink, a resource for educators, also provides mission information via the Internet. The system fully supports the following Internet services:

World Wide Web	**http://spacelink.msfc.nasa.gov**
Gopher	**spacelink.msfc.nasa.gov**
Anonymous FTP	**spacelink.msfc.nasa.gov**
Telnet	**spacelink.msfc.nasa.gov**

Spacelink's dial-up modem line is 205-895-0028.

Access by CompuServe

Users with CompuServe accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

QUICK-LOOK FACTS

Launch Date/Site	June 20, 1996/KSC Launch Pad 39-B
Launch Time	10:49 AM EDT
Launch Window	2 hours, 30 minutes
Orbiter	Columbia (OV-102), 20th flight
Orbit Altitude	153 nautical miles
Orbit Inclination	39 degrees
Mission Duration	15 days, 22 hours
Landing Date	July 7, 1996
Landing Time	8:49 AM EDT
Primary Landing Site	Kennedy Space Center, FL
Abort Landing Sites	Return to Launch Site - KSC Transoceanic Abort Sites Ben Guerir, Morocco Moron, Spain Zaragoza, Spain Abort-Once Around - Edwards AFB, CA
Crew	Tom Henricks, Commander (CDR) Kevin Kregel, Pilot (PLT) Rick Linnehan, Mission Specialist 1 (MS 1) Susan Helms, Payload Cdr, Mission Specialist 2 (MS 2) Charles Brady, Mission Specialist 3 (MS 3) Jean-Jacques Favier, Payload Specialist 1 (PS 1) Robert Thirsk, Payload Specialist 2 (PS 2)
EVA Crew (if required)	Susan Helms (EV 1), Rick Linnehan (EV 2)
Cargo Bay Payloads	LMS EDO Pallet
In-Cabin Payloads	SAREX

SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes for STS-78 include:

- Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with the orbital maneuvering system engines.

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit of the Earth before landing at the Kennedy Space Center, FL.

- Transoceanic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Ben Guerir, Morocco; or Moron, Spain.

- Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, and without enough energy to reach a TAL site, would result in a pitch around and thrust back toward Kennedy until within gliding distance of the Shuttle Landing Facility.

MISSION SUMMARY TIMELINE

Flight Day 1
Launch/Ascent
OMS-2 Burn
Spacelab Activation
LMS Operations

Flight Days 2-5
LMS Operations

Flight Day 6
LMS Operations
Off Duty Time

Flight Days 7-10
LMS Operations

Flight Day 11
LMS Operations
Off Duty Time
Crew News Conference

Flight Day 12-15
LMS Operations

Flight Day 16
LMS Operations
Flight Control System Checkout
Reaction Control System Hot-Fire
Spacelab Deactivation
Cabin Stowage

Flight Day 17
Deorbit Prep
Deorbit Burn
KSC Landing

STS-78 ORBITAL EVENTS SUMMARY

(Based on a June 20, 1996 Launch)

Event	MET	Time of Day (EDT)
Launch	0/00:00	10:49 AM, June 20
OMS-2	0/00:43	11:32 AM, June 20
Crew News Conference	9/23:50	10:39 AM, June 30
Deorbit Burn	15/21:00	7:49 AM, July 6
KSC Landing	15/22:00	8:49 AM, July 6

PAYLOAD AND VEHICLE WEIGHTS

	Pounds
Orbiter (Columbia) empty and 3 SSMEs	160,330
Shuttle System at SRB Ignition	4,517,152
Orbiter Weight at Landing with Cargo	256,170
Spacelab Module	21,272

CREW RESPONSIBILITIES

Payloads	Prime	Backup
Spacelab	Kregel, Henricks	Helms, Linnehan
LMS Experiments	Helms	
AGHF	Favier	Helms
BDPA	Favier	Helms
PGF	Helms	Favier
Other microgravity	Helms	Kregel
TVD experiments	Thirsk	Linnehan
ALFE	Linnehan	Thirsk
COIS	Thirsk	Helms
Metabolic	Brady	Linnehan
PAWS	Helms	Henricks
SACS	Thirsk	Brady
TRE	Thirsk	Brady
EVA	Helms (EV 1), Kregel (EV 2)	--------
Intravehicular Crewmember	Linnehan	--------
SAREX	Brady	Helms
DTOs	Henricks	Kregel
DSOs	Henricks	Kregel
Earth Observations	Kregel	Henricks

DEVELOPMENTAL TEST OBJECTIVES/DETAILED/ SUPPLEMENTARY OBJECTIVES

DTO 301D:	Ascent Structural Capability Evaluation
DTO 307D:	Entry Structural Capability
DTO 312:	ET TPS Performance
DTO 319D:	Shuttle/Payload Low Frequency Environment
DTO 623:	Cabin Air Monitoring
DTO 667:	Portable In-Flight Landing Operations Trainer
DTO 675:	Voice Control of Closed Circuit Television System
DTO 1126:	KCA Video Teleconferencing Demonstration
DSO 487:	Immunological Assessment of Crewmembers
DSO 491:	Characterization of Microbial Transfer Among Crewmembers
DSO 493:	Monitoring Latent Virus Reactivation and Shedding in Astronauts
DSO 802:	Educational Activities
DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography

THE LIFE AND MICROGRAVITY SPACELAB MISSION

The STS-78 crew will conduct a diverse slate of experiments divided into a mix of life science and microgravity investigations.

LMS life science studies will probe the responses of living organisms to the low-gravity environment of the Space Shuttle in orbit and highlight musculoskeletal physiology. LMS microgravity experiments will focus on understanding the subtle influences at work during processing of various samples, such as alloy materials, when gravity's effect is greatly reduced. On Earth, gravity distorts scientific results. Materials processed on orbit reveal underlying secrets masked or distorted in ground-based laboratories. Likewise, free from gravity, the human body undergoes changes that can affect astronaut performance. While LMS life sciences information will help prepare crews for longer duration missions as our role in space expands, the causes of, and cures for, similar ailments experienced on Earth also may be found.

In a manner very similar to future Space Station operations, LMS researchers from the United States and abroad will share resources such as crew time and equipment. Experiments for the mission were developed on a fast-track schedule -- about 21 months, versus 36 to 48 months for most Spacelab missions. This faster turnaround time from selection to flight also will hold true for many Space Station experiments. To develop effective countermeasures, the crew will perform various motor-skill tests and participate in measurements of bone and muscle density. These data will be supplemented and verified through ground-based studies and will be compared to data gathered before and after the flight.

LMS life science studies are divided into two fields -- human physiology and space biology. The five areas of human physiology are musculoskeletal, metabolic, pulmonary, human behavior and performance, and neuroscience. Three space biology experiments will study growth of pine saplings, development of fish embryos, and bone changes in laboratory rats.

Human Physiology Experiments

Four major space agencies sponsor the human physiology experiments that make up the Johnson Space Center Human Life Sciences Project. They are NASA, the European Space Agency (ESA), the French Space Agency (CNES) and the Canadian Space Agency (CSA). Since each complementary experiment studies a different body area, a well-rounded data base will be generated to help researchers understand how the body changes in low gravity so they can develop effective countermeasures.

Musculoskeletal Investigations -- Muscles that Control Movement

Effects of Weightlessness on Human Single Muscle Fiber Function
Dr. Robert Fitts, Marquette University, Milwaukee, WI

Objective: Although the skeletal muscles continue to control and move the body when on orbit, astronauts experience muscle wasting similar to the aging process or inactivity. This muscle loss seems to be short-lived and reversible, but long-duration flight effects are unknown.

Procedure: During crew sessions on an exercise ergometer, breathing and heart-rate measurements will be made. Right calf muscle performance will be evaluated using the Torque Velocity Dynamometer workstation. Measurements made several times during the mission will be compared to data collected before and after flight. Muscle fiber samples will be taken 45 days before launch and soon after landing for laboratory analysis.

Relationship of long-term Electromyographic Activity and Hormonal Function to Muscle Atrophy and Performance
Dr. V. Reggie Edgerton, University of California/Los Angeles, Los Angeles, CA

Objective: In space, muscle inactivity may modify movement control and alter chemicals secreted that protect against weakening. Researchers want to know whether unstressed muscles and the nervous system compensate for changes due to lack of adaptation and atrophy and restore movement ability both on Earth and in microgravity.

Procedure: Right arm and leg muscle movement will be measured by the Torque Velocity Dynamometer and electromyograph electrical impulses. Subjects also will compress a Hand-Grip Dynamometer to measure hand strength. To indicate the importance of nervous system fatigue versus tired muscles, the right calf muscles will be tested by repeated exercising to measure both force and electrical activity. Blood samples will monitor growth hormone levels.

Effects of Microgravity on Skeletal Muscle Contractile Properties
Dr. Paolo Cerretelli, Central Medical University, Geneva, Switzerland

Objective: On Earth, we take muscle contraction for granted. In space, without gravitational resistance, muscle function is impaired. This investigation will identify the effects of selective fiber atrophy, or shrinking, by examining muscle contraction data in the left calf.

Procedure: Muscles are made of fibers. Slow-twitch fibers generate force for prolonged, continuous activity, while fast-twitch muscles produce force for rapid movement and exercise. The Percutaneous Electrical Muscle Stimulation device will stimulate muscle contractions, enabling the Torque Velocity Dynamometer equipment to measure physical capabilities of both these muscle types. Contraction measurements will be correlated with Magnetic Resonance Imaging made before and after flight.

Effects of Microgravity on the Biomechanical and Bioenergetic Characteristics of Human Skeletal Muscle
Dr. Pietro di Prampero, University of Udine, Italy

Objective: Studies have shown that the maximum velocity at which a muscle can contract is inversely related to applied load, or resistance. Investigators want to know whether, and to what extent, this inverse relationship changes in microgravity.

Procedure: Using the Torque Velocity Dynamometer, crew members will exert a series of short elbow and ankle contractions made at different joint angles. Electromyograms will be collected to determine the role of nerve input on the total force output of the muscles. Measurements will be made before, during and after the mission. Findings will be complemented by a bedrest study conducted before the mission.

Magnetic Resonance Imaging After Exposure to Microgravity (Ground Study)
Dr. Adrian LeBlanc, Methodist Hospital and Baylor College of Medicine, Houston, TX

Objective: Many changes have been found in bone, muscle and blood from humans and animals exposed to microgravity. For example, astronauts often experience varying degrees of back pain, possibly related to lengthening of the spine in microgravity. These changes must be understood before longer missions are undertaken.

Procedure: Pre- and post- mission Magnetic Resonance Imaging (MRI) will measure the body's muscles. Muscle volume will be compared to performance measurements gathered on orbit during other experiments. As a complement to MRI data, Dual Energy Absorptiometry will measure total body and regional fat and lean tissue mass, and will monitor fluid redistribution after flight. Investigators also will study changes in the cross-sectional areas of discs in the lower back.

An Approach to Counteract Impairment of Musculoskeletal Function in Space (Ground Study)
Dr. Per Tesch, Karolinska Institute, Stockholm, Sweden

Objective: Investigators are seeking the mechanisms responsible for impaired musculoskeletal function in response to orbital flight. Whether it be muscle atrophy, or some other mechanism, overcoming these effects will enable crews to endure long missions.

Procedure: Before and after flight, electromyograms will determine the magnitude of nerve signals to the muscles being exercised. Using an ergometer with a resistive flywheel, subjects will establish individual values of force- velocity and joint angles and joint angle velocity. Voluntary leg press exercises will define maximum force and power output for each subject. MRI scans will make cross- sectional measurements of crew members' calf and thigh muscles.

Metabolic Investigations -- Regulatory Functions

Direct Measurement of the Initial Bone Response to Space
Flight Dr. Christopher Cann, University of California, San Francisco, CA

Objective: The dynamic human skeleton continually makes and removes bone from the body. In space, reduced gravitational loads may induce the skeleton to discard calcium; bone loss begins shortly after reaching orbit. While seeking countermeasures, researchers may discover treatments for the debilitating disease osteoporosis.

Procedure: Crew members will take a nonradioactive calcium isotope at each meal, from 10 days before the mission to 7 days after. By tracing the isotope in relation to food and drink intake, scientists will distinguish calcium intake from that shed through waste to determine the amount used by bones.

Measurement of Energy Expenditure During Space Flight with the Doubly Labeled Water Method
Dr. Peter Stein, University of Medicine and Dentistry of New Jersey, Stratford, NJ

Objective: This is the first measurement of the relationship between energy needs and calorie intake in space. During missions, crew members often lose weight. Like malnourishment, burning more calories than are ingested results in the breakdown of the body's protein reserves, which can lead to impaired performance and illness.

Procedure: The doubly labeled water method accurately measures energy output. Participants drink water with two nonradioactive isotopes that are shed by the body at different rates and by different paths. Energy expenditure will be analyzed using urine and saliva specimens. To learn how the energy needs in space vary from requirements on Earth, researchers will compare in-flight data with preflight and bedrest data.

Pulmonary Investigation -- Lung Function

Extended Studies of Pulmonary Function in Weightlessness
Dr. John West, University of California/San Diego, La Jolla, CA

Objective: Previous flight studies indicate gravity is not the only factor in perfusion/ventilation gas flow and blood flow differences between the top and bottom of the lung. These changes will be measured before and during exercise to determine the mechanisms of ventilatory changes.

Procedure: Using astronaut lung function experiment equipment, the crew member will inhale either cabin air or a test gas. Exhaled gases will be monitored continuously. A wired vest will gauge rib cage and chest motion to learn how microgravity affects the musculoskeletal aspects of breathing during heavy exercise, deep breathing and rest periods. Data also will be collected before and after flight and several weeks following the mission.

Human Behavior and Performance Investigations -- Sleep, Schedule and Skills

Human Sleep, Circadian Rhythms and Performance in Space
Dr. Timothy Monk, University of Pittsburgh, PA (Ground Study)
Dr. Alexander Gundel, Institute of Aerospace Medicine, Cologne, Germany

Objective: This is the first simultaneous study of sleep, 24-hour circadian rhythms and task performance in microgravity. While cues such as sunrise and sunset help "set" our biological clocks, in low-Earth orbit light and dark periods alternate every 45 minutes as the Shuttle circles the globe.

Procedure: Periodically during the mission, crew members will wear a beltpack connected to a temperature sensor and another to a sleep cap with electrodes that will measure brain waves, eye movements and muscle tone while sleeping. Mood and performance tests will be performed. Urine will be collected to help track normal daily rhythms. An identical ground study will be conducted after the mission.

Microgravity Effects on Standardized Cognitive Performance Measures using the Performance Assessment Workstation
Dr. Samuel Schiflett, U.S. Air Force Armstrong Laboratory, Brooks Air Force Base, TX

Objective: Cognitive, or thinking, skills are critical to successfully performing many on board tasks. This experiment will identify the effects of fatigue versus microgravity on specific information processing skills. In the future, this information may be used to optimize work schedules in space under a variety of conditions. The goal is to maximize productivity and job satisfaction of astronauts on extended missions.

Procedure: Astronauts will use the Performance Assessment Workstation laptop computer to gather performance data including the speed and accuracy of responses to rotated letters, math problems, letter sequences, etc. Data will be collected before and after flight, and on alternate days during the mission.

Neuroscience Investigations -- Adapting to Space

Torso Rotation Experiment
Dr. Douglas Watt, McGill University, Montreal, Quebec, Canada

Objective: Space adaptation syndrome, a common symptom of adjusting to microgravity, produces motion sickness. Although symptoms disappear in a few days, this syndrome is uncomfortable and affects performance.

Procedure: The flight crew at times will wear sensor packages that measure eye, head and torso movements during normal on-orbit activities early, midway and late into the flight. This information will be compared to data obtained before flight to help researchers recommend ways to move in order to reduce discomfort and improve performance.

Canal and Otolith Interaction Studies
Dr. Millard Reschke, NASA Johnson Space Center, Houston, TX

On Earth, we take balance for granted. Those with balance problems, as well as astronauts, will benefit from neuroscience research.

Objective: On orbit, the vestibular system, in the inner ear, becomes confused as to which way is up or down. Disrupting inner ear motion sensors -- semicircular canals and otolith organs -- leads to nausea and disorientation. It is vital to understand how the human vestibular system adapts.

Procedure: The experiment will study head movement and eye coordination in microgravity four times during the mission. Crew members will use special head gear with a screen that displays visual and motion targets; data will be collected on how the head and eyes track these cues. Readaptation times after flight also will be monitored.

Space Biology Experiments

The three space biology experiments and associated science support are managed by Ames Research Center, Mountain View, CA; Kennedy Space Center, FL; and Walter Reed Army Institute of Research, Washington, DC.

Lignin Formation and the Effects of Microgravity: A New Approach
Dr. Norman Lewis, Washington State University, Pullman, WA

Objective: Trees form inferior "reaction" wood when they right themselves from a bend. Lumber and paper industries want to know how to control and prevent this process. Biologists will study how pine seedlings respond on a cellular level to bending stress in microgravity to study the mechanism of this tree growth.

Procedure: The middeck locker Plant Growth Unit provides lighting, air control and specimen chambers that support growth up to 30 days. Pine seedlings will be placed in the chamber in a way that favors reaction wood formation on Earth. The crew will photograph the specimens each day and periodically preserve cuttings for ground-based study.

Development of the Fish Medaka in Microgravity
Dr. Debra Wolgemuth, Columbia College of Physicians and Surgeons, New York, NY

Objective: During embryonic development, a single cell divides into many cells, which become organs and function as a living system. Medaka fish embryos will help researchers determine gravity's role in normal development. This knowledge will contribute to theories about development conditions for other vertebrates, such as humans.

Procedure: The fish embryos will grow in a culture system called the Space Tissue Loss Module in the middeck. This module, designed by the Walter Reed Army Institute of Research, is fully automated except for startup, video transmission and reentry stowage. Scientists will observe the embryos on orbit via video and preserve them at various stages for later study.

Role of Corticosteroids in Bone Loss During Space Flight
Dr. Thomas Wronski, University of Florida, Gainesville, FL

Objective: Corticosteroid hormones are produced by the adrenal gland in response to stress. Excess corticosteroids may contribute to bone changes during space flight, as well as other stressful periods. To develop effective countermeasures, scientists need to determine how microgravity affects bone mass, levels of bone formation and resorption, and bone cell activity.

Procedure: The two self-contained Animal Enclosure Modules, located in the orbiter middeck, will house 12 laboratory rats. While feeding is automatic in this habitat, the crew will monitor the rodents. After flight, the rats will be euthanized for study at a ground-based laboratory.

Microgravity Science Investigations

In the microgravity environment of space, the masking forces of gravity are stripped away, allowing scientists to pursue research not possible on Earth. The goal of this research is to improve both production methods and final products of Earth-based industries.

STS-78 microgravity science experiments involve basic fluid physics investigations, advanced semiconductor and metal alloy materials processing, and medical research in protein crystal growth. These are conducted primarily through "telescience," a mode of operation where scientists on the ground remotely command experiments in orbit. Crew involvement is complementary -- they will check out and activate equipment once on orbit and install and remove samples.

Bubble, Drop and Particle Unit -- Fluid Physics Research

Fluid physics research in the Bubble, Drop and Particle Unit (BDPU) may lead to advances in materials processed on Earth. To enable this type of progress, scientists need a better understanding of fluid processes that play a role in the production of most materials. On Earth, gravity-induced flows, such as convection, often hide more subtle effects. By contrast, in space-based investigations these more subtle fluid processes often dominate movements in fluids. Using the BDPU, the fluid physics investigations will help uncover processes involving either gas bubbles, liquid drops or liquid layers. Products that will benefit from this research include new high-strength metals and temperature-resistant glasses and ceramics for building everything from better electric power plants to future spacecraft.

The BDPU was developed by the European Space Agency. Commands sent from the ground will inject bubbles or drops into liquid-filled test cells and then subject the cells to specific changes in temperature. Cameras and sensors will observe and record temperature, pressure and position of the bubbles or drops. The test cells will be used to study how bubbles and drops react in liquids with varying temperatures and concentrations, how they affect solidification, how convection affects liquid layers at different temperatures, and how evaporation and condensation affect bubble creation and growth, and how liquid columns react to electrical fields.

Bubbles and Drops Interaction with Solidification Fronts
Dr. Rodolfo Monti, University of Naples, Italy

Objective: As molten crystal and glass begin to solidify, gas bubbles may form, causing imperfections in the final product. Also, ingredients of liquid metal mixtures may separate during melting or solidification, forming bubbles or droplets in the mixture. This investigation will provide insight into better ways to prevent these flaws from occurring.

Procedure: A solid tetracosane test sample with implanted gas bubbles will be melted at low temperatures. Once melted completely, the liquefied tetracosane, now transparent, will be cooled, and a new solidification process will occur. The resulting interaction between moving pre- formed air bubbles and the solidifying edge will be studied.

Evaporation and Condensation Kinetics at a Liquid Vapor Interface; and Efficient Cooling of High Powered Small Electronic Devices by Boiling under Microgravity
Dr. Johannes Straub, Technical University of Munich, Germany

Objectives: The main goal of the first study is to investigate vapor bubble formation and collapse during evaporation and condensation. This will provide a better understanding of these processes, with applications for many technical operations that use heat and mass transfer.

A second study investigates heat transfer during boiling, using small heaters of different shapes and sizes. Since boiling is a very efficient way to exchange heat, it is used in many energy conversion systems that will benefit from research in this field. For example, boiling can be used to cool small, high-powered electronic devices, such as computer chips.

Procedures: These experiments flew on the second International Microgravity Laboratory (IML-2) in 1994. The test liquid is an alternative refrigerant, R123, which allows higher pressures and temperatures than the refrigerant used on IML-2. In the Evaporation and Condensation Kinetics at a Liquid Vapor Interface experiment, a vapor bubble is generated by a short heating pulse from a heater in the liquid.

The bubble remains and grows where it forms and is observed over time. Cooling or pressure increases are used to force the gas bubbles to collapse or condense back to liquid. For the second experiment, investigators will use advanced hardware, combining optical and electronic systems, to examine heat transfer between the heater, the liquid and the vapor that is formed on boiling.

The Electrohydrodynamics of Liquid Bridges
Dr. Dudley Saville, Princeton University, Princeton, NJ

Objective: This investigation will provide information about the stability of columns of a dielectric material (in this case, a liquid) that barely conducts electricity when placed in another liquid or in air and is subjected to an electric field.

This research may find application in industrial processes where the control of a liquid column or spray is necessary, such as ink-jet printing and polymer fiber spinning.

Procedure: The experiment will focus on the shape changes that occur in a fluid bridge suspended between two electrodes. While applying direct or alternating electrical fields, scientists can study the bridge's change as its ends are draw apart and the field is changed from a cylinder to a vase-like shape until the column finally breaks. The electric fields generated should stabilize the liquid columns even as they are stretched past the point when surface tension would normally cause them to break. Fluids to be studied include castor oil, eugenol and silicone oil.

Nonlinear Surface Tension Driven Bubble Migration
Dr. Antonio Viviani, Second University of Naples, Aversa, Italy

Objective: This experiment continues investigations into the motion of bubbles immersed in a liquid in a container with hot and cold walls on opposite sides. The study of this phenomenon applies to controlling defects in many aspects of materials processing in space, such as the solidification of better and stronger metals, alloys, glasses, and ceramics.

Procedure: Air bubbles of various sizes will be injected into a water-and-alcohol solution that is hot on one end and cold on the other. Investigators will vary the temperature and determine the speed and position of the bubbles. Of particular interest is the ability to control bubble motion at the temperature of the liquid in which the bubble has little tendency to move. Video images will assist scientists controlling the experiment from the ground.

Oscillatory Marangoni Instability
Dr. Jean-Claude Legros, Free University of Brussels, Belgium

Objective: Many manufacturing processes depend on melting and resolidifying a material encapsulated by a liquid coating in order to make single crystals for use in electronics. Often, the individual liquid components will flow due to Marangoni convection -- fluid flows caused by surface tension. Understanding this process is important for manufacturing of this nature.

Procedure: Scientists will gather data to accurately model these flows. A layer of methanol fluid will be placed between two layers of n-octane, a fluid that will not mix with methanol, and will be subjected to temperature differences. Investigators will study the flows in each layer to identify the temperature at which convection becomes unstable. Results will be compared with computer model predictions.

Thermocapillary Migration and Interactions of Bubbles and Drops
Dr. Shankar Subramanian, Clarkson University, Potsdam, NY

Objective: Bubbles and drops are components in the formation of metal mixtures and other materials processing applications, such as solidification. In long-duration space missions, for example, separation processes for waste material recycling might involve bubbles and drops. This experiment studies bubble and drop movements in a liquid under varying temperatures.

Procedure: Up to six test-run series will be conducted, each lasting about four hours, at various temperatures. In each series, six to ten bubbles or drops will be injected, two at a time, while investigators on the ground monitor their motions and interactions through on-orbit video.

Advanced Gradient Heating Facility -- Materials Processing

Scientists perform materials processing experiments to understand the conditions at which freezing materials change from solidifying with a flat boundary or transition surface (edge) to solidifying with cellular and dendritic (tree like) transition shapes. They also want to determine the influences that affect these changes, to enable achieving the exact structure desired in a material. Using the Advanced Gradient Heating Facility (AGHF) furnace for solidifying alloys and crystals, scientists can study these changes in ways that are not possible on Earth, improving our understanding of materials processing.

The AGHF uses pulses of electrical current to mark the internal shape of a material's solidifying edge, a process called Peltier pulse marking. By examining cross-sections of these crystals, scientists can locate these marks and determine the precise growth rate for each portion of a sample, as well as the shape of the crystal edge at the time of the pulse. The six materials processing experiments in this facility will increase knowledge of the physical processes involved in solidification, improving materials processing on Earth and in space.

Comparative Study of Cells and Dendrites During Directional Solidification of a Binary Aluminum Alloy at 1-g and under Microgravity
Dr. Henri Nguyen Thi, University of Marseilles, France

Objective: The growing edge of a solidifying material forms cellular shapes as its temperature changes quickly, and tree-like dendrite shapes when its temperature changes very quickly. Although researchers have conducted numerous Earth- based studies about the exact conditions at which these shapes change, many questions remain about how to improve microscopic qualities of materials by controlling this process.

Procedure: This experiment will melt and solidify two samples of an aluminum alloy at a precise growth rate. Then, they will be flash-cooled to preserve the shapes of their solidification boundaries. After the mission, these samples will be cut and polished so that investigators can determine the structure's qualities.

Coupled Growth in Hypermonotectics
Dr. Barry Andrews, University of Alabama at Birmingham, Birmingham, AL

Objective: Scientists are interested in a number of unique alloys that cannot be easily produced on Earth because the ingredients separate during processing. Controlling the internal structure of these materials during solidification could lead to alloys for engineering, chemical and electronic applications. On Earth, however, gravity hinders solidification studies.

Procedure: This experiment will process aluminum and indium samples, maintaining a flat edge as the material solidifies, so that indium fibers are more evenly spread and aligned in the final product. After the mission, investigators will cut, etch and chemically analyze sections of the samples to study the evenness of their structures.

Effects of Convection on Interface Curvature during Growth of Concentrated Ternary Compounds
Dr. Thierry Duffar, Atomic Energy Commission, Grenoble, France

Objective: As a metal alloy or semiconductor crystal solidifies, fluid flows and the movement of the solid's growing edge can cause the material's ingredients to separate, forming an uneven sample. Studies of this undesirable effect are hindered by gravity, which changes the shape of the sample's solid edge and causes flows that hide diffusion effects.
Procedure: This experiment will melt and resolidify a ternary, or three component, gallium-indium-antimony sample. The crucible containing the experiment will control the shape of the sample's solidification front and mark it with Peltier pulses. After flight, scientists will analyze curvature of the front and the sample's compositional uniformity.

Equiaxed Solidification of Aluminum Alloy
Dr. Denis Camel, Atomic Energy Commission, Grenoble, France

Objective: Depending on its temperature and other conditions, solidifying metal mixtures form either ordered, long column-like grains or unordered round grains that form around core particles, or nuclei. Investigators will compare samples processed in this experiment with theoretical models to better understand the influence of natural fluid flows in Earth-based metal alloy processing.

Procedure: Two samples of an aluminum-copper mixture will be solidified in a cartridge, one at a nearly constant temperature and the other in a high temperature gradient. One other cartridge with a different quantity of nuclei in the sample will be processed under identical conditions. The samples' structure then will be compared with those of theoretical models.

Interactive Response of Advancing Phase Boundaries to Particles
Dr. Ulrike Hecht, Aachen Center for Solidification in Space, Germany

Objective: Many composites, such as metal mixtures with particles in their crystal structures, offer unique properties such as strength and flexibility. Understanding the interaction between free-floating particles and the growing edge of a solidifying material will help verify theoretical models used to develop new materials and design better industrial processes.

Procedure: This experiment investigates the effects of solidification conditions on the spread of particles in a sample as it crystallizes. It focuses on the different shapes that form on the growth boundary of the solid region and how the development of these shapes is affected as the boundary contacts floating particles.

Particle Engulfment and Pushing by Solidifying Interfaces
Dr. Doru Stefanescu, University of Alabama, Tuscaloosa, AL

Objective: This experiment is designed to improve the understanding of the physics of liquid metals containing ceramic particles as they solidify. It also will investigate aspects of processing metal mixtures in microgravity to improve such processing on Earth.

Procedure: Two pure aluminum samples and one aluminum- nickel alloy will be solidified in the AGHF. Scientists will examine the samples after the flight to determine how fast the metal's solidification front must grow to engulf zirconia particles, instead of pushing them. A complementary ground- based experiment will use organic and polystyrene materials to simulate the solidification and help validate theoretical models of the process.

Advanced Protein Crystallization Facility -- Medical Research

The Advanced Protein Crystallization Facility (APCF) is the first facility ever designed to use three methods of protein crystal growth. By examining the molecular structure of proteins, medical researchers will gain insight into these basic building blocks of life. The APCF experiments could improve food production, as well as lead to innovative new drugs to combat disease.
Protein crystals, like snowflakes, are structured in a regular pattern. Earth-grown crystals show the effects of a growth process analogous to a sports stadium filling with fans who all have reserved seats. Each molecule of a crystal also has its own "reserved" seat. Once the gates open, people flock to their seats and in the confusion often sit in someone else's place. On Earth, gravity-driven convection keeps the molecules crowded around the "seats" as they attempt to order themselves. Unfortunately, many molecules take the wrong place or collapse. Such flaws are greatly reduced in microgravity.

Upon reaching orbit, the crew will activate the APCF, monitor the facility as it operates and deactivate the equipment prior to re-entry. After the mission, investigators will study approximately 5,000 video images to determine why and how crystal formation occurs. The space- grown crystals will be analyzed to determine their internal molecular arrangement. As X-rays diffract off the atoms of the space-grown crystals, a computer will map each atom's position.

Advanced Protein Crystallization Facility on the Life and Microgravity Sciences Mission
Dr. Alexander McPherson, University of California, Riverside,

The experiment team will work from remote sites and will be linked by teleconferencing instead of being based at a centralized facility. This foreshadows the way experiments will be conducted during the International Space Station era.

This investigation provides a particularly valuable opportunity because a large variety of experiments covering a broad range of samples and conditions can be conducted simultaneously. These experiments will contribute to better understanding of crystal growth on Earth and to the ability to define that process in conventional laboratories, possibly accelerating important advances in biotechnology, medicine, agriculture and industry. This experiment will grow a variety of protein and virus crystals. While protein samples will be included among the samples, the emphasis will be on viruses.

Crystallization of EGFR-EGF
Dr. Christian Betzel, European Molecular Biology Laboratory, Hamburg, Germany

The receptor for the epidermal growth factor is an important predictor for a series of human diseases. Knowledge of the three-dimensional shape of this molecule could open the possibility of tailoring appropriate drugs for the treatment of numerous types of tumors.

Crystallization of Crustacyanin Subunits
Dr. Naomi Chayen, Imperial College, London, United Kingdom

Crustacyanin is a member of the lipocalin protein group, which binds to certain pigments found in many plants and animals. Knowledge of the structure of the lipocalins will enable scientists to engineer proteins that will bind more strongly to pigments with anti-cancer properties.

Crystallization of Engineered 5S rRNA Molecules
Dr. Volker Erdmann, Free University of Berlin, Germany

The ribonucleic acid (RNA) 5S rRNA interacts with a number of proteins in cells and is essential for the biological activity in the part of the cell that produces proteins. Performed with intact and active RNA molecules, it will increase knowledge about the effects of microgravity on the crystallization of biological molecules.

Crystallization of Thermus Thermophilus AspRS
Dr. Richard Giege, National Center for Scientific Research, Strasbourg, France

Ground-based investigations have successfully crystallized two tRNA proteins. The crystal quality of the first protein complex, however, is inferior to that of one with natural rRNA. On the LMS mission, researchers will grow these crystals in dialysis cells to obtain higher resolution X-ray data than is obtainable in ground-based laboratories.

Monitoring of Lysozyme Protein Crystal Growth in Microgravity via a Mach-Zehnder Interferometer and Comparison with Earth Control Data
Dr. John Helliwell, University of Manchester, United Kingdom

Essentially perfect lysozyme crystals grown on earlier missions were three times more uniform than Earth-grown samples. Investigators want to determine the best duration of a microgravity mission for protein crystallization.

Crystallization of the Nucleosome Core Particle in Space
Dr. Timothy Richmond, Swiss Federal Institute of Technology, Zurich, Switzerland

The nucleosome core particle is the larger part of the nucleosome, part of the complex forming the major portion of the core material in cells that have a definite center. On LMS, scientists hope to obtain crystals with high uniformity that will allow more precise data collection.

Enhanced Resolution Through Improved Crystal Quality in the Crystal Structure Analysis of Photosystem I
Dr. Wolf Schubert, Free University of Berlin, Germany

In photosynthesis, the proteins Photosystem I and Photosystem II are responsible for the main conversion of visible light into chemical energy. This experiment will reveal details of the complete arrangement of chlorophyll molecules, which efficiently perform this conversion process.

Mechanism of Membrane Protein Crystal Growth: Bacteriorhodopsin -- *Mixed Micelle Packing at the Consolution Boundary, Stabilized in Microgravity*
Dr. Gottfried Wagner, University of Giessen, Germany

Bacteriorhodopsin converts light into voltage in the skins of light-sustained microorganisms, which are chemically and genetically different from bacteria and higher life forms. Resolution of the three-dimensional shape of this protein will help scientists understand the processes used to convert light to growth energy.

Crystallization in a Microgravity Environment on CcdB, a Protein Involved in the Control of Cell Death
Dr. Lode Wyns, Free University of Brussels, Belgium

Better understanding of the shape and behavior of the CcdB protein may lead to the design of new antibiotics and anti-tumor drugs. Specifically, crystal quality needs to be improved. On STS-78, researchers want to crystallize three specific samples that are large enough for data collection.

Crystallization of Sulfolobus Solfataricus Alcohol Dehydrogenase
Dr. Adrian Zagari, University of Naples, Italy

Alcohol dehydrogenase (ADH) is found in large amounts in the livers of mammals and plays an important part in several functions, including the breakdown of alcohol. Mammalian ADH is unsuitable at high temperatures. This limits its application to the making of organic compounds. ADH from certain bacteria that grow in high temperatures has greater stability, however, and is less affected by high temperatures. This substance is a good candidate for industrial applications.

Growth of Lysozyme Crystals at Low Nucleation Density
Dr. Juan Garcia-Ruiz, University of Granada, Spain

This experiment will use a new approach to lysozyme crystallization to evaluate the usefulness of ground-based experiments in predicting growth behavior under microgravity conditions. It also will test the accuracy of computer simulations of one-dimensional cells developed in terrestrial laboratories.

Accelerometers -- Characterizing the Microgravity Environment

Space Acceleration Measurement System (SAMS)
Ron Sicker, Project Manager, NASA Lewis Research Center, Cleveland, OH
Orbital Acceleration Research Experiment (OARE)
Bill Wagar, Project Manager, NASA Lewis Research Center, Cleveland, OH
Microgravity Measurement Assembly (MMA)
Maurizio Nati, Project Manager, European Space Agency/European Space Research and Technology Center, Noordwijk, The Netherlands

Microgravity science investigations require a stable, low-gravity environment to yield the most accurate data. Vibrations caused by crew activity and by the operation of thrusters, fans and cameras in the orbiter can impact the quality of research. LMS includes three instruments to measure the microgravity environment. By analyzing types of microgravity disturbances, researchers can assess the influence of Shuttle accelerations and other disturbances on scientific experiments.

The Space Acceleration Measurement System (SAMS) measures high-frequency accelerations such as Shuttle thruster firings. Several materials and fluid science experiments are particularly sensitive to accelerations in the frequency ranges that SAMS will record.

As the Shuttle travels at 17,500 miles per hour, it slows down slightly due to atmospheric friction. Also, friction varies as atmosphere density changes from day to night and with altitude. The Orbital Acceleration Research Experiment (OARE) makes extremely accurate measurements of low-frequency changes in accelerations and vibrations experienced during on-orbit operations

The Microgravity Measurement Assembly (MMA) facility determines both high- and low-frequency spacecraft disturbances. This onboard system provides a network of sensors at selected locations inside the Spacelab module and integrates the output of experiment-dedicated and remote sensors into an unified data set.

STS-78 MISSION MANAGEMENT

The Life and Microgravity Spacelab mission is directed by Program Manager David Jarrett; Life Sciences Program Scientist Dr. Victor Schneider; Microgravity Program Scientist Dr. Bradley Carpenter and Life Sciences Instrument Program Manager Angie Jackman, all of NASA Headquarters, Washington, DC. Responsible for Mission Management at the Marshall Space Flight Center in Huntsville, AL are Mission Manager Mark Boudreaux and Mission Scientist Dr. James Patton Downey. Life Science Project Scientist is Dr. Mel Buderer from the Johnson Space Center, Houston, TX. Flight Manager is Mr. Denny Holt, also from Johnson.

STS-78 CREWMEMBERS

STS078-S-002 **--** *These seven crew members will spend 16 days aboard the space shuttle Columbia, scheduled for launch in early summer 1996. Seated are astronauts Terrence T. (Tom) Henricks (left), mission commander, and Kevin R. Kregel, pilot. Standing, from the left, are payload specialist Jean-Jacques Favier, along with astronauts Richard M. Linnehan, Susan J. helms and Charles E. Brady, Jr., all mission specialists; and payload specialist Robert B. Thirsk. Favier is with the French Atomic Energy Commission (FAEC) and represents the French Space Agency (CNES). Thirsk is with the Canadian Space Agency (CSA). The twentieth flight of the space shuttle Columbia will be devoted to the Life and Microgravity Spacelab payload.*

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

Terence T. "Tom" Henricks (Colonel, USAF) will serve as Commander for STS-78. Henricks was born July 5, 1952, in Bryan, Ohio, but considers Woodville, Ohio, to be his hometown. He graduated from Woodmore High School in 1970, a bachelor of science degree in civil engineering from the United States Air Force (USAF) Academy in 1974, and a masters degree in public administration from Golden Gate University in 1982.

Henricks was selected by NASA in June 1985 and became an astronaut in July 1986. A veteran of three space flights, Henricks has logged over 620 hours in space. He was the pilot on STS-44 in 1991, and STS-55 in 1993, and was the spacecraft commander on STS-70 in 1995.

Kevin R. Kregel will serve as the Pilot for Mission STS-78. Kregel was born September 16, 1956 and grew up in Amityville, New York. He graduated from Amityville Memorial High School, Amityville, New York, in 1974, a bachelor of science degree in astronautical engineering from the U.S. Air Force Academy in 1978 and a master's degree in public administration from Troy State University in 1988.

Kregel was selected by NASA in March 1992. He was the pilot on STS-70 in 1995, and has logged over 214 hours in space.

Richard M. Linnehan (DVM) will serve as Mission Specialist-1 on the STS-78 mission. Linnehan was born September 19, 1957, in Lowell, Massachusetts. He graduated from Pelham High School, Pelham, New Hampshire in 1975, received a bachelor of science degree in animal sciences with a minor in microbiology from the University of New Hampshire in 1980 and the degree of Doctor of Veterinary Medicine from the Ohio State University College of Veterinary Medicine in 1985.

Linnehan was selected by NASA in March 1992. He completed his one year of training to be qualified for assignment as a mission specialist in on a future Space Shuttle flight crews in 1993. STS-78 will be Linnehan's first space flight. 26

Susan J. Helms (Lieutenant Colonel, USAF) is the Payload Commander for STS-78 and is also Mission Specialist- 2. Helms was born February 26, 1958, in Charlotte, North Carolina, but considers Portland, Oregon, to be her hometown. She graduated from Parkrose Senior High School, Portland, Oregon, in 1976, received a bachelor of science degree in aeronautical engineering from the U.S. Air Force Academy in 1980 and a master of science degree in aeronautics/astronautics from Stanford University in 1985.

Helms was selected by NASA in January 1990 and became an astronaut in July 1991. She has flown as a mission specialists on two Shuttle flights - STS-54 in January 1993 and STS-64 in September 1994. In completing her two missions, Helms has logged a total of 406 hours in space.

Charles E. Brady Jr. (Commander, USN) will serve as Mission Specialist-3 on the STS-78 mission. Brady was born August 12, 1951, in Pinehurst, North Carolina, but considers Robbins, North Carolina, to be his hometown. He graduated from North Moore High School, Robbins, North Carolina, in 1969, was pre-med at University of North Carolina at Chapel Hill, 1969-1971 and received a doctorate in medicine from Duke University in 1975.

Brady was selected by NASA in March 1992 and qualified for selection as a mission specialist on future Space Shuttle flight crews in 1993. In May 1995 he was assigned as a mission specialist for the LMS mission. STS-78 will be Brady's first space flight.

BIOGRAPHICAL DATA

Jean-Jacques Favier (Ph.D.) will serve as Payload Specialist-1 on the STS-78 mission. Favier was born April 13, 1949, in Kehl, Germany. He attended primary and secondary schools in Strasbourg, France, received an engineering degree from the National Polytechnical Institute of Grenoble in 1971 and a Ph.D. in engineering from the Mining School of Paris and a Ph.D. in metallurgy and physics from the University of Grenoble in 1977.

Favier has been a CNES payload specialist candidate since 1985. He was assigned as an alternate payload specialist on Mission STS-65, the second International Microgravity Laboratory mission that flew in July 1994. In May 1995 was assigned as a payload specialist for the STS-78 LMS mission. This will be Favier's first space flight.

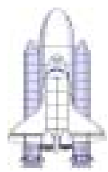
Robert (Bob) Brent Thirsk (M.D., P. Eng.) will serve as Payload Specialist-2 on the STS-78 mission. Thirsk was born August 17, 1953 in New Westminster, British Columbia. He attended primary and secondary schools in British Columbia, Alberta, and Manitoba, received a bachelor of science degree in mechanical engineering from the University of Calgary in 1976, a master of science degree in mechanical engineering from the Massachusetts Institute of Technology (MIT) in 1978 and a doctorate of medicine degree from McGill University in 1982.

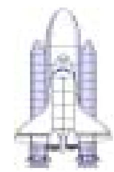
Thirsk was one of the six Canadian astronauts selected in December 1983 and served as back up Payload Specialist to Marc Garneau for Mission 41-G in October 1984. In April 1995, Dr. Thirsk was selected to participate in the Life and Microgravity Spacelab mission. STS-78 will be Thirsk's first space flight.

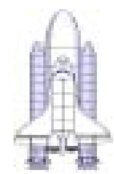
For complete biographical information on NASA astronauts, see the NASA Internet astronaut biography home page at address: http://www.jsc.nasa.gov/Bios/.

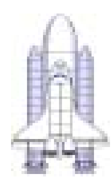
SHUTTLE FLIGHTS AS OF JUNE 1996

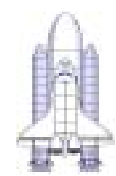
77 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 52 SINCE RETURN TO FLIGHT











OV-102 **Columbia** **(19 flights)**	**OV-099** **Challenger** **(10 flights)**	**OV-103** **Discovery** **(21 flights)**	**OV-104** **Atlantis** **(16 flights)**	**OV-105** **Endeavour** **(11 flights)**
		STS-70 07/13/95 - 07/22/95		
		STS-63 02/03/95 - 02/11/95		
STS-75 02/22/96 - 03/09/96		STS-64 09/09/94 - 09/20/94		
STS-73 10/20/95 - 11/05/95		STS-60 02/03/94 - -2/11/94		
STS-65 07/08/94 0 07/23/94		STS-51 09/12/93 - 09/22/93		
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93	STS-76 03/22/96 - 03/31/96	
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92	STS-74 11/12/95 - 11/20/95	
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92	STS-71 06/27/95 - 07/07/95	
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91	STS-66 11/03/94 - 11/14/94	
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	STS-77 05/19/96 - 05/29/96
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	STS-72 01/11/96 - 11/20/96
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	STS-69 09/07/95 - 09/18/95
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	STS-67 03/02/95 - 03/18/95
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 – 04/20/94
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	STS-57 06/21/93 - 07/01/93
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92