LESSON 2

The Future of Air and Space Power

Quick Write

How far is Mars from Earth? How long will it take to fly there?

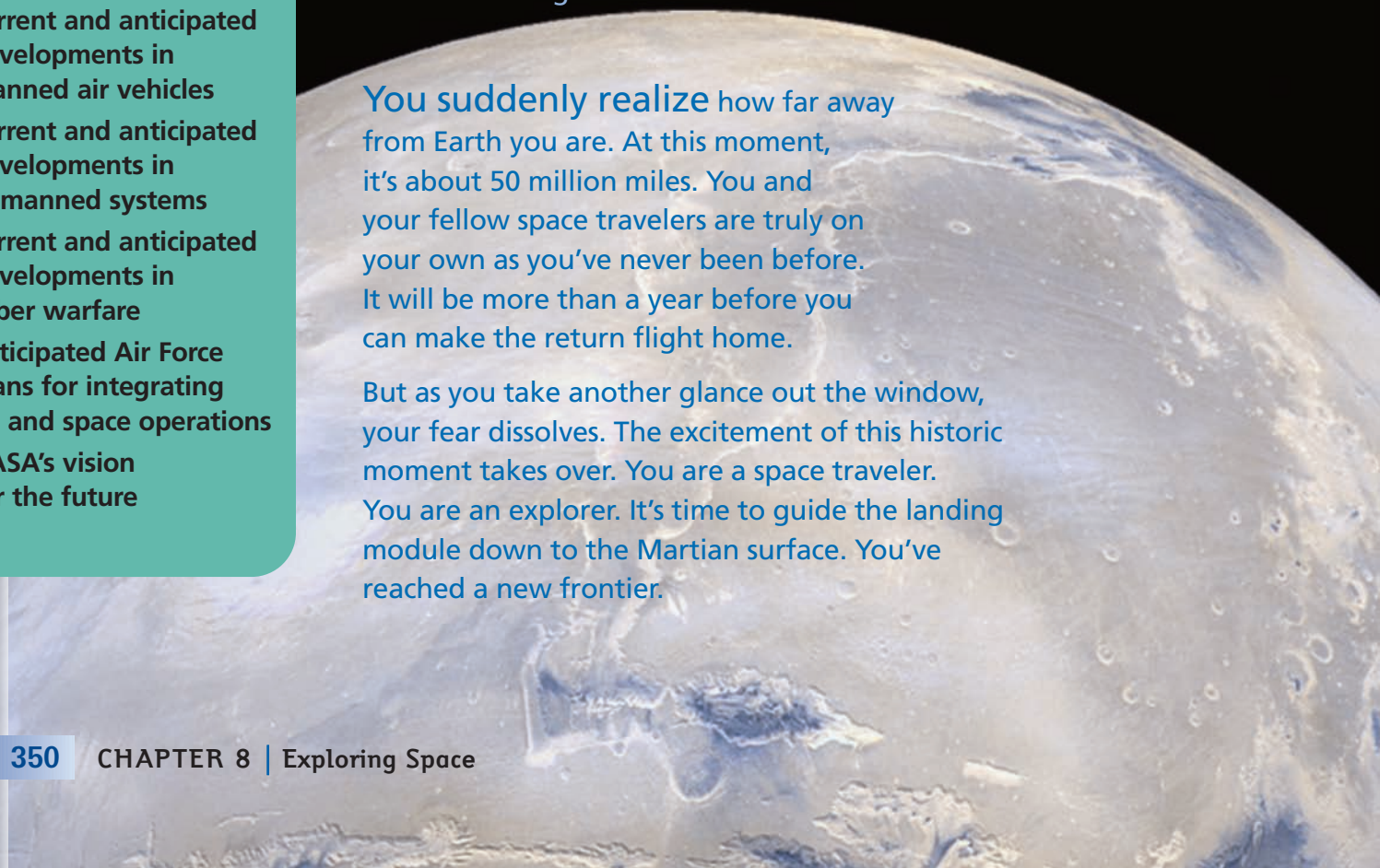
Learn About...

- current and anticipated developments in manned air vehicles
- current and anticipated developments in unmanned systems
- current and anticipated developments in cyber warfare
- anticipated Air Force plans for integrating air and space operations
- NASA's vision for the future

Imagine that you're an astronaut. You're peering out a porthole in your spacecraft. You've been soaring through space for months. At last you see your destination—Mars.

You and your crew know there's lots of work ahead. But for a few minutes everyone is silent. You realize that you will be the first people in the world to walk on a planet other than Earth.

You wonder whether the surface of Mars at your landing point will be firm or give way under your feet like sand. How hard will it be to move around in your spacesuit? What will Martian gravity really feel like? You practiced many times back on Earth, but this is the real thing.



You suddenly realize how far away from Earth you are. At this moment, it's about 50 million miles. You and your fellow space travelers are truly on your own as you've never been before. It will be more than a year before you can make the return flight home.

But as you take another glance out the window, your fear dissolves. The excitement of this historic moment takes over. You are a space traveler. You are an explorer. It's time to guide the landing module down to the Martian surface. You've reached a new frontier.

Current and Anticipated Developments in Manned Air Vehicles

Vocabulary

- hypersonic
- surveillance
- autonomous
- micro-UAV
- nanotechnology
- nano-UAV
- virtual
- cyberspace
- hacker
- deep space

Today's advanced manned aircraft would seem like the stuff of science fiction to early inventors such as the Wright brothers. In little more than a century, aircraft have progressed from clumsy gliders to jets that fly many times the speed of sound. The modern US arsenal features even more futuristic technology.

The F-35 Lightning II Joint Strike Fighter

The F-35 Lightning II Joint Strike Fighter is a perfect example of a modern military aircraft. It's a stealth fighter with a single engine. A single pilot flies it.

As of early 2007 the F-35 was still in the testing phase. Manufacturer Lockheed-Martin is designing three models, each for a different branch of the US military. The Air Force will get the conventional takeoff/landing model (CTOL). The Navy will receive the carrier variant (CV), which will make takeoffs and landings from carriers. And the Marines will fly the short takeoff/vertical landing aircraft (STOVL) version.

Many countries are taking part in the development of the F-35. The United States and Britain are the main sponsors of the new fighter. Other countries invested in the project are Italy, the Netherlands, Turkey, Canada, Denmark, Australia, and Norway.

What's attracting so many nations to invest in the F-35?

First, the parts of all three F-35 models are interchangeable. Between 70 percent and 90 percent of the parts can be used on any of the models. Second, it's a stealth fighter. It has radar that helps it avoid detection. Third, it can engage in dogfights as well as fight forces on the ground. It's not easy for an aircraft to take on both air and ground combat, but the F-35 can do it. It can carry missiles on its wingtips. It can also hold about 15,000 pounds of other kinds of ordnance.

Finally, the F-35 boasts sci-fi-style features. For example, it has a pilot's helmet that displays warnings about approaching missiles on the visor.

THE STEALTH F-35 LIGHTNING II

Courtesy of the US Air Force

Courtesy of the US Air Force

THE AIRBORNE LASER IS DESIGNED TO SHOOT DOWN ENEMY MISSILES. IT IS STILL IN THE TESTING PHASE.

The Airborne Laser

The Airborne Laser is another aircraft under development as of 2007. Its purpose is to find and blow up airborne ballistic missiles.

The Airborne Laser is an outfitted 747. Six modules with lasers and sensors make up the defense weaponry on board. Each module is the size of a sport utility vehicle. Each weighs 6,500 pounds and has 3,600 parts. Working together, these modules can destroy missiles from hundreds of miles away.

The modules begin by tracking a missile's exhaust trail. Once they've pinpointed a missile's position, the lasers focus through a telescope in the nose of the plane. Then they fire at the missile until it breaks apart.

THE X-43

Courtesy of NASA

Hypersonic Air Vehicles

Some new types of speedy aircraft are also in the works. They're called hypersonic aircraft. Hypersonic means *able to fly at or beyond Mach 5*, which is five times the speed of sound. One is the X-43, or Hyper-X. During a 2004 test flight, it flew at Mach 10, or about 7,000 miles per hour. Another model of the X-43 that's intended to fly at Mach 15 is under development.

Some of these aircraft use an engine called a *ramjet*. A ramjet is like a rocket. It gets its thrust by forcing gases from burned fuel through an exhaust pipe. The ramjet totes its own oxygen to help the fuel burn.

The X-43 goes a step beyond this. It relies on a *scramjet*. A scramjet propels a plane in much the same way as a ramjet does, but it sucks its needed oxygen from the surrounding air. For this reason, some people describe the class of aircraft to which the X-43 belongs as "air breathing."

Another hypersonic aircraft is the HyperSoar. This aircraft is still only a concept. Flying at speeds up to Mach 10, it would skip along Earth's atmosphere, coasting in space for hundreds of miles at a time. It would burn liquid hydrogen, which gives off water vapors. Therefore, it would run on clean fuel.

The HyperSoar could carry heavier loads than other aircraft of its size because of the way it bounces between Earth's atmosphere and space. It could launch satellites and other payloads into space. It could strike military targets. One day, it might even carry passengers in record time. A flight from Los Angeles to New York City might take only 35 minutes.

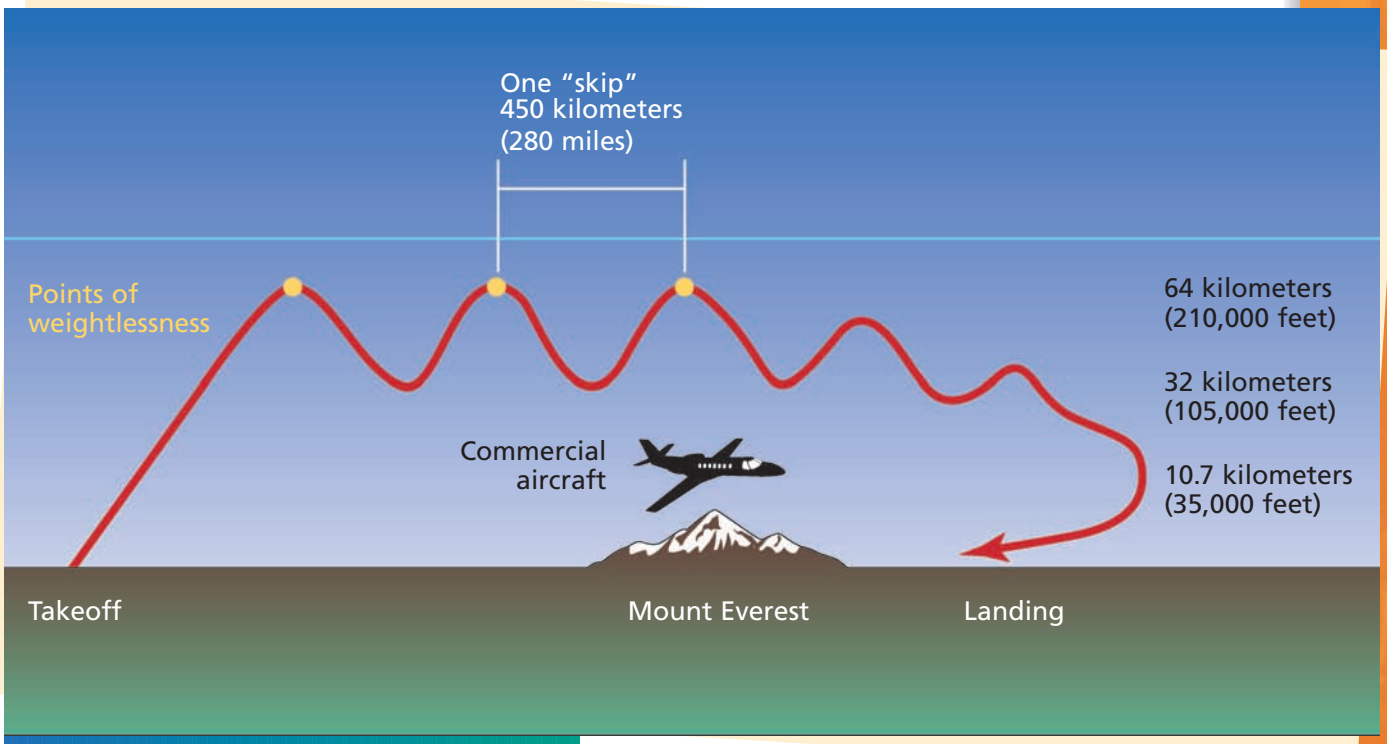


FIGURE 2.1

The HyperSoar aircraft is still only a concept. It would gain fuel efficiency by skipping along the Earth's s atmosphere.

Courtesy of the Lawrence Livermore National Laboratory

Current and Anticipated Developments in Unmanned Systems

A UAV

This drawing shows what a UAV might look like while refueling in midair.

Courtesy of Northrop Grumman. Illustration by Peter A. Barnett, Anne Beamon, and Christine D. Smith.

New developments are also in the works for unmanned air vehicles (UAVs). UAVs have traditionally flown reconnaissance. But they are now taking roles in combat. As technology improves, engineers will find many more uses for UAVs.

The current generation of UAVs includes the Predator. It conducts surveillance—or *reconnaissance*—and strikes enemy targets. It has been successful, but it is a small aircraft. Its small fuel tank limits its range.

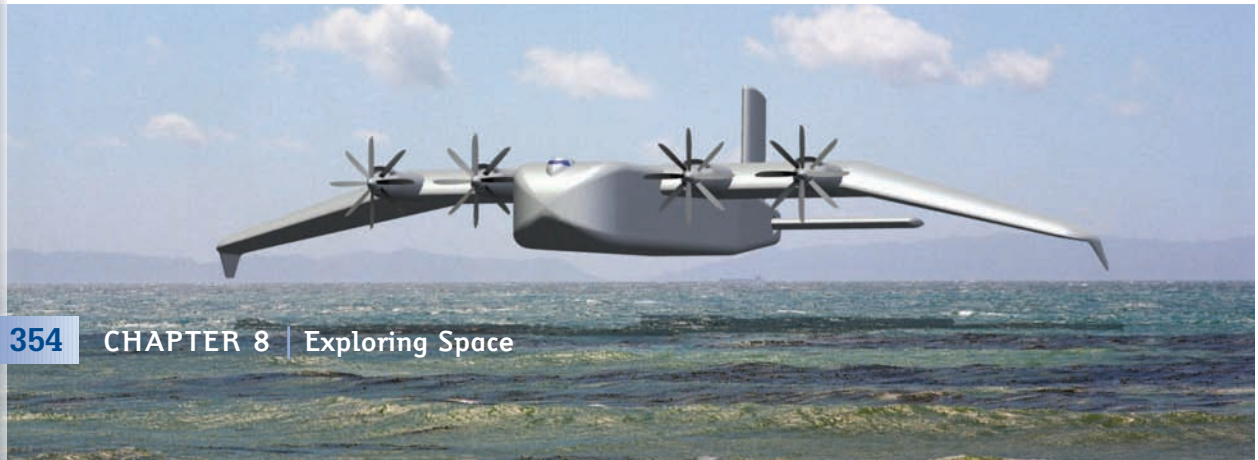
To achieve longer-range missions, among other goals, the Air Force is developing the Joint Unmanned Combat Air System. The UAV for this project is the X-45. As of 2007 UAVs could not refuel during flight. But one day the X-45 should be able to refuel in midair. The ability for autonomous refueling—*independent of human control*—would enable UAVs to conduct much longer missions.

The X-45 should also be able to carry bombs such as the 2,000-pound Joint Direct Attack Munition. And it will be a stealth aircraft. Ground crews will remotely direct the X-45's operations.

But the military also needs an efficient way to transport UAVs to faraway missions such as Operation Enduring Freedom in Afghanistan. The manned Pelican aircraft, now under development, will carry heavy loads such as smaller unmanned aircraft. It will be as long as a football field and will be able to carry the equivalent of 17 battle tanks.

The Pelican will be able to fly as high as 20,000 feet. But sometimes, to gain fuel efficiency, it will fly as low as 20 feet over large bodies of water like the Atlantic Ocean. To do so, it will take advantage of a natural phenomenon called ground effect, which decreases drag.

THE PELICAN CARGO PLANE



Courtesy of Boeing

Anticipated Developments in UAV Technology

In addition to autonomous refueling, military planners hope to make other important advances with UAVs. These advances involve three things: sight, size, and tactics.

First is sight. At the controls of a plane, the pilot can see if the aircraft is about to collide with another aircraft or a tall building. But having no pilot, a UAV has no human eyes. Sight is a problem. As of early 2007, for instance, there had been three midair collisions between UAVs and helicopters in Afghanistan during Operation Enduring Freedom.

Engineers are trying to give UAVs sight using electronic sensors. They are using a micro-UAV—*an aircraft that weighs as little as a few ounces or a few pounds*—to research the possibility of sight.

UAV sight probably won't become a reality until around 2015. But when it does, micro-UAVs may take on important roles in reconnaissance. Because of their small size, they could enter enemy territory unobserved. They could zoom around inside buildings to check for enemy positions. This means they could save lives, because people now must do this risky work.

Another avenue of research into size is nanotechnology. Nanotechnology *is the science and technology of building electronic circuits and devices from single atoms and molecules*. A nano-UAV, still to be invented, *is a UAV so small that it is invisible to the naked eye*. Nano-UAVs might one day take on the task of building a fighter jet. One futurist even predicts that billions of programmed nanos, equipped with microscopic robotic arms, could converge on a vat of supplies in liquid form and put together a fighter in only a minute. Sounds like the stuff of science fiction now, but researchers think it may one day be possible.

As designers make it possible for UAVs to see, a new application of warfare will become possible—combining UAVs and piloted aircraft on a mission. To do this, more effective command and control will be needed—leaders will need to coordinate the efforts of both types of aircraft. They will also have to train pilots to be comfortable flying alongside UAVs.

How the Use of Smart Systems and Other Developments Will Change the Traditional Concept of the "Pilot"

Sending pilots into battle means putting their lives at risk. By contrast, UAVs spare Airmen's lives. Pilots remotely control UAVs from a base on the ground. They can direct missiles and run reconnaissance while remaining hundreds of miles away from the action.

As progress in UAV technology continues, remote flight will become more common. This will change the definition of the word *pilot*. No longer will the pilot be a daring aviator flying Mach 2 over enemy territory. More and more, combat will involve skilled pilots, navigators, and missile-sensor operators who work with computers. UAVs will have major roles in the US military of the 21st century.

Current and Anticipated Developments in Cyber Warfare

Computers, chips, hardware, monitors, and plugs—these are the physical tools of the Internet. But the information we retrieve from the Internet is not physical. The data are stored in a place that is virtual, or *existing in ideas and outside the physical world*. Cyberspace *is a virtual place where information is stored*.

The US Air Force is expanding its responsibilities into the cyber world.

Why the US Air Force Established Air Force Cyberspace Command

In 2005 the US Air Force released a new mission statement. It says that the mission is "the defense of the United States of America and its global interests—to fly and fight in air, space, and cyberspace."

In 2006 Secretary of the Air Force Michael Wynne announced the formation of the Air Force Cyberspace Command. He cited many reasons for founding this organization. A key reason is that hackers, terrorists, and criminals often use the Internet to further their plans.

A hacker *is someone who uses programming skills to gain illegal access to a computer network or file*. If they apply these skills to military actions, hackers can disrupt communication lines between commanders and their troops. "Our ability to fight in ground, sea, air, and space depends on communications that could be attacked through cyberspace," Secretary Wynne said. He added that the "cost of entry into the cyberspace domain is low." This means that anyone wishing to do the United States harm has an easy means to do so.

Islamist terrorists who use the World Wide Web to recruit suicide bombers are an example of those who abuse cyberspace. Criminals who use the Global Positioning System (GPS) to arrange drug drops are another. Many new kinds of threats can hit the United States through the Web. That's why the Air Force has stepped in to defend cyberspace.

The Current Operations of Air Force Cyberspace Command

The 8th Air Force became the new Air Force Cyberspace Command in November 2006. Although the command continues to conduct bombing missions, it also focuses on guarding America's cyberspace.

The Air Force is mapping out career paths for Airmen who wish to enter the Cyberspace Command. It is also deciding how to train personnel to work in this field.

The goals of the Cyberspace Command are to:

- Protect cyberspace
- Make sure commanders have full access to all battlefield information available through cyberspace
- Carry out offensive missions in cyberspace
- Support reconnaissance missions.

The Air Force's Plan to Exploit Cyberspace by Offensive Means

What would an offensive cyberspace mission look like? It might involve an effort to destroy an enemy's power grid. Without power, enemy field commanders couldn't get orders to their troops. Radar couldn't spot approaching US fighters and bombers. And the enemy couldn't interfere with US lines of communications.

Computer viruses are another weapon in the US cyberspace arsenal. Airmen could infect an enemy's computer systems and cripple its ability to wage war with the United States.

Cyberspace can also be used for training. Pilots can practice combat scenarios in a modern simulator, a piece of computerized equipment offering virtual experiences. Using a simulator, a pilot can "fly" through a severe thunderstorm or enemy fire without having to go through the real experience. This virtual experience prepares pilots for actual combat. It also saves fuel and wear on aircraft.

The Possibility of Battles in Cyberspace

In his speeches, Secretary Wynne has discussed the possibility of cyber warfare. "One rough-and-ready demonstration that cyberspace is a true domain on a par with land, air, space, and sea is to apply the basic questions of the principles of war," he said in a 2006 address.

"For example, can one mass forces in cyber? Yes. Does surprise give an advantage in cyber? Of course. Simplicity? Economy of force? Clarity of objective? Yes, yes, and yes."

The Air Force is preparing for this very real possibility.

Anticipated Air Force Plans for Integrating Air and Space Operations

In addition to air and cyberspace, the Air Force exploits space to guard the United States.

For instance, satellites monitor the weather. They transmit communications. They pinpoint targets. These functions support military actions in the air and on the ground.

The Air Force uses the GPS satellite system for precision strikes. GPS satellites can see through bad weather to their targets. With GPS satellites, sandstorms don't present a problem during a desert mission such as Operation Iraqi Freedom (OIF). Operation Noble Eagle, which protects the US skies, relies on satellites to detect planes entering restricted airspace.

The US Space-Based Infrared System can detect missiles shot toward the United States and give warning. The Air Force's Counter Communications System can jam enemy satellites.

But other countries' technologies are challenging those of the United States. During OIF, the Iraqis jammed the US GPS to prevent precision strikes. The Air Force has devised ways to block the jamming attempts. It is working on even more-powerful defenses for its satellites through its Rapid Attack Identification Detection and Reporting System.

While still in the early stages, space operations are already taking a role in warfare. It's the military's job to figure out how to integrate these missions with its land, air, and sea resources.

Space-Based Missile Defense

The United States also protects its territory and its interests through a missile-defense system. This effort has three parts. All are space based. They are supported by GPS, by other satellites, and by radar.

You read about the first part earlier in this lesson. It's the Airborne Laser. The Airborne Laser targets hostile missiles in the early stage, or "boost phase," of flight.

Courtesy of the Missile Defense Agency

AEGIS DESTROYERS AND CRUISERS WORK WITH SATELLITES AS PART OF THE US MISSILE-DEFENSE SYSTEM.

The second part is US Navy Aegis cruisers and destroyers. Aided by communications satellites, they monitor missiles in midcourse. Navy ships will then try to shoot down these missiles. The task also sometimes falls to ground-based missile-command centers in Alaska or California.

The final part is the PAC-3, which is the latest version of the Patriot missile. The PAC-3 can destroy hostile missiles shortly before impact.

Evolved Expendable Launch Vehicles and Air Platforms

The Air Force launches its satellites into orbit aboard the Evolved Expendable Launch Vehicle (EELV). There are two varieties: the Boeing Delta IV and the Lockheed-Martin Atlas V. But expendable launch vehicles may have reached the limits of their effectiveness.

AN EELV FIRES UP FOR LAUNCH

Courtesy of the US Air Force

GM-3 LOADING

An Air Force crew loads a GM-3 onto a C-17 Globemaster III.

Courtesy of the US Air Force

So the Air Force is increasing its use of *air platforms*, which are command-and-control centers carried aloft by aircraft. The command-and-control packages are usually fitted into a trailer. The trailer is then placed in the hold of a cargo plane. Command-and-control centers, also known as C2s, run combat missions from the air. C2s rely on satellites launched by EELV to gather information. An example of a C2 is the Ground Mobile-3 (GM-3), which fits into a C-17 Globemaster III cargo plane.

Reusable Launch Platforms and Space Maneuver Vehicles

But the future may lie with reusable launch platforms. These platforms carry payloads into space and bring them back to Earth.

One such platform now under development for the Air Force is the unmanned Orbital Test Vehicle (OTV). It's about one-quarter the size of a space shuttle. It will get into space atop an Atlas V launch vehicle.

The Air Force will use the OTV for testing new satellites. The Air Force can send the new satellite aloft in the OTV. When the testing is done, the OTV returns to Earth with the satellite still on board. Engineers then study the results. Construction of the first OTV was nearly complete at the end of 2006.

Another platform in the works is the Space Maneuver Vehicle. This spacecraft will stay in orbit up to a year. It will carry payloads of less than 20,000 pounds. Its purpose will be to pinpoint hostile targets from space.

NASA's Vision for the Future

While the Air Force works on its futuristic aircraft and spacecraft, NASA is busy planning for future space exploration, too. Some people think space travel isn't practical. NASA doesn't agree. It's working now on concepts and inventions that will help get humans into deep space. Deep space *is any region beyond the solar system*.

Why NASA Plans to Explore Beyond Earth's Orbit

NASA flew men to the moon in the 1960s. Today it routinely sends astronauts to the International Space Station (ISS). But some people still ask: why explore space?

NASA Administrator Michael Griffin explains NASA's view:

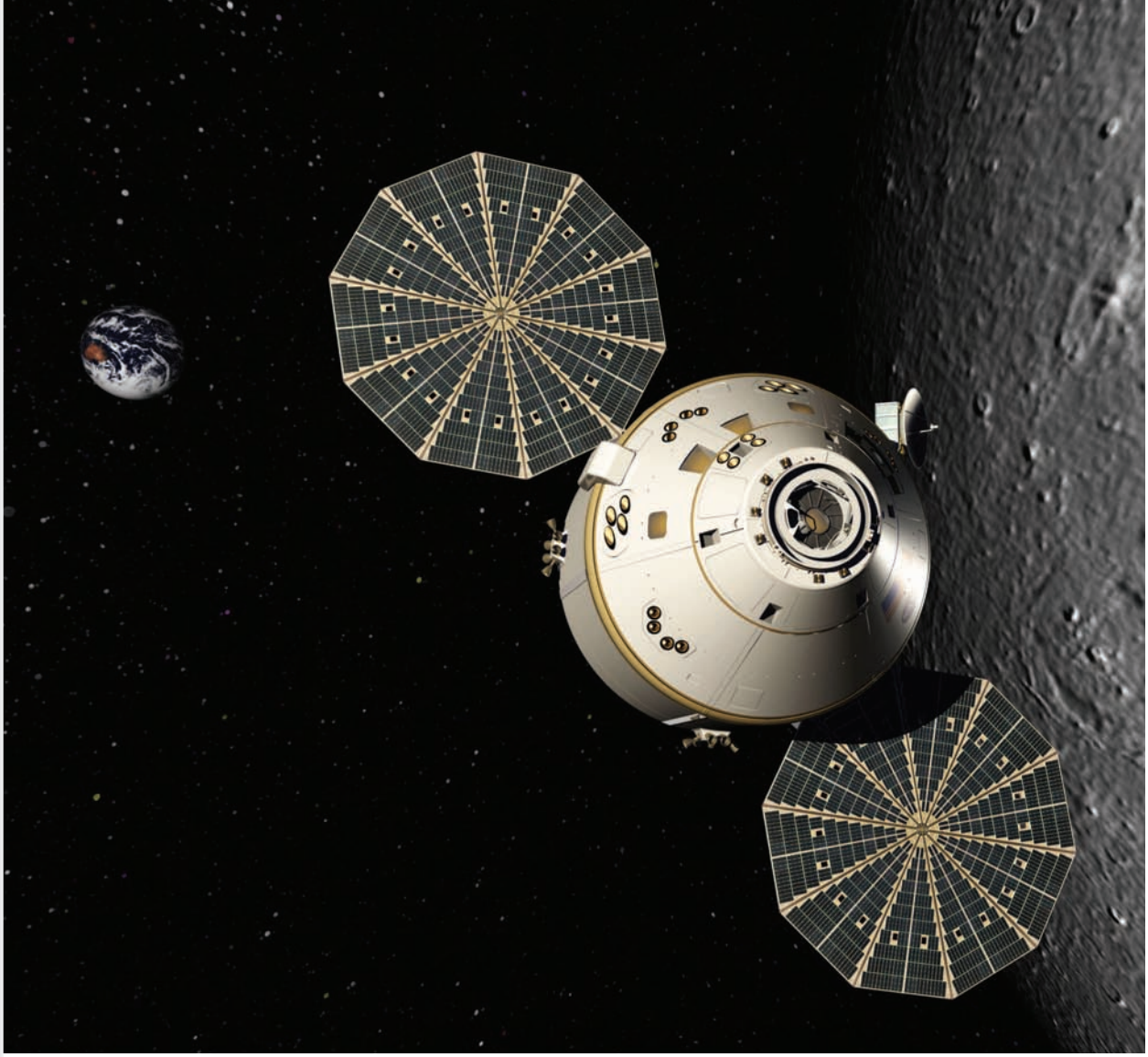
> Throughout history, the great nations have been the ones at the forefront of the frontiers of their time. Britain became great in the 17th century through its exploration and mastery of the seas. America's greatness in the 20th century stemmed largely from its mastery of the air. For the next generations, the frontier will be space.

Pushing the boundaries of space keeps the United States ahead technologically. It keeps the country dominant militarily. Scientists can conduct studies in space that are not possible on Earth. Since the 1970s hundreds of NASA inventions have benefited US industry and improved Americans' lives. NASA research has led to many breakthroughs in medical technology, for example. And Apollo research even helped improve athletic shoe design! Other important discoveries continue to be made.

Plus, many find the very idea of space travel exciting. Just as the Wright brothers had the thrill of being the first to achieve heavier-than-air flight, some brave astronaut may one day make history as the first person to step onto Mars.

NASA's New Orion Spacecraft and Ares Launch Vehicle

But you can't get to space without a spacecraft. The Orion spacecraft is NASA's newest vehicle for exploring space. Engineers hope to have it ready for its first mission by 2014. At that point, Orion will replace the space shuttles and begin ferrying people to the ISS. After Orion passes the needed tests, NASA will send it to the moon—and one day to Mars. It will also serve as the reentry vehicle into Earth's atmosphere.



Courtesy of AP Photo/Lockheed Martin

An artist's conception of the Orion spacecraft orbiting the moon.

Orion will be similar in shape to the Apollo spacecraft that first carried men to the moon. Engineers are sticking with the Apollo model because it successfully completed the tricky reentry. NASA is aiming for a lunar mission in 2020.

When the day comes for a lunar launch, a cargo launch vehicle called the Ares V will shoot into space to deliver a lunar module and a departing stage into low-Earth orbit. Orion will launch separately atop the Ares I launch vehicle. Orion will then dock with the lunar module. The departing stage will propel Orion and the lunar module to the moon.

Plans for Future Manned Exploration of the Moon, Mars, and Beyond

After successful Orion missions to the moon and Mars, what next? Try this on for size: establishing a space colony on Mars. NASA is already moving in this direction.

In the 1990s, for instance, NASA worked on the X-34. It was to be a reusable spacecraft that provided its own launch ability. Congress cut funding for this project in 2001, but the X-34 is still part of NASA's overall plan to explore deep space.

Additional trips to the moon are many years away. Voyages to Mars are likely decades away. But NASA keeps its options open. It's always pushing the envelope. It's always thinking ahead.

After Mars, what? NASA itself doesn't know yet. But one thing is sure: exploration of space will continue.

In this book, you've read about the history of aviation, airpower, and the exploration of space. You read how the imaginative thinking of Leonardo da Vinci led people in following centuries to experiment with parachutes and gliders. You read about the Wright brothers' careful and logical experiments that led to the first controlled, manned, heavier-than-air flight. You studied how aviation developed rapidly during World War I, how Charles Lindbergh captured imaginations with his trans-Atlantic solo flight, and how brave Allied flyers helped liberate Europe and the Pacific region in World War II. You read about the birth of the independent Air Force and the role air power has played in US global interventions since then. Finally, you read about the beginnings of the space program, the first men to reach the moon, and the accomplishments and tragedies of the space shuttles.

An X-34

Courtesy of NASA

Before you, as before no other generation in the history of mankind, the future of air and space power lies bright with promise and possibilities. Will you be part of it?

CHECKPOINTS

Lesson 2 Review

Using complete sentences, answer the following questions on a sheet of paper.

1. What's attracting so many nations to invest in the F-35?
2. What is the purpose of the Airborne Laser?
3. How fast is a plane flying if it's going at hypersonic speed?
4. What improvement is the Air Force making to the X-45 UAV that will give it a longer range than the Predator?
5. How small is a nano-UAV?
6. Define cyberspace.
7. What are the three parts of space-based missile defense?
8. When does NASA expect to launch the next moon mission?

Applying Your Learning

9. What are some of the reasons behind the exploration of space?