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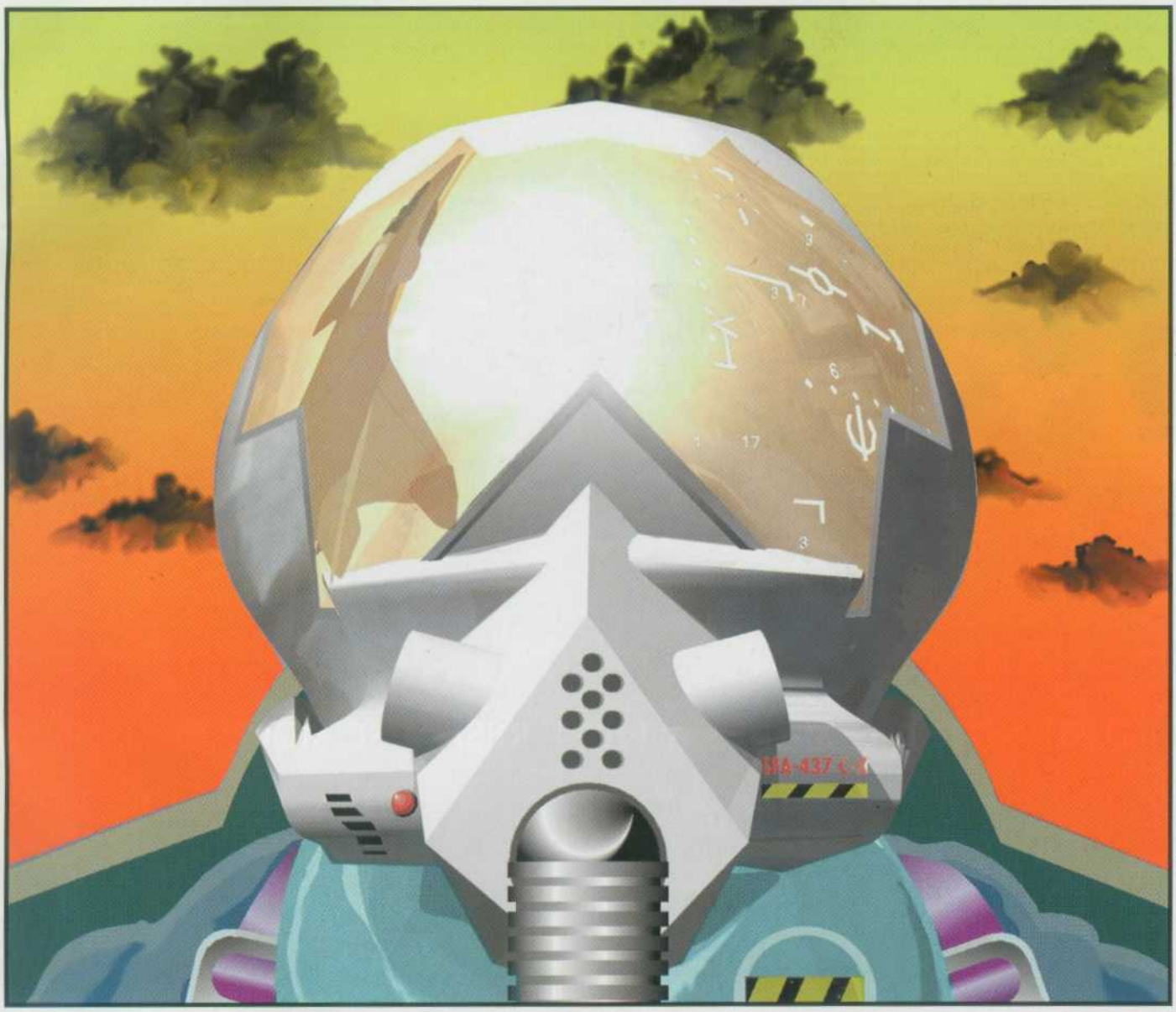


Vision 2020: reflections on future technology

Turning science fiction into fact

Not only the US Air Force is investing time and money in future air vehicle technology, as Nick Cook reports

Technologists who dabble in the interpretation of visions do not always get it right. Take this example from a specialist US aviation magazine in 1956: "We're already working with equipment to cancel out gravity," Lawrence D Bell, founder of the company that bears his name, was quoted as saying.

Bell, apparently, was not the only one working in this field. Others said to be seeking to master this arcane 'science' included the Glenn L Martin Company, Convair, Lear and Sperry Gyroscope. Within a few years, we were assured, aircraft, cars, submarines and power stations would all be driven by this radical new propulsion technology. Sadly, it was not to be.

However, despite some notable setbacks, the US Air Force has never given up on its 'vision'. The word recurs again and again in service literature and is always on the lips of those who run its science and technology (S&T) programmes. In no other air force — in no other nation — is such prominence given to the techno-visionary.

USAF is constantly looking 25 to 30 years ahead. It encourages those who work within the service — and the companies that build systems for it — to gaze into the future, to set ambitious goals and to strive to realize them. It goes so far as to map out this vision in unclassified literature — the periodically released 'Air Force S&T Program' — and has a formal mechanism for bringing revolutionary technologies to the boil. The latest example of this, Project Forecast II — the third in a series of studies going back to 1944 — was published in 1985.

Between the S&T Program and Forecast II, we are afforded a glimpse of what might be in 2020. By comparing these documents with the Pentagon's last Defense Technology Plan, published last September, which gazes a maximum of 10 years ahead, it is also possible to zero in on what revolutionary advances USAF may be looking for. The picture is only partly representative because of the enormous resources allocated to 'black' projects, programmes so sensitive that, technically, they do not exist. By their very nature, many future projects fall into this category. The picture is also blurred by USAF's failure to publish an 'S&T Program' since 1990 and the enormous political and military upheavals that have taken place in the interim.

Yet, revolutionary technology, according to USAF, is only partly dependent on these external forces. As well as what USAF calls 'capability needs' — requirements specified by its user commands — the other big driver is 'technology innovation': "the process," says the S&T Program, "whereby an air force laboratory or industry team conceives of a new technology and interests users in exploiting its capability." It goes on: "Most of the really significant improvements in military technology — radar, jet engines and the atomic bomb — occur this way." Even so, quantum leaps require a great deal of funding, and the USAF's S&T community, like the rest of the US military, finds itself with a static budget and short on personnel. USAF R&D and S&T funding for FY95, however, still hovers around the $11.5 billion mark — a considerable amount of money. Enough, certainly, to transition some key technologies to the user commands and so maintain technological superiority, considered by USAF to be the 'backbone of deterrence', well into the 21st century.

HYPERSONICS

Despite a rash of observer 'sightings' of unidentified high speed, high flying air vehicles in the late 1980s and early 1990s, the US Government has consistently denied it has developed or is developing an aircraft to replace the Mach 3-plus Lockheed SR-71 strategic reconnaissance platform. Its blanket denials of an 'Aurora-type' capability included hypersonic aircraft for missions

A manned wind-tunnel model of Germany's medium-range missile fighter, Lampyridae

other than reconnaissance.

That USAF entertained hypersonic ambitions for a range of roles in the mid-to-late 1980s, however, is not in dispute. Four out of eight 'mission area summaries' for air vehicles in the '1990 S&T Plan' — strategic offence, strategic defence, space and recce/intel — called for a NASP-derived vehicle to replace current bombers, orbital launch vehicles and reconnaissance aircraft. NASP was the X-30 National Aero-Space Plane, a NASA-led effort, since cancelled on funding and technical grounds.

Forecast II said: "The air force will be able to go into space and de-orbit on demand as a result of the improved understanding of hypersonic aerodynamics, particularly in the Mach 8 and Mach 25 regime." With NASP cancelled and, apparently, no Aurora capability in the offing either, does this mean USAF has abandoned all hope of fielding a hypersonic platform in the future? Apparently not.

In last year's Defense Technology Plan, a 'roadmap of technology objectives' lists a "flight demonstration of (a) Mach 8 hydrocarbon-fuelled scramjet (supersonic combustion ramjet)" as one of its key goals by 2005 in the aerospace propulsion field. Elsewhere, the document says, "the demonstration of a scramjet to M>12 may lay the foundation for single-stage to orbit space launch." That such a capability is not undergoing significant development in the classified R&D arena would, many qualified observers believe, be highly unusual. Mastering hypersonics is certainly consistent with one of two current overriding drives within USAF labs — operating at ever increasing range from the Continental USA (the other is making current technologies more affordable) as US overseas forces contract.

GAS TURBINE INCREMENTS

Research into more conventional aero-engine propulsion continues via the Integrated High-Performance Turbine Engine Technology (IHPTET) programme and other comparable efforts outside the USA. By 2005, the IHPTET will be delivering 100 per cent thrust-to-weight improvements over current fighter-type jet engines.

Artist's concept of British Aerospace's Future Offensive Aircraft for the UK

In the UK, Rolls-Royce is locked into a technology demonstration schedule that, all things being equal, will see it running a combat engine in the same time period with a 60 per cent improvement in thrust-to-weight ratio over the Eurofighter 2000's EJ 200 — an airframe-powerplant combination that, as *Jane's Defence Weekly* went to press, is yet to fly. Though less dramatic improvements will always be sought in other aspects of engine development — fuel burn, life-cycle and acquisition cost, for example — radical enhancements of the jet engine itself are finite. Doubling the power-to-weight ratio again by 2020 may simply not be worth the effort or cost. Alternatively, pushing for all-out power may have an adverse effect in other areas, such as 'signature management', ensuring engines remain as stealthy as their airframes.

THE SUPER COCKPIT

"Machines," according to Forecast II, "must respond reliably to voice commands and eye motion signals, and man and machine must interact to share the sense of touch." An area of research that will be critical in achieving this is virtual reality. It is predicted that the virtual cockpit — the pilot deriving his or her entire view of the outside world via cockpit and helmet displays — will begin equipping operational aircraft in 2020. Research at Aeronautical Systems Center laboratories at Wright-Patterson Air Force Base, Ohio, embodies the essence of what USAF calls the Super Cockpit. According to Forecast II, a two-way flow of visual and aural information between pilot and aircraft will enable him or her to aim and fire weapons or to activate other cockpit functions simply by looking or talking. Add 'thinking' to that list and the picture is even more complete.

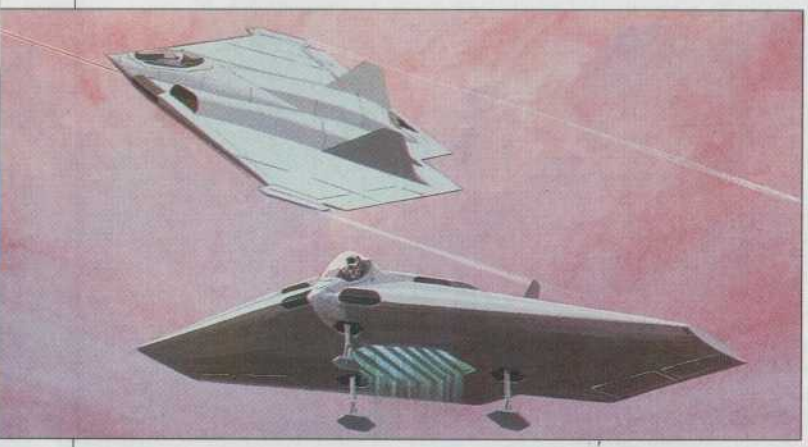
Revolutionary advances in the cockpit will be helped by a shift towards commercial off-the-shelf avionics, especially in the computer processor arena.

Modular avionics, based on slide-in, slide-out processor cards, will allow users to improve sensors and cockpit systems without implementing costly mid-life upgrades. Situational awareness will also be vastly improved thanks to real-time access to satellite communications, imagery and other intelligence information distributed between every echelon of the command and fighting forces. Also growing in importance are mission planning and rehearsal tools — most of them PC based — that allow pilots to fly sorties 'virtually' before they have even taken off to strike the target.

BAe Military Aircraft Division's concept for an air vehicle employing anti-gravity propulsion

WEAPONS

In the 'conventional armament' field, USAF's goal is to develop 'affordable, autonomous, all-weather, day and night stand-off weapon technologies that provide near-perfect accuracy'. By 2020, it will probably be dependent on an advanced ramjet-powered version of, or successor to, the AMRAAM medium-range air-to-air missile and the short-range AIM-9X dogfight missile or its pre-planned product improvement. Available P³I options are likely to include multi-spectral, stealth-defeating seekers. Beyond improvements to the next-generation air-to-surface weaponry typified by the Joint Direct-Attack Munition and the Joint StandOff Weapon, other more exotic tech-



Another BAe concept showing an anti-gravity propulsion system in action

nologies are being sought for soft and hard kill options. "We will transition high and medium power microwave technologies to developers for use as weapons, broadband countermeasure devices, radars and enhanced jammers," the S&T Program reports. "We anticipate breakthroughs in long-range, high-altitude, very high-velocity impact weaponry for use against a variety of hardened (including very deep) targets," Forecast II adds. This has been given added impetus by the development of Third World weapons of mass destruction, which might typically be stored in such places. The current development of an airborne laser for boost phase interception of theatre ballistic missiles is one of those rare leaps in capability that will change the way wars are fought. By 2020, miniaturization techniques may result in deploying lasers in smaller, tactical aircraft. Increased application of photonic as opposed to electronic-based equipment will make user aircraft less susceptible to damage from the EW threat. 'Smart skins' — outer panels containing embedded sensors — will allow aircraft to sense and communicate across multiple frequency bands in any direction from any attitude.

STEALTH

In 1985 and 1990, Stealth was so sensitive that Forecast II and the S&T Program barely gave it a mention. Stealth has changed irrevocably the way in which war in the air is being and will be fought. The USA — and other Western technical powers like France, the UK and Germany — are pouring considerable funds into the mastery of both Stealth and Counter-Stealth technologies.

Take the UK, for example. Since the mid-late 1980s, British Aerospace Warton has pumped over £100 million ($160 million) — about half of it coming from government sources — into infrastructure improvements geared towards Stealth. Much of this activity is aimed at meeting the RAF's need for a Future Offensive Aircraft (FOA) to replace the Tornado IDS. Traditionally, US firms such as Lockheed and Northrop have enjoyed a US-only monopoly in black programming — the development of aircraft that are invisible to public scrutiny.

Recent revelations that BAe is establishing a 'Skunk Works' on its own remote site at Warton and that the Germans tested manned wind-tunnel models of their Stealth fighter, the Lampyridae, in the mid-1980s — when the first-generation Lockheed F-117 was still so classified its existence was officially denied — show an emerging trend towards 'black' programme secrecy in Europe, mirroring that of the USA.

Together with advanced, lean manufacturing techniques that will allow companies to rapid-prototype and build small batches of aircraft at low cost, expect more from these countries in the way of classified technology demonstration and even low-volume production programmes, including full-sized air vehicles. 'More', because according to numerous sources, such activity is well advanced already. In the USA, it is widely accepted that a third generation of true Stealth aircraft (beyond the first generation F-117 and the second generation B-2) is already under test and perhaps even in service for missions spanning strike and defence suppression as well as tactical and strategic reconnaissance.

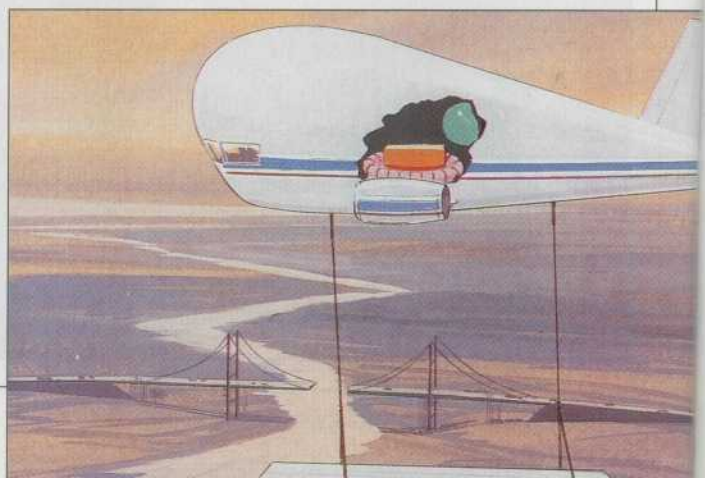
BEYOND 2001

Groom Lake, Nevada, is the epicentre of classified USAF research into Stealth and other exotic aerospace technologies. Several years after the collapse of the Soviet threat, activity and investment at this remote, highly secret air base (so secret its presence is, as yet, unacknowledged by the US Government) is still on the increase. While research into less sensitive technologies such as two-dimensional thrust-vectoring and advanced short take-off and vertical landing (ASTOVL) are pursued in the open at nearby Edwards AFB in California, Groom Lake is set to hang onto its secrets. The USAF's recent confiscation of 1600 ha of public land bordering the facility is consistent with the Pentagon's desire to maintain its lead in quantum leap technologies — some of which, according to well qualified observers in and around the Nevada area, defy current thinking into the predicted direction of aerospace engineering.

That aerospace companies continue to look at highly radical alternative air vehicle concepts is evidence of the ongoing quest for breakthrough designs. Glimpses into this world are rare, but provide some insight into likely 21st century research activity. The 1990 unclassified 'Electric Propulsion Study' (a quest for an antigravity propulsion system by another name) conducted by the USA's Science Applications International Corp on behalf of USAF's then-Astronautics Laboratory at Edwards AFB, shows that USAF's visionaries are still being given free rein. Until recently, BAe also provided internal resources for its own anti-gravity studies and even went so far as to outline this thinking with artists' concepts — a case of Lawrence Bell's vision perhaps being not so wide of the mark after all.

Before he died, Ben Rich, who headed Lockheed's Skunk Works from 1975-1991, was quoted as saying: "We have some new things. We are not stagnating. What we are doing is updating ourselves, without advertising. There are some new programmes, and there are certain things — some of them 20 or 30 years old — that are still breakthroughs and appropriate to keep quiet about. Other people don't have them yet."

Thirty years from now, we may still not know the half of what is currently being tested in and around Groom Lake. **JDW**



BAe concept for a heavy lift vehicle, also using an anti-gravity propulsion system