Horses for Courses
Which future transportation mode would you bet on?

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The advent of the 21st century has brought many possible contenders for the satisfaction of future transportation needs into the arena, where transport system aficionados/as and hoi polloi can discuss their relative merits and place their bets on whichever one(s) they think will win out. Transportation is not a game where there is just one winner and all other contenders are "also rans" (and, moreover, it isn't just for human beings). It is much more like horse racing, where the character and length of the course are the most important factors and the distances between the winner and 2nd and 3rd places may be wide or very close. Consequently, although in each type of race there will usually be a clear favourite, an "each way" bet could well prove profitable. This series of articles will consider future transportation in the air, on land and on water, in each case explaining the pros and cons of the various systems on offer, together with an overall evaluation of the market.

Part 1: Air

We'll start in the air for three reasons: Elon Musk's SpaceX has proposed that its BFR[1] could cut intercontinental journeys down to less than an hour—albeit that's just the flight time; a number of small electric and hybrid aircraft have hit the headlines, with prototypes already flying or taking off within a year; and on 28 February 2018 entries closed for Comac's future civil aircraft concept design competition.

It's unlikely that the BFR would ever be used as envisaged above, due to the necessity for passengers to be as fit as astronauts to withstand the high g-forces of takeoff and wear appropriate flight suits. It would probably be extremely fuel-inefficient in this mode and, due to the inevitable sonic booms produced while landing, insurance against breakage of glass in office towers and other buildings of the destination cities would be indispensable (and, no doubt, very expensive). Consequently, while being marvellous "click-bait", the proposal can hardly be regarded as serious.

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[1] See the explanation of acronyms and glossary of technical terms at the end.

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What is by no means unlikely is that the UK Skylon spaceplane, having progressed from a drawing board concept to the development and testing of hardware, will eventually be used for commercial intercontinental passenger transport. Its SABRE engine, fueled with liquid hydrogen, is a multimode hybrid: it operates as a conventional gas turbine for horizontal takeoff and landing; adds a SCRAM jet mode for air-breathing hypersonic flight at subspace cruise altitude; and becomes a pure rocket motor using on-board liquid oxygen for operations above the atmosphere. And Skylon is not the only such aircraft currently under investigation. But it shouldn't be the only customer for hydrogen fuel: One way to significantly moderate the increase of CO_2 in the atmosphere that is presently worrying many people, because of the consequent climate change, would be to significantly reduce the amount of fossil fuel burned worldwide, much of which is due to the rapid increase in passenger and cargo air traffic.

Converting jet engines to burn LH rather than jet fuel (aka kerosene) would slow the rate of CO_2 release but, instead, it would put into the atmosphere more water vapour, which is a much more potent greenhouse gas. It may take several years of research to determine whether or not that would be harmful climate-wise. Meanwhile, we can look at the practical implications.

In the UK, assuming problems of storage and safety on board aircraft could be resolved, we would be looking at the logistics of connecting a suitable high-volume supply (for example, seawater electrolysis plants colocated with and powered by offshore wind turbines) to the various airports; that is, pipelines from offshore to tank farms similar to those for LNG storage, and a parallel copy of the jet fuel distribution pipeline network. This will be explored more fully in the **LAND** sequel to this article.

Until comparatively recently, electrically-powered aircraft have resided firmly within the realm of science fiction; but now, thanks to advances in permanent magnets and lightweight, high-power motors and batteries (concerning which developments promising lighter weight, more storage capacity and faster charging seem to appear almost daily!), all-electric aircraft and hybrids (batteries used for takeoff power boost and landing, and being recharged by a small gas turbine generator during cruise) are already in the air.

One such hybrid for evaluation purposes is an aircraft in which one of the four gas turbine power pods has been replaced by a "drop-in" electric unit together with, in the main body, a battery and charging set. Here, if LH were available as a fuel, the gas turbine-powered range extender charging set could be replaced by a "solid state" fuel cell, which would require far less TLC.

Such electric aircraft are unlikely to grow beyond sizes suitable for regional feeder airlines—at least, for the foreseeable future; but they will certainly gradually take over that market, not only as older fuel-fired aircraft become BER but also because they will be considerably cheaper to maintain.

One of the main reasons for the Comac design competition is the big problem of how to cope with the ever-increasing numbers of people wishing to travel by air, given the restrictions imposed by the limited throughput capacity of existing large-hub airports, many of which are located near or, now, actually within the world's ever-expanding cities. The fraught and seemingly endless discussion of whether to expand London's main airport at Heathrow with another runway, expand one or more of the alternative airports at Gatwick, Stansted or Luton, or even create an entirely new airport in the Thames estuary is just one of many examples.

Presently, for several seaside cities, creating a dedicated airport island just offshore with bridge links to the mainland has been the preferred option. This trend is likely to continue, at least for a while; but the prospect of sea levels rising several metres within this century may well give proponents pause for thought. That prospect could lead to the construction of huge floating airports, such as the mid-Atlantic island envisaged in the period between WWI and WWII, when there was much demand for air travel between Europe and South America.

Although it would be possible to increase the runway capacities of existing airports by using improved ATC to reduce headway between successive arrivals and departures, the extent to which such theoretical increases in capacity can be availed of depends on the capacity of the airport to accommodate aircraft on the ground, the time taken to turn an aircraft around once it has arrived at a terminal, and the time required to disembark and board passengers. The chances of increasing the first are usually slim to none; the need for an aircraft on the terminal apron to be serviced by multiple vehicles leaves little room for improvement of turnaround time; and—often as a consequence of terminals having "just growed" over time—the handling of passengers and their baggage is much slower than optimal.

The introduction of the Boeing 747 jumbo jet can properly be credited for bringing air travel to the masses; but the larger, double-deck Airbus A380, to accommodate which only a few of the largest hub airports were willing to make the necessary revisions to their terminals, has not been able to make a similar leap in capacity. On the brink of having future orders canceled, it has only just (early 2018) been reprieved but the Sword of Damocles still hangs over it.

So, the intent of the Comac competition was to get aircraft and airport designers to put on their thinking-caps and, hopefully, come up with one or more ideas that could alleviate the situation. What could they be?

Finding a way to let large civil airliners take off and land vertically might be one. It would immediately free up a lot of ground space; and headway between aircraft landing and taking off would become almost irrelevant, raising traffic capacity. However, such a radical redesign of large aircraft can only be achieved on a long time scale and something is needed in the medium or, preferably, short term.

An alternative, which is already being investigated via simulation and has produced encouraging results, is for an airport to have a circular perimeter runway. This has the advantages that aircraft can land or take off according to the direction of the wind, or approach or depart in the direction of their flight leg, rather than having to comply with the present more rigid rules concerning holding patterns and fixed directions of arrival or departure. Also, taxiways from the runway to terminals can be tangential rather than at right-angles, making on-ground manoeuvering smoother and faster.

It would be incredibly disruptive, if not actually impossible, for most existing airport terminals to be redesigned for improved passenger and baggage flow. Hence, such improvements—if not made in the several large airport construction or expansion projects that are presently under way in countries having the luxury of having sufficient land to spare—must wait until refurbishment becomes imperative due to the building or its facilities becoming BER. It would, therefore, surely be sensible to consider a new concept for passenger-carrying aircraft in conjunction with the design of the terminal to service it, so as to achieve the fastest possible turnaround time.

For this, the air transport industry should seriously consider containerization, which caused a revolution in global goods transportation by rail, road and sea in the 1960s. However, instead of being rectangular and designed to stack like a freight container, for pressurization reasons the standardized passenger container would be similar to a regular aircraft fuselage, designed to be inserted into a tubular recess in the body of the carrier aircraft, and with active view panels instead of windows (see Box 1).

Box 1. The OLED revolution

Lifting body aircraft and the containerization of passenger transportation have become viable through developments in digital display technology, which has progressed rapidly from the first power-hungry plasma flat screen displays of only a few years ago, through more economical LCDs with flat backlighting—first fluorescent then white LED—to higher definition active colour OLEDs, quantum dots and the fully flexible substrates that would permit passengers to sit by “windows” showing the view outside as seen from an HD video camera.

But why go to these lengths instead of providing real windows, even with the severely restricted view offered by the typical delta wing, to prevent claustrophobia?

The answer goes back to the 1950s, when de Havilland Comet airliners—the first commercial jets—began to fall out of the sky. Research at the UK’s Royal Aircraft Establishment (RAE) at Farnborough proved that repeated atmospheric pressure cycling between sea level and the stratospheric cruise level caused fatigue cracking in the aluminum skin of the aircraft at the corners of the square windows. Based on this research, all subsequent jet aircraft window designs were made oval.

But any hole in a monocoque pressure hull reduces its structural strength, so aircraft designers have been waiting decades for a way out of the window/claustrophobia problem. Now, with curved “flat” displays, they have it, so passenger containers and economically-structured wide blended wing-body designs, which could accommodate two or three passenger containers side by side, are well and truly on the table for the future.

Within the profile of the standard passenger container, with its constraints on the locations of the connexions to terminal services, individual large airlines could fit them out to their own brand style and use their own carrier aircraft; while smaller or low-cost carriers and tour operators could use their own container livery but transport-as-a-service carrier aircraft.

Passengers departing on a containerized route would proceed directly from check-in to the container “gate lounge”, their baggage being loaded equally directly into its below-deck hold. At departure time, the container would be inserted into the carrier aircraft, which would directly proceed to the takeoff queue.

An arriving aircraft would transfer its container(s) to the terminal, where the passengers would disembark, directly collecting any checked baggage. The container would then be serviced by ground staff and “parked” in an automated storage facility, before being transported to a check-in station, ready to receive the next load of departing passengers.

Shifting cabin cleaning, together with toilet waste disposal and water tank refilling, into the terminal would considerably reduce the number of apron operations and minimize personnel movements, thus speeding up the aircraft turnaround time. However, to avoid unnecessary complication of the terminal services design, it would be preferable to retain the economies of scale of the present system of remote kitchens, with victualling of galleys in the carrier aircraft through scissor-lift apron service trucks.

But containerization could also revolutionize the handling of smaller items to be sent by air freight.

Presently, these need to be received at the cargo handling facility, sorted, and transferred into aircraft-specific boxes. These are then taken to the transport aircraft by trains similar to those used for passenger baggage, loaded into its hold by means of a mobile conveyor, and secured by a cargo handling team familiar with the provisions of the particular aircraft type.

Using common overall outlines and connexions for passenger and cargo pods would open the possibilities not only of avoiding the need to transfer this type of cargo into aircraft-specific boxes, but also of allowing shippers to load and unload air cargo pods at the factory or destination, as is presently the case with regular shipping containers.

With outline compatibility between passenger and cargo pods, a 1-pod carrier aircraft could deliver a pod of passengers, receive a pod of cargo which had been automatically transferred between the cargo and passenger terminal pod handling systems, and proceed on its next journey; while a multi-pod lifting-body aircraft could carry a mixture of passenger and cargo pods. This could maximize utilization of pod carrier aircraft, while minimizing the need for pure passenger aircraft and dedicated cargo aircraft, such as those designed to handle large, unwieldy loads or animals.

An aircraft turnaround at an airport terminal is very much like a construction project, in that many activities proceed in parallel, each according to its own internal sequence, but with links at various points where two or more must be synchronized. A *critical path* determines the overall duration of the whole operation and therefore requires careful planning. The art of planning is to arrange for the critical path to be as short as possible. The tricky part is that if one changes—shortens—the duration of one item on the critical path, something else then becomes critical.

With containerization, shortening the physical distance a passenger has to travel between check-in and entering a passenger pod is to no avail if the amount of processing the passenger must endure can't also be cut down; and it's helpful to ensure that processing the first passenger checked in takes at least as long as, but preferably little longer, than it takes for the cabin cleaning team to complete their task.

Presently, the time required for aircraft turnaround operations is balanced by that for processing of passengers, eating, window-shopping and purchasing gifts and duty-free goods; but, with a buffer stock of prepared pods, the passenger processing would become critical, the remaining "slack" being no longer required.

The present absence of tariff barriers between UK and the rest of the EU makes "duty-free" practically irrelevant, together with visa-free processing of travel documents enabling the maximum capacity benefit to be gained from containerizing short-haul traffic between the two. An important and unfortunate consequence of Brexit would be the need to reintroduce these time-wasting obstacles, resulting in an immediate loss of the traffic capacity increase.

So much for the high end of the market; but when looking to the future, we must also consider the many developments there have been in other fields of civil aviation.

Box 2. Passenger processing

While commercial aircraft design has been undergoing continuous incremental improvement, more radical changes have been made to several of the often-slow processes that air travelers must endure between entering an airport terminal and boarding their flight, or on arrival, particularly international.

The formerly ubiquitous multileaf carbonless copy IATA-standard air ticket has been superseded by electronic ticketing, with passengers able to simply present a bar or QR code downloaded to their smartphone or printed out at home after making an online booking.

Digital passports have helped to greatly speed up processing for international flights, although the introduction of biometric ID scanning has been slowed by concerns over the invasiveness of some systems, particularly retina scanning. Presently, facial geometry appears to be preferred.

In the future, however—and despite concerns over personal privacy and it being an invasive technology—the advantages of permanently identifying people with an embedded read-only microchip, as presently done for pet animals, deserves serious consideration. Apart from providing a secure means of identification (yes, there will always be the potential for hacking by those with nefarious intent), Iinkage to airline ticketing and nationality/border control databases would permit fast, smooth and, importantly, totally paperless check-in and passage through border control and departure lounge gates.

But that doesn’t mean that security could be dispensed with. Various unfortunate incidents over the past few decades have resulted in the expansion of CCTV to provide total coverage (with AI processing of the images to both avoid the need for many human operators and recognize, zoom in on and raise alarms for unusual activity); the replacement of film-fogging strong X-ray baggage scanners by much less powerful back-scatter devices with better discrimination, capable of identifying non-metallic weapons; the supplementing of metal-detecting gates with terahertz body scanners; and the unfortunately necessary prohibition of large volumes of liquids in carry-on baggage (unless purchased within the airport duty-free facilities!).

Luckily, all but the last of these measures have caused little or no extra delay in processing; but that one has created a previously non-existent delay which will be difficult to remove, unless scanners that can identify the substances within plastic bottles without opening them can be developed.

In the VTOL sphere it has taken very few years for the multirotor helicopter concept to explode into the innumerable variants we already see in the skies. From the first small prototype it was but another small step to apply the concurrent developments in short-range digital radio communication to permit *swarming* of drones, culminating in the stunning display using thousands of them at the recent (2018) Winter Olympics in Korea; while packet delivery drones are a reality and HD camera and video drones have been eagerly adopted for a vast range of applications, including building construction in which this writer has a particular interest.

Unfortunately, however, it is also too easy for such drones to be adapted to nefarious purposes, such as smuggling contraband into prisons, or to be flown carelessly—or perhaps even intentionally—into the path of larger, “regular” aircraft, risking damage to the craft itself and posing a hazard to passengers, which could extend to injury or even death in the event of a crash. And, while talking of hazards, it is appropriate to also mention the maleficent and dangerous action of persons on the ground shining strong laser beams at aircraft, affecting the vision of flight crews—not only at night but also in daytime.

Multirotor helicopters are also the go-to design for air taxis—both "Uber"-style and autonomous—although aircraft with motors that are either embedded in wings which can be oriented vertically for takeoff or landing or horizontally for forward flight, or rotated osprey-style, can also be found. A small helicopter with interleaved twin contrarotating rotors has also recently appeared.

There's a big problem with air taxis and packet delivery drones, however: they will inevitably create an intracity ATC nightmare. Through the carefully programmed CGI of S-F movies and video games we have become accustomed to seeing multitudes of air vehicles traveling smoothly in every possible direction, at multiple levels, while carefully avoiding major characters indulging in violent action and wild aerobatics. In the real future world, with all these vehicles operating independently, it will be nothing like as tidy.

What is of more concern, though, is the aftermath of a mid-air crash. While it is reasonable to believe that air taxis, whether piloted or autonomous, would be equipped with sensor systems similar to those of road AVs for collision avoidance, the same cannot be said for the much smaller "dumb" package delivery drones. With city skies possibly becoming littered with such devices, it appears that "accidents" involving them will be unavoidable.

In the case of a road accident, passers-by with normal hearing and vision would have a reasonable chance of noticing a dangerous situation and taking evasive action; but would a pedestrian notice and be able to avoid a dead or wounded drone falling and hitting the ground, or anyone walking on it, at a speed potentially greater than that of a Formula 1 car?

Already, today's road AVs have to process huge quantities of sensor data just to deal with travel along defined corridors on a 2-dimensional plane—and potentially much more, if V2V communication is mandated to facilitate the interlacing of traffic flows at junctions, which can increase road capacity. Small air vehicles additionally coping with a third dimension and no physical constraints would have to deal with a quantity of information orders of magnitude larger. It's a daunting prospect.

In the fixed-wing field there is at least one startup looking to resurrect the SST concept and expand its scope to include supersonic travel over land, thanks to NASA research into low-boom technology. Meanwhile other existing planemakers, apart from extensively tweaking wings, control surfaces and engines in the increasingly important struggle to reduce fuel burn, have been looking at the possible configurations of the conventional tube-and-wing design and lifting body aircraft with the aim of relying less on engine thrust to produce lift.

Another fixed wing design, researched for decades behind the Iron Curtain under the name "Ekranoplan" but which, having only recently appeared in the West, cannot now be ignored, is the "ground effect aircraft". Generally a seaplane, it is worthy of mention because, between the two World Wars, much intercontinental air transport was by means of large flying boats, such as the Imperial Airways Empire and Pan-Am Clipper.

Rather than large airports with hard runways, of which there were then very few, those for the times large (and very comfortable) aircraft needed only stretches of clear water for landing and takeoff—and in an emergency could be ditched almost anywhere. This was convenient, as many of the world's large cities are located on coasts or, in the case of North America, on the shores of the Great Lakes.

Although the ground effect aircraft could not be used in this application, as it relies on flying only a very short distance above the surface and could not tolerate large ocean waves, it might just reactivate interest in flying boats as a means of providing the much-needed increase in passenger capacity without more "hard" airports, which require huge investment in land and capital equipment, and without overcrowding the already full existing flight corridors.

In terms of really personal (and stripped-down) aviation, a minimalist can use a dirigible rectangular parachute to paraglide. While a skilled paraglider can do much that was previously only possible in a hard glider, strapping on a propeller backpack enables the paraglider to become a functional airplane. It's not the same as a British bobby with helmet, whistle and helicopter backpack directing air traffic envisaged by W. Heath Robinson, though!

In between paragliders and small fixed-wing aircraft are microlight aircraft, with the pilot seated in front of a pusher propeller having very basic steering and throttle controls (and few, if any creature comforts). Nevertheless, such aircraft have been used for many purposes—not least, and notably, allowing a naturalist to accompany a flock of geese on their annual migration.

We also mustn't forget jet packs, with or without soft or rigid *wingsuits*. In the early 1950s (if not before) they were S-F devices; but they are now well and truly real. When considering transportation, we can exclude those that are towed behind a speedboat, which also supplies high-pressure water through a hose to power the jets. However, there has been continuous, if slow, development of free-flying air jet units, whether powered by gas turbine or, more recently, electric fans.

The biggest obstacle has been overcoming the weight of the equipment and its power supply. Early gas turbine units supporting an upright flier had an operating duration of only a few minutes. Now, thanks to advances in materials and engine efficiency, fliers with rigid wingsuits can fly at high speed for tens of minutes; while similar advances in lightweight battery technology have made electric-powered units feasible.

Recently, near misses between paragliders or microlights and regular aircraft have occurred because these small flying devices are typically not registered by the aircraft's on-board collision warning radar. However, now that the problem has been highlighted, the obvious solution is to require them to carry radar transponders, so that they may be recognized and safely avoided, on the same principle as at sea: "steam should give way to sail".

There remains, albeit only sparsely, a type of aircraft that was very popular between the two World Wars but practically disappeared with the emergence of the first practical helicopter: the autogyro. Otherwise a conventional fixed-wing aircraft, in addition it has a freewheeling rotor above. As it gathers speed along the ground for takeoff, the increasing wind makes the rotor spin. This generates aerodynamic lift to augment that from the wings, enabling it to have a much shorter wingspan than its pure fixed-wing counterpart. Also, since the rotor is freewheeling, there is no need for the long body and torque-balancing tail rotor required by a conventional helicopter unless it has twin contrarotating rotors. Consequently, an autogyro can often be stored in an automobile garage rather than an aircraft hangar.

To finish this review of future air transportation, the writer would like to mention something which he believes has not received enough exposure: the variable-lift airship. Instead of the sealed envelope of a conventional airship (aka blimp), it would have a pervious shell containing multiple concertina-style gas bags filled with helium or hydrogen. For smooth landing and takeoff, load balancing or less than maximum lift, some of the gas would be compressed into cylinders, with replacement air flowing through the shell into the vacated space as the gas bags contracted.

This lighter-than-air craft could be invaluable in the fields of rescue and disaster relief because of its several advantages over the presently ubiquitous helicopters: not needing power to create lift, it has a much longer mission duration/range; it is easier to manoeuver and hover; and it can alight on water, allowing people in difficulty to be rescued quickly, without the need for slow and dangerous winching.

Also, it can be made with a load capacity as big as or bigger than the dual-rotor Chinook, while being more manoeuverable because, rather than the pilot having to always be careful to keep sufficient clearance between the two large rotors and the surroundings—for example mountains or buildings—the propulsion pods can be located within the plan area of the vehicle, allowing it to enter much tighter spaces.

In the context of changing to sustainable energy sources, airships could be particularly advantageous for the installation and servicing of large offshore wind turbines since, with a suitably large load capacity, they could carry fully-assembled head units, complete with blades, place them carefully in position for initial installation, and later remove them as a whole for servicing or repair at an on-shore facility.

All cranes, particularly the tower cranes used on high-rise buildings, are subject to hook swing, especially if there is any more than a little wind. For the crane in an airship above an offshore wind farm, accurate positioning of the heavy hook would be essential to avoid such swing and possible consequential damage to turbine blades. This could be simply achieved by adding to or incorporating in the hook a drone designed to position but not lift. The hook could then be guided safely and accurately toward the lifting eye by an operator on the turbine tower or in the airship using a normal drone control set.

Summary and predictions (air)

In the near future, we are likely to see a large increase in the proportion of electric and hybrid conventional aircraft.

As concerns over climate change increase, we could also see a quite rapid changeover from fossil jet fuel to hydrogen, initially just for smaller aircraft, until a long enough safety track record has been established. On the other hand, with a still-increasing global human population, biofuel will become a historical curiosity.

The uses of small drones will continue to multiply; but their use for package delivery will wane, after an initial surge, due to the frequency of accidents causing damage on the ground. However, air taxis will proliferate, provided traffic rules for AVs and human pilots are developed quickly and enforced strictly without fear or favour.

Airships (which “dropped off the radar” but never actually expired) will experience a resurgence, once their advantages in the situations described in this piece have been demonstrated a few times.

Further ahead, containerization of passenger and cargo air transport will surge; but only when the major hub airports reach their capacity limits under the present system and require a qualitative change to move forward—or, as with the containerization of shipping, when some visionary people are willing to invest in dedicated (and disruptive) container airports.

Explanation of acronyms

ATC	Air traffic control
AV	Autonomous vehicle
BER	Beyond economical repair
BFR	Big Falcon Rocket
CCTV	Closed-circuit television
CGI	Computer-generated imagery
HD	High-definition
IATA	International Air Transport Association
ID	Identity/identification
LCD	Liquid crystal display
LED	Light-emitting diode
LH	Liquid hydrogen
LNG	Liquid natural gas (methane (CH_4))
LOX	Liquid oxygen
NASA	National Aeronautics and Space Administration
NO_x	Oxides of nitrogen
OLED	Organic LED
QR	Quick response [code]: a 2D pattern holding much more information than a 1D barcode
RAE	Royal Aircraft Establishment (Farnborough, UK)
SABRE	Synergistic air-breathing rocket engine
SCRAMjet	Supersonic compression ram jet
S-F	Science fiction
SST	Supersonic transport
TLC	Tender loving care
UAE	United Arab Emirates
UAV	Uncrewed air vehicle
VTOL	Vertical takeoff and landing
V2V	Vehicle-to-vehicle
WWI	World War 1 (1914–8)
WWII	World War 2 (1939–45)

Glossary of technical terms

Apron	The aircraft parking & servicing area in front of a terminal building
Brexit	The process of divorcing the UK from the EU
Critical path	A set of linked activities that must be fully completed in the correct sequence to accomplish an operation; this path hence determines the minimum overall duration of the operation

Dirigible	Capable of being directed
Drone (UAV)	An aircraft that carries no human pilot. Presently, practically all such aircraft are operated by a human in charge of a remote-control system, whether the hand-held box used by an enthusiast or someone on, say, a construction site using a quadcopter camera drone within direct visual range, or the highly complex video terminal used by a military operator controlling a UAV for surveillance or offensive action in a battlefield halfway across the globe. Although a very few fully autonomous aircraft are under test, they are by no means as advanced as autonomous automobiles or trucks.
Headway	The time or distance separation between vehicles using the same defined transportation corridor—airport runway, railroad track or road traffic lane
Jargon	Often, "in-crowd" shorthand identifying a highly technical concept or procedure, or a complicated piece of equipment
Lifting body	An aircraft in which the aerodynamic lift is provided by the passage of air over the large area of a combined delta wing/body configuration at a lower speed and, importantly, with lower power demand than is required to get the same lift from a conventional transverse wing.
Monocoque	Enclosing a space within a non-load-bearing envelope requires a separate space frame for support. A monocoque envelope provides clear space with the required structural strength.
Paraglider	Early parachutes were circular, with little ability to change direction by pulling on the suspension cords. During the Vietnam war, rectangular parachutes (paragliders) were designed to provide the maximum possible directional control, allowing aircraft pilots shot down over enemy territory to (hopefully) glide to safety—and experience a very much lighter touchdown.
Quantum dot	Core component of a high-definition video display in which the pixels are exceedingly small
Swarming	The coordinated action of a number of robotic vehicles. It usually involves a combination of central command to direct and oversee the execution of a mission, autonomous control of each vehicle to account for field conditions, and V2V communication for station-keeping and transferring tasks to other vehicles, if expedient
Terminal	An airport building providing facilities for handling passengers (and their baggage) or cargo between an aircraft and means of ground transportation
Wingsuit	A soft wingsuit has cloth membranes stretched between the arms, body and legs, like the skin of a flying squirrel. A rigid wingsuit has rigid airfoil sections on which jet propulsion units are mounted attached to the flier's arms, with fuel kept in the flier's backpack.