# Unmanned aerial vehicle

Pioneer UAV flying over Iraq

UAVs in a hangar

A Boeing 720 being flown under remote control as part of NASA's Controlled Impact Demonstration

An **unmanned aerial vehicle (UAV)**, also called a **drone**, is a self-descriptive term used by the US military, the Israeli Defence Forces and others to describe the latest generations of pilotless aircraft. Taken literally, the term could describe anything from kites, through hobbyist radio-controlled aircraft, to cruise missiles from the V-1 Flying Bomb onwards, but in the military parlance is restricted to reusable heavier-than-air craft.

For a more detailed examination of UAV's, see A History of UAV's

## History

The earliest such craft were developed after World War I, and they were used during the Second World War to train antiaircraft gunners. Nevertheless, they were little more than full-sized remote controlled airplanes until the late 20th century. Lately, interest in such craft has grown within the higher echelons of the US military, as they offer the possibility of cheaper, more capable fighting machines that can be used without risk to aircrews. Initial generations have primarily been surveillance aircraft, but some have already been fitted with weaponry (such as the RQ-1 Predator, which has been fitted with AGM-114 Hellfire air-to-ground missiles). The military envisions that more and more roles will be performed by unmanned aircraft, initially bombing and ground attack, with air-to-air combat expected to be the last domain of the fighter pilot for now. A weaponized UAV is known as an Unmanned Combat Air Vehicle, or UCAV for short.

The Israel Aircraft Industries (IAI) have pioneered the production and usage of UAV for military purposes, as early as 1982. The IMI Scout UAV System has played an important combat role both in the service of the Israeli Ground Forces and Israeli Air Force, during the Operation Peace for Galilee. The Israeli Defence Force uses the UAVs mainly for reconnaissance, intelligence gathering, scouting and communications. The IAI Pioneer was purchased by the US armed forces and proved itself as a reliable system in the second and third Gulf Wars in Iraq.

## Degree of Autonomy

Some early UAV's are called drones because they are no more sophisticated than a simple radio controlled aircraft being controlled by a human pilot (sometimes called the operator) at all times. More sophisticated verions may have built-in control and/or guidance systems to perform low level human pilot duties such as speed and flight path stabilization, and simple prescripted navigation functions such as waypoint following.

From this perspective, most early UAV's are not autonomous at all. In fact, the field of air vehicle autonomy is a recently emerging field, whose economics is largely driven by the military to develop battle ready technology for the warfighter. Compared to the manufacturing of UAV flight hardware, the market for autonomy technology is fairly immature and undeveloped. Because of this, autonomy has been and may continue to be the bottleneck for future UAV developments, and the overall value and rate of expansion of the future UAV market could be largely driven by advances to be made in the field of autonomy.

Autonomy technology that will become important to future UAV development fall under the following categories:

- Sensor Fusion: Combining information from different sensors for use on board the vehicle
- Communications: Handling communication and coordination between multiple agents in the presence of incomplete and imperfect information
- Motion Planning (also called Path Planning): Determining an optimal path for vehicle to go while meeting certain objectives and constraints, such as obstacles
- Trajectory Generation: Determining an optimal control maneuver to take to follow a given path or to go from one location to another
- Task Allocation and Scheduling: Determining the optimal distribution of tasks amongst a group of agents, with time and equipment constraints

- Cooperative Tactics: Formulating an optimal sequence and spatial distribution of activities between agents in order to maximize chance of success in any given mission scenario

Autonomy is commonly defined as the ability to make decisions without human intervention. To that end, the goal of autonomy is to teach machines to be "smart" and act more like humans. The keen observer may associate this with the development in the field of Artificial Intelligence made popular in the 1980's and 1990's such as expert systems, neural networks, machine learning, natural language processing, and vision. However, the mode of technological development in the field of autonomy has mostly followed a bottoms up approach, and recent advances have been largely driven by the practitioners in the field of control sciences, not computer sciences. Similarly, autonomy has been and probably will continue to be considered an extension of the controls field. In the foreseeable future, however, the two fields will merge to a much greater degree, and practioners and researchers from both disciplines will work together to spawn rapid technological development in the area.

To some extent, the ultimate goal in the development of autonomy technology is to replace the human pilot. It remains to be seen whether future developments of autonomy technology, the perception of the technology, and most importantly, the political climate surrounding the use of such technology, will limit the development and utility of autonomy for UAV applications.

**UAVs in service**

Chinese Models:

- ChangKong-1
- ChangKong-2
- WuZhen-5
- WuZhen-9
- ASN-206

French Models:

- Sperwer

German Models:

- Drohne CL 289
- Aladin
- Luna X 2000
- KZO

Indian Models:

- ADA Nishant (RPV)
- HAL Lakshya
- Searcher MkII (with Israel)
- HAL Heron (with Israel)

Israeli Models:

- IAI Pioneer (with the USA)
- RQ-5 Hunter (with the USA)
- IAI Harpy
- IAI Heron
- IAI Ranger
- IAI Scout
- IAI Searcher
- IAI Skylite - Canister Launched mini-UAV system
- Elbit Hermes 450 - a variant of which (dubbed *Watchkeeper 450*) has been chosen for the British Army's Watchkeeper program

Iranian Models:

- Mohajer-3
- Mohajer-4

Jordanian Models:

- Jordan Falcon
- I-wing
- Jordan Arrow
- Silent Eye

Pakistani Models:

- UAV Vector

South African Models:

- Kentron Seeker
- ATE Vulture
- Denel Bateleur

Swiss Models:

- RUAG Ranger

U.K. Models:

- Mercator
- Phoenix
- Watchkeeper

U.S. Models:

- RQ-1 Predator/RQ-1 Mariner
- RQ-2 Pioneer (with the IAI)
- RQ-3 Dark Star
- RQ-4 Global Hawk/Euro Hawk

- RQ-5 Hunter (with the IAI)
- RQ-6 Outrider
- RQ-7 Shadow
- RQ-11A Raven
- GNAT-750
- ScanEagle
- Dragon Eye
- BQM-74E Chukar

NASA has been sponsoring research into a solar-powered UAV called Helios, which in 2001 reached an altitude of almost 30 km. Helios broke up and crashed over the Pacific on 26 June 2003.

Commercial interest in non-military UAVs has led to several startups that are designing and selling autonomous aircraft. These include Rotomotion, Neural Robotics, The Insitu Group, Micropilot and the Free Software autopilot project.

**See also**

- A History of UAV's
- UCAV
- UCAR
- Unmanned ground vehicle
- Remotely operated vehicle or ROV
- Unmanned space mission
- Autonomous Underwater Vehicle
- Controlled Impact Demonstration

**Trivia**

- UAVs have been used in many episodes of the science fiction television series Stargate SG-1.