Pictures in the Mind
NASA Langley Research Center
75th Anniversary Video

submitted by

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NARRATOR: The machines of flight. Each began as an idea, a dream, a "picture in the mind". For the picture to become real, ideas must take shape as concepts, which can be tested and verified.

This is Langley, where dreams become reality. Once an historic plantation and now NASA's Langley Research Center, this is where engineers solve the problems of flight. Where lessons of the past provide solutions for the future. Where pictures in the mind become the aircraft and spacecraft of tomorrow.

TITLE Pictures in the Mind animation

Music transition to period music #1

NARRATOR: They were dreamers too. In December, 1903, Orville and Wilbur Wright were building a machine in the hopes it would fly. It did, at a speed of just over seven miles an hour. At first, the world took little notice. The Wrights were persistent. They demonstrated that their "Flyer" had command of the air. European military planners paid attention. On the eve of the Great War, Europe's combatants counted thousands of military aircraft. The US had twenty-three.

WW I

Battle SFX

Armed combat quickened the pulse of technology. In 1914, trouble in the Balkans flared into the bloodbath of World War I. Flying machines were produced in great number, although those early airplanes were dangerous to fly. The war spurred America to action. In 1915, Congress created the National Advisory Committee for Aeronautics.

HANSEN: 067-(000140) What WW I did was take aviation out of the hands of the tinkerers and the sportsmen and really created an industry for the first time. Created an infrastructure for aviation, and the National Advisory Committee for Aeronautics, the NACA, was, proved to be a vital cog in that infrastructure after the war ended.

NARRATOR: The NACA established a research laboratory on the Virginia Peninsula, near Hampton. Built on the site of George

Wythe's plantation, this new lab was named for Samuel Pierpont Langley, a pioneer of manned flight. The young, untried staff of the new Langley Memorial Aeronautical Laboratory began work on its first wind tunnel.

graphic

The wind tunnel is the fundamental tool for understanding flight. It's an enclosed passageway in which air is driven through a "test section", where a model or part is mounted for testing. How the model behaves in the stream of onrushing air is measured using precision instruments.

Early problems and solutions

Transition music

HANSEN: 067-(756) Because the first and second generation of Langley researchers were so young and inexperienced, they just did not know that there were lots of things that couldn't be done, so they went ahead and did them anyway. (808)

NARRATOR: That sort of enthusiasm and drive was needed to conquer the early problems of flight. There was much to learn. As Langley's engineers compared their wind tunnel data to that from flight tests, they noted a nagging difference.The difference was one of "scale effects". Wind tunnels of the day operated at normal air pressure. An airflow parameter called the Reynolds number was too low on the tunnel tests with scale models.

VDWT

In June of 1921, Langley's Max Munk proposed building a wind tunnel in which air pressures could be varied. In 1922, Langley drew upon Newport News Shipbuilding's boilerplate expertise to build the pressure vessel for the Variable-Density Tunnel. Researchers could pressurize air up to 20 atmospheres while measuring its flow over small models, to minimize the problems of scale effects.

BAALS: 073- (065337) It was the premier wind tunnel throughout the world. Nobody else had duplicated that facility. So we went from the old five foot diameter wind tunnel at atmospheric pressure to a new facility now that could give us valid wind tunnel data at full-scale Reynolds

numbers. So we--Langley-- provided the airfoils for the whole world to use from that time period. (065418)

NARRATOR: Testing in the Variable Density Tunnel resulted in a report that detailed lift and drag curves for 78 different airfoils, or wing cross-sections. And it gained Langley worldwide recognition.

Impacts and refinements made

Langley played host to its first Aircraft Engineering Conference in 1926. This informal affair would quickly become an annual rite of spring for the leading lights of aeronautics.

NACA Cowling

At the 1927 conference, the Navy defined a problem: Could a covering, or cowling, be designed to fit around the cylinders of the radial aircraft engines then in widespread use?

Weick: (02;20;40) The Navy was sponsoring the development of radial air-cooled engines at the time. And these engines with the cylinders

sticking out in all directions had a great deal of drag or resistance.

Fred Weick led a team that designed and tested ten experimental cowlings in the new Propeller Research Tunnel.

Weick: (02;23;22) It became apparent that the worst part of the drag was probably caused by the very tips of those uh cylinders and valve gear that were sticking out there, and so we got the idea of enclosing the //cylinder// entirely in a cowling.

Weick's team systematically varied elements of the design to cool the engine while maintaining a streamlined shape. The final product, "NACA Cowling Number 10," caused a sensation.

In 1929, a Lockheed Vega equipped with the new cowling flew nonstop from Los Angeles to New York, setting a coast-to-coast speed record. Several months later, Langley was awarded its first Collier Trophy for excellence in aeronautical research.

HANSEN: 067-(1128) and what this showed to the American aircraft industry was that a place like Langley really knew its airplanes, knew its airflows, and that if you applied the experimental findings intelligently to particular types of airplanes, that you would have a much better airplane than what you started out with. (1148)

Other Improvements

Music change

NARRATOR: In the late 20s and early 30s, a new type of airplane emerged from technology created at Langley. Wood and fabric were replaced by metal. The double wing gave way to a single, internally-braced wing. Engines were lighter, more powerful, covered by a cowling, and moved forward on the wing.

Douglas DC-3

The Douglas DC-3 transport epitomized the design revolution of the '30s. Large enough for 21 passengers, it was durable, stable, and fast enough to be profitable. As the airplane changed, Langley changed with it by adding new facilities. The Full-Scale Tunnel, the Towing Tank, spin tunnels. Langley began its study of vertical flight with helicopters and autogiros. And researchers like John Stack and Eastman Jacobs were beginning to investigate phenomena near the speed of sound.

In response to the growth of the industry, NACA created new labs: Ames, Lewis, Dryden. Langley provided talent and leadership to each. Helping to maintained a reputation for excellence were Langley's cadre of modelmakers, wind tunnel technicians, and the so-called "human computers".

BAALS: 072-(061412) Well the technical staff was really the secret weapon we had at Langley. We were completely self-sufficient. We could design the wind tunnel at Langley, if need be we could build the components that were difficult to manufacture, //The work was all done in house.

NARRATOR: By the mid-1930s the wind tunnels of Langley had helped transform “wire and rag” biplanes into sleek, all-metal monoplanes. By 1940, a new war would provide the impetus for the airplane's next evolutionary leap

WW II and drag cleanup

War footage/SFX

Music change

NARRATOR: War meant that Langley made the improvement of military aircraft the first priority. The Germans and Japanese threatened to dominate the skies. Allied airplanes had to be equally agile and fast. One way to accomplish this was to streamline the surface of the aircraft as much as possible to reduce drag, or resistance to airflow. Less drag meant more speed, better fuel economy, and an extra edge for survival in the air. The wartime business of the Langley Lab would be "drag cleanup," as it was called, for a substantial portion of the American fleet.

Sound barrier

Music change

NARRATOR: World War II ignited the explosion of technology that gave us the word "aerospace". Jet aircraft, atomic weapons, radar, and rockets were all products of war.

Langley engineers were now among the first to explore the high-speed frontier called the "sound barrier."

graphic

In the 19th century, physicist Ernst Mach recognized that a moving object causes waves of air pressure to radiate from it at the speed of sound. An object at the speed of sound will experience an abrupt buildup of pressure, causing a shock wave. Since then, anything traveling at the speed of sound is said to be traveling at "Mach 1".

The most difficult speeds to study were <u>transonic</u> speeds-- those just below through just above the speed of sound. Transonic research began at Langley in the 20s, when John Stack and his colleagues observed the sharp rise in drag as airflow approached Mach 1.

graphic

The chief culprit was a phenomenon called "compressibility effects." As a plane travels faster, a pressure wave builds up on the top of the wing . As the plane approaches Mach 1, drag increases and lift decreases.The stresses could tear aircraft apart. Indeed, some pilots had died in their assault on the "sound barrier".

Wing sweep

Enter Langley researcher Robert T. Jones. In 1943, Jones was the first American to realize that the angle of an airplane's wings could make a critical difference in supersonic flight. Jones calculated that at faster-than-sound speeds, the air flowing over a thin sweptback wing would actually be <u>subsonic</u>, delaying or preventing compressibility effects. This swept wing concept would soon be the basis for a new generation of aircraft.

Slotted-throat transonic tunnel

But investigating transonic speeds was frustrating. As air moved through wind tunnels near Mach 1, shock-waves would form and the wind tunnel would "choke", rendering test data unreliable. This "choking" problem was eventually solved by John Stack and Ray Wright. By placing slots along the walls of the wind tunnel, they could reduce or eliminate shock wave interference.

BAALS: 073-(063105) Well it was the breakthrough that we'd long been looking for. /// it led almost directly to

the area rule concept which Dick Whitcomb and others discovered, from the experimental data in the tunnel. And the area rule concept changed how you would configure aircraft forevermore. ///..and in 1951 John Stack and his associates received the Collier Trophy. (063202)

PARD

NARRATOR: While Stack and his colleagues were trying to solve the "choking" problem, others gathered transonic data in other ways. Langley's Flight Research Division measured air flow around wing models during steep dives. And on Wallops Island, Langley's Pilotless Aircraft Research Division launched over 2000 rockets to gather high speed data. These rocket model tests developed skills that would be called upon in the near future.

X-series

But wing flow and rocket model tests were stopgap methods of gathering transonic data. The research airplane was the tool to shatter the sound barrier. Proposed by John Stack and developed by Langley researchers during the war, the rocket powered X-1 was ready for flight by 1947. Heavily instrumented, the X-1 was a flying laboratory using the sky as its wind tunnel. The pilot on this historic flight was a young Air Force major named Chuck Yeager.

As Yeager rocketed through shock waves, Langley ground crews confirmed that he had flown faster than sound. And a new era of aviation had begun from Langley research.

HANSEN: 070--(013918) The X-1 // forever ended the // idea that there was a wall, a sound barrier beyond which further flight was impossible. In terms of technology, because the X-1 was a heavily instrumented aircraft, the NACA and the aircraft industry learned a good deal about transonic and supersonic aerodynamics.

NARRATOR: But the sound barrier was broken by brute force, with rockets. More practical solutions were needed to make supersonic flight a reality.

Transonic area rule

Throughout the late 40s and early 50s, a new generation of military aircraft sprang from the

X-1 research. Conflict in Korea and the anxieties of the Cold War summoned forth new aircraft capable of going higher and faster. But some of these aircraft could not fly as fast as planned.
Langley research showed why. As conventional designs approached the speed of sound, two different shock waves built up: one on the fuselage and one on the trailing edge of the wing. Drag was greater than anyone had predicted.

WHITCOMB:((01064709) After I got all these results, they were very odd looking. (01082004) // I was sitting there one day with my feet up on my desk contemplating all these things and it came together just like a light bulb lighting over your head just like you see in the comics. And so that is how I arrived at the area rule, adding all these things together.

NARRATOR: Whitcomb envisioned a way to make more room for the air to stream along the fuselage of an airplane. His inspiration was to pinch the waist of the fuselage where the wings were attached. It was a simple, elegant and brilliant solution that would influence the design of all supersonic aircraft to follow.

HANSEN: 068-- (00394401) What we're talking about with both the slotted throat and the area rule is a result of a very creative process involving visualization...pictures in the mind. The area rule and the slotted throat really were design processes. And it was through pictures in the mind that the end products were achieved. (4031)

NARRATOR: New X planes would continue to travel higher and faster. New answers begat more questions. How to develop propulsion for these "hypersonic" speeds of Mach 5 and above? How to deal with the heat caused by atmospheric friction? How to guide and control these vehicles? How to reduce weight to a minimum?

The design of hypersonic wind tunnels
North American X-15

Researchers in Langley's 11-inch Hypersonic Tunnel began to unlock the secrets of hypersonic flight and its extremes of temperature and pressure.

To tie together a variety of hypersonic research, Langley began and led the X-15 project. From 1959 to 1968, the rocket-powered X-15s flew to the fringes of space.

BECKER: (01385418) What the X-15 tried to do was bridge the gap between very high speed flight in the atmosphere and flight out of the atmosphere into space. We did that in the X-15 in a limited way by designing it to fly out of the atmosphere for a few minutes of spaceflight, and then making a reentry in the manner of the shuttle and a glide landing.

HANSEN: 068 (004815) What engineers were talking about and what Langley people were seriously considering was a natural evolution of high-speed, high-altitude flight in the

atmosphere, a natural evolution from atmospheric flight into spaceflight.

Sputnik

NARRATOR: But events were about to take a much different course. In 1957, the Soviet Union shocked the world by launching Sputnik, the world's first satellite. The space race had begun.

American pride was injured and the need to catch up became a driving political force. Within a year of Sputnik, NACA disappeared. Langley, the other NACA centers and four military facilities were merged to form NASA--the National Aeronautics and Space Administration--whose priority would be to make America first in the race for space. Langley Lab became the NASA Langley Research Center, the cornerstone of the space effort with the creation of the Space Task Group and Project Mercury. The arrival of the seven Mercury astronauts thrust Langley into the national spotlight.

Kennedy speech:

"I believe that this nation should commit itself to achieving the goal,

before this decade is out, of landing a man on the moon and returning him safely to earth. No single space project in this period will be more impressive to mankind, or more important for the long range exploration of space. "

NARRATOR: It was a daring gamble. The prestige of a nation had been entrusted to Langley's Space Task Group. The Mercury program was the first step. In 1961, astronaut Alan Shepard was the first American in space, making a suborbital flight of 15 minutes. In 1962, John Glenn was the first American to orbit the earth. Mercury demonstrated that men could be launched into space and safely returned.

Scout

The space effort demanded a myriad of experiments. The nation needed a launch vehicle to carry small payloads into space. The Wallops experience with rockets, tracking and data acquisition helped Langley create Scout. The Scout team launched the first of a long and successful series in 1961.

Support for Apollo

After the Space Task Group left for Houston in 1962, Langley resources remained committed to space. In the Rendezvous Docking Simulator, full-scale models of the Gemini spacecraft hung from the rafters of the West Area Hangar. Gemini astronauts "flew" the vehicles to rehearse and perfect their docking skills.

LLRF

Likewise, in the Lunar Landing Research Facility, Apollo astronauts felt the impact of firing thruster rockets in a simulated one-sixth gravity, and maneuvered in the harsh light of a simulated lunar landscape.

Lunar Orbiter

Langley's Lunar Orbiter Project was designed to map the moon to find landing sites for Apollo crews. The first of five Lunar Orbiters was ready for flight a mere 28 months after the contract was signed, and all five were in orbit within 14 months of the first launch. The Orbiter's cameras took pictures of the moon, processed the film on board, and sent the resulting images to Earth.

TABACK: 075--122502 It was extraordinary to believe that at the time

when we started that we would be successful in firing five spacecraft to the moon and have every one of them be a success. To that degree the program was extraordinary.

SFX

NARRATOR: On July 20, 1969, Neil Armstrong took those first fateful steps on the surface of another world. As Langley researchers watched the first lunar landing, they could remember that the manned space effort all started on the site of a former Virginia plantation.

Back to Basics

Music change

NARRATOR: By the time men were walking on the moon, Langley advances in safety and performance had been incorporated into a new generation of aircraft.

variable-sweep

One such breakthrough was development of a variable-sweep wing: a wing that could be adjusted to different angles for either subsonic or supersonic flight. Langley tests resulted in production of the nation's first variable-sweep fighter, the F-111. Variable sweep wings are also used by the B-1 and F-14.

Research in cryogenics led to the development of a new kind of wind tunnel in the 70s. Using cold gaseous nitrogen as a test medium, Langley's National Transonic Facility became a way to bridge the Reynolds number gap at transonic speeds.

And Langley's Richard Whitcomb continued a remarkable career of invention with a new wing shape-- a "supercritical" wing to delay the onset of drag at high subsonic speeds. Whitcomb later showed how winglets-- small airfoils attached to the end of airplane wings-- could increase fuel economy and reduce costs.

Langley began research on development of a supersonic transport, and continued study of vertical and short takeoff and landing aircraft. Langley tested aircraft tires and runway grooving at the Landing Loads Track. And the Lunar Lander Research Facility was reborn to study airplane crashes to increase pilot and passenger survival.

Viking

Music change

In the years following Apollo, the nation's priorities changed. NASA projects would have shorter terms and more specific aims.
Viking was Langley's largest space science project after Apollo, and hoped to discover whether life existed on Mars.
Two different vehicles would travel on one spacecraft. Once in Mars orbit, the Viking Orbiter would select a landing site for the Viking Lander. The Lander would maneuver to a soft landing on Mars, and then perform a series of experiments on Martian geography, weather, chemistry, and biology.
On July 20, 1976, seven years to the day after the first lunar landing, Viking Lander 1 touched down on the Martian surface.

HANSEN: 071--(01585918) To this day, Viking represents perhaps the most difficult space project that's ever been undertaken, in some respects even more difficult than even the manned lunar landings.

NARRATOR: Viking found no life but sent a body of information and spectacular photographs back to earth.

Shuttle development

Music change

The next logical vehicle for manned spaceflight was a reusable spacecraft. This was the Space Shuttle, developed in the late 70s. NASA drew upon Langley's long research and development of wingless "lifting body" aircraft to influence the shuttle's design. Shuttle scale models underwent over 60,000 hours of testing. When Columbia soared on her maiden flight in 1981, Langley researchers once again took pride in their contributions to a new generation of spacecraft.

New visions

Music change

NARRATOR: For 75 years, Langley research has responded to changing national needs. As NASA and Langley look to the next century of flight, new priorities demand new visions of the possible.

Atmospheric sciences

A growing concern for the global environment has spurred a variety of missions to planet earth.

Langley's Atmospheric Sciences Division explores the behavior of the ocean of air that surrounds us. Studies include the effect of clouds on global climate, the nature of ozone depletion at the poles, the "greenhouse effect", the impact of large scale burning, and atmospheric chemistry.

A better understanding of weather helps Langley researchers work to improve aircraft safety, such as preventing the effects of wind shear.

Langley researchers have studied the feasibility of a space station for years. When a space station someday orbits the earth, crews will need a "space taxi" for travel to and from earth. Langley researchers are planning such a vehicle, a winged lifting body able to return to conventional runways.

Hypersonic research continues at Langley with the next generation of advanced aerospace planes. These may take off from existing runways, travel to low-earth orbit, and return for an airport landing. Langley researchers work on new composite materials, and use supercomputers to create imaginary wind tunnels. It's the latest version of the job that Langley engineers have been doing for 75 years.

HANSEN: 071--(012323) There have been some incredibly talented devoted, hard working and creative people at Langley over the years. Together these people thought they could do almost anything, when you think about it, they almost did.

Reprise opening music

NARRATOR: For 75 years, it has been the belief that "they could do almost anything" that has unified generations at Langley. The people of Langley have built new research tools, invented new technologies, provided practical solutions, and developed leaders for a mighty industry. Langley remains the place where the "pictures in the mind" of flight's inspired dreamers are made real.