A close-up of a soldier's helmet with a mounted display unit. The helmet is dark and has a large, curved visor. A camera or sensor unit is mounted on the side of the helmet. In the background, a military helicopter is visible against a sunset sky with orange and purple hues.

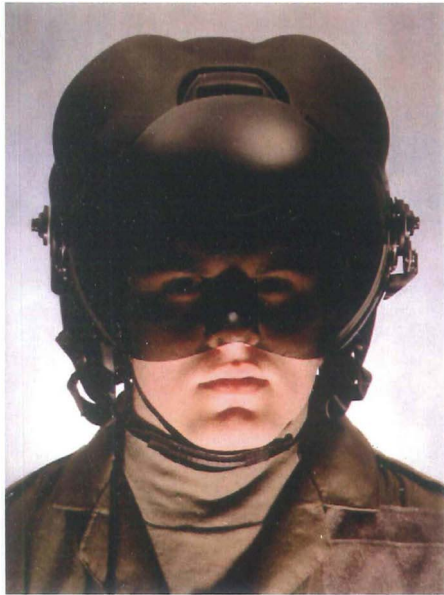
STRIKER

Helmet Mounted Display for ATAK

BAE SYSTEMS

Striker

ROTARY WING HELMET MOUNTED DISPLAY SYSTEM



Part of a family of Visor
Projected Displays



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The Preferred Solution for the AH-1Z

The Striker Helmet Mounted Display System (HMDS) employs a visor-projected approach, proven in many hours of flight test on a variety of platforms. BAE SYSTEMS was the first company to develop and fly a binocular visor projected HMDS and has built on this experience to offer low risk Striker helmet solutions now entering production for the multi-national Eurofighter programme and in full scale development for the US Marine Corps AH-1Z attack helicopter. The Striker family of Helmet Mounted Displays is the most technically advanced currently available, offering unparalleled performance combined with excellent in-service supportability and the capacity for technology insertion as the Turkish Armed Forces requirements develop.

In comparison, the competing solutions offered by other manufactures are based on a fundamentally older generation of technology, with lower in service performance and utility, offering little scope for future performance improvement or growth.

As an integrated element of the helicopter avionics sub-system, the Striker helmet system supports improved communication and reduces cockpit workload leading to improved mission effectiveness. The helmet is a key element in furnishing information superiority on the battlefield and improved communications

allowing the application of precision force in diverse scenarios such as military operations in urban terrain.

Competitor products are unlikely to deliver anything beyond a very basic level of performance and capability with little prospect of growth to support changing operational needs over the life cycle of the ATAK platform.



STRIKER HELMET MOUNTED DISPLAY FOR
EUROFIGHTER

System Capability

A key feature of any HMD design is that it combines both avionic functions with aircrew life support and protection functions in a single entity.

The BAE SYSTEMS Striker HMD is the only HMD that fully meets these somewhat contradictory requirements for the AH-1Z and also for other helicopter platforms.

The less capable HMDs offered by other manufacturers have not been designed or qualified to meet the AH-1Z requirements.

The Striker HMD is an important functional element within the AH-1Z cockpit displays, enabling the aircrew to interact with the aircraft systems, providing the high quality display of information in the form of symbology in daytime and symbology overlaid on high definition night vision imagery at night. The HMD also provides routes for audio information such as speech and caution warnings.

Competitors HMD products do not provide all of these capabilities and have been designed to meet less demanding system requirements for other applications.

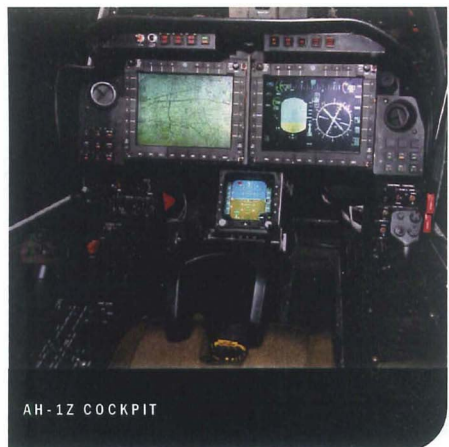
The Striker HMD enables the user's head motion to point sensors and weapons and to control symbology displayed on the HMD more accurately than any competing system. It

provides a flight proven capability to deliver ordnance or point sensors with very high precision at large off-axis angles.

The Striker HMD's angular coverage and head motion box are larger than most competing systems.

The Striker HMD is the only HMD that provides a comprehensive information display of symbology, in both day and night conditions without requiring helmet reconfiguration and with no performance compromises.

Competing solutions from other companies require component changes to configure the HMD for day or night or simply provide poor performance in daytime and compromised night-time performance due to limitations of the design concepts adopted.



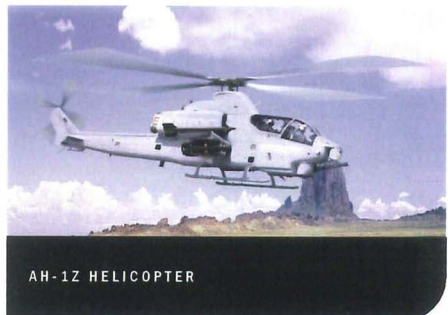
Product Maturity

The Striker HMDS benefits from 15 years experience of binocular, 24 hour HMD development and flight test working with world class experts from customers which include the US Navy, US Marine Corp, US Airforce, NASA, UK MOD, German Army and German Airforce. The helmet optical system, a key element of the HMD, is fully proven, having been selected for both the Eurofighter and AH-1Z programmes, whilst the Head Tracking System is a state-of-the-art, metal tolerant system, proven on the Tiger helicopter (also selected for the USMC AH-1Z) and now in full production.

The Striker HMDS will shortly be fully qualified for the AH-1Z helicopter to a demanding US Marine Corps specification and is therefore compatible with most other helicopters.

Striker provides the high performance system required for any Turkish Armed Forces helicopter application with very low risk.

It is surprising that some of the competing helmet systems come from suppliers with absolutely no track record or flight experience in advanced 24 hour, binocular helmet displays. Furthermore, the AC electromagnetic head trackers used by our competitors are essentially older designs offering very poor installed accuracy.



AH-1Z HELICOPTER

Day / Night Capability

The Striker Helmet Mounted Display provides a true 24-hour day/night capability using detachable intensified night vision cameras. Unlike competing systems this is achieved using a single lightweight display module fitted to lightweight basic helmet.

Competing HMD products require component changes (on the ground) to configure the helmet for day or night operation or alternatively limit the user to flying with heavy optical systems all of the time.

The BAE SYSTEMS Striker HMD operates in all light levels providing high quality symbology in full daytime or symbology overlaid on high definition, night vision, imagery for night flying. The display modules provides a fully overlapped 40° binocular field of view, visor projected display of symbology displayed over the full binocular 40° FOV.

One of the competing systems provides symbology over a restricted monocular 30° FOV with a very limited display brightness, severely limiting the HMD operational capability in normal daytime conditions.

The Striker display module is equipped with fully raisable dual visors, normally an inner clear visor and an outer sun visor (laser visor options are also available). This user friendly visor

system, confers maximum flexibility in the operational utility of the Striker HMD, for example operating in bright sunlight, through twilight and dusk into night flying conditions without any reconfiguration of the HMD.

Competing designs do not provide dual visors or the ability to easily raise or deploy visors, significantly reducing the capability for 24-hour operation and reducing operational flexibility.

The dual Night Vision Cameras may be fitted or removed at any time either preflight or during flight at the pilot's discretion.

Competing designs either limit the user to either day or night operation or restrict the user to flying with heavy and bulky optical systems all of the time.



Head Mounted Night Vision Sensor

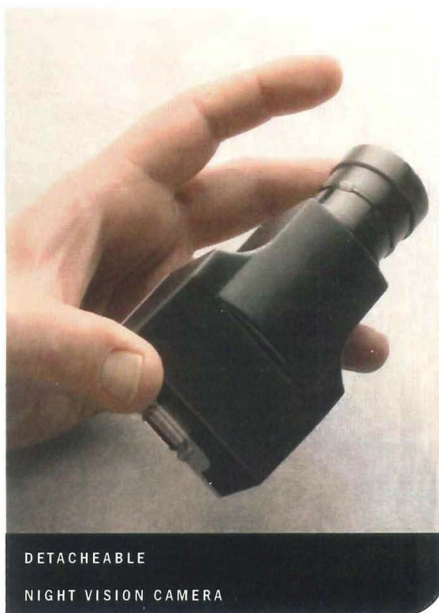
BAE SYSTEMS Striker HMD uses two, in flight detachable advanced Night Vision cameras, located on the helmet in positions which ensure minimum effect on centre of gravity, no reduction in head mobility (especially in the compact AH-1Z Cockpit) and minimise visual obscuration and spatial disorientation effects.

The design of the Striker HMDS and location of its Night Vision sensors results from many years of flight test experience with the German Army, extensive human factor studies and has been tested in the AH-1Z cockpit.

Some competing systems use two conventional image intensifiers (and associated bulky optics assemblies) mounted high on the head and in locations likely to result in a night vision image which in our experience introduces unacceptable spatial disorientation, significant obscuration caused by the cockpit bow-frame and an unacceptable centre of gravity. The latter is likely to cause fatigue in normal operation and unacceptable neck loads in emergency egress situations.

The STRIKER HMD exploits electronic image combination using high definition night vision cameras. These provide a total night vision performance, which exceeds that offered by the directly viewed un-enhanced image intensifier.

Competing designs optically combine the output of a display device with the output of the image intensifier tube. This results in multiple optical channels, which add bulk and weight to the HMD. It is a much less flexible system and results in compromised HMD performance. It is stuck with the limitations of the un-enhanced Image Intensifier Tube which although providing good resolution in high light levels, provides relatively poor performance at low light levels where the eye may not resolve imagery available on the Image Intensifier Tube. In urban situations the halo around bright light sources obscures surrounding detail and the user has no control of image brightness and contrast.



DETACHEABLE
NIGHT VISION CAMERA

Night Vision Performance

The Striker HMD provides enhanced night vision from the two miniature helmet mounted Night Vision Camera. The output video signal is fed back to the remote display drive electronics where it is electronically combined with the symbology and displayed on the helmet mounted CRTs in the normal way.

This approach provides better night vision than un-enhanced Image Intensifier Tubes, allowing the user direct control of image brightness and contrast. The built in real time image processing extracts the performance available from the Image Intensifier Tube, eliminating the effects of halo and making visible detail not previously visible in dark conditions.

There is no fitting and set-up time required, as the Night Vision Cameras are essentially “clip on and use” devices.

Additional benefits arise from the flexibility to locate the NV Cameras in the optimum location unconstrained by the HMD optical system. These include improved centre of gravity, improved crash safety and of course, better HMD performance - not constrained by optical coupling.

The Night Vision cameras use the very latest Generation 3, Omnibus 4 low halo image

intensifiers which are the highest performance devices available today. The output image is processed (inside the camera) in real time, to provide an enhanced night image on the HMD. The built in Advanced Anti Blooming Technology (ABT) allows the system to see through the halo around bright lights whilst the Enhanced Automatic Gain Control (E-AGC) dynamically compensates the scene image to improve the dark scene imagery whilst preserving high light details with no loss of sensitivity.

Intensifier gating and Micro Channel Plate (MCP) Control provide improved interscene dynamic range so that the NV Cameras operate in light levels from overcast starlight to day light fully automatically without requiring any display adjustment or a mechanical iris.

None of the competing solutions offer the user this level of total night vision performance and flexibility to operate in nearly all light levels including daytime. In fact the Image Intensifiers used in competing solutions will be damaged by very bright lights or inadvertent exposure to daylight.

Night Vision Performance

Intrascene dynamic range 1,000,000 : 1

The Night Vision Camera provides the ability to see objects normally obscured by the halo round bright lights or to see down a dark alley next to a street light and enhanced detail in dark regions with no loss of high lights details.

Interscene dynamic range 100,000,000 : 1

The camera provides a high quality video image of the outside world scene operating over a very wide dynamic range from very low light levels (overcast starlight) to high light levels (day light)

Field of View - Binocular 40 degrees fully overlapped.

Provides comfortable night viewing whilst maintaining all of the available depth cues in the binocular scene.

One of the competing approaches is understood to provide a reduced binocular FOV of only 30° with monocular viewing outside this central region. US Army Human factors studies have shown that this approach reduces performance and results in peripheral flicker and noise effects.

Resolution is normally defined using the modulation transfer function (MTF) of the system where each element within the display system makes a contribution to the overall system MTF.

The Striker HMD display with NV Camera imagery achieves a limiting resolution of

>1cycles/mrad (moon light) which is comparable with optical coupled systems.

System MTF for a typical optical coupled Image Intensifier Tube (assuming a high performance optical subsystem) is 1.1 cycles/mrad (moonlight) (compared with a NVG which achieves around 1.3 cycles/mrad)

The Night Vision Camera performance at low light levels exceeds that of the unaided Image Intensifier – therefore the Night Vision Camera solution provides a total Night Vision performance which exceeds that of all competing solutions .



Optical System Approach

The BAE Striker HMD utilises our revolutionary high performance visor projected optical system. This patented design is entering production for the multinational Eurofighter program and forms the basis of the HMD for the USMC AH-1Z.

It is the worlds most compact and lightweight 40° field of view optical system, and utilises visors of standard spherical form (and low cost).

The unique design offers exceptional image quality over the full binocular field of view of 40 combined with large (>20mm) exit pupil. The visor is fully adjustable and may be raised and lowered in the same way as a conventional helmet visor. The Striker HMD Visor projected design exploits the spherical symmetry of the visor so that it is insensitive to downstop position.

Competing designs use either a pseudo visor project approach or locate large eyepieces in front of the user eyes.

The former approach requires a visor of non standard (and costly) form, which is rigidly fixed to the display module. This means that the whole display module must be tilted to raise or lower the visor and also that visor alignment is more critical. The limitations of the bi-spherical visor approach are well understood by BAE

SYSTEMS having been tested and rejected for the Eurofighter HMD programme on the grounds of high cost, limited performance and pilot acceptability. Such a visor also significantly limits the true interpupillary range available.

Other competitor systems utilise large combining eyepieces as the final element of an optical system. This design concept was initially pioneered by BAE Systems some 15 years ago.

The ultimate eyepiece system is now in production as the Knighthelm HMD for the German Tiger in preference to a lower performance alternative HMD. BAE SYSTEMS have not proposed the Knighthelm HMD for ATAK as the Turkish Armed Forces have rejected eyepiece based optical configurations and because the Striker HMD offers a significant performance benefit.

The eyepiece implementation offered by one of our competitors is a somewhat outdated design offering only monocular CRT imagery over a limited field of view. It has a reduced binocular display of intensified night vision and most probably suffers from relatively poor night vision performance. It's day time performance is relatively poor so that even with the single dark visor deployed it will be barely visible in bright sunlight conditions.

Head Tracking System

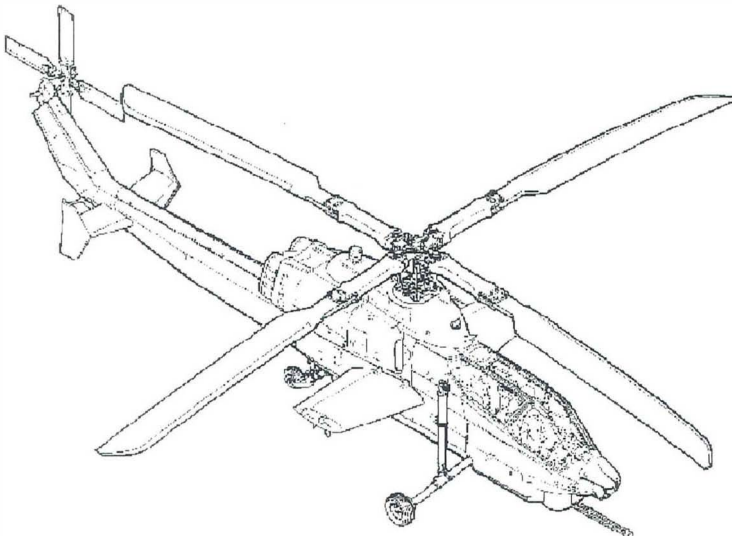
The Striker HMDS incorporates a high performance Helmet Tracking System with flight proven installed accuracy sufficient to allow weapon aiming.

The Helmet Tracker system is far less susceptible to cockpit metal than conventional electromagnetic systems and allows the use of a generic cockpit map for all aircraft of that type. This means that only a few cockpits need to be mapped initially and this map is then suitable for application to the rest of the fleet.

The Striker HMDS Helmet Tracker is now in full production for attack helicopter programs.

Competing systems use older generation a.c. electromagnetic head trackers, which are very susceptible to cockpit metal and require the mapping of every single cockpit in the fleet.

Furthermore, the accuracy of these systems, when measured installed in a cockpit is not suitable for use in weapon aiming. One such system has been assessed by the German Army as a limitation in weapon aiming and for night pilotage during nap of the earth flying.



Pilot Comfort and Protection

The Striker Helmet is the only design available, which meets weight, centre of gravity, shape and structural requirements for the US Navy and Marine Corps for the AH-1Z and other rotary wing platforms.

The primary function of the helmet is that of pilot protection. The normal working environment for the military aviator is demanding and the Striker helmet therefore provides protection from impact and penetration loads both during aggressive manoeuvring and also during the physical extremes encountered during a crash or other emergency.

Similar the Striker HMD is the only solution which meets the stringent US Navy audio protection requirements and also provides exceptionally high quality audio communication.

The one size inner helmet is suitable for the 5th to 95th percentile head range of and is provided to each pilot as personal equipment and precisely fitted to his head using a customer fitting process. This fitting technique ensures excellent stability and a high degree of comfort, even over long operating periods. Both the German Army and the US Navy/Marine Corps in extensive fitting trials have validated this approach.

Competing systems either provide only a limited

coverage of the user community head size range or are based on modified standard helmet shells, which were never designed as a platform for a display. They therefore tend to exhibit poor comfort levels and unstable helmet fit, especially during aircraft flight manoeuvres.

Once fitted, the user simply clips the outer helmet, which contains the display components onto his inner helmet. The outer helmet provides a simple, user operated adjustment to cater for a wide range of user eye positions and ensures optimum set-up for each individual pilot.

Competing systems either fail to provide the necessary level of adjustment or provide only limited adjustment capability. In our experience, this reduces the operational utility of these systems as system performance is demonstrably reduced by inaccurate fit.

The Striker helmet is also an integral element of the pilots life support equipment with proven compatibility with equipment such as the CBR respirator (AR-5) and range of other items of standard equipment.

Competitors helmet designs are understood not to provide this level of compatibility without significant design change and modification.

Helmet Weight and Balance

The Striker HMD is the only HMD available which meets the US Navy AH-1Z requirements for mass and centre of gravity for safe operation in terms of neck loads in normal and extreme situations.

The design of the helmet exploits advanced materials technologies and manufacturing techniques together with advanced structural and mechanical design to provide the lightest helmet design yet achieved whilst maintaining very high levels of pilot protection and structural integrity for mounting display optics.

The Striker HMD is lighter than all competing designs in both day and night configurations.

The modularity of the Striker HMD allows the user significant scope in configuring the helmet for the mission. For example as the NV cameras are simple clip on devices (even using gloved hands) the user can choose not to fit the NV cameras until the ambient light levels reduce to a level which requires night vision. In daytime therefore the Striker HMD weighs only 1.65 kg including binocular display and dual visors. With both Night Vision cameras fitted the weight is 2.17kg.

Competing designs state a night configuration weight of 2.2 kg with little or no reduction for a day configuration. These designs are heavy

due in part to the optical configuration chosen but also as a result of the basic design and construction of the helmet shell. One competing design appears to utilise a standard helmet shell, which significantly increases the true head support weight.

The Striker HMD centre of gravity is maintained within the US Navy/US Army safety and comfort criteria for all helmet configurations (i.e. with or without Night Vision cameras fitted).

With a world beating head supported weight and excellent centre of gravity well within US Navy and US Army safety guidelines, the Striker HMD provides a safe solution which minimises neck loading problems in high g or crash situations.

One of the competing designs has a potentially hazardous centre of gravity due to the physical location of the optical systems high up on the helmet. In this instance, centre of gravity is most probably located forward and vertically up so that in certain aggressive aircraft manoeuvres or in crash scenarios there is an increased possibility of pilot neck injury.



Cockpit Installation in the AH-1Z

BAE SYSTEMS have been working with Bell on the AH-1Z cockpit design for a number of years and are very familiar with the constraints of the compact cockpit of the AH-1Z helicopter.

The Striker HMD is fully compatible with the AH-1Z cockpit. The helmet envelope (with cameras fitted) ensures full head mobility without interference with the cockpit structure or canopy

Some competing HMD systems have their Night Vision Sensors mounted in a position high up on the helmet and this is likely to interfere with the cockpit structure or canopy reducing head mobility and restricting the pilots visual coverage.

All of the competing designs are likely to present cockpit installation problems, simply due to the shape and configuration most probably adopted for a very different cockpit shape.

The Striker helmet tracker Installation has also been proven for the AH-1Z cockpit.

Competing Head Tracker systems are far more susceptible to cockpit metal and there is a very high risk that they may not work properly in the AH-1Z cockpit.

Installation of cockpit mounted parts of the helmet tracker is problematic for these tracker

systems based on the results of trials of similar AC Trackers in the AH-1Z cockpit.

The Striker quick release connector (QRC) installation has also been proven for the AH-1Z cockpit.

The QRC and its installation is a major safety concern. Poor QRC design and installation has resulted in serious consequences in some cases for users of HMDs from other suppliers.

BAE SYSTEMS have therefore developed a new QRC for the AH-1Z application, which incorporates a number of safety features and failsafe mechanisms. It is a compact and user friendly design, which is easy to use with one hand.

BAE SYSTEMS Striker HMD does not require any electronics to be located within the helmet or on the body of the user.

All of the competing solutions require a body mounted electronic unit containing a high voltage power supply and other electronic functions possibly due to the limited performance of the display drive electronics.

Logistic and In Service Support

The Striker HMDS has a number of key features, which result in a simplification of Logistic Support and corresponding reduction in Life Cycle costs. These include :

- **Single Size Inner helmet fits all pilots**
- **Non handed Night Vision Cameras**
- **2 part modular helmet**
- **Integrated Helmet requires no module substitution when transitioning from day to night operation (and vice versa)**
- **Modular design allows simple replacement of display source and Night Vision cameras**

Some competing systems require :

- Several helmet sizes, thereby increasing basic helmet spares holding
- Right and Left handed Night Vision Sensor assemblies
- Awkward removal or addition of modules in order to reconfigure the helmet for day or night operation

Logistic support of the HMD in service introduces additional challenges as the helmet brings together life support and avionics functions. Ease of maintainability and simple replacement of items such as visors are important design drivers if life cycle costs are to be minimised.

The Striker HMD has been designed for ease of support. For example the only user

adjustment required is to select the interpupillary setting using a simple 4-position knob. No other user adjustment is required, as each pilot is provided with his own custom fitted inner helmet shell.

Visor replacement is a simple operation requiring no special tools and taking just a few minutes to complete.

Competing designs probably require more complex fitting and set-up before use due to inadequacies in their optical and mechanical designs. For example one design utilises the helmet shell as the mechanical linkage between the two monocular assemblies. This compromises basic binocular alignment and reduces system accuracy.

The optical design of another competitor does not easily support the full range of eye separations and requires component changes to convert the HMD between day and night missions. Visor replacement is also complex due to the complex shape of the visor.

Technology Transfer

BAE SYSTEMS is offering a state of the art system which will:

- **provide the level of technology transfer required by the Turkish Armed Forces**
- **provide a system easily adaptable to other platforms**
- **allow future upgrade as improved or new technologies emerge**

Competitor Systems appear to offer older technologies, which we believe will soon be (or are already) outdated. In our opinion they have little or no growth capability to take advantage of future flat panel display technologies and Night Vision camera enhancements. Although workshare may be offered, technology transferred may be limited.

BAE SYSTEMS have a proven track record in industrial partnerships with Turkish Industry and offer extensive technology transfer and training to our Turkish partners. As the worlds largest defence contractor, BAE SYSTEMS has extensive research and development programmes developing new technologies within the company but more usually with our partners world-wide.

BAE SYSTEMS operate a program of technology insertion into our products so that future technology transfer opportunities exist to update the Striker HMD systems when the need arises..



Battlefield Digitisation

The mission environment demands for “network centricity” and battlespace situational awareness will increase dramatically over the next few years. To improve operational effectiveness Helmet Mounted Displays are becoming a valuable tool in the network centric warfare environment with the ability to display tactical information to the pilot/gunner in addition to sensor imagery, attitude and targeting information. They will enable critical filtered information to be displayed to the pilot in an easy to assimilate “real world” reference frame, enhancing sensor to shooter target location information.

A major safety concern is the high potential for information overload with conventional information displays. The HMD which provides an out of window display of information in a more readily assimilated manner reduces pilot overload eases the “climb to cope” problem.

The AH-1Z incorporates a modern combination of sensors, displays and information processing. It therefore provides a system solution meeting the demand for enhanced situational awareness in the network centric environment of the modern battlefield where the exchange of complex information such as video imagery, maps and other forms of tactical information allows the co-ordinated execution of the mission. The crew interface is a vital part of the avionics,

and the BAE SYSTEMS Striker HMD is an essential core element of this integrated Avionics Subsystem Architecture.

The avionics system including the BAE SYSTEMS Striker HMD provides for improved communications and reduced cockpit workload leading to increase mission effectiveness. The avionics architecture is linked to the provision of information superiority on the battlefield and improved communications allowing the application of precision force in diverse scenarios such as for example, military operation in urban terrain. It is designed to provide the aviator with capabilities for the execution of time critical missions by providing a consistent understanding of the battlespace.

The BAE SYSTEMS Striker HMD is therefore the only solution which can meet today's requirements and also provide the growth in capability that will be required as the ATAK mission requirements develop once it enters service.

Competing designs are unlikely to provide the flexibility and growth potential to meet these emerging requirements. In our view, they are dead end designs, which do not meet today's requirements fully and cannot be developed to meet tomorrow requirements.

Growth Potential

Unlike competing HMD solutions the Striker HMD's modular design and advanced construction facilitates technology insertion to add capability as and when the Turkish Armed Forces require it.

Competing designs appear somewhat outdated and in our opinion have very limited growth potential.

A good example is the miniature CRT which is still the display device of choice for high performance HMD applications. The display device used in Striker is the highest resolution miniature CRT in existence. However, significant research and development activity has been expended on the replacement of CRTs with alternative miniature display technologies. Prototype HMDs based on the Striker HMD have been produced to demonstrate the feasibility of various display technologies. Illustrated is a full colour binocular display using a reflective AMLCD technology with a full illumination system. It is believed that this display is the worlds first full colour binocular visor projected HMD. This has been achieved using the "standard" AH-1Z Striker HMD with minimal change.

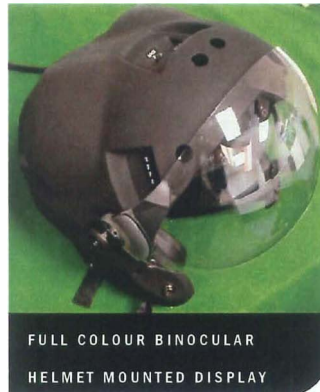
For some applications a larger HMD field of view may be required. The current design provides a fully overlapped 40 degree FOV and

could be adapted to provide a larger horizontal field of view by reducing the binocular overlap.

However, there is significant evidence from US Army Trials that partially overlapped systems that reduce the binocular overlap significantly lower than 40° are less than ideal. Therefore a new visor projected optical configuration that allows a 50% growth in the field of view has been designed by BAE SYTEMS. The availability of display technologies providing the required pixel density is also in the pipeline.

The Striker HMD is therefore the only solution that offers significant growth in functionality without requiring major modification or requalification. Design updates are already in the pipeline, which will be made available for local manufacture if required in Turkey.

Similarly advances in processing, graphic and image enhancement are planned as part of our technology insertion programme.



Specifications

MAIN FEATURES

- 24 hour capability
- Visor Projected Display
- Two part helmet assembly
- One size fits all, custom fit inner liner
- High resolution display
- Miniature night vision cameras
- High accuracy head tracker
- Optimum centre of gravity

PERFORMANCE

- Field of view 40 degrees
- Exit pupil >15mm
- Eye relief 70mm
- Head supported weight <1.65kg
- Twin visors Dark and clear
- Tracker coverage Azimuth $\pm 180^\circ$
Roll $\pm 180^\circ$
Pitch $\pm 90^\circ$



STRIKER HELMET MOUNTED DISPLAY FOR
EUROFIGHTER

