NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE

AIRLIFT MISSION—LOADMASTERS AND CARGO

Students will learn about the history of airlift missions (both humanitarian and combat) as well as to learn about the position of Air Force Loadmaster, and about basic cargo aircraft load planning. The U. S. Air Force's Global Reach is emphasized!

LESSON PLAN (F)

Learning Objectives

The students will

- Learn about the important role played by the Aircraft Loadmaster, and how the position actually evolved
- Learn about the basic considerations of cargo aircraft load planning, as it pertains to the C-5 "Galaxy," the C-17 "Globemaster III," the C-130 "Hercules," etc.
- Learn about the correlation between fulcrum/weight/ arm/moment, and how it relates to an aircraft and cargo
- Learn about the history of both humanitarian and combat airlift missions around the world
- Learn about the variety of cargo and refueling aircraft which have been used throughout recent history
- Learn about the U. S. Air Force's successful development of "Global Reach and Global Power"

Introduction/Background

Airlift and transport missions were not a real priority during the early years of flight, primarily because the small aircraft at the time were not conducive to large cargo loads or multi-passenger movement. As airplanes developed and their size and capacity increased, airlift operations became a reality. The very first successful airlift was accomplished by Germany in 1936, when they transported 20,000 stranded Spanish troops across the Strait of Gibraltar and on to Seville, Spain. It took the Germans 677 flights (sorties) using their modified Junkers Ju.52 trimotor aircraft. After hearing the news of this successful, initial airlift, other countries began developing their own cargo/transport Aircraft. The British utilized transport-bombers, such as Their Vickers Victoria airplane. The United States developed transports that were actually Douglas DC-3 and Douglas DC-4 commercial airliners, and with modifications, these two aircraft became C-47 "Skytrains" and C-54 "Skymasters," respectively. The conversions included removing the airliner interiors, adding heavier floors and creating large cargo doors. C-47s were affectionately called "Gooney Birds," and the Army Air Corps first ordered these cargo airplanes in 1940. By the end of World War II, over 9,300 "Skytrains" had been procured. C-54 "Skymasters" could carry much heavier loads than the C-47s (28,000 pounds of cargo versus 6,000 pounds) and the U. S. military (the Army Air Corps and Navy) began using C-54s in 1942.

Grade Level: 4—6

National Science Education Standards:
Science as Inquiry, Science and Technology, Physical Science, Science in Personal and Social Perspectives and History and Nature of Science

National Standards for History:
Chronological Thinking and Historical Comprehension

National Standards for Mathematics:
Data Analysis and Probability, Problem Solving, Communication, Measurement and Geometry

Materials Required:

- Magic board and markers
- PowerPoint presentation
- Laptop, monitor, digital projector
- Demo items as listed within lesson plan

Resources:

- General Information:

http://www.amc.af.mil/library/factsheets/factsheet.asp?id=229 and id=239 and http://www.centennialofflight.gov/essay/Air_Power/cargo/AP19.htm and http://www.futurefirepower.com/us-air-force-airlift-global-us-military-aircraft and http://www.theaviationzone.com/factsheets/c5.asp (and c17.asp and c130.asp) and www.konnections.com/airlift/berlin.htm and www.caa.govt.nz and http://www.grc.nasa.gov/WWW/k-12/WindTunnel/Activities/balance_of_forces.html and http://avstop.com/technical/weightbal.htm and http://www.dod.mil/execsec/adr96/airforce_report.html and http://www.af.mil/information/factsheets/index.asp and http://www.Airforce.com/learn-about/history/part4/ and http://www.answers.com/topic/air-mobility-command and http://www.grc.nasa.gov/WWW/K-12/airplane/acg.html and www.nationalmuseum.af.mil/education

From 1942 through 1947, the Army Air Corps procured 1,164 C-54 "Skymasters." Special Note: the U. S. Air Force was not a separate branch of the U. S. military until 1947. However, from its very beginnings as a distinct entity, the Air Force has NOT just used its airlift capabilities to transport combat troops and supplies into, and out of, theaters of war (as exemplified by Operation Desert Storm, one of the largest strategic airlifts since World War II). Humanitarian airlift efforts have always been a key component and top priority for the Air Force, and these missions have made an extremely positive impact on the lives of countless individuals around the world. For example, in June 1948, when the Air Force was still in its infancy, the Soviet Union decided to block all roads, railways and rivers going into the city of Berlin (which was still in ruins after World War II). They cut all power as well, so the 2.5 million inhabitants of West Berlin faced certain starvation. There were, however, three narrow air corridors left open, as the Soviets thought the Allies' airlift capabilities would be negligible. The United States, Britain and France agreed to join forces to keep West Berliners supplied with coal and food, and above all, to keep them free from Soviet rule. The Berlin Airlift, nicknamed "Operation Vittles'" lasted for fifteen straight months, and nearly 2.3 million tons of supplies (4.6 billion pounds) were flown into Berlin during 277,000 flights (there was one flight every three minutes)! The workhorses for this incredible humanitarian airlift were C-47s and C-54s, and that is what makes this whole airlift operation so amazing—none of the gigantic cargo aircraft of today, such as the C-17 "Globemaster III," the C-5 "Galaxy" and the C-130 "Hercules," were in existence! More recently, the Air Force has been heavily involved in global humanitarian airlift missions, which provide relief and assistance to victims of civil war, famine, floods, earthquakes, wildfires, harsh winter weather, etc. Some of the countries that have benefitted from these humanitarian operations include Somalia, Bosnia, Kosovo, Greece, Peru, Ecuador, Venezuela, the former Soviet Republics, Rumania, Rwanda, Iraq, Turkey, Mozambique, Madagascar, Pakistan, India, Japan, Haiti, Honduras, El Salvador, Nicaragua, Afghanistan and Indonesia! Some of our states that have benefitted from the Air Force's humanitarian efforts include Oklahoma, Kansas, South Dakota, Louisiana, Hawaii, California and Florida. In 1992, the Military Transport Service (airlift division) merged with Strategic Air Command's refueling operations to form the Air Mobility Command (AMC). AMC is a major command which is headquartered at Scott Air Force Base in Illinois, and it provides worldwide cargo and passenger delivery, air refueling and aeromedical evacuation. It is also the command which is the focal point for all Air Force humanitarian airlift operations. With regard to air refueling operations, the two primary aircraft that allow the Air Force to have such amazing "Global Reach" are the KC-135 "Stratotanker" and the KC-10 "Extender." They extend the range of our tactical fighters and strategic bombers during overseas operations, and they also provide refueling support to the Navy, the Marine Corps and many aircraft of our allied nations. Not only do these aircraft play a key role in the mobilization of our military assets, they are also capable of transporting litter and ambulatory patients utilizing patient support pallets during aeromedical evacuations! Regarding modern cargo aircraft, such as the C-17 and the C-5, their inherent performance and flexibility greatly improve the ability of the Air Force's 'total airlift system' to fulfill its global air mobility requirements. These requirements have increased significantly, since the size and weight of U. S. mechanized firepower and equipment have grown in response to the improved capabilities of our potential adversaries. Finally, the ultimate measure of airlift efficacy is the ability to rapidly project and sustain an effective combat force in close proximity to a potential theater of war. Most assuredly, the U. S. Air Force has that ability! And, its proficiency in providing humanitarian aid is beyond repute!

Procedures:

NOTE: Teachers may use as much of the information contained within the "Intro/Background" section as they deem appropriate for their students; similarly, teachers may wish to pick and choose items within this "Procedures" section. Teachers may wish to cover the role and history of the Aircraft Loadmaster one day, then cover the basic considerations of cargo aircraft load planning on a different day (including fulcrum, weight, arm and moment). Background PowerPoint is at http://www.nationalmuseum.af.mil/shared/media/document/AFD-121218-021.pdf.

- Write (on board) the things that will be covered/discussed/reviewed in class, including: the development and role of the Aircraft Loadmaster, basic considerations of cargo aircraft load planning, the history of airlift operations, the types of aircraft used for airlift missions and a PowerPoint presentation.
- Hook: set up a small teeter-totter model at the front of the classroom (a board with a brick or box under the center) or you could simply balance a ruler on your finger! Ask students if they can recall when they played on a teeter totter with a larger student, and ask them what happened when that larger person was on the seat opposite them—they would stay up in the air until the classmate with more weight got out of their seat! Demonstrate this—place a small object on one end of your teeter totter facsimile and a larger, heavier one on the other side. Tell them that, if you move the heavier weight closer to the center, balance can be achieved!

Procedures (continued)

- Tell the class that ALL problems related to the weight, balance and center of gravity of an aircraft and its cargo are based upon this very elementary physical law of the lever!
- You may also wish to draw a teeter totter on the board to further illustrate the relationship between a fulcrum and weights—and at this point you may wish to introduce the concept of 'arm and moment.' Write '0' above the teeter totter's fulcrum/center point and tell the class that anything on this part of the teeter totter is at the zero point, and any distance measured in either direction is called an 'arm!' Tell them that a 'moment' (or a 'torque') is the force pushing down on both ends of the teeter totter!
- You may wish to delve a bit more deeply into this subject at a later time by referring to Lesson Plan 'D.'
- Tell the students that the development of the Aircraft Loadmaster position is rather interesting and unique. As a matter of fact, this entire career field evolved due to the unique needs and requirements of airlift operations! During World War II, as large-scale airlift missions became common-place, the need for someone to load and unload cargo correctly, figure out weight and balance, perform airdrops properly and supervise passengers and troops became very evident.
- Tell the class that each of these duties is an important safety issue! The weight/balance officers, cargo-loading officers, flight traffic clerks, kickers and pushers (described later) were all filling important roles in the early years of the airlift system, and they all helped to develop the aircraft loadmaster position of today.
- During World War II, current loadmaster responsibilities were divided between a variety of specialties, both officer and enlisted, without any uniformity or standardization between units. Quite often, whoever was available for duty pitched in to assist with the loading of aircraft. Airdrop missions produced another name for enlisted personnel in the rear of a cargo airplane. An experimental airdropping detail was created, which established the very first 'kicking detail,' and this group consisted of three or four enlisted personnel who pushed cargo from the aircraft (kickers and pushers were terms used interchangeably).
- Tell the students that, in 1947, Army Air Force Manual 35-1 listed a position description for Flight Traffic Clerk, and it was quite similar to the present loadmaster position description, sans airdrop duties. It outlined responsibilities including loading/unloading cargo, tie-down, passenger safety, control of traffic and customs documentation and jettison procedures. In 1951, the Flight Traffic Clerk position was replaced by the Air Force Senior Flight Steward, and in 1953, the Aircraft Loadmaster and Aircraft Loadmaster Technician job descriptions appeared in Air Force Manual 35-1.
- Between 1975 and 1993, the loadmaster position description was further revised, and it emerged more clearly defined as a true cargo aircraft crewmember. Even as you relate these facts to your students, Aircraft Loadmasters are flying around the globe, maintaining the Air Force's global reach and global power!
- Prior to class, write the various tasks handled by an Aircraft Loadmaster on 3 x 5 index cards.
- Have each student pick a card; call on individual students and have them come to the front of the classroom and read the duty written on their card to the class—you may wish to write abbreviated versions on the board (feel free to lead a mini-discussion regarding any of the loadmaster's tasks)…..
- Loadmaster responsibilities include: performs preflight checklist of aircraft/aircraft systems; accomplishes post-flight checklist of aircraft/aircraft systems; receives cargo/passenger load briefings; checks placement of cargo/passengers against aircraft's actual limitations; determines adequacy of cargo documentation; plans loading of both cargo and passengers; supervises cargo/passenger loading and offloading; determines cargo placement and restraint requirements; directs and checks placement of cargo restraint equipment; computes aircraft weight and balance; demonstrates use of life support equipment; accomplishes passenger comfort activities during flight; performs the airdrop of personnel, equipment and supplies; completes required aircraft forms documentation; completes border clearance requirements; possesses knowledge about types, capacities and configuration of various cargo aircraft; possesses knowledge about in-flight emergency procedures and equipment; interprets loading charts, diagrams and technical publications; operates cargo loading equipment; knows principles of dispensing and preserving food aboard cargo aircraft; complies with all safety directives applicable to air transport of cargo; computes p.s.i. and shoring requirements; completes aircraft weight and balance records; verifies DOT classification/markings/safety precautions for all hazardous materials; completes cargo aircraft load distribution records; performs scanning duties to detect problems with the aircraft or cargo during both ground and flight operations…..AND Aircraft Loadmasters get to travel to countries all over the world, many times assisting with life-changing humanitarian aid!
- Utilizing the PowerPoint presentation referenced on page 1, show the class a slide of the C-5 "Galaxy," the C-17 "Globemaster III," the C-130 "Hercules" and the C-141 "Starlifter."

Procedures (continued)

- Create a large, rectangular outline on the floor using tape or string. The outline must be 88 inches by 108 inches.
- Have all students stand within the perimeter of this large rectangle, and tell them that this size and shape represents a 463L pallet, which is the main air cargo pallet used by the Air Force, and the "crown jewel" of the U. S. military's Material Handling Support System. Tell them that it is specifically designed for palletizing and transporting air cargo on roller-type conveyors in terminals, restraint rails and roller conveyors inside cargo aircraft, and on cargo loading/uploading systems on ground vehicles. The 463Ls are made of aluminum with a soft wood or fiberglass core and framed on all sides by aluminum rails.
- You may also wish to draw the shape on the board, notating the 88 inch by 108 inch outline. Tell the class that these pallets are 2.25 inches thick, and they weigh 290 pounds empty—ask the students how much weight they think one of the 463Ls can hold safely (the answer: 10,000 pounds)!
- Write these aircraft designations across the top of the board and underline them: C-5, C-17, C-130 and C-141.
- Regarding the C-5, tell the students that the interior cargo floor of this gigantic airplane is 121 feet long (one foot longer than the Wright brothers' first flight)! Ask them how many 463L pallets they think will fit on the C-5s cargo floor (answer: 36…..write this number under the C-5 heading on the board).
- Regarding the C-17, tell the class that this cargo airplane is not as large as the C-5, but it is much more flexible and it is a more modern aircraft. Ask them how many pallets they think will fit in a C-17. Write 18 on the board and tell the students that a combination of pallets and vehicles can be loaded and carried together when needed!
- Regarding the C-130, tell the students that this aircraft has been used by the Air Force for more than fifty years, but it is still extremely useful! Its cargo compartment can carry over 42,000 pounds (five 463Ls and a ramp pallet for baggage will fit into a C-130). Write 5 + on the board.
- Regarding the C-141, tell the class that this airplane can hold thirteen 463Ls (although fewer pallets combined with other cargo may also be airlifted). Write 13 on the board.
- Tell the class that there are three types of airdrops (aerial delivery of cargo): a) parachutes pull the cargo (up to 42,000 pounds) from the aircraft; when the load is clear of the airplane, cargo parachutes deploy and lower it to the ground; b) the Container Delivery System (CDS) uses the force of gravity to pull from one to 16 bundles of supplies from the airplane. The bundles can weigh up to 2,200 pounds each and when they leave the aircraft, parachutes lower them to the ground; c) LAPES delivery method. Up to 38,000 pounds of cargo is pulled from the airplane by huge cargo parachutes (while the aircraft is only five to ten feet above the ground). The load then slides to a stop after traveling a short distance!
- Teachers may wish to use the instructions found on page 5of this lesson plan to assist students in building a simple parachute. It is a fun activity and it helps to tie the whole lesson plan together!

Assessment/Evaluation

The students should be evaluated on their class participation, listening skills and ability to follow verbal instructions, especially when they are involved in participatory activities, class discussions and parachute building.

References

The C-47: Flying Workhorse of WWII by Richard D Harvey; Bloomington, IN: Author House; 2005

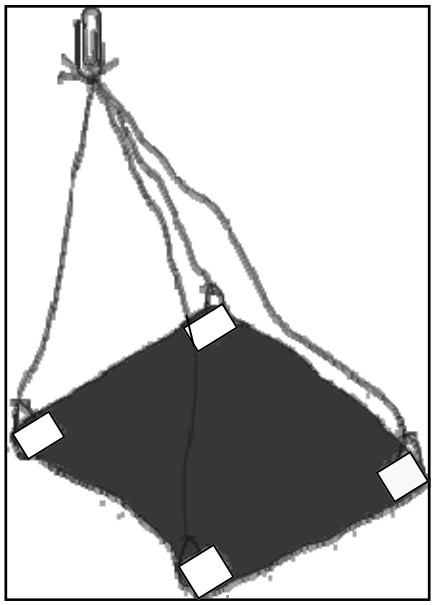
C-54-PLM Revisited by Ralph L. Stevenson, Jr; Sante Fe, NM: Sunstone Press; 2010

Humanitarian Airlift Operations by Daniel L. Haulman; Washington, DC: U. S. Printing Office; 1998

The Lockheed Martin c-130 Hercules by Peter C. Smith; Manchester, England: Crecy Publishing Ltd.; 2010

The "C" Planes: U. S. Cargo Aircraft 1925 to Present by Bill Holder & Scott Vadnais; Atglen, PA: Schiffer Publishing Ltd.; 1996

The Boeing C-135 Series: Stratotanker, Stratolifter and other Variants by Don Logan; Atglen, PA: Schiffer Publishing Ltd.; 1998



Make sure each student has the following:

- One paper napkin
- Four sections of string, each 12 inches in length (you may wish to pre-cut the string before class, or you may opt to have your students cut their own sections of foot-long string using a ruler as a guide)
- Four small labels or pieces of Scotch tape for securing the strings to the napkin
- One jumbo paper clip (if you decide to have the class perform steps 9 through 11 below, each student will require three large paper clips)

Making the parachute:

1. Open the napkin completely
2. Place a section of string on one of the corners, so that the end extends onto the napkin about half an inch
3. Secure the string to the corner with the label or tape (hint: it will stay in place better if you curve the end of the string a bit before securing)
4. Repeat with the other three sides of the napkin
5. Carefully gather the four string ends, and ensure that they are of equal length by lifting the napkin slightly off of the work surface (a balanced, symmetric parachute always flies/descends better)
6. Thread the four string ends through a large paperclip and tie them into a single knot
7. Have the students stand by their desks and have them test-drop their parachutes
8. If there is a location with a balcony or other elevated area, you may wish to have your students individually test their parachutes under your direct supervision (make sure there are no persons in the proximity of the drop zone, etc.)
9. You may wish to have students drop their parachutes a second and a third time, with an additional paperclip added for more weight/mass each time
10. You may wish to have your students observe and record descent times during the first, second and third drops of their parachutes
11. A simple chart to record data might include: student's name, drop number and time aloft
12. Have students discuss what happens (and why) when more weight is added to their parachute

SPECIAL NOTE: This activity was originally published in the 1997 edition of Project SOAR: Science in Ohio through Aerospace Resources Curriculum Guide!