The Future of Aviation

This morning's video included a lot of information about the history of aviation at DARPA. Now let's talk about the future.

It's easy to predict the future, if you can make a large number of guesses!
That's the right approach for dealing with technology advances for aviation. At DARPA, we have the opportunity to work on a wide range of advanced concepts in the quest for improved military aircraft. We are constantly looking for new concepts and ways to improve old ones.

My mission this morning is to tell you about some possible directions for the future of aviation; to show you a wide range of out of the box possibilities, and to invite you to contact us and discuss your innovative aviation ideas. I am going to list a set of new ideas for aviation research. We will first talk about manned aircraft designs.

(Wright Brother's slide)

First, warping to morphing. The Wright brothers used wing warping. If DARPA had been around, I'd like to think we would have supported these guys.

(Wright Flyer quad slide)

Incidentally, one hundred years later, we weren't quite able to duplicate their first flight. But, the wing warping concept is a good one. In fact, we would like to go one step further.

(Morphing Aircraft Structures slide)

Current aircraft wings typically have very limited flexibility, but Dr. Terry Weisshaar in the DARPA Defense Sciences Office is investigating wing MORPHING. A low speed reconnaissance aircraft could convert from a high aspect ratio loiter configuration to a low aspect ratio high speed configuration to conduct strike missions. Technical challenges with morphing structures include developing materials that can change form, all the while retaining adequate stiffness. You can imagine the challenges in controlling the distributed actuators that act as the muscles for this mechanical bird. But, of course, that is precisely how animal systems locomote.

(X Plane slide)

Throughout its 46 year history, DARPA has been involved in aviation development. In fact, if you wanted a glimpse into the proverbial crystal ball of aviation, you only had to

take a look at what DARPA was doing. DARPA has been involved with [] both manned and unmanned X planes. These revolutionary aircraft demonstrated significant advances in aerodynamics, propulsion, structures and flight controls. DARPA is still heavily involved in hypersonic research. Dr. Steve Walker will be following me this morning and will talk about the future of hypersonic aircraft.

But let me tell you about our most recent X Plane, the X-50 Dragonfly. Last December, while preparations were underway at Kitty Hawk for the Centennial celebration, we were preparing for its first hover flight in a drier climate at the Yuma Proving Grounds.
The X-50 is an unmanned canard-rotor-wing built by the Boeing Phantom works. The canard rotor wing is the most recent attempt to design a stopped rotor aircraft. You may recall the X-wing design in the mid 80's that went through detailed design, but never flew. Like the X-wing, the canard rotor wing is designed to slow and then stop the rotor in flight. At this point the rotor becomes a fixed wing and high speed is now possible. Unlike the X-wing, the canard rotor wing will perform this conversion with the rotor unloaded. This is possible because the weight of the aircraft can now be supported by the canard and the wing during this critical maneuver. Applications for this type of aircraft range from UAVs, to ground attack aircraft, to transports.

(CRW video clip-30 sec)

At this point, the X-50 Dragonfly has only operated in hover mode.
Here you see this first flight that took the aircraft out of ground effect hover. The reaction drive rotor is spinning at 1100 RPM, but requiring minimal anti-torque control from the directional control jets located on each side of the aft fuselage.. In the coming weeks and months we will advance to low speed forward flight and then to compound helicopter flight and finally transition to fixed wing flight.

(Blended Wing Body slide)

We are all familiar with aircraft that are composed of a cylinder for a fuselage and a beam for a wing. One brought me here this week. These have served us well, but we are now looking at blended wing body aircraft in an attempt to smoothly integrate aerodynamic and propulsion subsystems with fuselage and payload systems for a variety of missions. We expect that an airplane like this one will have lower drag and improved powering performance. We imagine that a blended wing body aircraft could have uses ranging from a tanker that refuels manned and unmanned aircraft to a long range standoff weapons platform. What are the technologies needed for non-cylindrical pressure vessel aircraft? How might we make such an aircraft modular so that it can have multiple roles? Additional challenges exist in control systems and propulsion integration.
Futurists have been predicting aircraft like this for some time. At DARPA we are trying to make it a reality. We invite your participation.

What other novel shapes and architectures might produce military utility?
Well, we might find new applications for old concepts.

How about an airship?

How about a big airship?

(Walrus slide)

I give you Walrus.

(Walrus video clip-30 sec)

[IN] We want to transport an entire Army unit, including mechanized infantry, from fort to fight in 3 to 5 days. Walrus might be just the ticket to achieve such a global projection capability. When completed, Walrus will be the largest airship ever developed and will have the capability of transporting several hundred tons of cargo and people to anywhere on the globe. Technologies of immediate interest include advanced materials, vacuum tanks and robust control technology. Seek out Preston Carter at the TTO booth and share your ideas with him.

(A 160 Slide)

Here is another variation on an old theme.

Helicopters have been in service for a long time and have proven their military worth. At DARPA today we are looking at technologies to improve [IN] helicopter performance. The A-160 is intended to achieve higher efficiency and longer endurance and quieter operation, through a variable speed rotor. Maybe there are other novel helicopter concepts, or other variations on old aircraft architectures, that when looked at from the perspective of new propulsion, new materials, or new algorithms, might yield similar radical performance gains.

In the area of unmanned aircraft, there are a lot more possibilities, because the aircraft isn't constrained by a human on board. DARPA has spearheaded the Unmanned Air Vehicle revolution and we will continue to work on the technologies that will enable us to realize the full potential of unmanned air systems.

(Unmanned Aircraft slide)

The Global Hawk and Predator are long endurance unmanned aircraft. Their aerodynamics are excellent, but to achieve the next level of endurance, we will need more

fuel efficient engines. An active area of research for long endurance aircraft is the development of diesel engines. We know that diesels can give us superior fuel economy, but can we bring the engine weight down to the point where diesels can replace gas turbines? This will require significant advances in engine design and the wholesale application of super light weight materials. Are there any other heavy fuel engine options? We are open to all possibilities.

(Micro Flyers slide)

DARPA has been a leader in Micro Air vehicle development. We want vehicles that can operate in the urban terrain and perch on the ledge of a building or land on the side of a pole. We want vehicles that can fly inside buildings. In the field of aviation, relatively little thought has been given to perching previously. Except, of course, by birds. There are no text books on this subject yet. But if we can learn from birds and insects then a lot of new possibilities open up. Perching saves the enormous energy expenditure of hovering. And flying inside and around buildings offers tremendous opportunities for surveillance. But note that these are aircraft where it is hard to separate the propulsion system from the airframe from the sensors. Integration is the key. Surely there are some concepts out there that we haven't seen yet.

But as we will learn when the Joint Unmanned Air Combat System office gives presentations, single platform UAVs are just a beginning. We are interested in swarms of UAVs.

(SWARM slide)

SWARM is a term we use for agents acting in concert. Some day we envision swarms of unmanned aircraft working in together with other systems. But for now, we are investigating the swarm concept with small, inexpensive UAV's carrying a variety of distributed sensors. These might be useful in their own right. Can these systems be made inexpensive? If so, they might be intended for one time use. Can the sensors be made small yet robust? What about communications? Can we make use of the distributed swarm to assist in creating the communication network? If the units are intended for one-time use, what strategies are best for specific missions? Swarming represents an entirely new area for innovation.

(UCAR slide)

The Unmanned Combat Armed Rotorcraft or UCAR will be a force to be reckoned with on the battlefield of the future. Don Woodbury in TTO is leading the effort to integrate

survivability, autonomous operation, command and control and weapons delivery in the UCAR system. Don can also be found at the TTO booth.

(A 160 slide)

The A-160 Hummingbird is a very long endurance unmanned helicopter. There I am on the right with one of my favorite airplanes and two of my favorite people. The A 160 will provide fixed wing levels of persistence in a highly autonomous vertical take off aircraft. The A160 achieves this unprecedented level of performance by using the patented optimum speed rotor system or OSR. OSR varies the rotor speed as a function of gross weight and speed to maintain maximum overall efficiency. The A160 is designed to support a range of sensors including radar, IR and visual. I expect the A160 to be the airborne jeep in the future battle field.

(DARPA Home Runs slide)

In closing, DARPA has a rich history of aviation innovation. We hit a lot of home runs. And the way to hit a lot of home runs is to take a lot of "at bats". That's what we intend to keep on doing.

If you have an idea, we want to talk to you!

Thank you.