



Council of Scientific &
Industrial Research

Drishti for the Fighter Aircraft

FIGHTER aircraft flying at supersonic speeds, manoeuvring, flying at low height at high speed, multitasking, operation of the aircraft, etc. leaves the pilot with a lot of workload. So, the hassle of the pilots to divert their attention several times for monitoring of flight information in different directions is reduced manifold with the advent of glass cockpits.

A Head Up Display is the most vital part of the flight management systems employed in the glass cockpits. It gives pilots access to the critical flight information needed to safely fly the aircraft while allowing to focus their attention outside the cockpit for potential conflicts or threats by overlaying flight information on forward view providing simultaneous view of flight symbology and forward view. This implies that both are at infinity plane thus avoiding shift of pilot's attention from far to near planes and vice-versa.

The Head Up Display provides real time flight information like altitude, airspeed, angle of attack, target, artificial horizon, navigation, infrared imagery during night and low light conditions along with real time human-machine interaction through control panel, mission computer and FLIR. Therefore, HUD has been designated as the primary flight instrument of a fighter aircraft and known to enhance pilot's situational awareness tremendously.

The CSIR-Central Scientific Instruments Organisation (CSIR-CSIO), Chandigarh has successfully developed/deployed HUD variants, HUD components and assemblies and associated test equipment like bore sighting system & head up display test equipment ensuring end-to-end solution to multidisciplinary HUD technology. The development

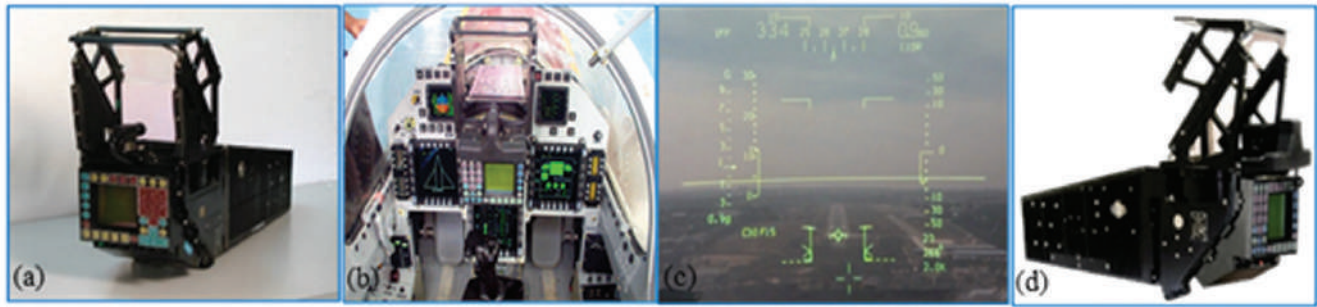
has been made for multiple aircraft platforms which are in various phases of development, active usage, and flight trials for platforms such as LCA-AF, Naval LCA, Intermediate Jet Trainer Aircraft (IJTA), HAWK-i, Su-30MKI and Dornier DO-228.

Features of Head Up Display

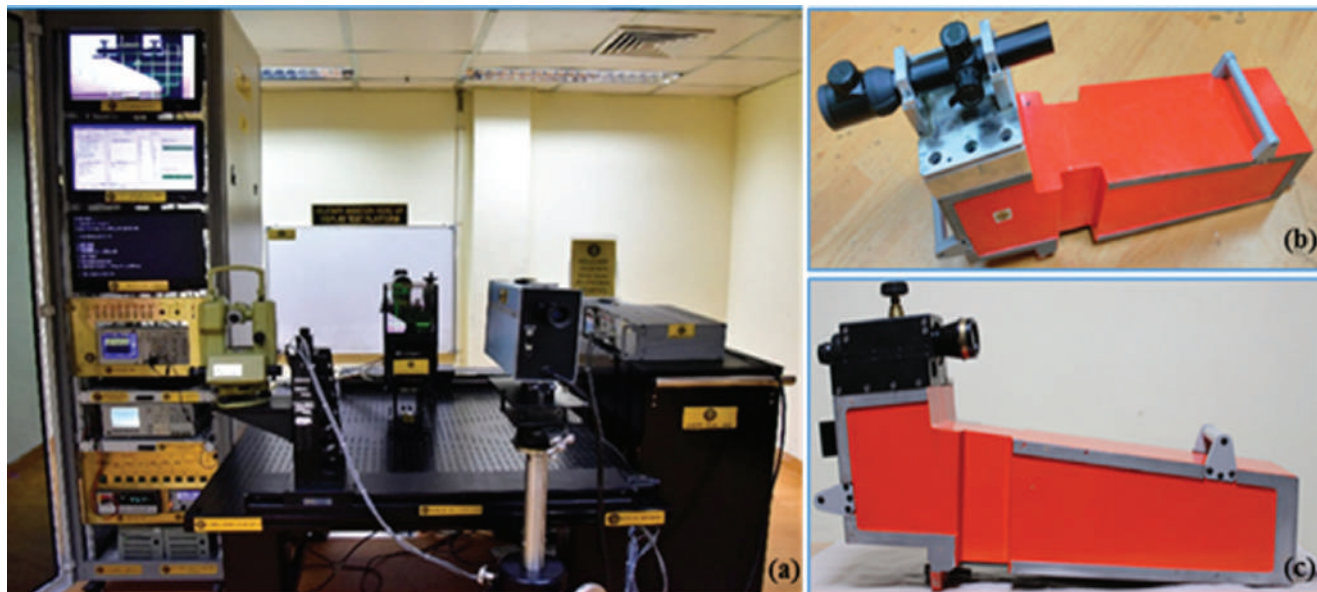
The Head Up Displays designed by CSIR-CSIO display stroke symbology, low visibility stroke-in-raster mode and autonomous/standby display in case of Mission Computer failure. It provides real time communication through Mission Computer, Multi-Functional Up-Front Control Panel and health monitoring. The display brightness from 8000 cd/m² to total blank display, Wide Total field of view (TFOV) > 25°; IFOV: 20°x18°, accurate symbol position accuracies, practically no parallax, binocular disparity, sun-reflections and ghost-image errors, resolution better than 1±0.5 mR, Low power consumption, MTBF ≥ 8500 hours, etc. are few features which make the HUD designed by CSIR-CSIO a worldclass technology.

Innovative solutions to design challenges such as cockpit size and geometry restriction to the space envelope and geometry available, weight and power restrictions, large field of view and luminance requirements, high display brightness, practically no sun-glare and no ghost images and full readability against sunlight, display accuracy, etc. are highlights of the state-of-the-art HUD technology.

The HUD MK1 developed for LCA-AF is now an integral part of full operational clearance of Tejas Mk1 with more than 110 HUD MK1 Units produced by BEL under licensed



(a) Head Up Display HUD MK1 for LCA-AF (b) HUD MK1N for LCA-Navy (c) HUD Day Flight Symbology (d) HUD Mk1-NP for N-LCA



(a) Military Head Up Display Test Platform (b) Bore Sighting Tool for LCA-Navy (c) Bore Sighting System for LCA MK1 (AF)

production from CSIR-CSIO while order of additional 120 HUD units and one unit of Military Head Up Display Test Platform is in final stages of grant.

The end-to-end solution provided by developing associated test equipment namely Military head up display test platform, Automated test rig and Bore sighting system and equipment to test and evaluate optics and electronics, error correction, optical & mechanical interface functionality of HUD at Intermediate, Operator and Depot Level provide the user and production agencies with a comprehensive solution. These solutions have been designed for HUD, PDU and display units of LCA MK1 (AF), LCA-Navy, LCA NP and IJT Aircraft.

Future of HUD in India

Like aircraft, not all HUDs and Optical Sights are created equal. Each one is built with a customized field of view which signifies how wide the pilot can visualize the outer world through combiner glasses left or right with symmetry to the

aircraft nose. As each type of cockpit has different spatial geometry based on the aircraft class and built, the HUD construction in terms of opto-mechanical layout, critical optical and combiner's coating design changes drastically.

These developments by CSIR are useful not only for Airforce and Naval Aviation but find relevance in civil aviation, army and coast guard aviation and other domains like surface transport for paramilitary forces and railways. With expertise gained in digital micro-mirror devices, organic led displays, LCoS displays and MicroLED display devices along with advanced research in optical technologies viz. Aspheric optics, diffractive optics, waveguide optics, holographic optical elements, Rugate coating, etc., the stage is set to build advanced technologies such as volumetric display devices, immersive virtual reality devices, wearable display devices, digital holography, 3D imaging, etc.

CSIR-Central Scientific Instruments Organisation
Adapted from the CSIR Blog (<https://www.csir.res.in/csirblog-success-stories>)





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Innovative construction of live rail and road underpasses

RAPIDLY growing population and proportionate increase in vehicular traffic in metropolitan cities have left little or no space for further expansion of infrastructure on the ground surface. Flyovers and underpasses are inevitable, and these need to be constructed without major disruptions to the live traffic. Sometimes in thickly populated areas, road diversion, safety consideration and other site constraints arise during the construction of flyovers. In such a situation, the construction of underpasses below the existing highways or railways become the best and viable option.

The construction of an underpass is generally taken up by the cut-and-cover method, which usually requires extra soil cutting. Sometimes, the removal of soil may trigger caving in, leading to surface collapse which could harm nearby structures as well. The cut-and-cover method also takes many months.

In recent times, the box jacking technique with ground improvements is a non-disruptive technique for underpass construction without disturbing the live traffic. The technique is also inherently safe, simple, economical, requiring less equipment and enabling speedy construction.

Box jacking involves the fabrication of a series of large sized precast RCC box segments. The box segments are pushed with the help of jacking force applied through hydraulic jacks installed at the rear end of the segment. The jacking reaction is obtained from the pocket provided in the thrust bed and rear wall.

In the last two decades, the construction of an underpass by jack pushing without disturbing the existing structures (road/rail track etc.) has become popular. To date, the technique has

been used to create underground space primarily for rails and roads, car parking, water pipelines, drainages, and pedestrian accesses. This is usually done after the implementation of some site-specific ground improvement techniques/measures.

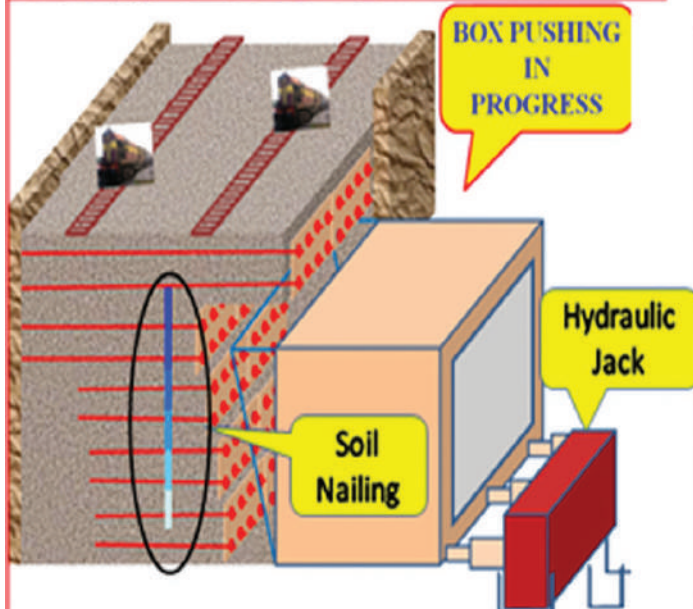
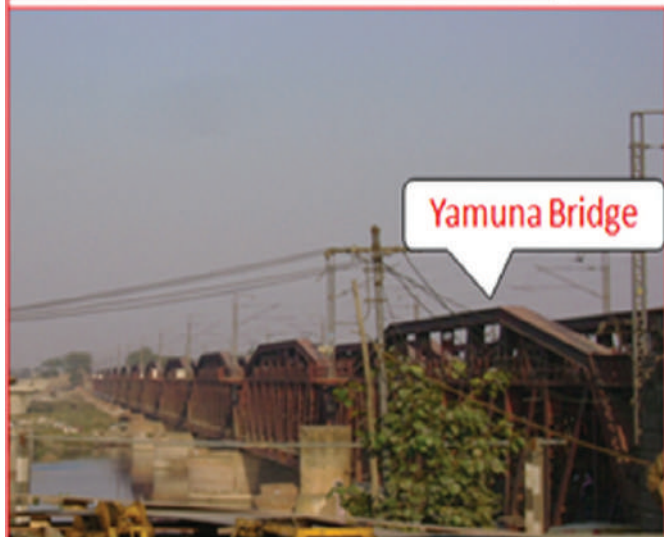
Whenever a precast box tunnel is pushed to create an underpass beneath any existing structure, the Overburdened Soil (OB) experiences a considerable increase in the pressure on either side of walls and above the box face. The excessive increase in pressure may lead to differential settlements (upheave or settlement) or collapses. Similarly, the redistribution of stresses at the box tunnel face also occurs due to soil particles' lateral movement. Sometimes, the magnitude of the stresses and strains at the box tunnel face crosses its allowable limits of the soil resulting in instability on its box face or differential settlement at the ground surface.

The challenging site conditions demand a novel ground improvement technique, which could stabilise the overburdened box/tunnel face in controlled conditions during box jacking operation and regular running rail traffic. In many box jacking projects, ground improvement techniques like ground freezing, grouting, and chemical stabilisation were used to stabilise soil to reduce the settlements or displacement of soil during box jacking. Sometimes, these techniques may not be feasible due to environmental or site conditions besides being time-consuming.

It is essential to stabilise the soil at the box face during the box pushing operation. Often, it has been observed that the soil slope in front of the box suddenly collapses, and workmen get buried during box pushing operation. The project becomes

Completed Project-I

Yamuna Bazar Underpass, Delhi



more challenging and risky when such underpasses have to be constructed through cohesionless soil such as sandy soil.

CSIR-Central Road Research Institute (CSIR-CRRI), New Delhi, invented a technique for reinforcing or strengthening the soil at the box face during box jacking operations. Soil nailing is one of the ground improvement methods, which has been widely used for controlling the displacements and protection of natural and man-made slopes. CSIR-CRRI's "Soil Nailing with Box jacking" method has been patented in India and abroad, including the US, Great Britain, Singapore, Sri Lanka, and India (<https://patents.google.com/patent/WO2014013508A2/en>).

This technique was successfully used for the first time in the world to construct three adjacent large-size underpasses

below double rail tracks on the Old Delhi-Shahdara section near Salimgarh Fort, Yamuna Bazaar in Delhi. Since then many more projects have been completed or are underway, including Apsara Border (Delhi), Sahibabad (Ghaziabad), Pragati Maidan (Delhi), Gurugram, Jhalawar (Rajasthan), Kota (Rajasthan) and Road underpass at Mahipal Pur, New Delhi.

CRRI scientists Dr Kanwar Singh, Sudhir Mathur and Dr P.S. Prasad who developed the technology were awarded the Supreme Engineer's Award, 2012 by Economic Research of India, Mumbai, for the Yamuna Bazaar project.

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