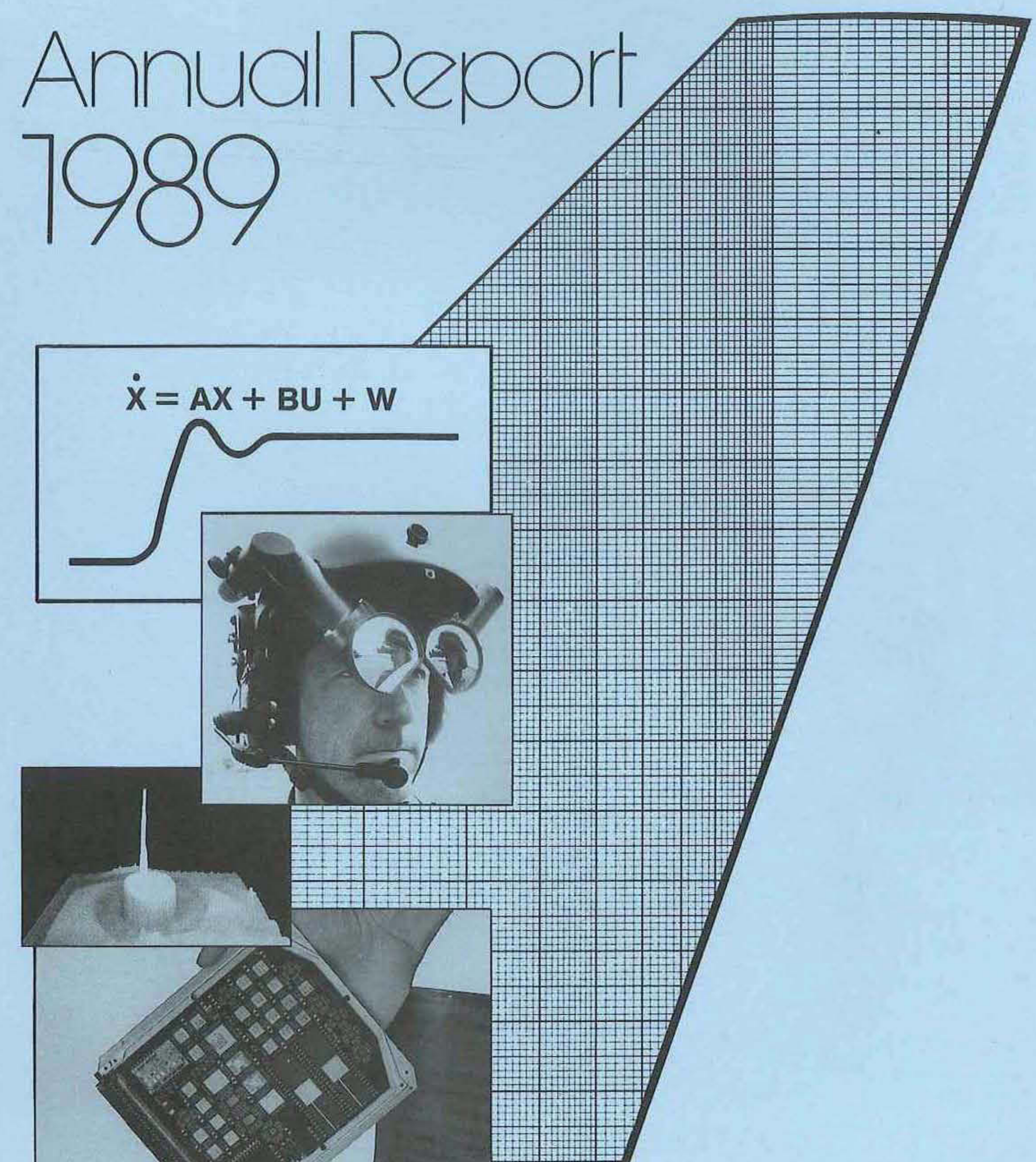
GEC AVIONICS

Annual Report 1989



FLIGHT AUTOMATION RESEARCH LABORATORY

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1990 Annual Report

FARL Report No. 262/2772 Issue 1 December 1989

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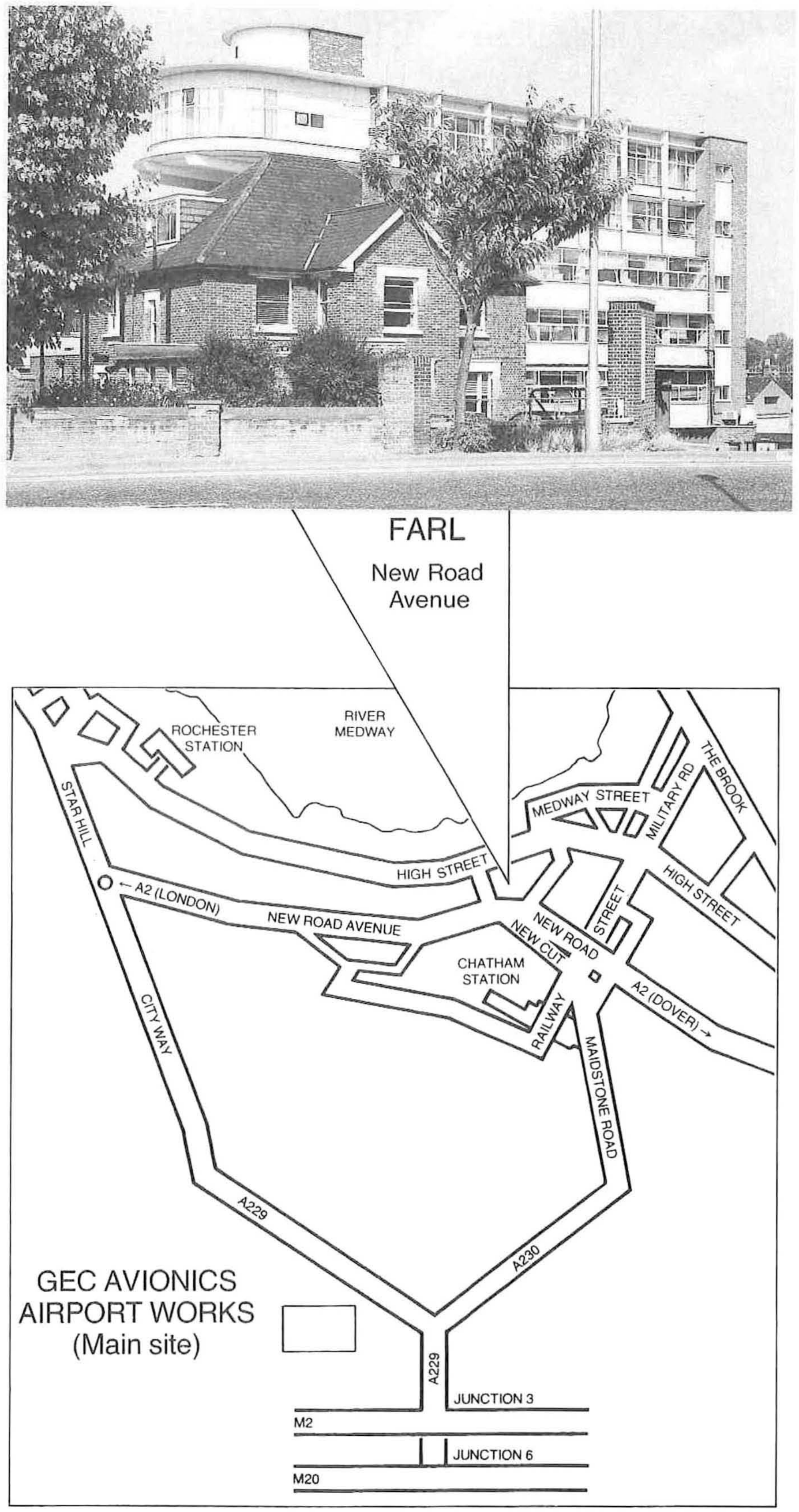
R.P.G. Collinson
DIVISIONAL MANAGER



INTRODUCTION

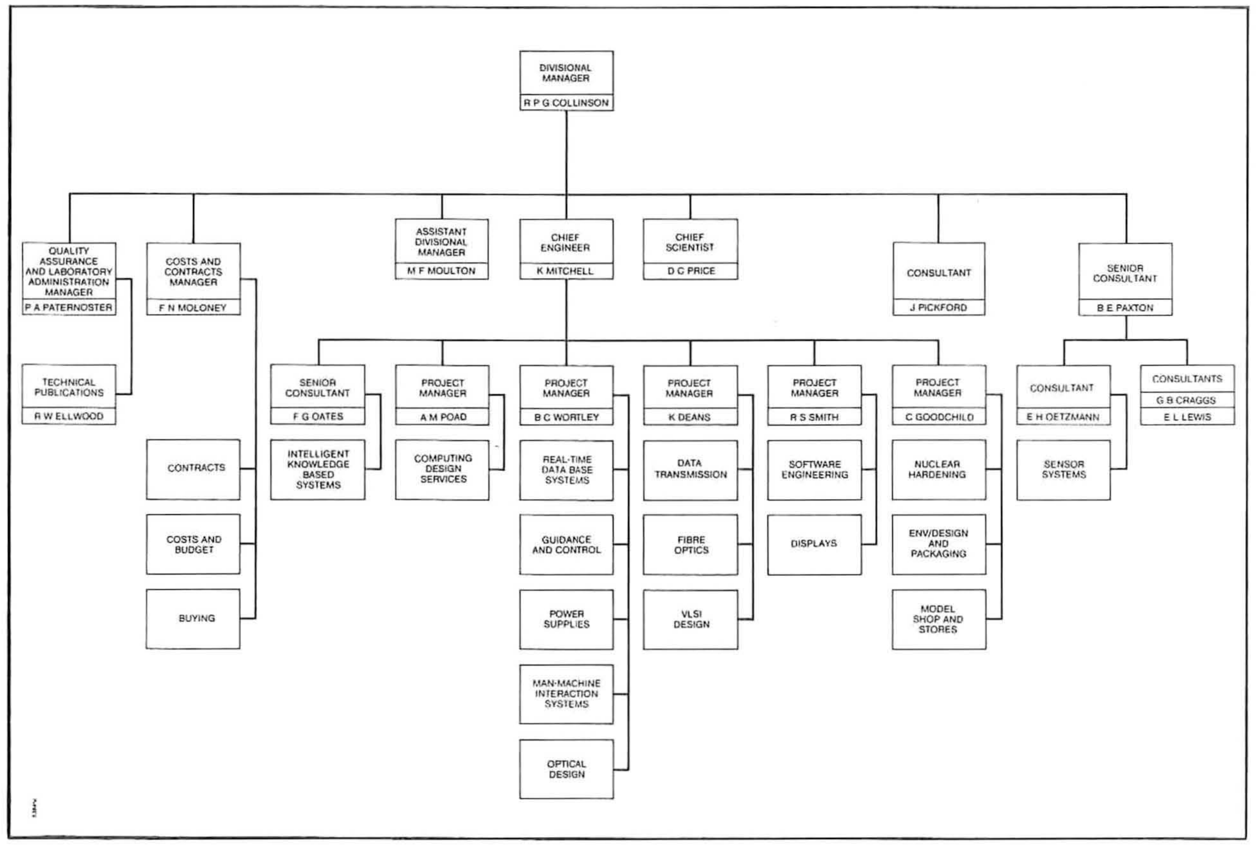
Introduction

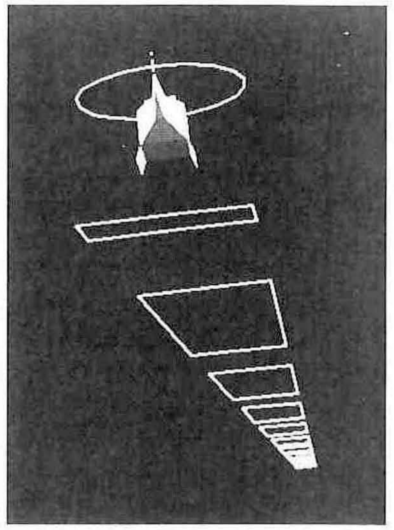
The Flight Automation Research Laboratory which was formed in 1961 currently occupies 10,200 square feet in the New Road building, Chatham, and employs approximately 90 people including about 75 engineers with Graduate or equivalent qualifications in Electronics, Electrical and Mechanical Engineering, Physics, Computer Science and Mathematics.

The role of the Laboratory is to provide the Product Divisions of GEC Avionics with new systems and technology which will enable them to maintain a competitive edge in their products and also enable them to establish themselves in new product areas.

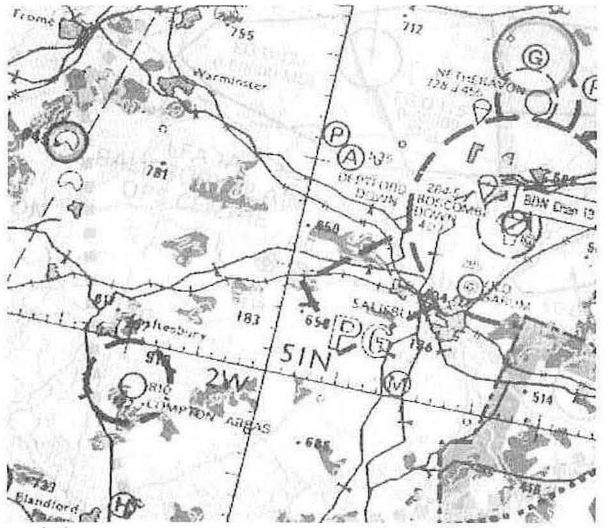
The Laboratory is organised into teams, as shown below, whose specific skills embrace the following areas:

- Future Avionic Systems
- Man/Machine Interaction Systems
- Intelligent Knowledge Based Systems
- Guidance and Control Systems
- Sensor Systems
- Software and Computing
- Data Transmission and Data Management
- Displays
- Optical Design
- VLSI Design
- Environmental Design and Packaging
- Power Supply and Analogue Design

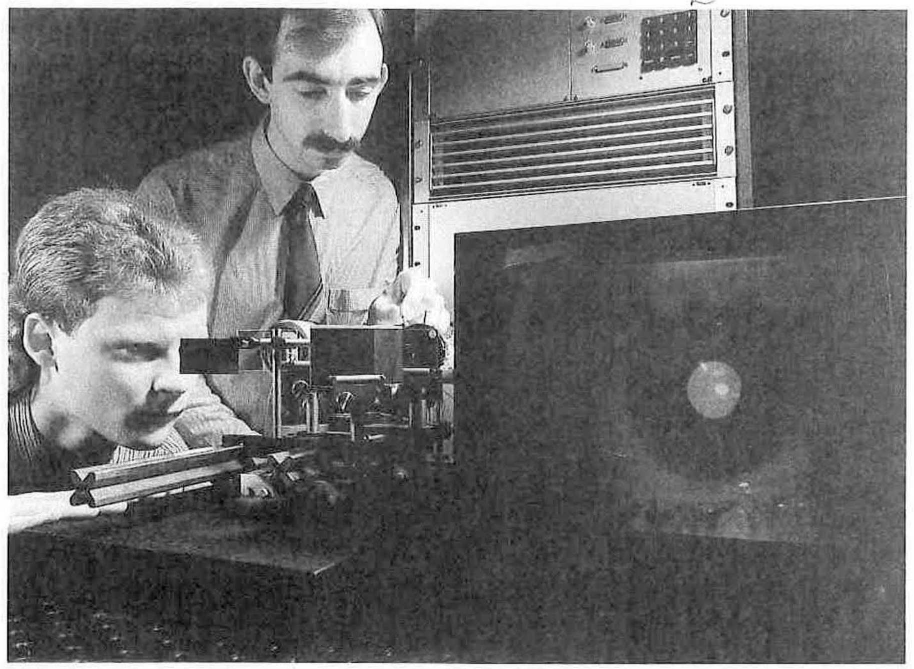




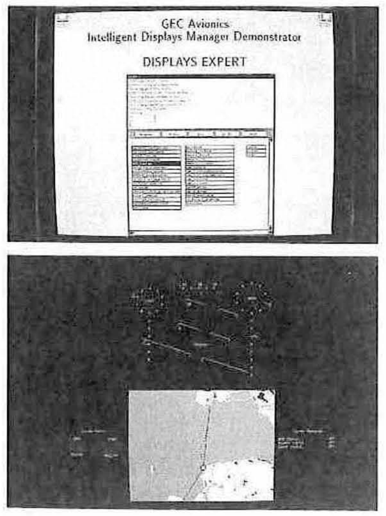
3D Situation Display for Virtual Cockpit



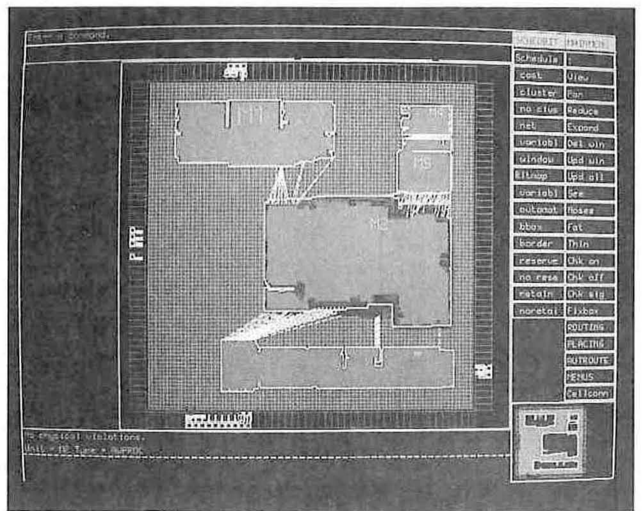
Real Time Map Display Generation



PEPS Eye Tracker R and D



IKBS Displays Management



VLSI Design-EFA BUS Protocol Chip

MANAGEMENT SUMMARY

This report covers the period from November 1988 to December 1989. The year has seen the successful completion of a number of research programmes primarily for RAE, and the launching of several new programmes exploiting earlier work. These externally funded projects have accounted for about 25% of our engineering resources. Support to the GEC Avionics Product Divisions has involved a further 25% of our effort and has covered areas where we have an established expertise, such as Optical Design, Fibre Optics, Displays Technology, Nuclear Hardening and Software Engineering. Company funded longer term research has accounted for the remaining 50% and has covered areas such a Future Avionic Systems, Man-Machine Interaction Systems, IKBS Applications, High Speed Data Bus Systems, Software Engineering Research and Environmental Design. It should be noted that the Laboratory is a little smaller than a year ago, our overall strength is now around 90 compared with 100 a year ago. Our main achievements and activities and their relevance to the GEC Avionics Product Divisions are summarised below:

Helmet Mounted Display system development has resulted in two new contracts which should provide very valuable expertise for future systems applications and are of direct relevance to Airborne Display Division (ADD). A new wide field of view Binocular HMD with an integrated Eye Tracker has been designed and an order placed by MM2 Dept RAE for Helicopter Simulator research. This new HMD system offers major advantages for helicopter applications. The binocular field of view exceeds 50° and it incorporates an integrated Eye Tracker for a total helmet weight of 2.5Kg approximately. Southampton University Institute of Sound and Vibration Research have ordered the earlier 40° FOV HMD with an eye tracker option for a research programme they are conducting for Wright Patterson Air Force Base and the RAE on target designation accuracy under vibration.

*'**PEPS' Eye Tracker** system development has made excellent progress. An Electronic Processing Unit and accompanying software to compute gaze angles at video frame rates (50Hz) has been designed and commissioned. Robust eye tracking in real time is being demonstrated with a bench optical rig pending the construction of the new integrated optical system designed for the 50° field of view Binocular HMD. The integrated HMD and Eye Tracker system offers the capabilities of accurate target designation under high g or vibration conditions, (used in conjunction with a helmet position sensor) and interaction with the display by 'eye pointing.' This is of direct relevance to ADD.

Alpha Helmet Mounted Sight contract was completed and 4 Helmet Sights were delivered to RAE. These are now being used in flight trials for off-boresight missile launching. Programme is of direct interest to ADD.

Virtual Cockpit Research has made excellent progress following the acquisition of a high speed graphics workstation (Primagraphics Topaz) in January 1989 and also a Polhemus head position sensor. We are currently demonstrating dynamic 3D situation displays on the Binocular HMD by generating left eye/right eye images with appropriate stereo disparity. A simple aircraft dynamic model and pilot's joystick has also been integrated into the rig so the pilot can interact with the display. The importance of the Virtual Cockpit concept for indirect viewing with the advent of laser eye damage weapons should be noted, the work complementing ADD's activities in this field.

IKBS Applications Research made good progress and a workstation based demonstrator of an Intelligent Displays Management system was successfully completed and delivered to RAE in August 1989. Since then work has continued under private venture funding to improve the speed of response and near real time operation is now being approached. Work to date has demonstrated the potential of IKBS technology to assist the pilot during high work load emergency situations and further development to a flight worthy system is a prime objective. This real time IKBS activity is of direct relevance and interest to ADD and several GEC Avionics divisions.

**PEPS Pilots Eye Pointing Sensor*

A^3P (Advanced Avionic Architectures & Packaging) activities have included the completion of a Logistics Study and a Technical Study of advanced architectures and modular avionics for MOD(PE), the studies being carried out in collaboration with British Aerospace, Ferranti Defence Systems, Smiths Industries, and GEC Sensors. Further studies are envisaged leading to a Technology Demonstrator programme. The impact of A^3P concepts will have a profound effect on future avionics systems and the work is of direct relevance to all GEC Avionics divisions.

High Speed Data Bus Systems activity has been mainly concentrated on the development of a STANAG 3910 Terminal for the Eurofighter EFABus. Key areas addressed have been the Fibre Optics, Optical Transceivers and the PROTOCOL device design. Design of the PROTOCOL chip is nearly complete and devices should be available around April 1990. The device is the most complex design we have yet undertaken with 20,000 gates and is equivalent in complexity to a micro-processor. This programme is of direct relevance to all the GEC Marconi divisions involved with the Eurofighter programme.

Fibre Optic Data Transmission activities have included the generation of detail procurement specifications for the fibre optic components and electro-optical Transceivers for EFABus to enable these critical components to be procured from several suppliers. Successful development and demonstration has been carried out of bi-directional transmission of data (both video and digital) over links of several kilometres length using single mode optical fibre for both subsea and air vehicle applications involving the Offshore Projects Group, Nailsea and Flight Controls Division (FCD) respectively. Work on a high bandwidth (up to 2 Giga bits/sec) switched optical network has been initiated in support of Instrument Systems Division (ISD).

Edge Detection Navigation (EDN) development has progressed with the completion of Phase 2 of this MoD(PE) funded programme in April. A Phase 3 programme is now proceeding aimed at integrating the navigation information from the EDN system with that from the SPARTAN terrain reference navigation system developed by Guidance Systems Division (GSD). The integrated use of both techniques has produced excellent results and has provided enhanced robustness and accuracy, since the two techniques are complementary. The programme is of direct relevance to GSD and close collaboration is being maintained.

Video Map Generation has made excellent progress using state of the art graphics processor chips. A system has been developed in conjunction with GSD which uses the same hardware to generate a real time moving map display from either a vector feature digital map data base or from GSD's compressed pixel map data base (derived from the video processing of paper maps).

Formal Methods are being investigated for use in the generation and subsequent validation of safety critical software. Close collaboration is being maintained with FCD and an asynchronous safety critical control function in the Boeing 7J7 Primary Flight Control Computer has been used for this evaluation exercise. Good progress has been made and a formal specification of this function has been derived and proved mathematically. Software tools for improving the visibility of this process and to assist in the production of the final code in provable stages are currently being evaluated. The objective is to establish a methodology to assist software engineers in all the GEC Avionics divisions involved in safety critical software.

Software Tools have been evaluated in conjunction with ASET (the company's software engineering taskforce) for assisting Structured Design methods and Project Control and these evaluations should be of interest to most GEC Avionics divisions.

Nuclear Hardening expertise has been provided to several GEC Avionics Product Divisions in response to the EFA nuclear hardening requirements. The successful completion of a nuclear hardening exercise on a Station Interface Unit for MOD(PE) has enabled us to confirm a sound theoretical and practical methodology for this task. Support to the Microsystems Facility of ISD has been given on the Nuclear Event Detector (NED) they are producing from a FARL design. A new autonomous, self powered, NED has been developed.

Environmental Design research has been at the level of about 1 engineer year and has concentrated on the EMC and thermal design aspects of the new surface mount technology Standard Electronic Modules. The work is of direct relevance to most of the GEC Avionics Product Divisions.

Power Supply Design research has continued into high frequency switching power supplies as well as investigations into high voltage designs for driving 1 inch CRT's for helmet mounted displays. Consulting assistance to the Product Divisions has covered a wide range of power supply problems.

Optical Design activities have been mainly directed to supporting ADD. The main programme during the year has been the successful completion of the optical design of the new Single Combiner holographic HUD. This design is the most advanced we have yet carried out and exploits Computer Generated Hologram technology.

Fibre Optic Pressure Sensor development is proceeding based on earlier work carried out at UKC, Canterbury. The use of a new miniature silicon pressure capsule only 4 mm diameter, developed by Fulmer Research, and liquid crystal tunable filters developed by MRC, Great Baddow are being investigated. These developments offer high promise of leading to a very rugged system able to operate at high temperatures. ISD and MCD are following the development and will become more involved as the system progresses towards a producible device.

UMA activities include a multi discipline study of the system requirements for a UMA towed drogue system involving aerodynamics design, towline dynamics and a remote position measuring system. FCD will become progressively involved if the study leads to a demonstrator programme.

Airship optically signalled FCS has been refurbished and modified for FCD in order to drive the new control surface configuration of the Skyship 600 airship. It was gratifying to confirm that all the fibre optic components were as new in spite of exposure and use in all weathers and the actuators (designed and built in FARL) show no sign of wear, although they have had several years usage with extensive ground testing.

Video Circuit design support has been provided to Recording Systems Division (RSD), Nailsea who are developing the Cockpit Video Recorder system for the Tornado mid-life update programme. The Laboratory's expertise in displays technology has been of great assistance to RSD in enabling very tight timescales to be met successfully.

VERDI (Vehicle Electronics Research and Development Initiative) is a co-operative programme launched by RARDE (Chertsey) in July 1989 with the aim of providing integrated vehicle electronics demonstrators. GEC Avionics is participating in the programme and senior engineers from FARL have been closely involved in the initial system definition and specification stages.

Alvey '**Trailblazer**' VLSI design programme led by GEC Avionics (FARL) and involving MRC, Great Baddow and the University of East Anglia was successfully completed and demonstrated to the DTI and various other organisations in July. The project has established the feasibility of a top down design route for VLSI device implementation although further refinement of the software to achieve user friendliness and extend the generality of the technique is required before it can be fully exploited by the GEC Avionics divisions.

Alvey '**Design-to-Product**' (DtoP) task for FARL has been to investigate the integration of existing CAD tools and the GEC Avionics computerised Production Planning and Scheduling methods with the emerging DtoP system tools such as the Expert Designer System and the highly automated DtoP production system. The DtoP technology is still evolving but its potential benefit to all the GEC Avionics divisions is high.

Dick Collinson

December 1989

1 REAL-TIME DATABASE SYSTEMS

Project Manager: Brian Wortley
Project Leader: Derek Jordan

1.1 Introduction

This team currently comprises the Project Leader plus five software/systems engineers. During 1989 the team has continued development of the Edge Detection Navigation technique, and has undertaken work programmes in several other areas. Continuing from the initial feasibility study outlined in the 1988 FARL Annual Report, a further private venture funded investigation has looked at some of the techniques required for the automated production of terrain maps from SPOT satellite image data. This was followed by an externally funded study of the application of SPOT derived map data to Edge Detection Navigation.

Other areas of activity have included writing Data Gathering software for the new SPARTAN Replay System (funded by Guidance Systems Division); assistance to GEC Avionics management in the initial assessment of advanced parallel-processing architectures; completion of the Alvey Trailblazer synthesis system and its successful demonstration to the MoD and the DTI; design of the built-in self test software for AQS 903 (funded by the MoD as a sub contract from Maritime Aircraft Systems Division); and a brief study of the feasibility of applying Neural Network techniques in image processing and feature recognition.

SPARTAN is the name given to Guidance Systems Division Terrain Reference Navigation System.

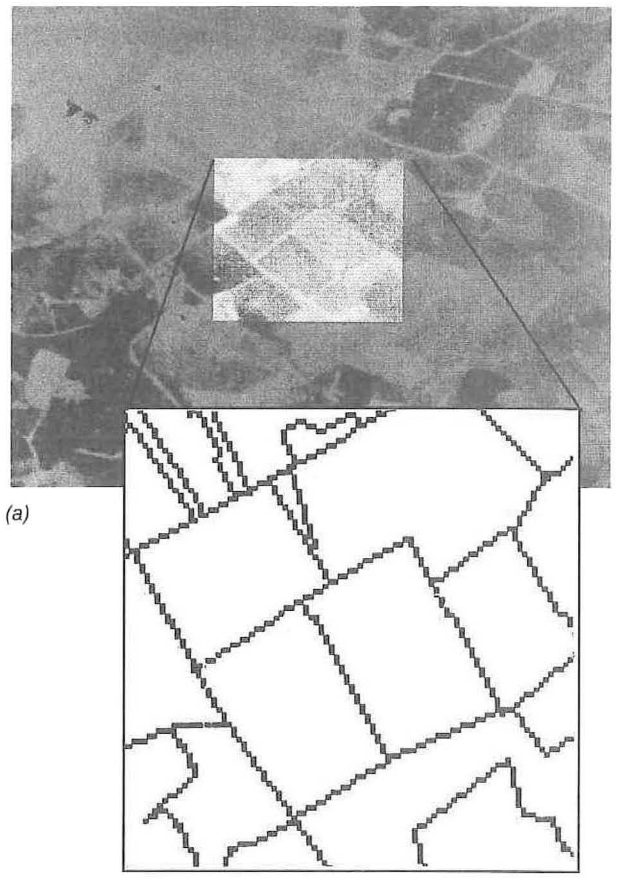
1.2 Edge Detection Navigation (EDN)

During the year work has commenced on several items of study under external funding. The major area has been the analysis of navigation behaviour using actual flight trials data, using the EDN technique both on its own and in an integrated environment, where information from the EDN system and from the SPARTAN system (developed by GSD) are used. The integrated use of both techniques has provided excellent results and has produced enhanced robustness and accuracy, since the two techniques are complementary.

As mentioned in Section 1.1, the feasibility of using SPOT satellite data to provide the necessary terrain information has been studied. Again, the results of this work have been very encouraging and suggest that satellite images could be used to provide map data for any required part of the world. Figure 1 shows an example of the type of information available; the 'raw' image is shown in Figure 1a (following image grey-level enhancement and geo-referencing to remove imaging distortions, so that features in the image can be related to National Grid positions). Figure 1b shows the boundaries manually captured for a 1Km x 1Km area. The initial study of the use of this data by EDN has produced encouraging results and has indicated ways in which feature selection and boundary capture rules can be modified so as to produce data which is well suited to the requirements of the EDN techniques at relatively low cost.

Details of Classified Reports available on request.

Figure 1



(a) (b)

1.3 Data Gathering Subsystem

This piece of software is responsible for collating and aligning data from various sources before it is used within the remainder of the SPARTAN Replay System. Recent system and architecture improvements, including the intended transfer of the Replay facility onto a micro-vax computer, have enlarged the data preprocessing task and so the detailed design and software implementation of a new Data Gathering Subsystem (DGS) was undertaken for GSD.

In addition to accepting various data elements from several source processes, the DGS is responsible for ensuring that message synchronisation is maintained; timing and data-range anomalies detected and removed; correctly formatting data messages for the subtasks within the main Replay system; and detecting and announcing (by the use of suitable error messages) any irrecoverable data error states.

The software package was designed, implemented and subjected to stand-alone testing at FARL before delivery. It was accepted by GSD in 1989 following successful integration tests.

1.4 AQS 903 System Self-Test

The AQS 903 acoustic processing system under development by MASD is a very large software facility of considerable complexity. Once installed in the EH 101 Merlin aircraft, the self-test function is required to perform autonomously a range of built-in tests as well as providing the operator with a selection of on-demand equipment checks. In order to ensure independent design, the Engineering Test Programs of the Dataface subsystem were designed within FARL during the period November 1988 to April 1989, using top-level functional specifications supplied by MASD.

The Engineering Test Program covered four different types of test - Initialisation, Parallel, Requested and Dedicated. Initialisation testing is performed immediately after power-up for each of the subsystems, and provides details of system status to the other subsystems. Parallel testing is a continuous operation, and is performed on all system facilities without disrupting operational processing. The operator only becomes aware of Parallel testing when he is informed of a detected failure.

Requested testing is a mode selected by the operator in order to test buoy processing. The subsystem generates buoy test signals, and the operator is responsible for passing or failing the test based on the results.

Dedicated testing is a mode used to locate faulty hardware items after a failure has been detected. This should enable faults to be isolated to one line-replaceable item such as a PCB, transmitter, receiver or power-supply.

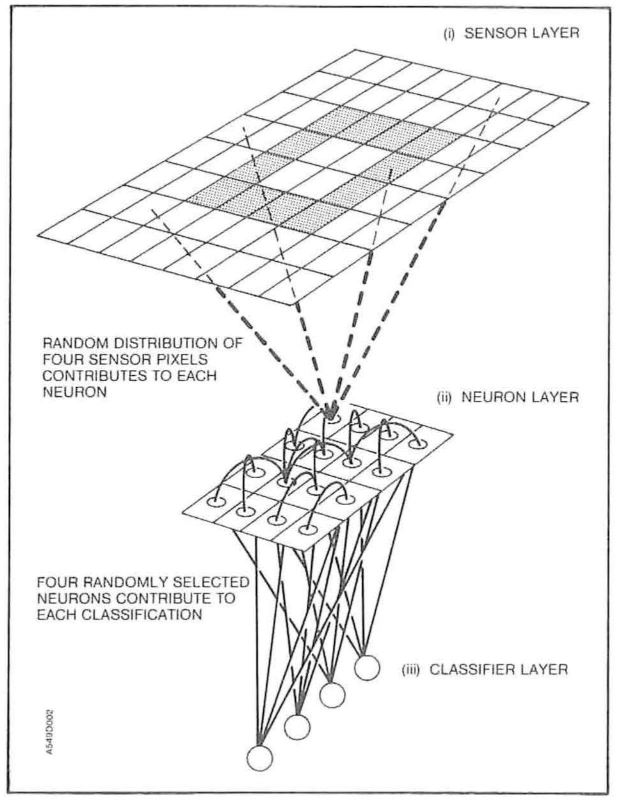
The work, although complex, was completed on-time and to MASD's satisfaction.

1.5 Neural Network Study

Investigations have been performed into the suitability of Neural Network techniques for certain parallel architecture applications. Specifically, image processing operations were studied, since standard serial processing techniques require machines which have considerable power. The use of a Neural Network approach avoids this problem by providing an array of relatively small but highly interconnected processors. A training process is employed which configures the network into an optional state - adapting the strength of the processor interconnection according to the application required.

An example Neural Network configuration for an image processing application is shown in Figure 2. It consists of three specific sections: (i) an input

Figure 2



sensor layer which contains the image to be processed, (ii) a central neuron layer containing the many processor interconnections, and (iii) the output classification layer. The advantage of the Neural Network approach is that, once a network has reached its optimum 'fully-trained' state, input image classification is virtually instantaneous.

1.6 'Outside World' Generator for the Virtual Cockpit Demonstrator

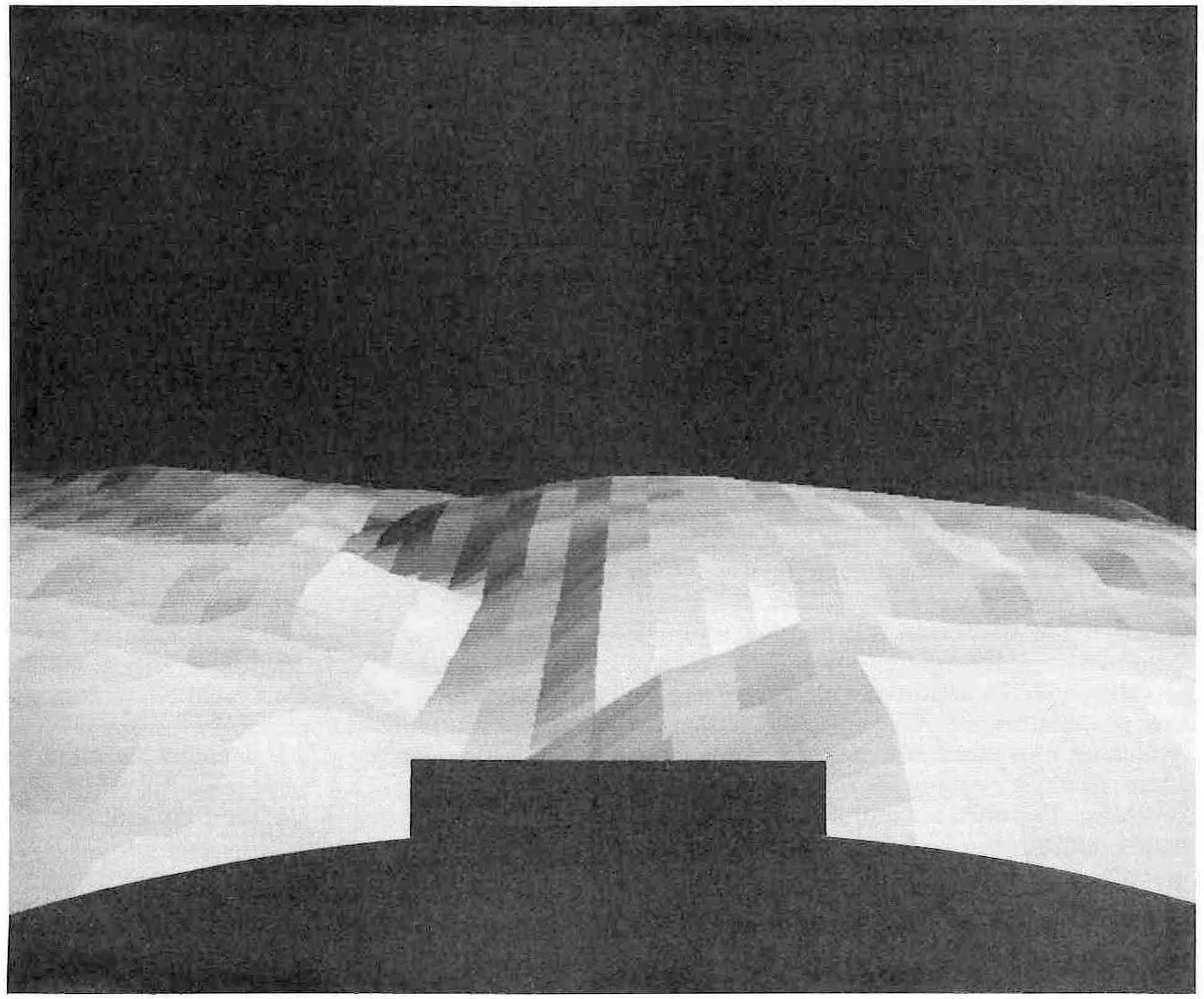
In collaboration with the FARL virtual cockpit research programme, the team was responsible for producing a representation of the outside world for integration with the other virtual-cockpit symbology. The outside world information is necessary to provide a context in which all the cockpit instrumentation can be related, as well as allowing the 'pilot' to plan and execute manoeuvres.

Figure 3 shows one of the two stereoscopic components of the outside world view.

Computations take into account eye separation so as to produce a natural degree of stereo depth convergence so that the pilot gains an immediate and strong impression of feature range. The height information is shown in the form of a wire-frame model obtained from a stored Digital Terrain Elevation Database and thus represents realistic terrain data. The work was based on team experience with perspective map image generation, and incorporates many of the features found in previous similar systems. These include hidden surface removal, sun-angle shading, intensity depth cuing, and target/obstacle display capability. This last item allows objects such as tanks and other vehicles, buildings, chimneys, waypoints and target points to be displayed as three-dimensional symbols.

The system is currently capable of an update rate of 1 to 2Hz. This is adequate for translations of the viewing position, but a higher performance would allow rotations to be displayed to a far better effect.

Figure 3



2 GUIDANCE & CONTROL

Project Manager: Brian Wortley
Project Leader: Phil Lamb
Senior Systems Engineer: John Mulcahy

2.1 Introduction

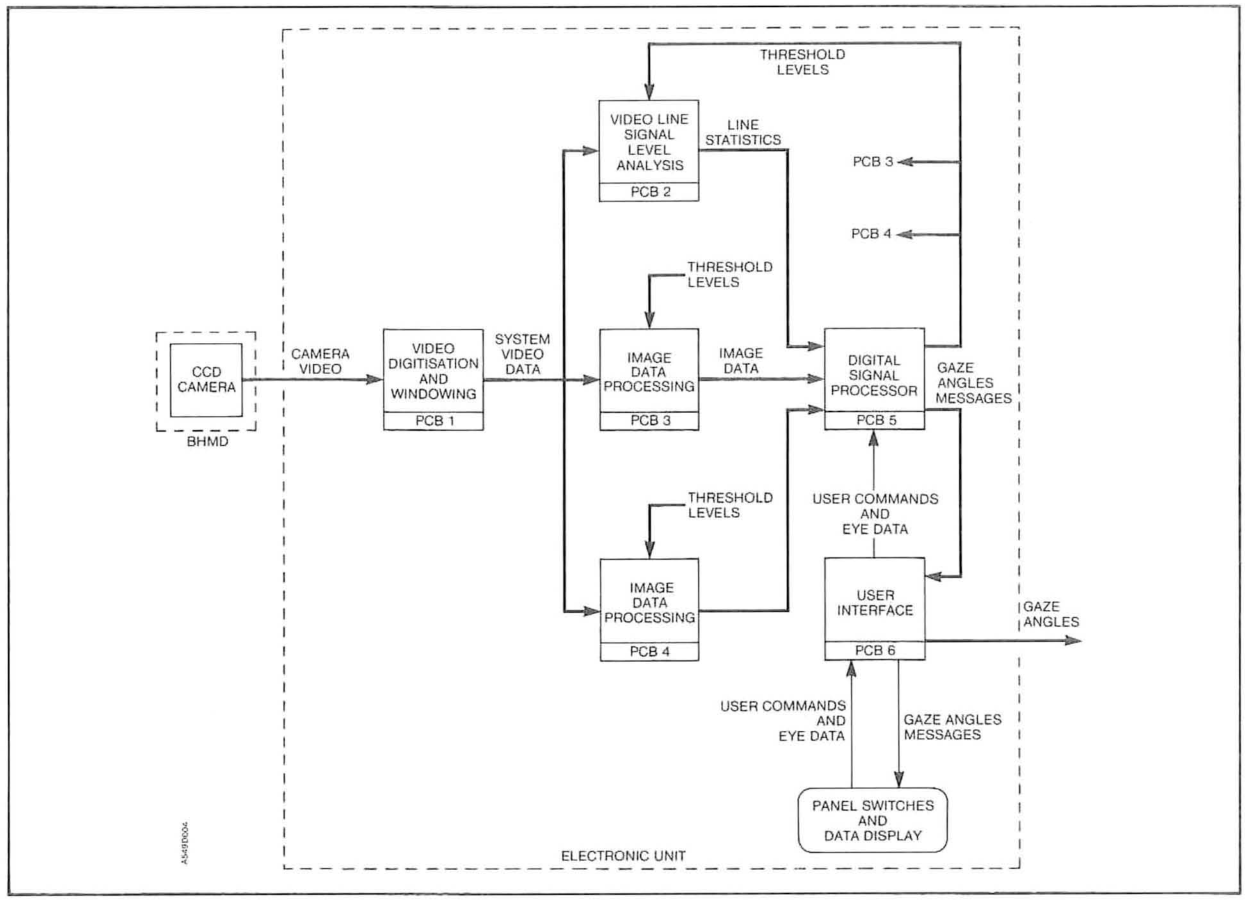
The team currently comprises the Project Leader plus six engineers of varying disciplines and provides a broad based centre of expertise with specific emphasis on closed loop control systems, real-time processing architectures, software development, digital flight control and digital aerodynamic modelling. The activities of the team during 1989 have been quite diverse.

2.2 Real-Time Eye Tracker System - 'PEPS'

An extensive development programme was initiated in December 1988, under private venture funding, to produce an Eye Tracker System Demonstrator capable of computing pilot gaze angle to an accuracy of better than 0.5° at video frame rates (50Hz). The system is based on our earlier work carried out in 1987/88 and has been given the acronym'PEPS' - Pilot's Eye Pointing Sensor. The functional software was written in 'C' and developed on an IBM personal computer. The definitive system uses an Analog Devices ADSP2100 Digital Signal Processor and incorporates a large percentage of dedicated high speed digital hardware for the real time analysis of the video input signal. The hardware is now at a very advanced stage, and robust, real time tracking is being demonstrated. Figure 4 illustrates the electronic system block diagram.

The development system is built on an optical bench with a parallel activity aimed at incorporating the optical concept in the 50° FOV

Figure 4



Binocular Helmet Mounted Display. Integration of the PEPS and HMD hardware will result in a powerful and versatile man-machine interaction system. It should be noted that the high accuracy of the binocular HMD (less than 1 milli-radian parallax error) enables it to be used for calibration and performance measurement of the integrated PEPS system. The system has attracted great interest from potential customers. A contract extension has just been received from MoD (PE) to provide an integrated PEPS system for the 50° FOV Binocular HMD system ordered for the RAE Helicopter Simulator Research programme, and a number of other orders are anticipated in the near future.

2.3 UMA Towed Drogue Study

The team are currently carrying out a study of the system requirements for a drogue towed by an unmanned aircraft (UMA). The study covers a number of different areas including drogue aerodynamic design, towline dynamic analysis and design, and drogue position measuring systems.

2.4 Airship Optically Signalled FCS

After its refurbishment in FARL in 1988 the optically signalled flight control system developed for Airship Industries completed a very successful flight trials period during the latter part of 1988, accumulating over 60 hours flying time at the Airship Industries base in Weekesville, North Carolina. The team provided on-site support, including in-flight observation, for the majority of this period. The system functioned perfectly throughout.

A system upgrade has been undertaken during 1989 in readiness for flight trials testing of the revised X-tail configuration of the Super 600 airship, which will serve as a proof of concept demonstrator for the configuration proposed for the larger ODM airship under development for the US Navy.

Relevant Reports: *262/2665 Acceptance Tests, Skyship SKS600 FCS (X-Tail Configuration)*

262/2478 Operational Notes For The SKS600 FCS (Issue 2)

2.5 Processor/Memory Noise Susceptibility Investigation

Two members of the team provided support to Flight Controls Division in the identification of noise and layout problems with a Processing Unit Card and Memory Board. This resulted in the recommendation of a package of modifications to the existing design aimed at reducing its noise susceptibility. The team also acted as design consultants on a new single card solution.

2.6 Semi-Autonomous Rapid Inspection and Survey Vehicle (SARIS)

In order to be able to operate the SARIS submersible remote from its mother ship, it is desirable to decouple the submersible from the ship by use of a small, light, low drag optical fibre link from the vehicle to a radio communication buoy on the surface which maintains contact with the mother ship. See Section 10.5.2.

The team conducted a study of the navigation and sensor system requirements of SARIS which is under consideration for development by the Offshore Projects Group, Nailsea. A parallel study of the optical communication link was also carried out by the Data Transmission team.

Relevant Report: *262/2600 Remotely Operated Vehicle Navigation And Sensor System Market Evaluation*

2.7 Other Activities

The team has also provided considerable support in the preparation of a number of proposals on behalf of Flight Controls Division. These covered preliminary studies of the aerodynamic and control system requirements of a fibre optic guided air vehicle and the GEC Avionics FRIGATE BIRD UMA proposed for shipborne applications, and have resulted in the award of two independent study contracts which will be supported by the team.

3 POWER SUPPLIES

Project Manager: Brian Wortley
Principal Engineer Dave Morris

3.1 Introduction

The Power Supplies team comprises two engineers providing Product Division support as required, as well as conducting privately funded work on new power supply configurations and techniques, and supporting other teams within the Laboratory as necessary.

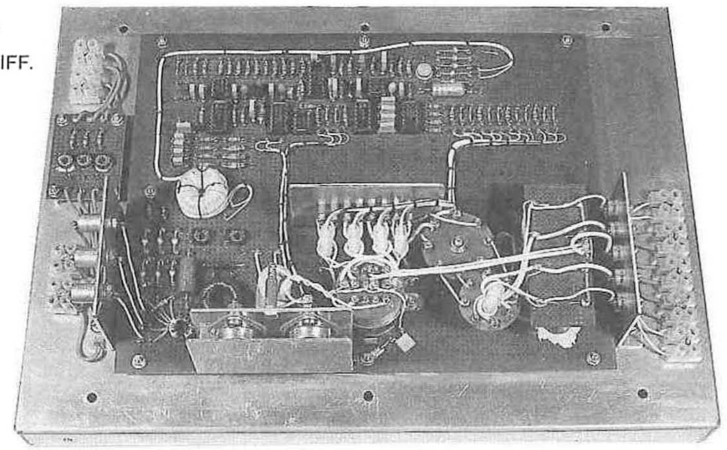
Company funded work during the year has covered breadboarding and computer simulation of different topologies for use in high frequency switching power supplies as well as investigations into high voltage designs for driving 1 inch CRT's for helmet mounted displays. Support to Product Divisions has mainly consisted of consultancy assistance with a wide range of power supply problems.

3.2 Power Supply Research

High frequency switching power concepts investigated in detail have included a 50Watt, zero current switching, quasi-resonant converter and a zero-voltage switched, multi-resonant forward converter. The latter has the advantage that a large load swing can be accommodated with an operational frequency switching range of only 4.8MHz to 7.2MHz, with the advantage that parasitic components are only used in the resonance circuitry.

Figure 5

- POWER DENSITY: 5 WATTS/CU. IN. PACKAGED
- EFFICIENCY: 84 TO 90% MEASURED UNDER DIFF. LOAD CONDITIONS
- OUTPUT RAILS: ±15VOLTS AND ±30VOLTS
- 200 KHz SWITCHING FREQUENCY
- 200 V 3 PHASE INPUT



An initial report has been written detailing the development of the quasi-resonant converters and a further report will be produced towards the end of the financial year describing the multi-resonant topology.

Work on a 200kHz half bridge converter providing 200Watts is now complete, and provides a good indication of power densities achievable for avionic power supplies using conventional circuitry. Figure 5 shows the breadboard for this power supply along with relevant performance figures.

Company funded work on high voltage power supplies has resulted from the requirement to provide a colour display for helmet mounted systems using two-colour Penetron CRT's. A breadboard of a design incorporating rapid shutdown for laboratory assessment is under development.

Relevant Reports: *262/2642 Initial Study On High Frequency Resonant Power Supplies*

262/2690 Management Overview Of Report 262/2642 On HIF Resonant Power Supplies

262/2746 Design And Evaluation Of A 200 Watt Multiple Output PSU Operating From A 200V 3 Phase 400Hz Supply At A Switching Frequency Of 200kHz

4 DISPLAYS

Project Manager: Renny Smith
Project Leader: David Thorndycraft
Senior Consultant: Geoff Craggs (Display Generation)

4.1 Introduction

The Displays team comprises the Project Leader plus four engineers and, in the past year, has been primarily engaged in work on Helmet Mounted Sights and the design of advanced analogue and digital electronics for a video recording system.

Research activity included the design of grey scale drivers for Active Matrix LCD panels and the investigation of the possibility of colour displays based on Land's principle. A research programme by the Senior Consultant into the capabilities of new graphics chips has resulted in a very promising development in video map generation.

4.2 Alpha Helmet Sight

A contract to develop a lightweight Alpha Helmet Mounted Sight has been successfully completed with the delivery of four experimental flightworthy helmets to RAE Farnborough. (See Figure 6). These are currently being used to assess pilot's effectiveness when using a combined Helmet Mounted Sight, Head Trackers and a missile with wide off-boresight capability. Further orders and development are anticipated as a result of this activity.

Relevant Report: *262/2640 Alpha Sight Final Technical Report*

4.3 Grey Scale Drivers for LCD panels

Because of the outstanding technical merit and potential of the grey scale active matrix LCD panels developed by Hirst Research Centre and produced by EEV/LUCID, work has continued on the development of a grey scale drive system, suitable for VLSI implementation, which will interface them to graphics processor symbol generators. This work is proceeding with electronic circuitry capable of driving a full panel, and close liaison with EEV/LUCID and Airborne Displays Division will aim to progress the design through to eventual prototype chips.

Relevant Report: *262/2560 Technical Report on Active Matrix Addressed LCD's*

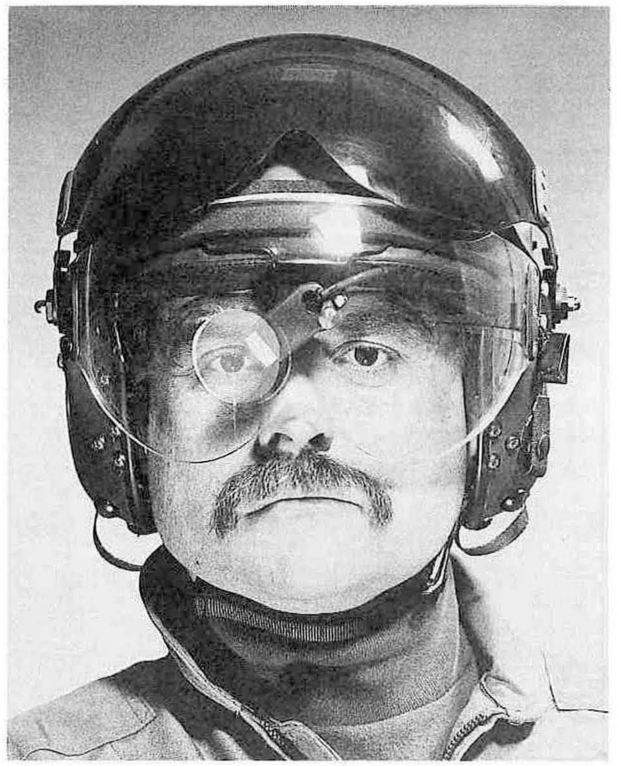
4.4 Land's Colour Principle

Investigative work has also been completed on assessing whether colour displays are feasible utilizing the Land's colour principle when used in conjunction with a switched LCD shutter. This work was performed in conjunction with ADD and Bristol University.

4.5 Video Electronics Design for Ground Replay Facility

The team has recently completed the design for a Video Electronics Unit under a sub contract from Recording Systems Division (RSD) Nailsea. It formed part of the ground based equipment of the Cockpit Video Recorder System which RSD are developing for the Tornado Mid-life Update programme under MoD (PE) contract. The work involved the detailed specification, design, and the provision of suitable documentation for RSD to build and commission the equipment. The system

Figure 6



enables video pictures, previously encoded onto a standard S-VHS video cassette by the Tornado Video Recording System, (using a field sequential method) to be replayed on up to six monitors.

Relevant Reports: *262/2719 Analogue Functions Technical Description*
262/2720 Monochrome Field Store Technical Description
262/2721 Colour Option Technical Description

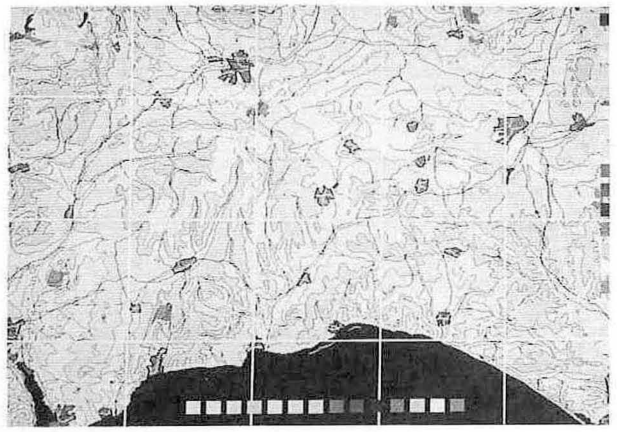
4.6 Display Generation

This research programme was initiated last year with the aim of evaluating the newly available graphics processor chips and their suitability for future display requirements. Initial assessment has concentrated on the AMD QPDM (Quad Pixel Dataflow Manager) which, due to its parallel architecture, is likely to be one of the fastest single chip processors currently available. One aim of this work is to use benchmarks to enable valid performance comparisons to be made with other graphics processors and architectures. Another aim is to investigate the factors which affect display acceptability, such as interlacing, anti-aliasing, and improved horizontal or vertical resolution.

The display task chosen as a benchmark has been the generation of a non-interlaced colour map from a vector map database. This is a very exacting requirement and is also of direct interest to Guidance Systems Division (GSD). Initial work addressed the de-compression of vector map data, using some early 250,000:1 PACE map data processed into 150 by 150 pixel 'tiles' (See Figure 7). The initial result achieved was the generation of a full screen 768 by 574 pixel display (20 tiles) in less than 5 seconds. This is in fact fast enough for a real time moving map display once the initial map is generated and we are confident this time can be substantially reduced by changes to the processing software. GSD are supporting the evaluation programme as they have a requirement for a Video Map Generator capable of using both vector map data bases and compressed pixel map data derived from the video processing of paper maps. We have now implemented GSD's pixel de-compression algorithm in the QPDM and are currently generating a 512 by 512 pixel map display (16 tiles) in 1.3 seconds and are optimistic that this time can be reduced. See Figure 8.

In the future it will be possible to produce hybrid maps with a mixture of both vector and pixel features - for example, the pixel aeronautical map overlay onto vector cultural features. At present we do not know of any vector map data base which

Figure 7



includes the required aeronautical overlay detail. In the near future we intend to evaluate other graphic chips, such as the National Semi Conductors' AGCS (Advanced Graphics Chip Set) and the Texas 34010/20 GSP. We also intend to look at the TMC 2302 Advanced Image Resampling Sequencer for the rotation and translation of digital map displays etc.

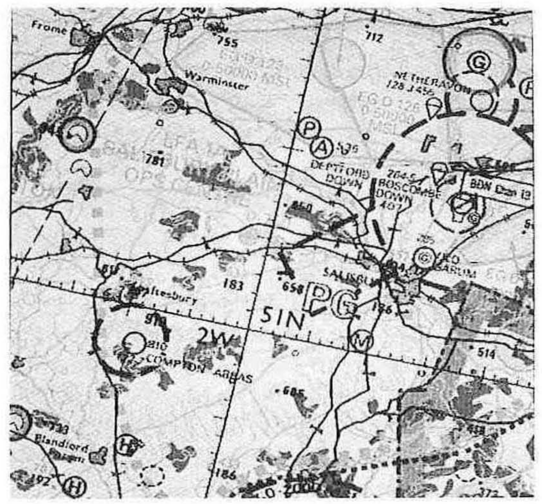
4.7 Other Activities

Work to support ADD in their EFA HMD proposal has also been completed.

A follow-on order for a Remote Site Switching Network for the Advanced Groundstation at Llanbedr, developed by FCD, has been delivered.

Looking to the future, a proposal for an advanced Helmet Mounted Sight is being submitted to the RAE. This is based on using a holographic combiner element in the visor which will eliminate the need for a prism.

Figure 8



5 SOFTWARE

Project Manager: Renny Smith
Principal Software Engineer: Steve Carter
Senior Software Engineer: Jane Daragon

5.1 Introduction

The Software Engineering team currently comprises two mathematicians, five software engineers and a trainee software engineer.

The team has followed two major research programmes this year: an investigation into the use of formal methods; and a study of tools and methods to improve software quality. The team has been sponsored by *ASET on a number of small programmes and has also supported the Product Divisions on various software projects.

* ASET (Advanced Software Engineering Task Force) is a software engineering initiative supported by GEC Avionics, GEC Sensors and GEC-Marconi Software Systems. The principal objective of ASET is to provide a focal point for Software Engineering expertise for the supporting companies.

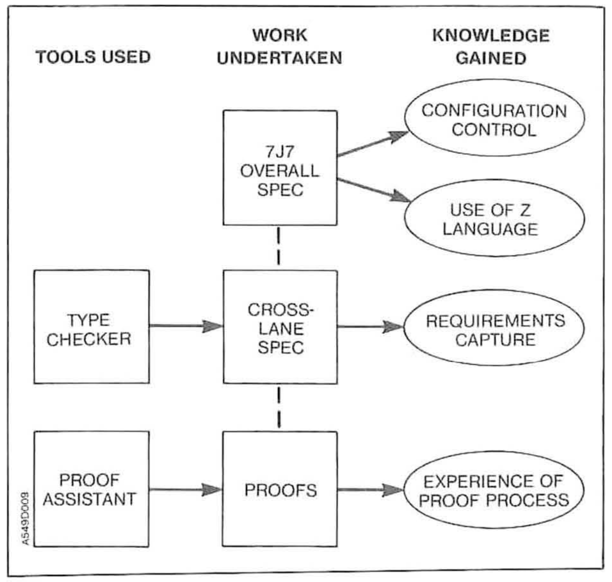
5.2 Formal Methods Research

The main emphasis this year has been on expanding our formal methods experience and establishing a centre of expertise in the use of formal development techniques. A period of training and familiarisation was followed by the application of formal techniques to a current project for Flight Controls Division (FCD). Effort was concentrated particularly on system specification and proof of requirements, to establish a generalised approach.

The redundancy management functions of the 7J7 Flight Control System were selected for our investigations into specification and proof. An 80 page specification of the whole system was produced in the Z specification language. It drew attention to the need for good configuration control and the avoidance of inconsistencies in naming variables, for example.

A more detailed study was undertaken as part of the FCD validation programme of the Cross-lane Functions, generating a new specification and using syntax and type checking tools. The specification was then proved to satisfy safety requirements which were also expressed formally in Z. Figure 9 outlines the process followed.

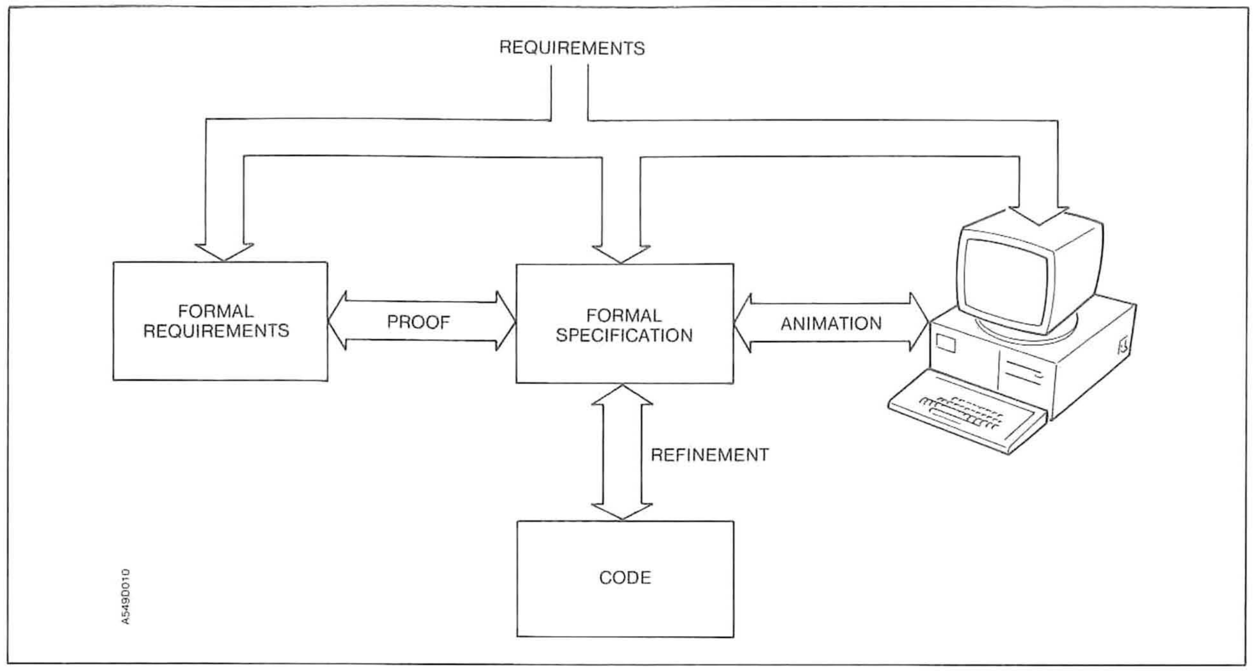
Figure 9



To help FCD determine the role of formal methods in the 7J7 programme we were invited to assist their Redundancy Management Validation Team. FARL gave FCD a tutorial on formal methods and Z, and repeated it to their customer. Some individual tuition was given in the use of Z.

Initial investigations into Animation and Refinement have been undertaken and will continue in the coming year. Animation is the process of producing a demonstration of the meaning of a specification, intended to give a graphical representation of the system to assist requirements capture and system validation. Refinement refers to the production of code from formal specifications by the application of rules and proofs to give a provable implementation of the system. Based on our initial studies we have proposed a life cycle model for software developments using formal methods. See Figure 10 for the process involved.

Figure 10



Our latest work area is to investigate the possible linking of formal and structured methods into a combined technique. It is hoped that Structured Analysis will allow engineers unfamiliar with formal notation to understand specifications more easily and also bring design heuristics to formal methods, and that formal methods will provide facilities for more semantic expression in Structured Analysis.

In the coming year we plan to increase our commitment to the research by involving another software engineer in the programme; our strength will then be two specialist mathematicians and two specially trained software engineers. At this level we will be able to continue our technology transfer to the Product Divisions and pursue our overall research objective of preparing the Company for the take-up of formal methods as part of our standard development process for safety critical applications.

Relevant Reports: 262/2708 Formal Specification of a Redundancy Management System
262/2713 Formal Specification of the 7J7 Cross Lane Functions

5.3 Software Tools and Methods Research

We have addressed real-time aspects of the development of real-time software by investigating two sets of extensions to Yourdon Structured Analysis; these were the Ward/Mellor and Hatley/Pirbhai approaches.

The Hatley/Pirbhai technique was found to be more natural to use and capable of capturing more information within the diagrammatic notation.

An evaluation of a prototype Object Oriented Design tool IDE (Interactive Development Environment) was carried out. It was found to be very promising and when incorporated in the CASE (Computer Aided Software Engineering) tool, 'Software through Pictures' (StP) by Interactive Environment Inc, the tool was found to be significantly more expressive and flexible.

A valuable addition to our tool set is a requirements tracking facility which has been developed by FARL and fully integrated into our existing CASE tool.

The FARL software engineering procedures have been updated to take account of the use of CASE and improved testing techniques employed by FARL.

Relevant Reports: 262/2731 Procedures for the Software Lifecycle Using StP

5.4 ASET Programmes

(a) Tool Integration

Three programmes on IPSE (Integrated Project Support Environments) were undertaken: The completion of the GENOS report; a survey of IPSE; and an evaluation of ISTAR, the IPSE from Imperial Software Technology. The overall conclusion was that commercial IPSE are currently unsuitable for avionics applications.

Following this work, a preliminary study of low cost software tool integration is being undertaken, involving canvassing the Product Divisions regarding current and desired levels of tool integration, and is establishing how they might be achieved.

Relevant Reports: *262/2596 A Report on the GENOS Evaluation*

262/2684 A Survey of Relevant IPSEs

262/2700 ISTAR Integrated Project Support Environment Evaluation

(b) Structured and Formal Methods Comparison

This exercise compared a specification generated by formal methods with a semi-formal specification derived by applying Structured Analysis to the same requirement. The comparison showed that the formal specification dealt well with the implementation detail and the Structured Analysis provided a specification at a much higher level dealing with structure. There was no overlap of specifications in the example chosen and this increases our confidence that research to combine Structured Analysis and formal methods will yield some positive results.

We have also prepared a report for ASET on StP which contains FARL's evaluation of the product and a summary of comments collected from other GEC-Marconi units with experience in using the tool. FARL have significant experience in using the tool and have provided demonstrations and advice to many of the Product Divisions considering purchasing software development tools.

(c) Distributed Software

A study of the software issues of distributed processing was undertaken to allow more informed discussion on the subject. After consultation with Product Divisions and a literature survey, a report is being written which classifies systems, discusses state-of-the-art, identifies novel developments and future trends.

5.5 Software Development Support

The work on the FCD test set for the Boeing 7J7 Primary Flight Control Computers (PFCC) was completed this year, and the experience gained has enabled us to support them on the Phoenix test set. We have also assisted in the documentation of the software for the A320 Slats and Flaps Control Computer programme.

In the past year the team has provided nearly a man-year of support to Maritime Aircraft Systems Division (MASD) for further development of the AQS903 software.

A senior engineer was seconded to Automatic Test Equipment Division (ATED) to provide Yourdon design expertise for the development of a Mission Planning Demonstrator to be used in their bid for the Advanced Mission Planning Aid (AMPA) for the Harrier GR Mk 7. The team has also assisted ATED by determining an appropriate formal development technique for the Mission Validation requirement.

Relevant Proposal: *262/0408 Advanced Mission Planning Aid: Mission Validation Programs*

6. MAN MACHINE INTERACTION SYSTEMS

Project Manager: Brian Wortley
Project Leader: Steve Heptinstall

6.1 Introduction

The Man Machine Interaction team currently comprises the Project Leader plus three engineers and a technical assistant, with support from the packaging and optical teams. This year the team has been involved in various helmet mounted display contracts and virtual cockpit related research, as well as several proposals.

Relevant Proposals: *262/0406 Veil Image Generation System*

262/0386 Veil Display System

6.2 Binocular HMD for Southampton University

We are currently producing a 40° by 30° field of view binocular Helmet Mounted Display system for Southampton University. This will be used in connection with two contracts they hold, one with RAE Farnborough for studies into display performance under typical aircraft vibration, the other with Wright Patterson Air Force Base related to virtual cockpit research.

Relevant Reports: *262/2702 Design Requirements Specification for a BHMD for Southampton University*

6.3 55° Binocular HMD For RAE Farnborough

During the early part of this year the development of a 55° field of view binocular Helmet Mounted Display was initiated, resulting in the system shown in Figure 11. Two systems are now being manufactured, one for MM2 department of RAE Farnborough for simulator trials, the other for FARL use in the Virtual Cockpit rig. The major features of this system are;

- Wide FOV (55° on-axis)
- High resolution (approx 900 lines derived from 1024 line interlaced signal)
- 30mm eye relief
- Fully adjustable eye relief and inter-ocular separation
- 12mm exit pupil
- Light weight < 2.5kg.

It is considered that the design has major potential over a wide range of applications including helicopter use, and offers performance and facilities not available in any existing designs.

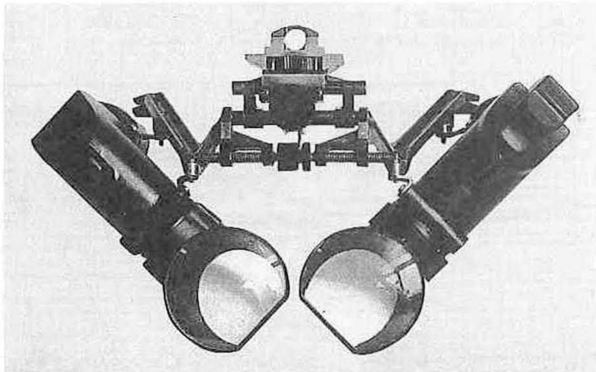
Relevant Reports: *262/0390 Proposal for a Wide Field of View Binocular Helmet Mounted Display for Helicopter Simulator Research*

262/2765 Mechanical Specification for a Wide Field of View BHMD

262/2757 Electronic Specification for a Wide Field of View BHMD

262/2762 Optical Specification for a Wide Field of View BHMD

Figure 11



6.4 Helicopter HMD System

The 40° binocular HMD designed and built by FARL for Airborne Display Division has been used on a number of trials over the last two years, including in-flight refuelling tanker boom operation and obscured driving experiments, both using remote viewing, and is now being modified to form the basis of the demonstrator system for the German PAH1 helicopter. The system will be able to drive either a Binocular Helmet in either pilot's or copilot's seats, or one or two monocular systems. Initial ground trials will use an early skeleton frame helmet and the flight trials will use two new helmets developed by ADD, driven by the original electronics.

6.5 Colour and High Resolution HMD Research

The work on two-colour systems has taken somewhat lower priority due to more immediate demands on the available effort. Advances that have been made include the design and building of frame conversion cards, which produce the required frame sequential colour raster signals at 100Hz from the conventional 50Hz interlaced signal. Modifications have also been completed to the BHMD control circuitry, to produce the higher speed waveforms necessary. As a byproduct of this work we have run the system from a 1024 line 50Hz interlaced signal. Some blanking modifications are necessary to the signal, and the CRT limits the resolution to about 900 lines, due to minimum spot size. This work proved valuable in the design of the 55° field of view helmet.

6.6 Virtual Cockpit Research

Using the Primagraphics Topaz graphics workstation it has been possible to advance the Virtual Cockpit research enormously. Figure 12 is a block diagram of the current virtual cockpit system. In addition to the graphics system there is an input/output processor which deals with functions such as head position analogue inputs. Additions will be an integrated PEPS eye tracker and a voice recogniser/synthesiser, which will also communicate through the processor. We have modified the graphics library supplied so that it runs more efficiently for our application. The Virtual Cockpit display is a 3d representation of an arbitrary instrument panel, its main purpose being to improve our understanding of how the graphics system operates. However, parts of the display will be used in a modified form in later investigations. The display allows the user to pan round a 160° horizontal by 120° vertical virtual environment, and the various instruments and displays can be placed anywhere within that area.

Figure 13 shows the current "Gods Eye" View demonstrator. The system allows users to move their viewing point around the virtual helicopter, which is displayed relative to a moving flight path. Both viewing position and aircraft flight can be controlled by the user. Further developments will lead towards a navigation aid similar to that shown in Figure 14, which is a collection of ideas from the three display modes described here.

Figure 12

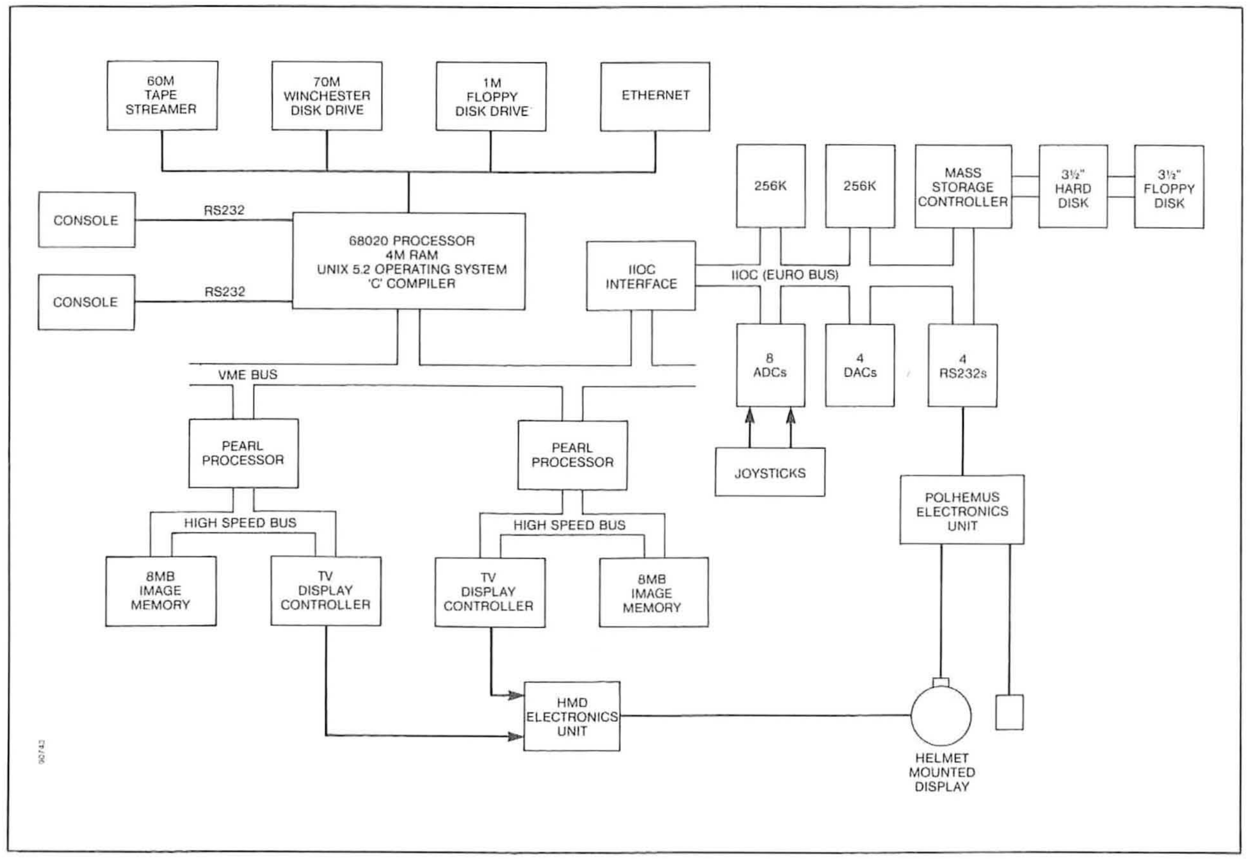
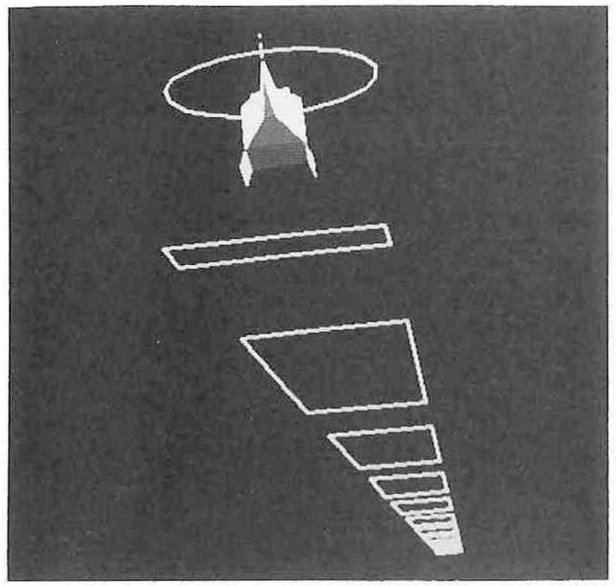


Figure 13

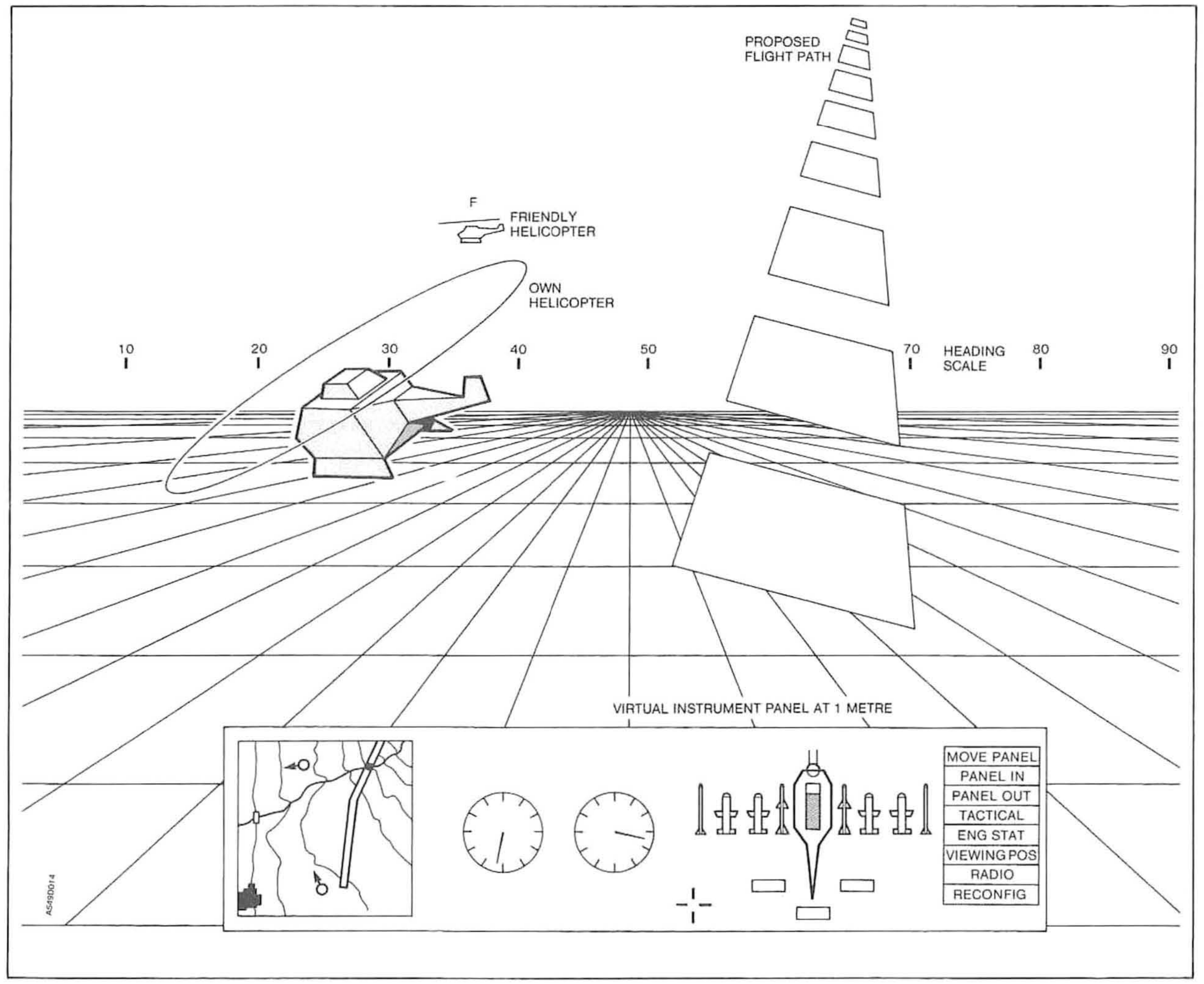


A display of a three dimensional terrain, which has been drawn from a height database is shown in Figure 3, Section 1.6. Currently, an update rate of about 1Hz can be achieved, which may well be adequate for the navigation mode, but for a synthetic outside world overlay a much quicker drawing rate would be needed.

Relevant Reports: *262/2501 Final report - Stereo Designator*

262/2594 Research into Stereoscopic Displays and Virtual Cockpit Concept 1987 to 1989

Figure 14



7 INTELLIGENT KNOWLEDGE BASED SYSTEMS

Senior Consultant: Frank Oates
Project Leader: Neil Milner
Principal Systems Engineer: Liz Doe

7.1 Introduction

The IKBS team currently comprises the Project Leader plus four engineers. The majority of the team's effort this year has been devoted to the development of an Intelligent Displays Management Demonstrator, which was satisfactorily completed and installed, on time, at RAE Farnborough in August 1989. A new area of preliminary investigation has been that of 'deeper reasoning' applied to fault diagnosis.

One team member has been assisting the Alvey Design to Product Demonstrator work by developing an 'intelligent/adaptive' user interface. (See Section 14).

Figure 15

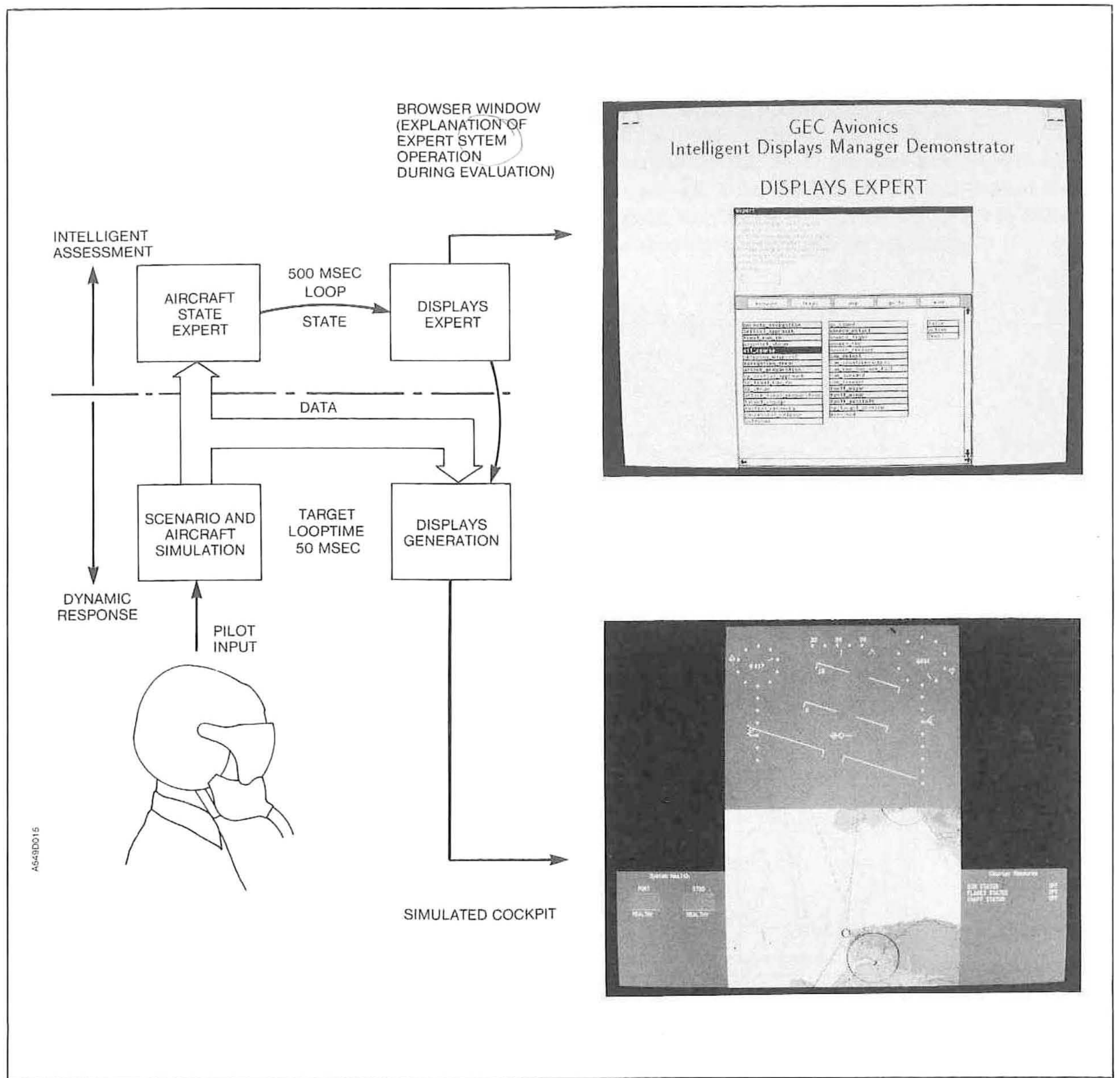
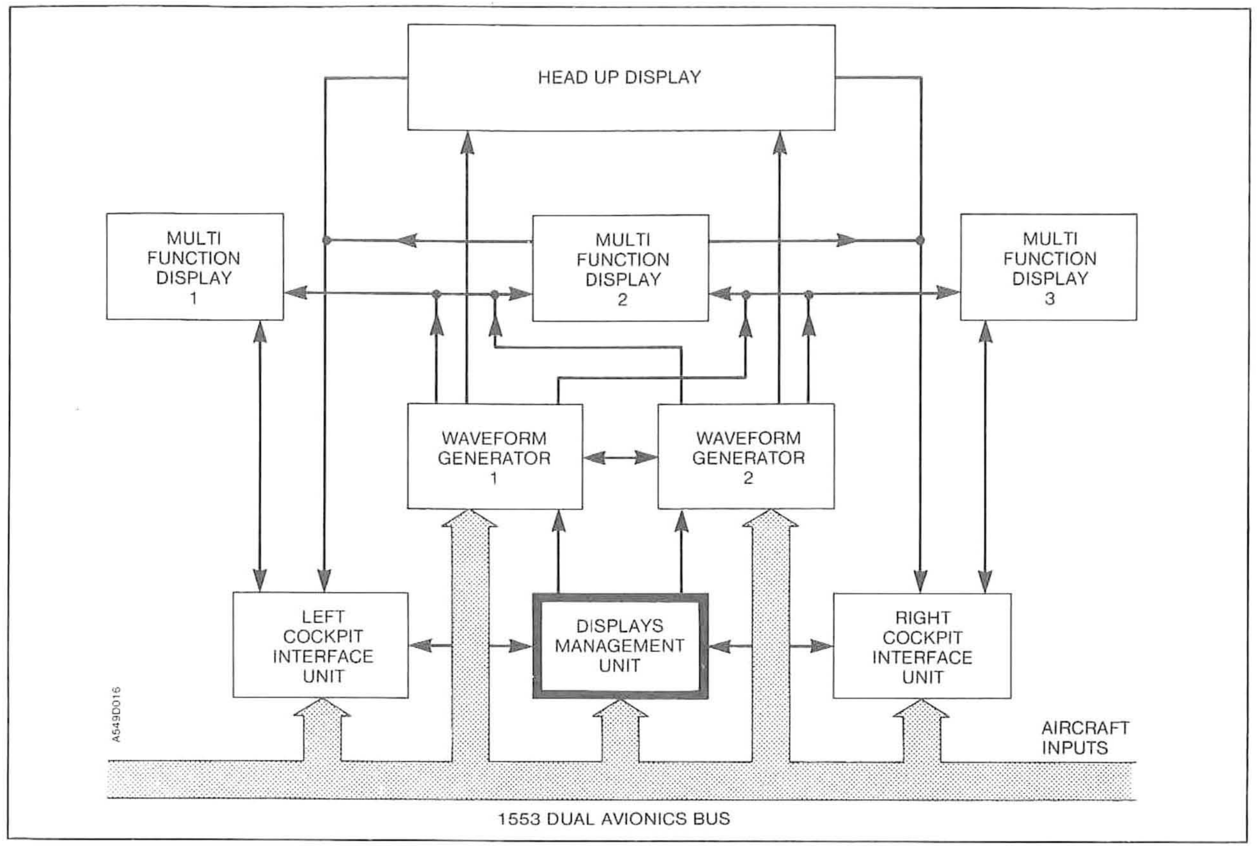


Figure 16



7.2 Intelligent Displays Management

This project was initiated by RAE, MM4a Dept, following an earlier study into the ways in which knowledge based systems might be used to anticipate and reduce the workload of a pilot during times of exceptional stress and work load, thus enhancing his effectiveness. The current demonstrator manages a range of cockpit display surfaces (HUD, HDD, Map) presenting information appropriate to the current phase and activity in a mission, while responding rapidly to changing priorities.

The demonstrator was developed on two networked workstations, the major system functions being shown in Figure 15. A feature of the design is the use of a rapid 'data loop' for pilot's inputs, the generation of simulated aircraft and scenario data, and the generation of dynamic displays. A slower 'knowledge based loop' controls the displays, selecting the information to be presented, the symbology and format. This latter loop uses an 'aircraft state expert' to assess what is happening and a 'displays expert' to estimate workload and the types of information of use to the pilot in his immediate situation. Figure 16 shows how an Intelligent Displays Management Unit might be incorporated in a multibus aircraft environment. The demonstrator is currently being evaluated at RAE. A common demand has been for 'intelligent advice', especially for re-routing in response to a counter attack. This shows the need for more 'intelligent systems' throughout the aircraft, capable of providing knowledge based advice in addition to pure data. It also shows the need for a management aid capable of collating such advice to generate a revised mission plan.

A follow-on contract to incorporate enhancements to the present system is anticipated.

7.3 Deeper Reasoning: Reasoning With Engineers' Knowledge

The diagnosis of faults in newly designed equipment, where there is no direct experience of failure modes and symptoms, can be costly. There are immediate costs to the Company during production, especially of small batches, and to our customers particularly during early maintenance.

This preliminary study is investigating the feasibility of using knowledge based systems for fault diagnosis by reasoning with the types of engineering knowledge readily available within the Company, such as drawings, schedules, parts lists, specifications, block diagrams, descriptive material, as well as general knowledge. A feature of the method being used is that it is applicable to processor based equipment where the system behaviour is dependent not only on hardware and software, but the interaction of the two.

7.4 Mission Management Aid: Joint Venture Research

This project relates to a Joint Venture collaborative programme between four major UK aerospace companies (GEC Avionics, British Aerospace, Smiths Industries and Ferranti) and RAE, Farnborough. The overall objectives for the Joint Venture Team are:-

- To specify a real-time mission-capable simulation of a 'Mission Management Aid'
- To functionally simulate such an MMA
- To define the interface for the resultant MMA using the RAE simulator facilities for later phases of the programme.

A senior FARL engineer has been seconded to the Joint Venture Research team at RAE, Farnborough to lead the MMA group of six engineers. This group has the task of the development of sensor fusion, situation assessment, tactical plan generation, and the presentation of plan options to the pilot. It is proposed to have initial prototype demonstrations early in 1990 which, with further integration and development, will lead to a full mission capable simulation.

Progress has been made in all the four core functions of the MMA i.e. Sensor Fusion, Tactical Plan Generation, Situation Assessment and MMI, using the software prototyping facilities within the team. Some integration of these functions will progressively occur during the year as each functional prototype is linked over the LISP workstation network.

7.4.1 Documentation

262/0387	*Scenario Manager: RAE Farnborough MM2*
262/0417	*Displays Management Enhancements: RAE Farnborough MM4a*
262/0410	*Sensor Fusion: RARDE Chertsey*
262/2678	*Automated Fuel Accessory Test System: USAF Kelly AFB (in support of ATED)*
262/2718	*Intelligent Displays Manager: Final Technical Report:*
262/2707	*DtoP Third Party Interface*

8 OPTICAL DESIGN

Project Manager: Brian Wortley
Principal Engineer: Dave Hubbard

8.1 Introduction

The Optical Design team comprises a Principal Engineer and two Senior Systems Engineers who provide an optical design facility to the Product Divisions and to other teams within FARL. The main programme of work during the year has been in the area of off-axis holographic HUD design for Airborne Displays Division (ADD).

The other main area of interest has been in a wide range of Helmet Mounted Display designs including the incorporation of optics to enable pilot's eye direction of gaze to be determined.

8.2 Off-Axis Holographic HUD Design

For the majority of the year the team has been involved in the design of an off-axis holographic HUD as part of an ADD programme to build a demonstrator for a number of potential customers, but specifically targeted at the EFA and ATF requirements. Patents are being sought for the novel optical arrangement for the relay elements in the design. The work also included the design of the hologram construction optics and full definition of the computer generated hologram. Other tasks have related to the production aspects of the design and, in particular, have covered the modelling of the master copying hologram process. The design work is now complete and ADD is proceeding with the manufacture of the demonstrator.

8.3 HMD Optical Design

The team has provided optical design support to a number of FARL project teams working in HMD activities as well as supporting ADD's programme on visor projection.

8.3.1 Alpha Helmet Mounted Sight

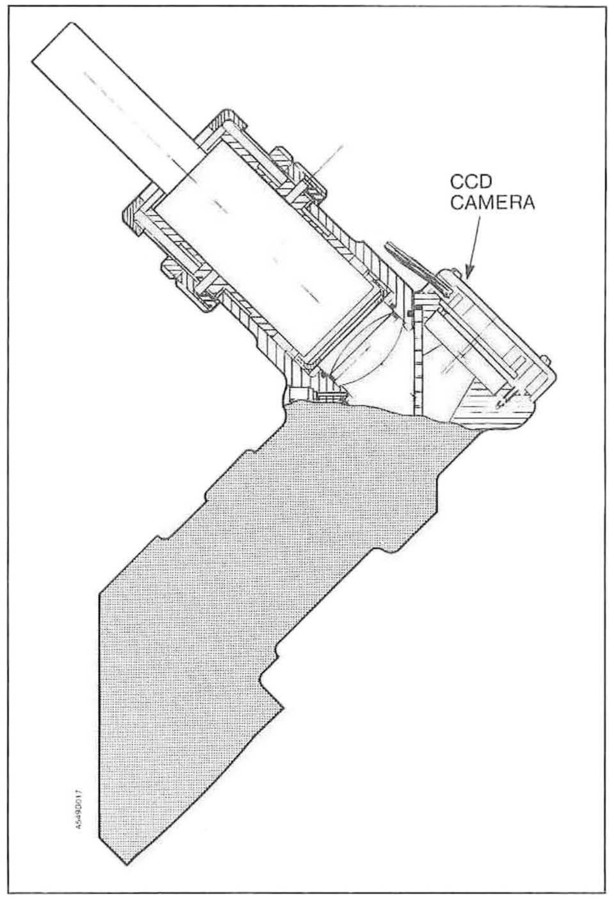
The work for the Displays team has covered the design of the optics and post-delivery support of the Alpha Helmet Mounted Sight. (See Section 4.2 Figure 6). This work was of a high enough calibre to warrant submission by one of the optics engineers as a Haskett Trophy entry.

This system uses a dichroic patch on the visor to reflect a LED sighting array into the pilot's field of view. The team has also been involved in feasibility designs for a holographic patch instead of the dichroic patch which could potentially provide better outside world transmission and reduce the number of optical components required.

8.3.2 Eye Tracker Optical Design

Integration of the PEPS optics in the wide FOV binocular HMD is a novel patented optical design using the minimum of extra optics by using IR specific components. Figure 17 is an outline concept of the optical assembly of the 50° binocular HMD, incorporating the integrated PEPS optics and CCD camera.

Figure 17



8.3.3 Wide FOV Binocular HMD

Work on binocular HMDs has involved upgrading the FARL 40° by 30° FOV design to provide a 50° FOV system. The design retains the same basic mechanical configuration but has a completely redesigned set of optics. The same high accuracy is achieved and parallax errors are less than 1 milliradian. This 50° FOV binocular HMD has now been ordered by MM2 Dept, RAE for Helicopter Simulator Research.

8.3.4 Visor Projection HMD

Other HMD related work has been for ADD who are funding the optical design of a visor projection HMD. The aim of this task is to provide an HMD which uses the visor as the combining surface for the display and the outside world, enabling a very compact, low weight solution to the problem of providing high brightness display symbology on a helmet.

8.3.5 Optical Design Software Development

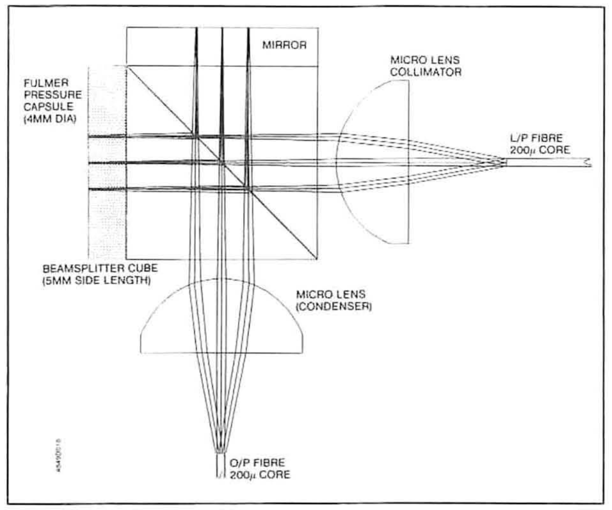
The optical design program suite is continually being developed and refined to meet the increasing demands of the optical systems designed with it. Two areas of improvement that are being actively pursued are optical tolerancing and 3D ray tracing.

Optical systems are normally symmetrical, but for complex optical systems such as HMDs, where the optics must fit around the head and utilise curved visors, full 3D ray tracing is necessary. In support of ADD's helmet design work, a full 3D ray tracing facility is being incorporated into the design suite.

8.3.6 Other Optical Designs

The team has been involved in a number of feasibility studies during the year for other FARL projects including optics for pressure transducers and for position measuring systems for towed drogues. Figure 18 illustrates the Optical Interface for the miniature pressure sensor (See Section 9).

Figure 18



Relevant Reports: *262/2429 EFA Holographic HUD Complete System Summary*

262/2421 EFA Holographic HUD Construction Optics Design

262/2531 Design Requirement Specification for the FARL Alpha Helmet Mounted Sight

262/2623 A PEPS on the Binocular HMD Initial Optical Design

262/2762 Optical Specification for a Wide FOV Binocular Helmet Mounted Display

262/2775 PEPS Eye Tracker Specification

9 SENSOR SYSTEMS

Project Manager: Brian Wortley
Project Leader: Steve Heptinstall
Consultant: Ted Lewis

9.1 Introduction

The activity on Sensor Systems as a whole is small but important, and also involves the Optical Design team and consultancy support. (See Section 8).

9.2 Fibre Optic Pressure Sensor Development

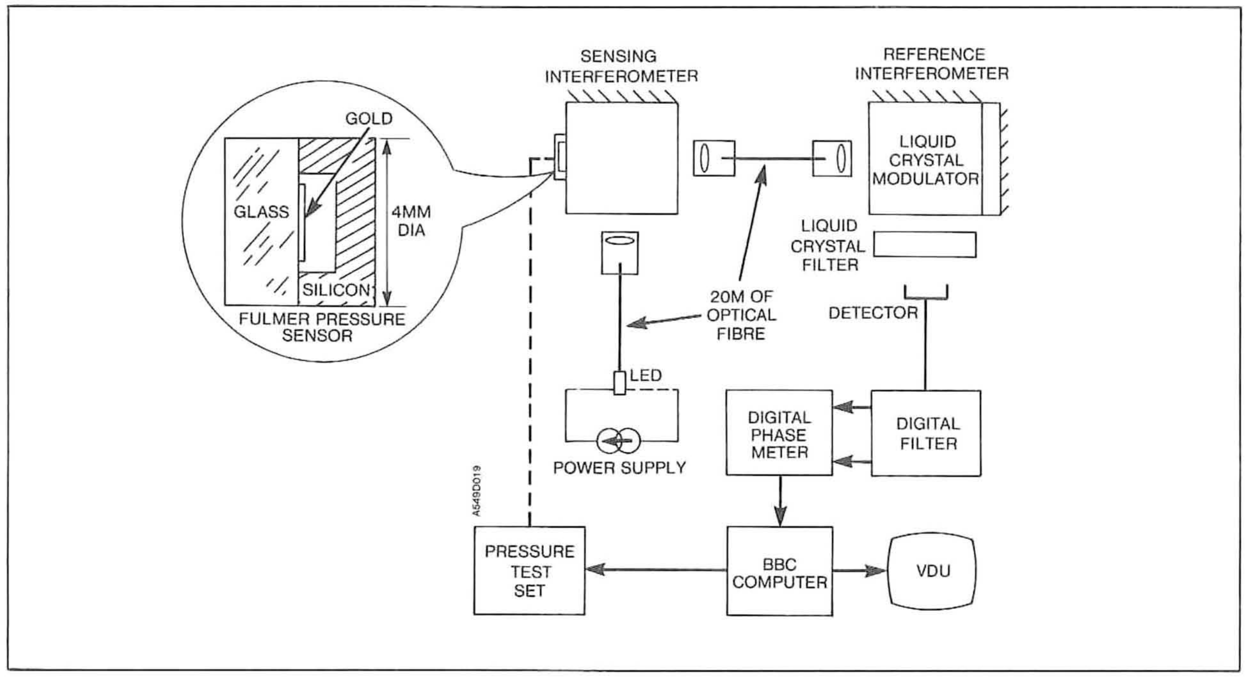
Work over the past year has been the continuation of the development of the Passive Fibre Optic Pressure Sensor described in last years report.

This has progressed to the stage where a more realistic prototype can be manufactured, using a single LED source from which two close frequencies are selected by a liquid crystal filter. The pressure capsule, designed by Fulmer Research, was originally a capacitive device but is now being modified to form part of an optical interferometer (See Section 8.3.6).

Figure 19 is a schematic diagram of the system. As well as work on the sensor we propose to test the system using a Sperry pressure test set with the results being recorded using a BBC microcomputer.

Relevant Report: *262/2641 Fibre Optic Pressure Sensor Investigation*

Figure 19



10 DATA TRANSMISSION SYSTEMS

Project Manager: Kenny Deans
Project Leader: Alan Birch (Data Bus Systems)
Senior Systems Engineer: Rob James (Fibre Optics)

10.1 Introduction

The Data Transmission team comprises the Project Leader plus three Engineers but, due to the overlap of activities with the Fibre Optics and VLSI teams, forms part of a 'centre of excellence' for the Company on data transmission.

Much of the work of the Data Transmission team during this year has been associated with the STANAG 3910 Protocol Device development and Advanced Avionic Architecture and Packaging (A^3P) programme detailed elsewhere in this report.

10.2 Standardisation

Following the publication of the Society of Automotive Engineers (SAE) Linear, Token Passing, Multiplex Bus (AS 4074.1) and High Speed Ring Bus (AS 4074.2) standards last year in the United States, FARL has continued to participate in the refinement of the standards and the production of the User Handbooks. These handbooks outline the development of the standards, stating reasons for the choice of particular characteristics, and provide guidance on how to design and use the data buses. The parallel standardisation activities of the Joint Integrated Avionics Working Group (JIAWG) have also been monitored by the SAE and joint efforts made to produce a single Linear, Token Passing, Multiplex Bus standard.

Attendance of the Avionics Systems Standardisation Committee (ASSC) here in the UK has also involved FARL in the discussion and proposed standardisation of the draft STANAG 3910 on high speed, 20Mbit/sec data buses. This has resulted in the proposal of a new document (ASSC/120/2/8/) including the use of an electrical high speed network and point to point(s) links. Due to the considerable effort in STANAG 3910 design, both system and detailed logic, FARL has been able to provide a major contribution to the development of this document, which has been distributed to the NATO countries as the UK input to the STANAG 3910 requirement.

10.3 LTPB Station Design

Following the selection of Lear Astronics Inc as the source for the Integrated Vehicle Subsystem Control (IVSC) for the Lockheed ATF team, FARL and Instrument Systems Division were given the task of producing a Flight Critical Avionics Bus Interface module. Having carried out the functional requirements definition for the module and generated interest in the design, particularly the projected low power dissipation, the need for such a module was superseded by an architecture change. Work has, however, continued in defining the module, although it has been largely overtaken by the more pressing STANAG 3910 developments.

A proposal has been generated which outlines a plan to implement the station and is currently being discussed with Marconi Electronic Devices Limited, Lincoln and Microsystems, Swindon.

Relevant Reports: 262/2592 Specification for a linear token passing bus interface
262/2644 An example of a high speed bus interface

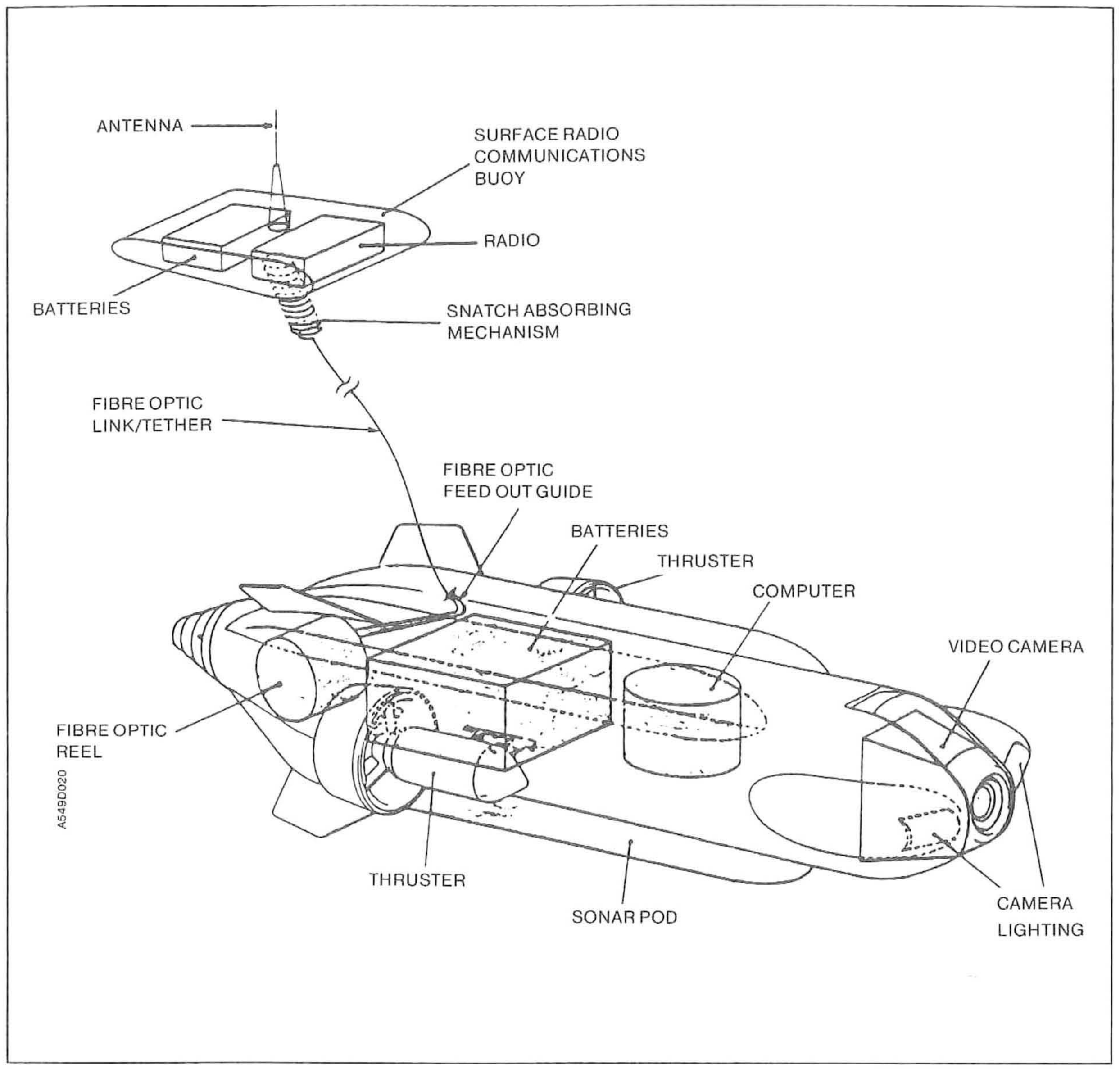
10.4 High Speed Data Bus Evaluation Study

In conjunction with British Aerospace, ERA Technology, Ferranti Computer Systems and Smiths Industries, FARL has been involved in the evaluation of the two SAE data bus standards (Linear Token Passing Bus and High Speed Ring Bus), the Fibre Distributed Data Interface (FDDI) and the proposed STANAG 3910, for future avionic systems.

The main purpose of the evaluation was to provide the MoD with guidelines for the use of each of the candidate High Speed Data Buses, so that future avionics system design may be optimised. FARL has been involved in the review of the system architecture, the data sets used, the simulation models and the boundary condition results.

Relevant Reports: 262/2650 HSDB Review of terminal
262/2657 HSDB Review of architectures
262/2741 HSDB Evaluation Support Implications

Figure 20



10.5 Fibre Optics

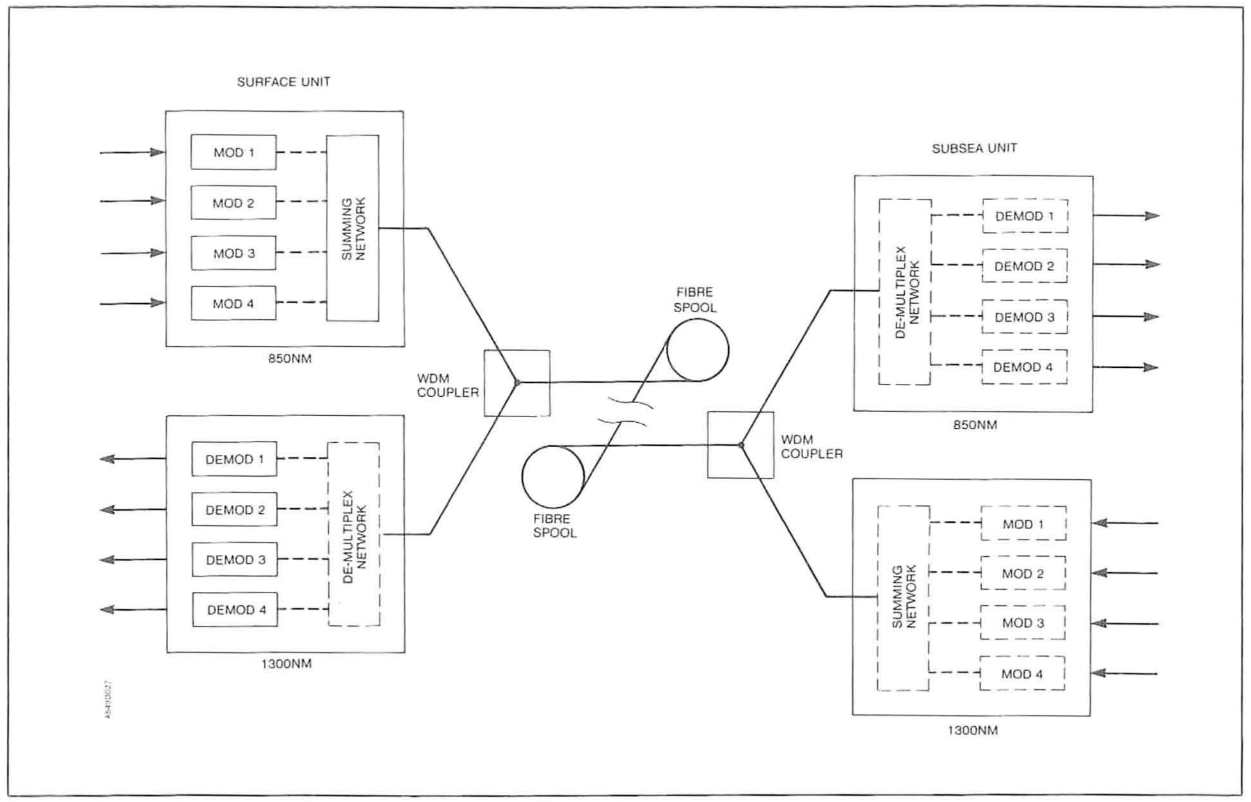
10.5.1 Introduction

The Fibre Optics team comprises 3 Engineers and has, over the past year, been involved in investigating a range of applications which use Fibre Optics as an enabling technology. Included in this are specification work done on STANAG 3910 Transceiver Components, system work on data links for Remotely Operated Vehicles and continuing support on the Airship SKS 600.

10.5.2 SARIS - Remotely Operated Vehicle Link

The Fibre Optics team have undertaken work on behalf of the Offshore Projects Group (OPG) at GEC Nailsea as part of the overall SARIS (Semi-Autonomous Rapid Inspection and Survey Remotely-Operated Vehicle) project. OPG identified the fact that current underwater Remotely Operated Vehicles (ROVs) have a limited range and depth capability from/to their supervisory mother vessel, mainly because of the constraints and drag of the umbilical cable. It was proposed to free the ROV by means of a fibre optic umbilical and radio link. The system concept is shown in Figure 20. The study was to evaluate the fibre optic link and data transmission options and to build a suitable laboratory demonstrator. The major design considerations for the link were that it must allow the ROV to operate at distances of up to 3km and be able to carry the required data which are video and three bi-directional signals for control sonar and payload sensors.

Figure 21



A detailed optical power budget analysis of the proposed system was carried out and a demonstrator built. A block diagram of the system is shown in Figure 21. The demonstrator comprised a 3.4km umbilical using a standard grade 50/125fm multimode telecommunications fibre. Two units representing the sub-sea and surface electronics housed electrical and optical components. Optical multiplexing was used to give the link the required bi-directionality and used wavelengths of 850nm and 1300nm. Electrical multiplexing in the form of a frequency stacked carrier system was used to give the link the capability of transmitting eight simultaneous video transmissions, four in each direction. Digital data transmission was also provided as an option to any of the video channels.

The results of this study proved that it was feasible to use fibre optic cable in this manner and that it would be beneficial to both technical and physical requirements. The very low drag of the fibre optic cable is also a major advantage.

Relevant Report: 262/2622 Optical data link for SARIS

10.5.3 Airship Support

After the successful initial flight trials of the SKS600 Optically Signalled Flight Control System at Weeksville, North Carolina during 1988, the equipment was returned to FARL for the modifications required for the new X-tail configuration of the airship, where the control surfaces are at 45 to the horizontal and vertical.

This involved some hardware and software modifications to the flight control computer. While these modifications were underway a quality check made on all the optical terminations and the power and sensitivity of the transmitters and receivers, showed no degradation which would affect system operation.

Consultancy was also provided to FCD who were having the main fibre optic looms lengthened and modified. The modifications included ready-terminated spare fibres within the optical looms to facilitate maintenance in the event of fibre breakage.

10.5.4 Digital Video Link

This activity covered the design and building of a simple digital video link module that could be used as a transmitting element within some of the higher speed buses under consideration, such as FDDI II and HIBSON. The link was also used to investigate the modal noise effects that arise when using laser transmitters. A qualitative comparison was made between normal analogue video transmission and digital video which showed no degradation of the signal.

Each digital interface is made up of three main elements. At the transmitting end are an A/D converter, a standard AMD TAXI (Transparent Asynchronous Xmitter/receiver Interface) chipset and an FDDI (Fibre Distributed Data Interface) compatible optical transmitter. At the receiver end of the optical fibre are a receiver, a TAXI and a D/A converter. Sampling of the video input is 8bit packages at 12MHz, but encoding overheads and sync pulses raise the digital data rate to 120MHz.

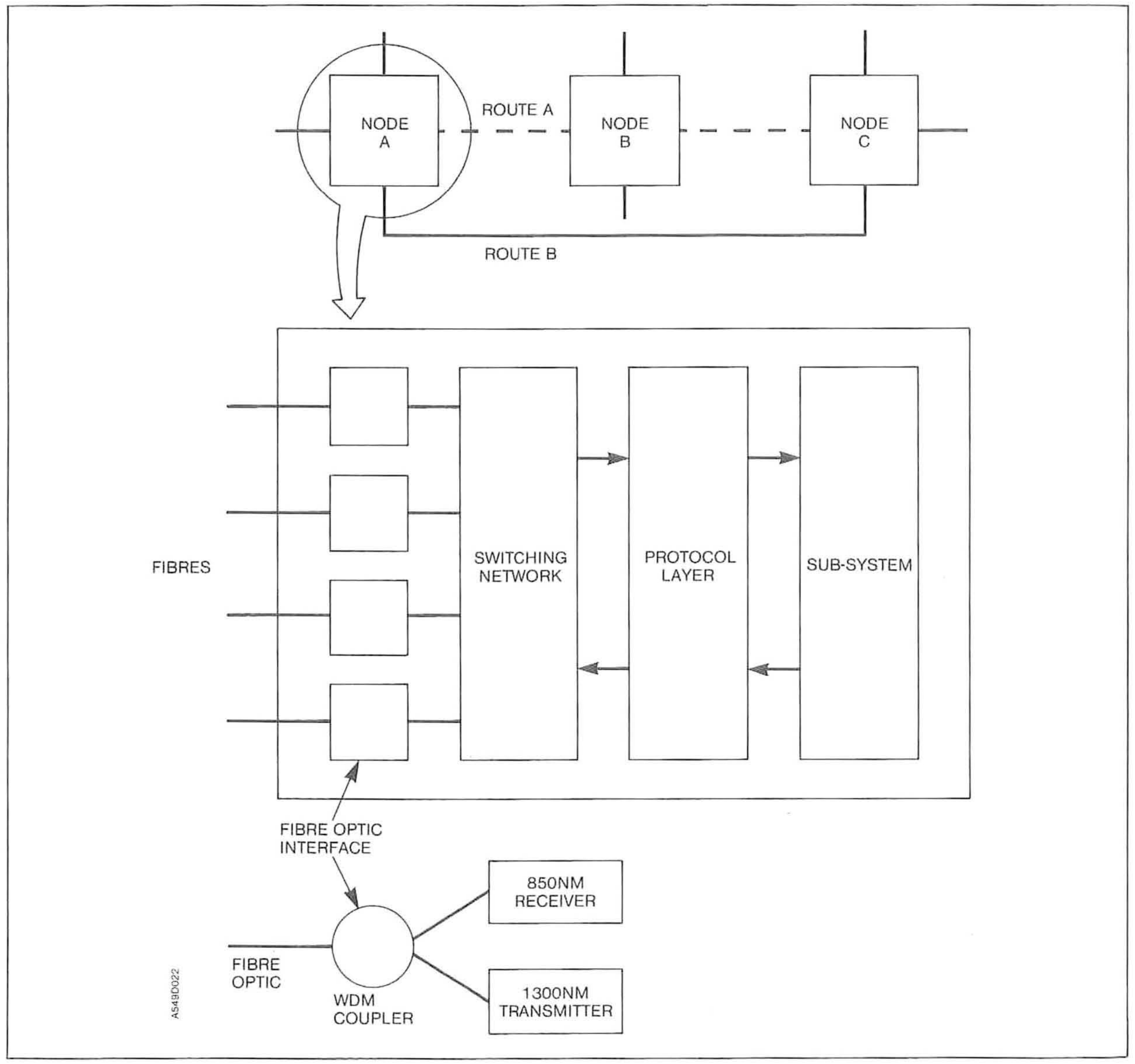
10.5.5 'HIBSON' High Bandwidth Switched Optical Network

This work is still in its early stages with funding for an initial study provided by Instruments Systems Division. The High Bandwidth Switched Optical Network (HIBSON) is a reconfigurable bus network that will be able to handle the transmission of video and other analogue data as well as digital data. The aim is to design a network with a 2Gbit/sec per channel capability with multiple reconfiguration channels.

Due to the high data rates involved it may be necessary to move towards single mode fibre technology for optimum performance. The study will examine the system aspects of the network and most practical implementation.

The system concept is shown in Figure 22 where each node comprises a Fibre Optic Interface, Switching Network and Control Electronics. It is predicted that such a system could absorb failures and demonstrate a high degree of fault tolerance.

Figure 22



10.5.6 STANAG 3910 - EFA Bus Fibre Optic & Transceiver Aspects

This activity has seen considerable progress over the last year. Procurement specifications for a fully integrated and hybridised fibre optic Transceiver, which includes the'Y' coupler, have been drawn up and discussed with possible Transceiver manufacturers.

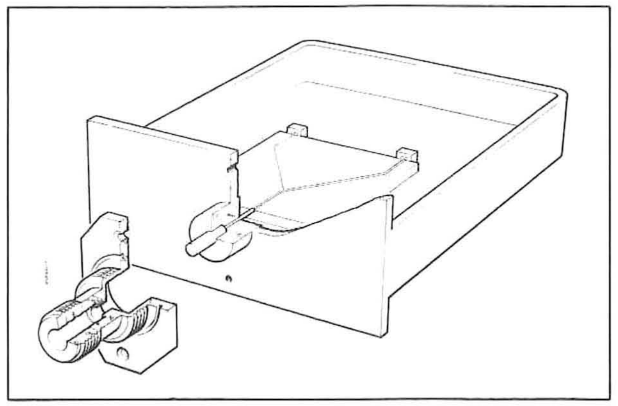
In conjunction with this, an interface study document and specification have been produced to provide a standardised interface between the Protocol device and the Transceiver.

Both specifications have been submitted to the AECMA (Association Europenne Des Constructeurs De Materiel Aerospatial) for consideration as a European Standard for the transceiver.

The design of the Transceiver module and it's installation have been constantly under review. Close liaison with the connector manufacturers, hybrid manufacturers and the GEC Avionics Product Divisions is aimed at providing a single design that is achievable and practical for all parties. One possible design is illustrated in Figure 23.

The team has developed interface circuits and an optical transmitter in-house to meet most of the requirements for STANAG 3910. This work will be incorporated into a bus demonstrator rig under construction at FARL. The team is liaising with several manufacturers developing components to this specification and will be procuring prototype devices for evaluation on the rig.

Figure 23



The inclusion of circuitry to enable investigation of a system level tester into the concept demonstrator will result in a test and validation rig for the PROTOCOL Device being developed at FARL, and provide the basis of a possible product for Automatic Test Equipment Division.

Relevant Reports: *262/2631 Optical Fibre Transceiver Specification for STANAG 3910 Issue 2*

262/2747 Interconnections for STANAG 3910 Protocol Device to Optical Transceivers

262/2505 Optical Fibre Cable for Avionic Data Transmission systems. General Specification

262/2546 Comments on EFABus Specifications

11 VLSI DESIGN

Project Manager: Kenny Deans
Principal Systems Engineer: John Gilmour

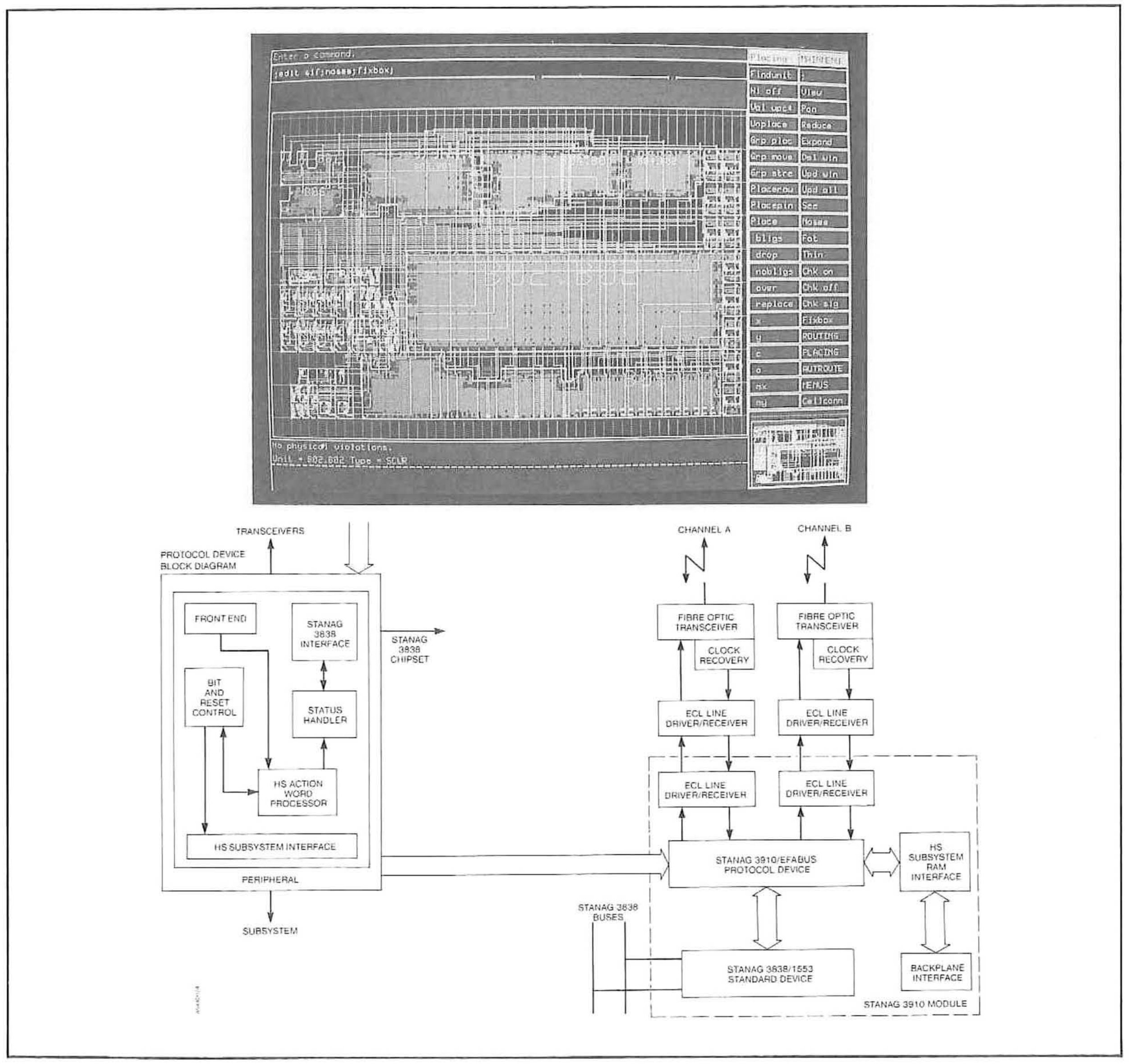
11.1 Introduction

The VLSI Design team comprises of the Principal System Engineer plus four Engineers who have built up particular expertise in the VLSI implementation of complex serial data transmission systems. The team's activities over the past year have been mainly directed to supporting the High Speed Data Bus programme, in particular the VLSI implementation of STANAG 3910 components, and has continued to monitor developments in VLSI which would be of benefit to the Product Divisions.

11.2 STANAG 3910 Protocol Device Design

The STANAG 3910 Protocol Device, illustrated in Figure 24, is designed to handle the high speed data

Figure 24



transfers which are required in STANAG 3910 and EFABus systems. The Protocol Device interfaces with a variety of STANAG 3838 (MIL STD 1553B) chipsets including MA805, MA3690/3691, and MCT83910. HS Action Words received by these chipsets on the STANAG 3838 bus are passed to the Protocol Device and initiate High Speed data transfers. The Protocol Device is also designed to be used in any of the different types of terminal which are required for a STANAG 3910 system, including Remote Terminal, Bus Controller, standby monitor, instrumentation monitor, and active monitor applications. It can also be used in point-to-point links using similar protocols to STANAG 3910.

The main activity of the team during 1989 has been the design of this device using Plessey Semiconductors' 1.5 micron CMOS "sea-of-gates" gate array technology CLA60000. Design capture was carried out using the CASE schematic capture software on IBM-PCs and simulation and layout carried out using the Plessey Design System Software (PDS2) on FARL's VAX system.

The device, which has a complexity of about 19000 used gates, will be manufactured by Plessey Semiconductors. It is intended that it will be marketed by Marconi Electronic Devices, Microsystems Division as part of a component set.

FARL have designed the Protocol Device using a structured, top down design approach. Following partitioning of the design into individual functional modules, module specifications were produced. Logic design and test waveform specifications were produced for each module, which was simulated in isolation before integration to form the whole device. Simulations were carried out at each stage of the integration phase, and the design was subjected to an Acceptance Test Plan (ATP) simulation which tested all functions. In addition to this, a test waveform was developed for use in production testing of the device by Plessey, and fault simulation was used to verify the quality of this production test. Post layout simulation using estimated values of track capacitance will be carried out before manufacture of prototypes.

Other team activities connected with STANAG 3910 were attendance at various committees, support of Product Divisions' EFA bids, and preliminary design work on test circuitry for evaluation of Protocol Device prototypes.

11.3 VLSI Research

The team research activities have had to take a low priority compared to STANAG 3910 developments. A survey of Product Divisions was carried out to confirm that FARL research was closely attuned to their needs. VLSI research has included attendance at relevant meetings and colloquia.

Relevant Reports: 262/2422 Issue 2 Specification of a protocol device for STANAG 3910

262/2770 Design methodology for STANAG 3910

262/2652 GEC Avionics requirements for FARL VLSI team

12 ENVIRONMENTAL DESIGN AND ELECTRONIC PACKAGING

Project Manager: Clive Goodchild
Senior Project Engineer: Dave Larner (Nuclear Hardening & Environmental Design)
Senior Development Engineer: Jack Wilkinson (Electronic Manufacture & Model Shop)

12.1 Introduction

The team comprises the Project Manager plus six Engineers, three of whom specialise in design requirements for electromagnetic, chemical and nuclear hardening. The rest of the team is concerned with a variety of activities, including advanced avionic architectures, electronic packaging research, mechanical design and prototype manufacture.

12.2 Design and Manufacture

The mechanical design team has supported the other teams in the Laboratory in most aspects of hardware, notably the mechanical design for the integration of PEPS within the Binocular HMD. Other projects include the investigation of future avionics packaging architectures.

12.3 Modular Avionics

Whilst the team has mainly been engaged on Company funded research this year, technical support has also been given to both the A^3P Technical and Logistic studies.

12.3.1 Surface Mount Demonstrator Module

The team has continued the study of the implications of future avionic packaging concepts with the successful commissioning and testing of a surface mount SEM-E style conduction cooled module. The module comprises an 8086 16 bit microprocessor, memory devices and a MIL-STD-1553B data bus interface. A Nuclear Event Detector was also incorporated to give gamma dose rate protection. The module has been programmed to drive a flat panel LCD instrument display to give a simple visual indication of correct functioning. Environmental testing has been limited to EMC in FARL's Crawford cell over the frequency range of 1 to 300MHz at a field strength of approximately 60V/m with no apparent upset or errors.

Relevant Report: 262/2614 Surface Mount Demonstrator Module

12.3.2 'Thermal' SEM-E Style Modules

Two conduction cooled SEM-E style modules have been designed and manufactured for an evaluation of the thermal implications of high density packaging. The electrically similar double sided modules with different central heat exchangers (copper-invar, aluminium) carry a range of Lead-less Chip Carrier Components which can be driven to allow a range of power dissipations to be evaluated.

12.4 Nuclear Hardening

The team has been engaged on both Company funded and MoD(PE) funded research this year.

12.4.1 SUBWOG 36C Presentation

The Nuclear Hardening team, at the request of the RAE Farnborough, gave a presentation of the SIU-A work to the SUBWOG-36C meeting held at the Sandia Laboratories in the USA in September 1989. This was to demonstrate the UK's expertise in hardening avionic electronic equipment as part of the joint information exchange programme concerning radiation effects on avionics between the US and the UK.

12.4.2 Nuclear Event Detector

The Microsystems Department of Instrument Systems Division has repackaged the FARL designed Nuclear Event Detector. FARL have given technical support and have qualified the devices using the weapon simulators at AWE Aldermaston. The test results have been assessed, and modifications to improve the device have been implemented.

Relevant Report: 262/2727 Nuclear Event Detector Hybrid Testing Equipment

12.4.3 Assessment of Station Interface Unit (SIU-A)

An MoD research programme is currently being carried out by FARL and is concerned with the implications of radiation hardening a representative sub-system of a modern Stores Management System. The unit selected was the Station Interface Unit, SIU-A, developed by Instruments Systems Division as part of their Modular SMS. The contract involves the assessment and hardening of the SIU-A to gamma dose rate effects. The work to date has involved a theoretical assessment, and component trials using the weapon simulators at AWE Aldermaston. The system has recently been irradiated using the Flash X-Ray machine at AWE (Figure 25) and the results are currently being evaluated. Hardening the system uses both active and passive measures, i.e. a nuclear event detector (NED) and current limiting networks. A report will be issued showing the results of the hardening measures and will give an indication of the protective shut-down time of the full Modular Stores Management System. This work will allow future designs to incorporate the features necessary to ensure that nuclear hardness requirements can be met.

12.4.4 Autonomous Nuclear Protection Device

Under Company funding, some preliminary computer modelling and gamma dose rate testing have been conducted on a modified NED. This device is powered by a Cockcroft's voltage doubling network, and is not dependent on having a stabilised power supply during the nuclear event (see Figure 26).

Relevant Report: 262/2723 Autonomous Nuclear Protection Device

12.4.5 EFA Consultancy

The team has continued to support Product Divisions in responding to the EFA Nuclear Hardening requirements. This has involved upgrading the Nuclear Hardening Annex, and assistance has been given in writing the nuclear hardening section of proposals. Thermal and total gamma dose tests on some holographic combiners for ADD have also been arranged and successfully conducted.

12.4.6 Electro-magnetic Interference and NBC Studies

Research has continued into the implications of electro-magnetic interference on future packaging concepts; this has involved both practical and theoretical analysis of the 8086 SEM-E type module in the FARL Crawford Cell.

Figure 25

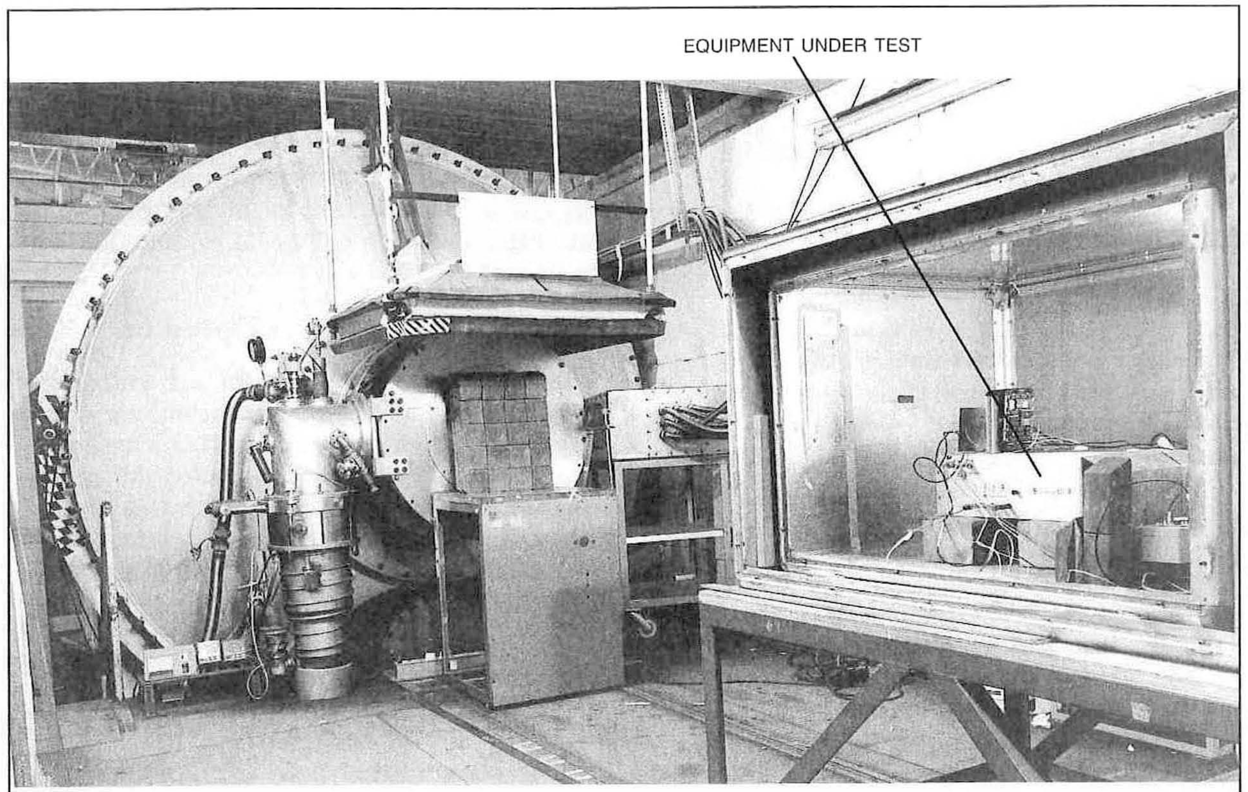
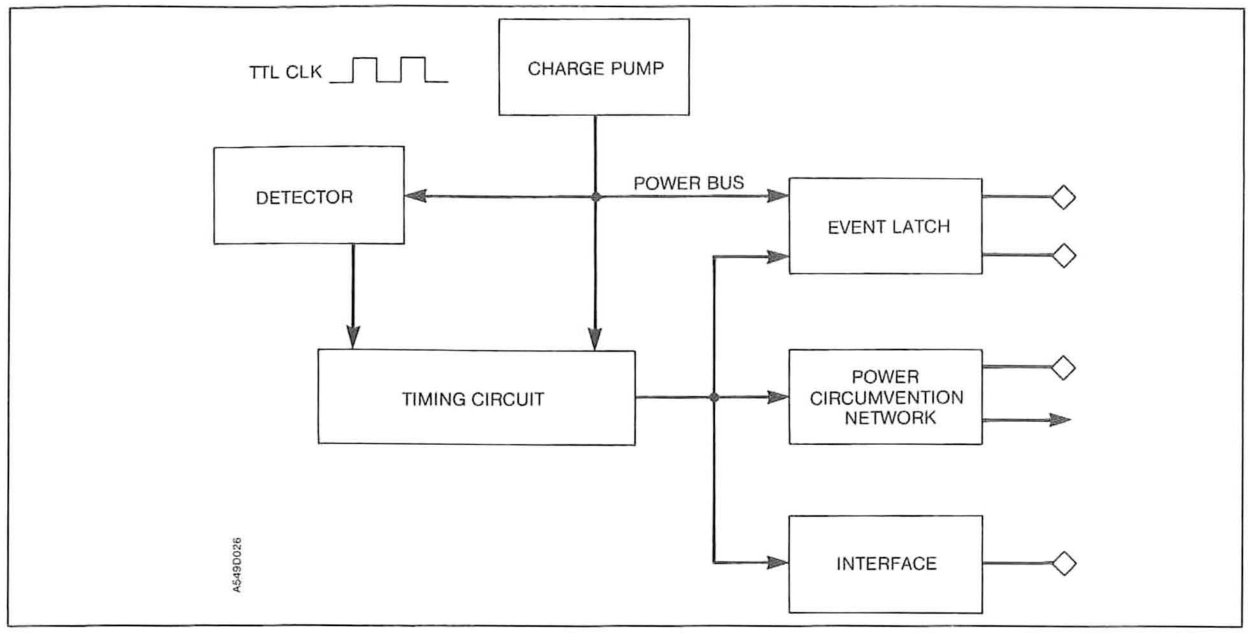


Figure 26



Work continues on the implications to avionics of the new EMC, lightning and NBC requirements. Information is being collated concerning pulsed lightning requirements and the potential effects of high RF fields that future civilian and military aircraft will have to meet from high power broadcast, communication and radar facilities.

During the past year two members of the team have attended NBC courses held at the RCMS, Shrivenham.

12.4.7 Lightning and NEMP Modelling

Current studies include an appraisal of the circuit simulation programme SPICE to model the EFA BCI and lightning verification test requirements. A number of computer simulations have been conducted and a preliminary report has been issued. More detailed modelling of circuits is currently under investigation.

Relevant Report: 262/2653 Modelling Current Injection using 'SPICE' preliminary investigation

12.4.8 Future Work

Several proposals are under consideration by the Ministry of Defence for both INR and Electromagnetic studies.

13 CONSULTANCY ACTIVITIES & STUDIES

Consultants: Brian Paxton
Em Oetzmann
Geoff Craggs
Jim Pickford
Ted Lewis

13.1 Introduction

The consultancy service has continued in 1989 covering support for work in FARL, Product Divisions and Inter-Company Groups. A wide range of assistance has been provided in the form of proposals, studies, advice and general liaison.

Integrated modular avionics has continued to be a topic of major importance and studies have been carried out into countermeasures against laser threats in aircraft missions. System studies have been extended to the army fighting vehicle environment by participation in the VERDI programme (Vehicle Electronics Research Defence Initiative).

The high temperature pressure sensor research has been supported with investigations into miniature pressure capsules and the use of optical modulators. (See Section 9).

13.2 ASSC Steering Committee

Three Steering Committee meetings of the Avionics Systems Standardisation Committee were attended this year. These have addressed a wide range of topics in the data transmission, computing and packaging fields, all relevant to future avionics architectures and the four nation initiative to promote a standard avionic architecture through the ASAAC (Allied Standard Avionics Architecture Council).

Relevant Report: 262/2729 ASSC Activities in 1989

13.3 IAWG Participation

FARL participation in the Industrial Avionics Working Group has continued throughout the year, during which there have been six meetings. Emphasis has continued on investigations into communications, future avionics requirements, architectures, and technology demonstrator programmes.

The architecture sub-group has produced a series of documents examining the functionality and architectural possibilities for a range of future aircraft operating in the hostile environment expected beyond the year 2000. These classified documents form the FACT 2000 Series (Future Avionics Concepts and Technology) the subject matter of which was presented to the four IAWG companies in the Summer.

Relevant Reports: 262/2673 (FACT 2000-1) Functional Architecture FACT 2000-2 Implementation Architecture

262/2701 A Methodology for Assessing Redundancy in Avionics Systems Architectures

13.4 Vehicle Electronics System Studies - VERDI

The need has been identified for fighting vehicle electronics to be integrated to retain effectiveness as the necessary number of functions escalates. A new word for this, 'Vetronics', has entered the language, as a parallel to avionics in aircraft. A programme of work has been initiated by the Royal Armament Research & Development Establishment (RARDE) at Chertsey under the banner of VERDI. This is a co-operative programme between a large number of members of the defence electronics industry and RARDE. The aim is to provide integrated demonstrators for the 1990 and 1992 British Army Equipment Exhibitions. These will show how the vehicle electronics used in the reconnaissance role will be integrated together in a number of multifunction crew stations in a typical vehicle.

GEC Avionics is a fully committed partner in this venture and has been enthusiastically pursuing the objectives of the initial design stage during the latter half of the year. Although the system largely comprises donated equipment from suppliers, considerable work is needed to ensure compatibility and data exchange between them and to define and implement the required functionality in the crew stations.

Several members of FARL have played key parts in this early stage to the extent that the project is now able to move from the definition and specification stages to detailed work on software design and system integration. Although not an avionic application there are many areas where experience from avionics is essential and where the Product Divisions may well learn of future markets if they participate. As we see it, at the moment the relevant areas are in Crew Station design and manufacture, together with Displays, Helmet Mounted Systems, Hand-controllers and Sticks, Map Displays, Navigation Equipment (IN, GPS etc), Attitude References, and Power Control.

Relevant Reports: 262/2689 VERDI Architecture Working Group Initial Assessment Report

13.5 Acoustic Signal Processing

Work on acoustic signal processing has been carried out for MASD over the last two years. This work has been wide ranging and involved many aspects of hardware design and system analysis.

In order to operate successfully, an airborne ASW system receives radio signals transmitted by a battery operated sonobuoy. The acoustic signal is received by a hydrophone array and multiplexed onto the RF carrier and the multiplexed signal is then decoded on board the aircraft. The acoustic signals are very weak and masked by sea noise and in a rough sea the sonobuoy can add mechanical noise to the signal and waves breaking over the aerial can interfere with the RF signal which is already limited by the battery power. The sea motion also interferes with the sonobuoy compass if it is a directional sonobuoy. On board the aircraft receiver noise is added to the acoustic signal especially during washover. This causes target detection problems and also interferes with the demultiplexing process.

The work at FARL has been aimed at solving these problems by improving the sonobuoy performance, and a number of design changes have been suggested. Measurements have been carried out on various receivers and techniques have been devised for limiting the effects of the receiver noise. More recently a classified patent was filed for a new signal processing algorithm for sonobuoy data.

Relevant Reports: 262/2420 Cardioid Signal Processing
262/2414 Suggested Sonobuoy Improvements

13.6 Electro-optic Counter Measures

The threat from laser weapons requires protection for the air crew's eyes and aircraft optical sensors, and the nature of the threat requires a high-speed, wide-band response. This has stimulated FARL to investigate new materials and high-speed switching techniques based upon work in the nuclear hardening field. This will form the basis for helmet-mounted protective systems and protected image intensified viewing systems.

FARL has submitted proposals with Marconi Research Centre for feasibility studies that should receive joint funding in 1990.

13.7 Advanced Avionic Architectures and Packaging (A^3P) Studies

These studies were carried out by the following Senior Engineers

Consultant:	Jim Pickford
Project Leader:	Alan Birch
Principal Software Engineer:	Steve Carter

13.7.1 Introduction

During the year we have responded to an MoD request for studies into future avionic architectures, two contracts being completed.

The Advanced Avionic Architecture and Packaging (A^3P) Technology Demonstrator Programme is an MoD initiative to study modular avionics and standardisation with particular emphasis on low life cycle cost, in a four phase programme:- Identify alternative architectures and examine their logistical advantages; produce a detailed architecture; reduce risks; produce a Technology Demonstrator.

In collaboration with British Aerospace, Ferranti Defence Systems, GEC Sensors and Smiths Industries, GEC Avionics were awarded two concurrent Phase I studies, partly funded by the MoD. These were a Logistics Study to identify benefits in life cycle costs for alternative architectures in an existing aircraft, and a Technical Study to investigate and define the benefits of advanced architectures, and the use of new technologies, with the requirements of a future aircraft as a basis for the study.

13.7.2 Logistic Study

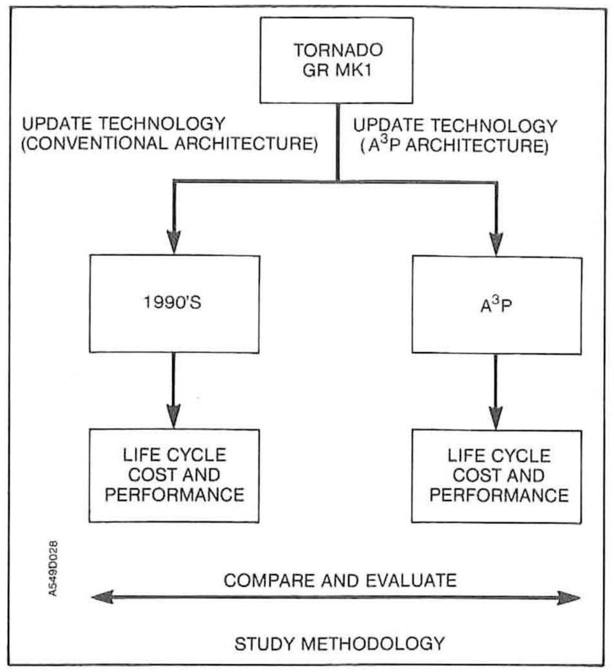
Taking the Tornado GR MK1 as a baseline, comparison was made between a conventional architecture and hardware fit, using Line Replaceable Units (LRU's) and ARINC ATR racking systems, and an A^3P architecture with Line

Replaceable Modules (LRM's) and standardisation where applicable.

In order to compare 'like for like' costs for alternative architectures, it was agreed with the MoD that the existing Tornado architecture would be updated to 1990's technologies whilst maintaining the original functionality and performance, and an A^{3}P architecture would be developed with advanced technologies again maintaining the original functionality and performance. See Figure 27. To assist in the comparison of the architectures it was necessary to model the effect of changes on logistics, using software tools such as PRICE, OPUS, GECOMO and other in-house models. None were considered adequate and so a software model called CompAcT was generated, consisting of sets of equations in a top down hierarchical structure. It allows the operator to input the relevant information/data, and can react quickly to change. The model accepts information at Line Replaceable Item (LRI first line replaceable) level, together with global information such as the number of aircraft and bases, and constants like MTBF. See Figure 28.

The model showed many areas, detailed in the relevant reports, where potential cost savings could result from advanced architectures. The number of aircraft is, however, a major factor in these savings. The study showed that for the aircraft fleet under consideration, which was based on a procurement of 180 aircraft and operation of 150 aircraft over 20 years, there was no significant cost difference between the two systems.

Figure 27



13.7.3 Technical Study

FARL were involved in all aspects of the Technical Study based on the requirements of an Advanced Short Take-Off and Vertical Landing (ASTOVL) aircraft and made major contributions in the enabling technology areas. Within these areas FARL led the Topology and Architecture working groups, with considerable input to the Common Modules, Operating System and Software Methodology working groups.

Figure 28

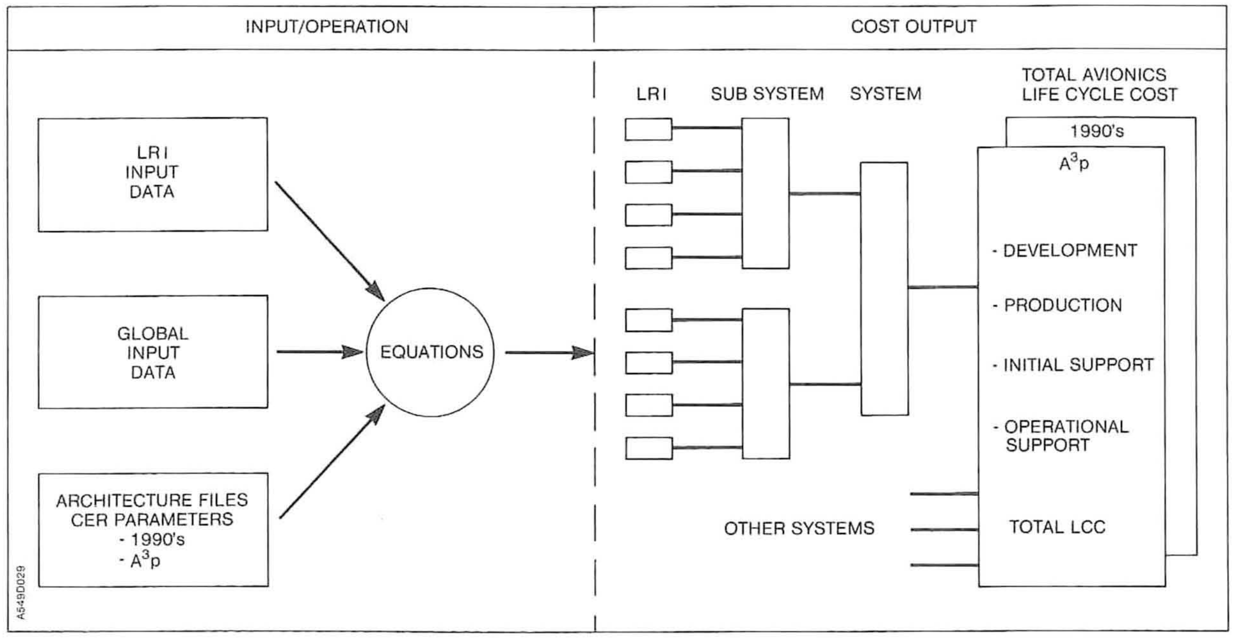
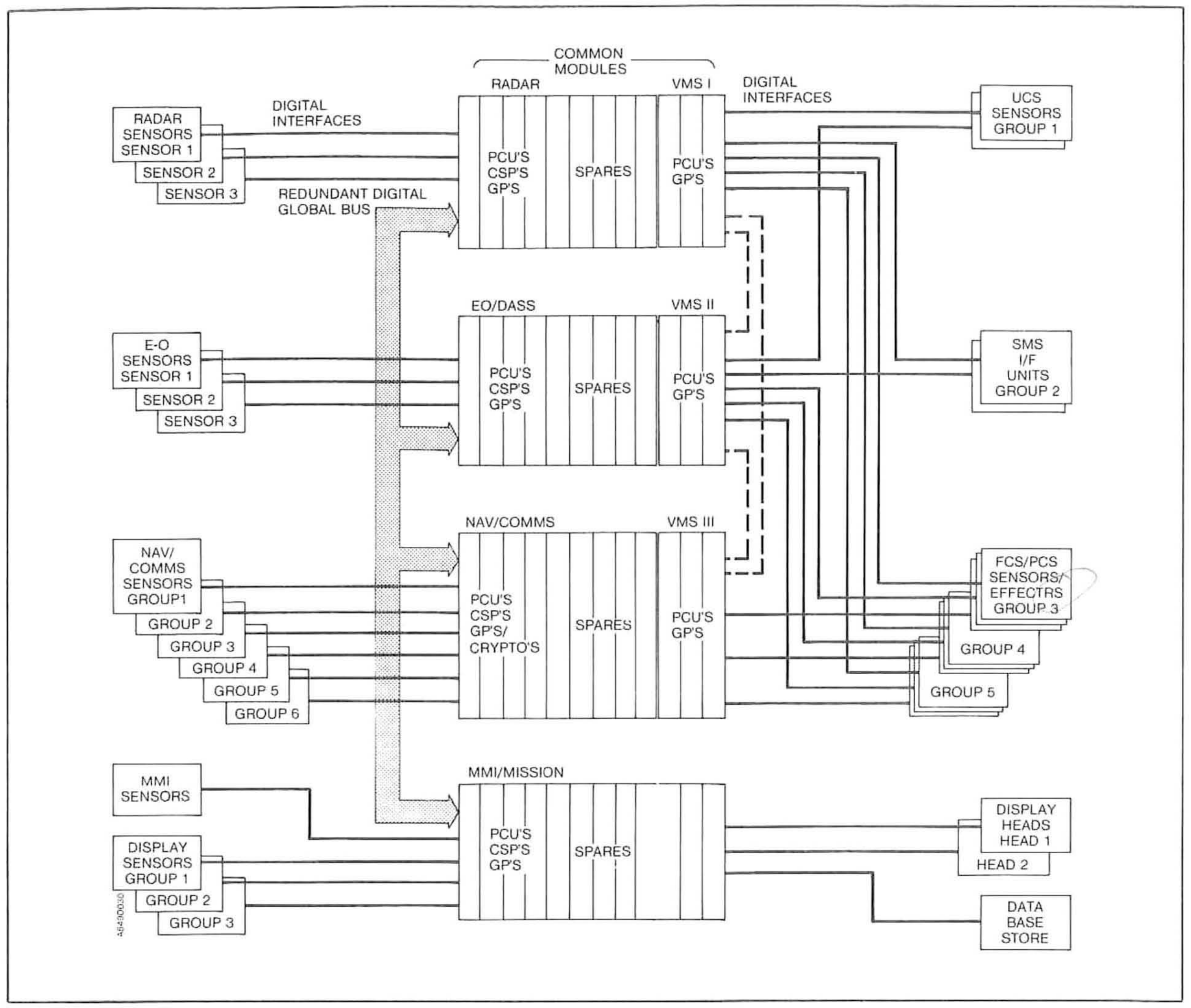


Figure 29



Candidate architectures were evaluated for performance, reliability, maintainability and cost, and an optimised architecture (see Figure 29) with the following key features was derived:-

- Use of high throughput digital data buses.
- Use of common electronic modules.
- Use of modular redundancy.

Future phases of the A^{3}P Demonstrator Programme will produce specifications and detail the technology requirements of a modular architecture. Areas which need to be addressed are:-

- Software to enable redundancy and reconfiguration
- Standard module capability
- Bus technology
- High integrity fault detection

Relevant Reports: *262/2638 A^{3}P Topology*
262/2639 A^{3}P candidate architectures
262/2668 Advanced Avionic Architectures and Packaging

14 COMPUTING DESIGN SERVICES

Project Manager: Andy Poad
Consultant Engineer: Arie Vandertak
Computing Services Manager: Peter Holland

14.1 Introduction

The team comprises the above staff plus a trainee software engineer, and matrix support from other teams if required. Support to the project teams has been maintained through management of the Laboratory's computer network facilities and involvement in advanced Computer Aided Engineering techniques.

14.2 TRAILBLAZER Project

The Alvey funded CAD 038 project 'Trailblazer' has been a collaborative research programme led by GEC Avionics and involving the GEC-Marconi Research Centre at Great Baddow and the University of East Anglia, and has been aimed at high level design, mainly for VLSI ASIC technology.

The industrial contract for the project was completed in July this year and has been successfully demonstrated to MoD, DTI and various industrial representations. Two papers based on this project have also been presented to the IEE during 1989. The University of East Anglia is continuing the research until September 1990, which we will monitor, since the work has identified a promising new approach to hardware synthesis, in that a formal behavioural description of the required system can be transformed into a hardware description incorporating testable structures.

The Occam language, based on the formal semantics of Communicating Sequential Processing (CSP) theory, was chosen as the behavioural description language and ELLA was chosen as the hardware description language, mainly because it is supported in the UK as a common interface to silicon vendors' CAD systems. The design hierarchy is shown in Figure 30.

A rule-base synthesiser has been developed to transform the Occam behavioural description into a structural, low-level behavioural description expressed in ELLA. The project considered two target architectures; bus-based architecture which was implemented (see Figure 31), and point-to-point architecture.

The demonstrator design example showed the various stages in the conversion from Occam to ELLA for the MIL-STD-1553B Remote Terminal (MA805) to MIL-STD-1750 avionic processor interface chip. The ELLA output was then transferred to the Mentor CAD system to produce a gate-level representation.

One of the advantages of a rule-base synthesiser is that use of another language, such as VHDL, would only require that the rules be modified. Testability has been considered from the outset, and all designs produced by the synthesiser are inherently testable.

Relevant Reports: 262/2664 Technical Overview
262/2698 Phase I Final Report

14.3 Design-to-Product Demonstrator

The Alvey Design-to-Product Project is a collaborative venture between a number of industrial and academic centres. GEC Electrical Projects based at Rugby provides the project management. The Design-to-Product (DtoP) is scheduled to end in March 1990.

The software under development at FARL is to demonstrate the integration of a third party software tool, such as Applicon 'Mechanisms', with the DtoP Designer System.

Figure 30

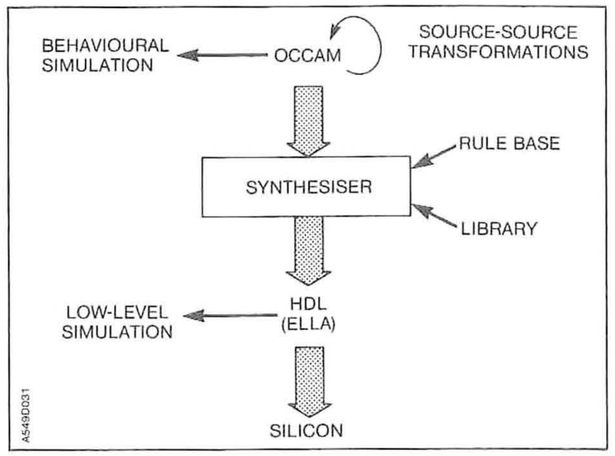
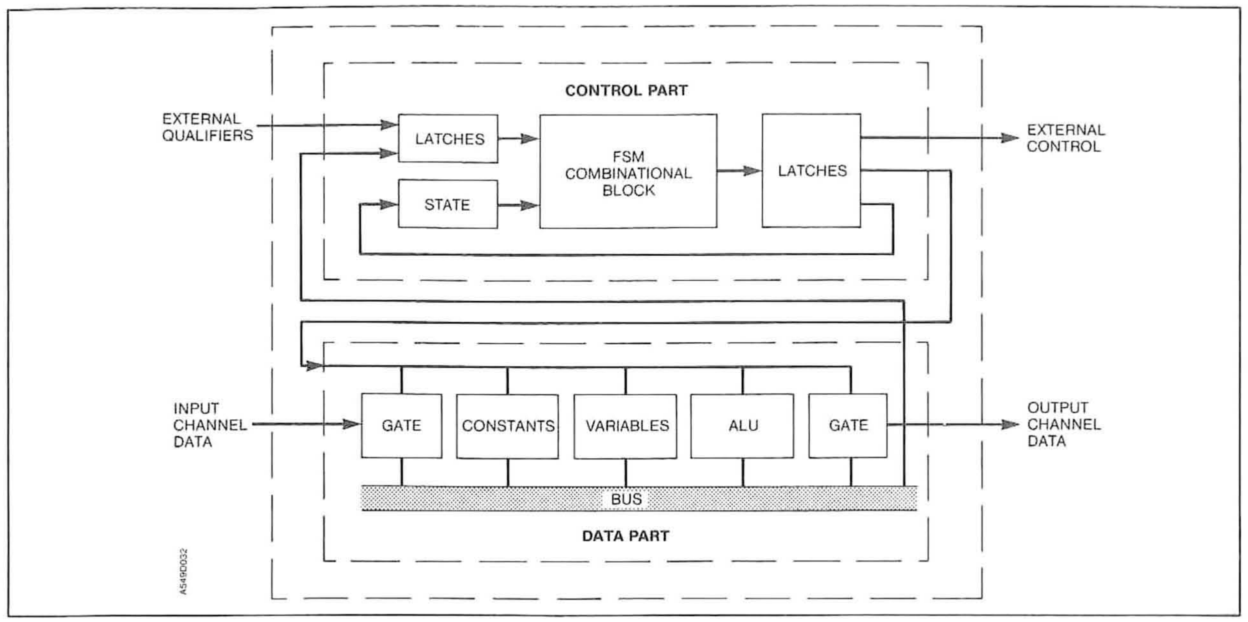


Figure 31



14.3.1 Third Party Tool Integration

It is often desirable for a designer to use a specialist software package to analyse a particular aspect of the design. The problems associated with these invariably expensive expert packages are:

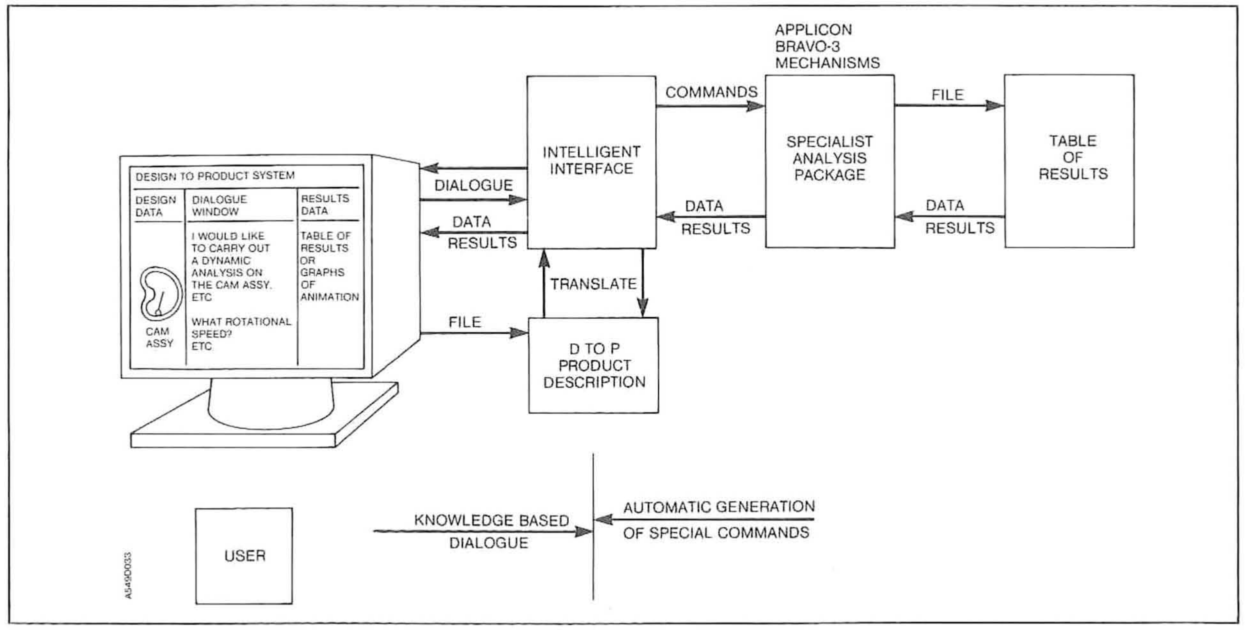
- geographical - i.e. not hosted on the designers workstation but some other machine on the network,
- difficult to use for a non-programmer.

In order to make these expert analysis packages more accessible to the designer, a third party, intelligent interface system is being designed to overcome these problems.

The designer selects from the Tool Manager's menu the required third party specialist analysis tool by using the intelligent interface software, (Figure 32).

The intelligent interface will conduct a knowledge based dialogue to extract and translate the relevant information required for the expert analysis software package. The results from the analysis

Figure 32



package are translated, by the intelligent interface, into the required formats, tables, graphs, and animation, acceptable to the designer and his workstation.

Relevant Reports: 262/2704 DtoP Third Party Interface Performance Specification

262/2707 DtoP Third Party Interface

14.3.2 Drawing with the DtoP System

In order to assess the ease of using the DtoP system for design sketching and drawing, it was decided to draw a heatsink for a Surface Mount Technology (SMT) module prototype, this being a typical example of a component for future packaging of avionics. To use the DtoP system to its full capability, any component to be manufactured requires a complete specification in the Edinburgh Designer System (EDS). This enables all the information on a component to be available in the Design Description Document of the EDS for further processing, for example Process Planning, Cutter Path Verification, NC Coding, and finally Machining, Inspection, and Assembly - all part of the fully integrated DtoP system.

The designer creates a Module Class Definition File of the heatsink (Figure 33), which is tedious but not difficult. Also shown are the shape primitives by which the final shape is obtained. These primitives, in the form of shape equations, are used in the process planning and automatic coding.

Relevant Report: 262/2739 Using the EDS for Detail Drawing

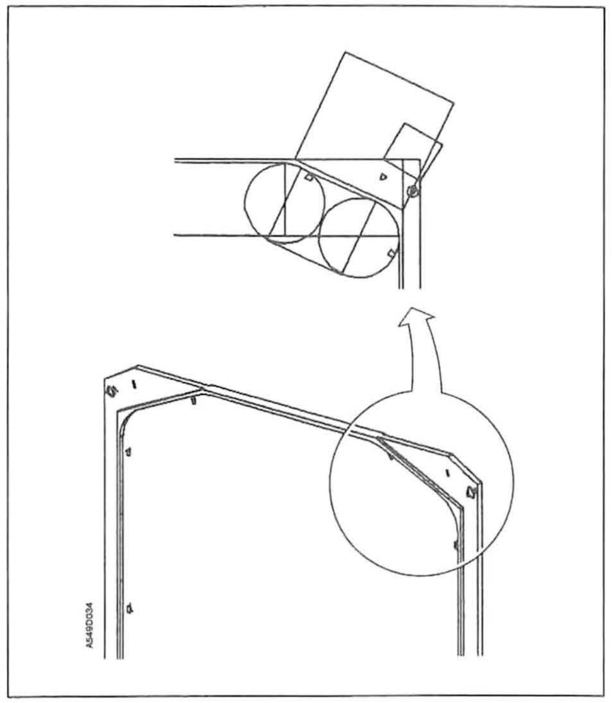
14.4 Esprit II ATMOSPHERE Project

Any engineering task is supported by tools, methods and services, and involves a number of interrelated processes such as, design, manufacture, management and quality, which are constrained by various rules and requirements. This forms the engineering environment.

The Esprit Project ATMOSPHERE (Advanced Tools and Methods for System Production in a Heterogeneous, Extensible and Real Environment) is a collaborative programme with Siemens as coordinating contractor, and as main partners Bull, Philips, Nixdorf, GEC-Marconi, and the two EUREKA projects EAST and ESF.

The main project aim is to define and implement a common computer-controlled Engineering

Figure 33



Environment framework into which existing standards, methods, tools and services can be integrated to support the development of specific applications in the Information Technology domain, such as VLSI systems, real-time embedded systems, and communication systems. The basic framework would manage operations such as configuration and version control, and project management over the product life-cycle, as well as tool and database integration. Another aim is to prove the effectiveness of the Environment in controlling specific tasks. The project began in March 1989 with the first year concentrating on the definition requirements.

FARL is subcontracted by GEC Marconi Software Systems, who are managing the contract on behalf of GEC-Marconi, to select and specify three avionic systems for potential development, using the ATMOSPHERE Framework, Tools and Services. The work will be carried out during years 2 and 3 and will provide test coverage of the Environment from the users viewpoint.

The applications identified and submitted are:

- Linear Token Passing Bus Development
- Active Matrix Addressed LCD Grey Scale Driver
- Display Architecture

Relevant Report: 262/2745 GEC Avionics Applications

14.5 Computer Management

Computer services for design and analysis are provided to all personnel in FARL on a range of networked equipment consisting of three VAXs, twenty IBM PCs and nine SUN workstations, (see Figure 34). The routine work involves taking regular data backups, installing software updates, and managing system resources to provide an efficient and secure system. Two MicroVax 3300 computers have replaced an obsolete non-standard VAX 11/780. These have been 'clustered' with the existing VAX 8200 to give a powerful integrated VAX/VMS environment. Work throughput has increased two to three-fold depending upon the application.

This year has seen further integration of Personal Computers into the Laboratory's network with additional facilities. These include network software such as WordPerfect, Harvard Graphics, AutoSketch, SuperProject Expert, 2020 Spreadsheet and CUPL Programmable Logic Compiler. Hardware additions include networked Postscript and colour ink-jet printers.

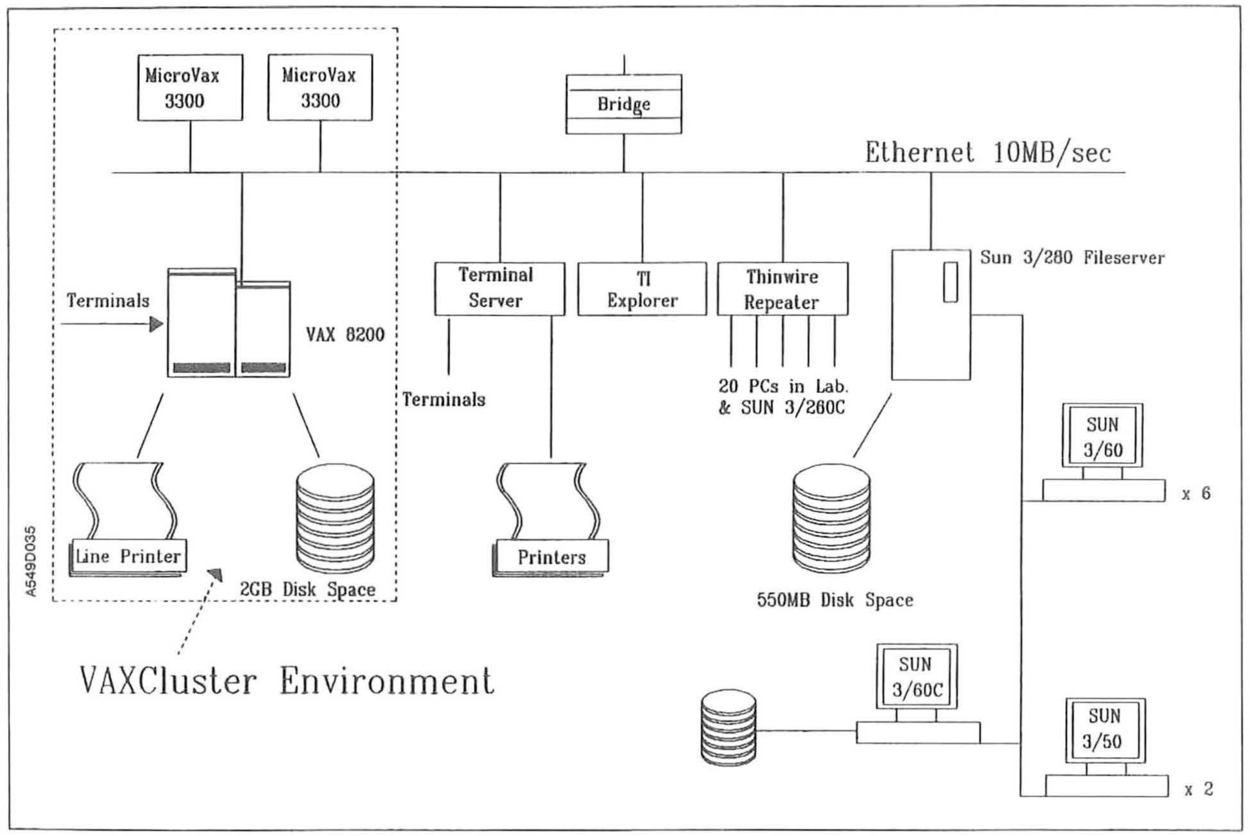
Further expansion is planned to give all personnel access to either a networked PC, a terminal, or a workstation.

Relevant Reports: 262/2645 Final Report on Work Carried out on PVR&D 262 742

262/2692 Overview of FARL Computing Facilities

262/2712 User Guide to Timesheet Bookings Query System

Figure 34



15 COMPANY REPRESENTATION

A number of senior FARL personnel have the task of representing Company or Group interests by serving on a number of Committees which recommend policy to industry and the Government, or represent GEC Avionics' interests in GEC inter-Company Committee activities. These activities, together with the current FARL contact, are listed below for information.

ESASC	— The EEA and SBAC Avionic Systems Committee Current Contact: Malcolm Moulton
FSRCC and NCRCC	— Research consultative committees of ESASC, with MoD, for flight systems and NCRCC navigation and communications. Current Contact: Malcolm Moulton
IAWG	— Industrial Avionics Working Group Current Contact: Brian Paxton
ASSC	— Avionics Systems Standardisation Committee Current Contact: Brian Paxton (representing ESASC) Renny Smith Alan Birch Martin Bishop Rob James
VERDI	— Vehicle Electronic Research Defence Initiative Current Contact: Brian Paxton
ESPRIT	— Industrial Working Group Peripheral Sub-Systems Current Contact: Keith Mitchell (Chairman 'Input' Sub Group)
SARI	— Stealth Avionics Requirements Investigation Committee Current Contact: Malcolm Moulton
SIWG	— Systems Integration Working Group Current Contact: Brian Paxton
ASET	— Formal Methods Panel Current Contact: Steve Carter (Organiser)
HPSSC	— High Performance Semi-conductor Systems Club (of DTI) Current Contact: Don Price (Secretary)
SIGSAS	— Special Interest Group (of HPSSC) for systems Architecture on Silicon Current Contact: Don Price (Chairman)
RAE, Bedford	— GEC Avionics technical liaison FM2 Operational Systems Current Contact: Keith Mitchell
VLSI Working party	— Comprises GEC-Marconi companies Current Contact: Kenny Deans (Secretary)
Special Interest Group	— GEC inter-company committee High Integrity Systems Current Contact: Renny Smith

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 Printed in England PLA549