Memories of CDSC

(where the Navy went to bits!)

Foreword
by
CHIEF OF NAVY

I have often been a customer of the Combat Data Systems Centre (CDSC) organisation during my career and I know that the effectiveness of this valuable facility has been vital, though behind-the-scenes, in keeping the combat system of each ship that I've served in at peak efficiency. I am personally very familiar with just how much the RAN has owed to the many hundreds of people who have been involved with CDSC over its history – a particularly rich and colourful history – at the centre of combat system technology in Australia.

From the time it was first established at Fyshwick in 1974, CDSC was the Navy's combat systems centre and powerhouse for the unique development of NCDS in Australia. CDSC provided the backbone of warfare technology for the DDGs and subsequently the FFGs, and established a long and fruitful technical relationship with partner organisations in the US Navy. It is worth reminding ourselves that those early efforts both at CDSC and overseas placed Australia at the forefront of combat system technology and there were many times when the work conducted there provided 'world first' system development and functionality.

CDSC also provided one of our earliest examples of effective commercial support in the then innovative area of combat system technology. The Fyshwick facility was, almost from day one, a collaborative venture with Australian industry; EMI was but the first of many support contractors that have provided commercial support for NCDS hardware and software at the Centre. Although the end is nigh, a small but dedicated team from SERCO Defence Australia still works side-by-side with Defence staff at Fyshwick to maintain vital tactical data link and combat system services to the Defence Materiel Organisation (DMO) and Navy.

In addition to the direct effect of system software and hardware support, CDSC has always provided an exclusive knowledge base for NCDS. Through its specific training role and employment opportunities for staff, CDSC has provided an efficient and effective pathway for the growth of Navy combat systems expertise in our Officers and sailors for both operations and weapons engineering specialisations. This growth path has been nurtured by the array of talent, knowledge and enthusiasm that has been a hallmark of CDSC.

In the late 1990s another future area of technical expertise blossomed at CDSC, the now massive world of system interoperability and data communications. The ADF Tactical Datalink Authority started its life under the CDSC umbrella, later moving into DMO as it expanded and played an increasingly high profile part in developing a fully integrated ADF. CDSC staff continue to provide resources and expertise for military datalink needs under the new banner of the Directorate of Navy Warfare Systems (DNWS).

The amalgamation of CDSC with the Navy Warfare Systems Agency in July 2006 was a major achievement that established the basis for future Navy combat system technology management. Since then further refinement of the Navy Systems Branch has seen DNWS become the focus of Navy's subject matter expertise in, and technical governance of, combat systems. Readers of this history of CDSC should be rightly pleased that the endeavors and ideals of the past will be reflected into the DNWS future. The management of Navy's combat system technology continues to be a core element of our current and future warfare capability.

For an organisation born of operational necessity and with a history of technical foresight and achievement, CDSC remained to the end a vibrant and professional team that supported a wide range of activities and contributed extensively to the ongoing management of combat system technology within the ADF.

I congratulate all those involved in the substantial task of preparing this unique book and, as a grateful customer, I applaud all those persons here in Australia and in the United States who have been part of the CDSC story. Although it was some time ago now, I recall with pleasure the facility's 30th year of service - then Chief of Navy, VADM Chris Ritchie, RAN, took that opportunity to recognize and pay tribute to the excellent contribution of so many personalities from the past, and I reiterate his thoughts. CDSC will remain forever a glowing example of one of those times when Navy got it right; your Navy says, "Thank you and Well Done!"

Vice Admiral Russ Crane, AM, CSM, RAN
Canberra, May 2009

PREFACE AND ACKNOWLEDGEMENTS

With the demise of the RAN's *Perth* Class DDGs, and the progress of the Upgrade program for the *Adelaide* Class FFGs, it became obvious that the days of the Combat Data Systems Centre were numbered. In this atmosphere, the idea of writing a book about CDSC to both commemorate its passing and also to preserve some of its memories was born. It has been long in gestation. Tony Bone, the then Director of CDSC, asked David 'Ginge' Wellings Booth, a civilian working for the maintenance support contractor at CDSC and who was (and still is) the longest continuously serving person at CDSC, if he would undertake the unenviable task of collecting the material for this book and being its main author. Ginge accepted this invitation, and laboured in isolation with only minimal support for many months. During the uncertain times surrounding the amalgamation of CDSC into the Naval Warfare Systems Agency (now Combat Systems Engineering Group), the project all but died. Finally however, in an oft-interrupted flurry of activity during 2008-09, CMDR Geoff Cannon (now a part-time Reservist) and LCDR Glenn Bridgart (one of the last CDSC officers remaining in DNWS), took Ginge's original work and made it ready for production. The fruits of these combined labours are now before you.

Apart from David Wellings Booth's prodigious efforts, numerous other people contributed significantly to the final content. Principal among those who provided valuable support and great advice were the following former senior members of CDSC staff: Peter Hutson RAN (Rtd), Phil Kennedy AO RAN (Rtd), Dean Walkington RAN (Rtd), Tony Bone, Peter Mogg, 'Orm' Cooper RAN (Rtd), John Currie and John Evans, sadly now both deceased, Kevin Durick, Mike Strudwick, John Robinson, Gordon Stone RAN (Rtd), CAPT Simon Woolrych RAN and Ed Goldsmith. Others have also contributed to greater and lesser extents, and apologies are offered for not naming them all individually here.

Special thanks also go to David L. Boslaugh from the USA, who gave permission to copy some of the early history details from his book 'When Computers Went To Sea'. That book describes in detail the origins and development of the US Navy's creation of the NTDS digital naval combat data system. Thanks also go the current Director of Navy Warfare Systems, CAPT Steve Basley, for his ongoing support of this extended project that has allowed it to finally reach fruition, and to CMDR Carmel Barnes for her invaluable assistance to the editors. Pat Lynch (one-time member of the support contract team) who drew the cartoons contained herein gave his permission for their inclusion, which is much appreciated. The job of combat system support is not hugely photogenic but the various photographs used do attempt to depict some of the people, places and things that were CDSC – these images have mainly been drawn from CDSC archives and are, regrettably, unattributed.

Despite Ginge's research efforts, and with his full acknowledgement, this book does not seek to provide a full or definitive history of CDSC. That would have been a task beyond the resources that CDSC in its final years was able to provide. Rather, it is a snap-shot of some of the events of those 30+ years, and hopefully can provide a stimulus for the memories of all those who worked at or for this facility over all the time of its existence. Enjoy!

Memories of CDSC

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The Origins of NCDS

THE HISTORY OF NCDS IN AUSTRALIA

The Australian Navy of the early 1960s was largely comprised of ships and weapons systems of British origin. However, in acquiring the American-built DDGs (HMA Ships *Perth*, *Hobart* and *Brisbane*, derived from the USN's *Charles F Adams* class) from 1965 onwards, the RAN launched itself into a new support environment focused on the United States Navy (USN). Fitted with the (analog) Tartar surface-to-air guided missile system and offering multiple channels of fire, the DDG represented a significant leap in anti-air warfare technology. Indeed, the missile system and the need to provide effective anti-air defence for the Fleet were decisive in selecting the American design over a British alternative. As one historical assessment noted: 'The selection of the DDGs was nothing short of a revolution for the Royal Australian Navy but it was a necessary revolution if the RAN was to sustain the combat power it needed in the missile age'.

When first operated by the RAN, however, the DDG's operations room functioned in a manner similar to that of existing Fleet units. Management of combat information remained based on manually updated plotting boards and tables, using tactical data separately received by visual means, radar, sonar, weapon designation systems and electronic support measures. A ship's combat effectiveness depended largely on its command team's efficiency in correlating, ranking and presenting this information for the captain's decision. The process had been refined during the latter part of the Second World War and after, but was clearly inadequate in coping with the multiple threats and increasing pace characterising modern naval warfare. The inherent problem, as explained in the article 'Combat Computers' in the Navy Quarterly, Vol 2, No 2 Autumn/Winter 1973, was the time involved in piecing all the bits of information together, calculating the engageability of each target and then displaying the results:

> *'A poor or incomplete job means that the decision taken may be wrong. Also, was the decision taken on data which represented where the contacts were or where they actually are now? Stale information may lead to the wrong decision.*
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> *Armed with pencil and paper or magnetic symbol and plot, the operator struggles to perform tasks for which human capabilities do not adequately equip him – data processing. It is an area where machines are infinitely superior to man. The modern representation of that machine is the digital computer. …The effect is that at last we can have the tactical picture presented to the captain in what is called real time, that is, 'like it is' and not 'like it was'. And no operation's room crew can match that feat even if their lives depended on it.'*

The RAN had begun exploring automated command and control systems in 1968, and to better inform the eventual assessment set up the Naval Combat System (NCS) Project. Captain (later Commodore) P.R. Hutson RAN was a seaman officer specialising in gunnery, and, whilst CO of HMAS *Vendetta*, had put forward the idea of a naval command & control system being adopted by the then Light Destroyer Project. Frank Lord, who at the time was the director of the Williamstown dockyard in Melbourne, was asked to review the idea. The subsequent discussions eventuated in Peter Hutson being brought from the Fleet into Navy Office to lead the NCS project.

The project carried out a searching look at what naval Command and Control (C2) automated systems were either available from, or under development in, various other countries in the world. Peter Hutson took a team of very talented people, including Dr John Wilson (WRE

team leader) and Dr Jim Adams, to the US, UK and several countries in Western Europe. This team, which had data-handling knowledge gained during development of the IKARA anti-submarine weapon project, considered various feasible systems before focussing on one based on the USN's Naval Tactical Data System (NTDS). As related by D.L. Boslaugh in 'When Computers Went To Sea: The Digitization of the United States Navy' (Hoboken, NJ: Wiley-IEEE Computer Society, 1999), NTDS, which had been at sea since 1962, was the USN's first seaborne digital computer system. The product of an extensive development effort starting in the early 1950s, NTDS aimed to markedly reduce response times to fast aircraft and missile attack, and had since become one of the USN's most successful major projects.

Peter Hutson, CDRE, RAN (Rtd), wrote:

> *'Following recommendations from the Light Destroyer Weapon Evaluation Study lead by me as the Director of Weapons and Electrical Engineering, the RAN had begun exploring automated command and control systems and in 1969, to better inform the eventual assessment, set up a Naval Combat Data System Project with me as Project Director. The team received considerable technical assistance from the Weapons Research Establishment from the then Department of Supply in examining options from the US and Europe. Having considered feasible systems, the RAN selected one based on the USN's Naval Tactical Data System (NTDS). NTDS, which had been at sea since 1962, was the USN's first seaborne digital computer system.*
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> *In 1972 the Australian Government approved an ambitious $33 million upgrade of the DDGs to fit them with NCDS: 'the "great leap forward" needed to take the ship's nerve centre into the "missile age" and to join the sensors and weapon systems to make an integrated fighting system'. Also included were improvements to the missile launcher and fire control radars to allow the three destroyers to fire the longer range Standard SM-1 missile. An extensive collaborative effort was initiated in Australia and the United States to develop the NCDS program from the version of NTDS used in the USN's DDGs and known as the JPTDS (Junior Participating Tactical Data System).'*

A further visit of the project team to the USA resulted in the development of what became 'Project Directive 63' – a project to implement an RAN combat data system in the DDGs. After careful consideration of PD 63 by the Navy Board, the Univac offering of an AN/UYK-7(V) computer, combined with Hughes OJ194 displays, was endorsed and, in February 1972, the Australian Department of Defence authorised the spending of $A42,000 ($US50,000 at the 1972 exchange rate of A$1 = US$1.19) to allow the transfer of US Navy JPTDS information to the RAN. The Weapons Research Establishment (WRE) in South Australia was quite disappointed about this decision to buy USN software instead of having WRE develop 'Australian' software – particularly after their success in the development of IKARA.

There were a lot of technical details to sort out, such as the RAN being initially informed by USN that the proposed C2 system could not interface to the digital Tartar system. It turned out that this was incorrect, as the RAN were buying 2-bay AN/UYK-7(V)s rather than the single bay AN/UYK-7(V)s being used by the USN for JPTDS.

In the following August (1972) the Australian Government approved a $33 million upgrade of the DDGs to fit them with a digital combat data system: 'the "great leap forward" needed to take the ship's nerve centre into the "missile age" and to join the sensors and weapon

systems to make an integrated fighting system'. Also included were improvements to the missile launcher and fire control radars to allow the three destroyers to fire the longer range Standard SM-1 missile. One notable fact about this agreement is that it was the first time that the US had approved the release of 'state-of-the-art' military technology to a foreign navy, and underlined the continuing importance of the alliance partnership to the USN and RAN.

An extensive amount of collaborative work in the US and in Australia was necessary to evolve the RAN combat system operational program from the JPTDS (Junior Participant Tactical Data System), the version of NTDS used on the USN *Charles F Adams* Class DDGs. The RAN had more extensive operational requirements expected of the DDGs compared to their USN DDG-2 Class counterparts, as well as some differences in equipment fitted, and hence there was a need to make unique Australian changes to the acquired JPTDS version of NTDS.

As part of the $33 million package, the Cabinet also approved the funding for the establishment of an Australian base charged with developing and maintaining a digital combat data system for the RAN's three DDGs. This base became known as CDSC (Combat Data System Centre), and the RAN's version of the US Navy JPTDS became known as NCDS (Naval Combat Data System). Later, after the advent of the FFGs, the CDSC name was changed to Combat Data Systems Centre.

On 31 July 1974, HMAS *Perth*, the first DDG scheduled for upgrade, sailed from Sydney for California (10 days to Honolulu – 4 days in Honolulu – 10 days to Long Beach) berthing at the Long Beach Naval Dockyard near Los Angeles where the modernisation was to take place. On the way over, the old "Weapons Direction Equipment" (WDE) suite was confirmed as fully operational (a contract requirement) prior to it being removed and replaced by the NCDS suite. The moment *Perth* arrived, US Dockyard personnel came on board and almost immediately started to pull equipment off – ship's staff were not allowed to do anything except watch and ask as many questions as they could. Only when the new suite started to be installed and tested did it start to get interesting.

The first Australian personnel to do the relevant NCDS courses in the USA were LEUT John Ridler (WEEO), CPOEMWR Kim Daw, LEMWE Graham Blucher, LEMWE Greg Smith, Mr. Maurie Hart (GID), Mr. Bill Schreiber (GID), and Mr. John Higginbotham (GID). They went to the USA (East Coast) in late May 1974 - their courses lasted from June until August. The four RAN personnel joined the *Perth* at Long Beach in early September 1974 about 1 week after the ship's arrival and, together with LEMWR Stephen Bloomfield, later became the original NCDS technical crew on *Perth* – except Greg Smith who was placed in a 'Forward Radar' billet. In February 1975 some of these personnel were sent to San Diego to join the USS Towers for 1 week at sea to get a bit of NTDS operational experience - the USS Towers being fitted with the latest NCDS equipment. In 1975 they all did a tour of the Howard Hughes factory (California) which manufactured the NCDS equipments – they were taken through the entire assembly line in which some of our *Perth*'s own suite was still being made, and Howard Hughes bought them lunch.

In September 1975 *Perth* sailed from the United States with her weapons updated and her manual plotting equipment largely replaced by computer-driven consoles. She arrived back in Sydney in early October 1975, after 14 months away from home. Her Commanding Officer throughout the upgrade and initial NCDS at-sea trials was CAPT Hutson, and he stayed with the ship until May 1976. After arriving home *Perth* spent the next 9 months weekly running off Jervis Bay where all and sundry (RAN & civilian) joined to see how it all worked. The modernisations of *Hobart* and *Brisbane* followed during 1976-1977, and were carried out in Australia.

THE USN's NAVAL TACTICAL DATA SYSTEM

The story of the Combat Data System Centre and the Royal Australian Navy's embracing of digital combat system technology in NCDS essentially has its origins in the ground-breaking development activities occurring in the United States Navy following the Korean War. This is how it all began.

The Beginnings of NTDS

Up to, during, and for several decades after World War II, an enormous amount of work was carried out by several countries in developing analogue computing devices to solve the geometric problems involved with vehicle navigation and the prediction of aircraft and missile flight paths. Such devices were fine examples of electromechanical engineering utilising synchronous transmission of data and precision-made gear trains to resolve the integral and differential equations involved in such predictions. A shortcoming of those carefully engineered devices was that their design parameters could not be altered easily without a huge engineering effort. It came to be realised that changing to digital computing devices offered a great advantage, as such devices could easily have their design parameters altered by changing lines of code in the software controlling them.

By the early 1950s, several development programs were being used to try to resolve these problems by practical and faster methods of controlling ships' combat information. Traditionally, the backward writing 'grease-pen' approach had sufficed in the command and control area. Now, particularly with the advent of higher speed aircraft and missiles, there was a pressing need to speed everything up. Several navies, including the Royal Navy and the Royal Canadian Navy, had been attacking the problem, but still were depending upon analogue systems.

In 1954, Rear Admiral Rawson Bennett US Navy initiated Project Lamplight at the Massachusetts Institute of Technology. This project was to formulate recommendations for continental air defence. He skilfully used the navy portion of this study to develop a unified navy position for a Fleet combat data system. The Lamplight committee was directed to propose alternatives to shipboard glass displays, grease pencils, intercoms and sound-powered phones. The committee recommended a system based upon a digital computer including a cathode-ray tube 'situation display', radio data links and certain peripheral equipment. The Lamplight Project Officer, Commander Irvin L. McNally, with the help of Everett E. McCown of the Naval Electronics Laboratory, described the system concept that recommended the development of a shipboard tactical data system using solid-state digital equipment. The Naval Tactical Data System (NTDS), as it was known, was first announced to the world from San Diego, California in August 1960. By April 1963, the system had been approved by the Chief of Naval Operations for service use in the US Navy.

Achieving the support of the USN CNO was no mean feat, but as a warfare officer, Commander McNally understood the shortcomings of existing operational equipment, and appreciated the capabilities of digital combat systems. However, the difficulty was selling the idea to a USN that was fixated upon Second World War operational experience and deeply suspicious of a new technology. Commander

(eventually Captain) McNally and his team fortunately had both the enthusiasm to convince sceptical admirals to support the concept of a digital combat system and the professional ability to make it work.

NTDS was expected to collect tactical data from a number of shipboard sensors, including search radars, the 'identification friend or foe' (IFF) system, electronic counter measures (ECM), intercept receivers and navigational inputs. It was then to correlate this data from these sources and combine the results with target data received over the data link from other units, and present all data as a clear picture of the air tactical situation. After all that, the system was to analyse and present data to aid operational decision-making, then communicate users' decisions to selected weapons systems, including interceptor aircraft. There was thus a myriad of data-processing tasks, and the NTDS operational computer program was the key to accomplishing this work.

The original functionality of NTDS reflected the USN requirements for major capital ships. To meet the lower capacity needs of Fleet escorts, a less capable version of NTDS, known as JPTDS (Junior Participating Tactical Data System) was developed. JPTDS was thus an adaptation of hardware and digital computer software design concepts utilised in NTDS on larger USN ship classes. It was designed to provide as many NTDS capabilities as possible, consistent with minimum cost and the space, weight, power and cooling restrictions found in the DDG-class ships. It was this JPTDS version of NTDS that the RAN would subsequently acquire.

Central to the operation of JPTDS was a third generation 'micro-miniaturised' digital computer designated AN/UYK-7(V) and the associated OJ-194/OJ-197 Multi-Functional Displays used by the operators. The UNIVAC AN/UYK-7(V) military computer used as the core of NCDS represented a leading edge technology when first introduced into the RAN. It was remarkable for the density of component packaging, using a mixture of discrete and integrated circuit components on small cards of specific purpose. An earlier version of the AN/UYK-7 had been used to calculate the trajectory shaping of the Apollo missions to the moon. That this processor continues in use today is something of a tribute to its designer, Seymour Cray, who was one of its designers at UNIVAC and who went on to design and build the 'Cray' supercomputers of the 1970s. An input/output unit (known as the Data Exchange Auxiliary Console, or DEAC) provided the computer programmer with a selection of peripheral devices – a paper tape reader/punch, two seven-track magnetic tape drives, and a teletype machine. In addition, a separate device, the signal data converter, provided analogue-to-digital conversion of synchro and status signals from other systems within the ship for use by the AN/UYK-7(V) hosted program.

The programs operating within the AN/UYK-7(V) computer also provided for automatic exchange of tactical data messages between 'ownship' and other ships equipped with either NTDS or JPTDS. These data exchanges were accomplished by direct digital control of a HF communications system, called LINK-11, by the AN/UYK-7(V) program. Each ship fitted with the NTDS/JPTDS would be able to act either on its own or as part of a group.

A software building-block approach was adopted which allowed the system to add or remove different sensors and weapons as technology advanced. Such was and remains the nature of a combat system at the turn of the 20th century. For operational flexibility, this was a paramount requirement. For example, the primary tactical data link developed for NTDS/JPTDS represented a system that would have failed had there not been a capability to reprogram the building blocks to accommodate it; the message structure used in that data link was continuously evolving. Consideration of the requirement for flexibility clearly indicated the need for a general-purpose, stored-program computing device. Whereas now almost every technological device utilises a stored program computer in some way or other, in 1955 to

do so was considered a great leap of faith. Many other projects of that era were limited due to design freezes of the overall design and because the building-block approach was not used.

The RAN Becomes Involved

Australian options for the equipment purchase, initially intended for the DDGs and the Oberon class submarines, included a US Litton Industries designed L304D computer and a Dutch system 32.bit computer system called 'Daisie'. There was 'senior level' support for the Litton system however the project regarded the Dutch system as having the greater future potential. The Litton system had the advantage of offering lower hardware costs than other alternatives (such as the NTDS), and the use of in-country expertise at the WRE to develop the necessary software. However, events in the US Navy were to cause a change of plan. The US Navy wanted to install NTDS on certain of their platforms but lacked sufficient funding to provide for the training equipment fit. If the RAN were to order equipment for the three DDGs plus a training suite, several advantages would accrue to the US Navy. Firstly, there would be scope for the US to use the designated RAN training equipment until equipment application and operator courses were repatriated to Australia; and secondly, the overall unit cost to the US Navy would be substantially reduced. These benefits, probably coupled with the use of RAN DDGs in the Vietnam conflict, influenced the US authorities to favourably consider Australian acquisition of NTDS. From the Australian perspective, the major benefit would be access to the US Navy-developed operational software rather than significantly cheaper hardware. This was an important milestone in Australian military procurement because it was the first time that the US Navy had made such software available to another nation.

When NTDS (and JPTDS) was being developed for USN ships there was no deliberate intention for the system to be used by any other navy. The visit by the NCDS project team stimulated the beginnings of an opportunity for the RAN to gain access to new command and control technology of NTDS. Captain Eric Swenson was the NTDS Project Manager at that time and his enthusiasm for getting the RAN into his project was an essential ingredient in the mix. The RAN project team included Tony Bone and Ed Goldsmith, and it was their early realisation of the potential of NTDS that encouraged the RAN to consider the acquisition. NTDS was, at this stage, still in its infancy of development and there was extensive developmental work going on between the USN and the prime contractors UNIVAC, HUGHES and COLLINS RADIO. There was nothing resembling the current Foreign Military Sales organisation to help broker the deal and the decision to grant the RAN access was sponsored by Captain Swenson to gain official endorsement. Faith Rawden-Smith worked on the original proposal documents and she subsequently coordinated the USN side of the acquisition including the involvement of US contractors with the establishment of the CDSC facility. During the early 1970's there were many times when the determination of people such as Faith were instrumental in maintaining access to USN resources and thereby keep progressing the CDSC installation; this was because assistance to foreign navies did not attract a high priority for resources within USN commands.

Captain Swenson visited Australia several times in the early 1970s to help in setting up the CDSC. He left the project in the mid/late 70's but his legacy has been the robust and long lasting cooperation on NTDS between the USN and RAN.

LIFE BEFORE NCDS

This article on life in a ship's operations room before the Naval Combat Data System (NCDS) draws mostly on interviews conducted in October 2003 with two naval reservists – WO James 'Shorty' Meredith and CPO Al 'Ack Ack' Smith – then both serving at the Combat Data System Centre.

James Meredith has served in HMAS *Duchess* (formerly HMS *Duchess*; a 'Daring' class destroyer), HMAS *Melbourne* (an aircraft carrier), HMAS *Stuart* (a Type 12 anti-submarine frigate) and HMAS *Canberra* (a guided-missile frigate).

Al Smith has served in HMAS *Sydney* (a troop carrier), twice in HMAS *Brisbane,* (a guided-missile destroyer), in HMAS *Melbourne* (aircraft carrier) and in HMAS *Perth* (a guided-missile destroyer).

Introduction

The Royal Australian Navy of the 1960's comprised ships and weapons systems of largely English (Royal Navy) origin. In acquiring the three *Charles F Adams* Class DDGs the RAN launched itself into a new support environment focussed on the United States Navy (USN) and the vastly different development and maintenance infrastructure that existed to support these warships. The USN DDG was the first destroyer fitted with the Tartar long range anti-aircraft missile system – a far cry from the Seacat missile then used by the RAN. Although almost everything associated with the maintenance and support of our DDGs was organised along USN lines - even the system of identifying compartments within the ship was different - the DDG's Operations Room (when first operated by the RAN) functioned in a manner that was not dissimilar to that in the Daring Class destroyer and Type 12 Destroyer Escort Fleet units. The management of information was based on Plotting Tables with target information separately acquired by sensors and weapon designation systems – the effectiveness of a ship generally depended on the efficiency with which Operations Room teams could correlate and prioritise radar and sonar information. This historic method of handling tactical data was to change dramatically with the USN's development of computerised data handling systems that became available in the late 1960's. The RAN started investigating automated command and control systems in 1968 and established the Naval Combat Data System Project. The project team worked extensively with Defence organisations such as DSTO using knowledge gained during development of the IKARA Project, and with industry in Australia and the United States, to consider feasible systems for the DDG. Navy bravely accepted the opportunity of upgrading the DDGs by incorporating JPTDS – this decision would totally change the processes for managing tactical information in the Operations Room.

The Ops Room

Plotting tracks in those pre-NCDS days involved a basic radar screen, two or three electro-mechanical plotting tables and rather terrible Bakelite sound-powered headsets. 'The sound powered communications units were very evil to use.' These headsets were not used for surface/anti-submarine warfare (ASW) plotting although it was a very noisy environment. The surface and ASW pictures were compiled on

plotting tables. The surface picture was plotted on tracing paper, which was on big rolls. The enemy was always marked in red and the friendly units in blue. Contacts were plotted every minute including visual bearing advice from the bridge. One piece of tracing paper would cover a 30-minute period of operations before the roll was advanced and another series of contacts representing the next 30 minutes was pencilled on. Left any longer, the tracing paper would become very cluttered.

The plotting tables had a horizontal surface through which was projected a graticule compass rose with range rings engraved on it. The graticule was interchangeable to allow for the different ranges over which the plotting could be done. The ship's gyrocompass and log drove the whole projection. A sheet of tracing paper was laid over the screen onto which was drawn the contacts observed by the operators. Normally, a sheet of tracing paper would contain about 30 minutes worth of manually plotted contacts.

Air plots were compiled on vertical magnetic boards, using metal symbols with magnetic strips on the back. It was quite difficult to keep an accurate picture due to the person reporting the air contacts being at a radar display, calling the range and bearing to the plotter. Even in the 1970s, aircraft were already travelling fairly quickly.

The air plot was located near the fire control system. With all plotting conducted manually, the surface and ASW plot records had to be retained for analysis after major exercises such as the 'Rim of Pacific' (RIMPAC) naval exercises. Operations during early RIMPACs were plotted manually. With NCDS, at least you could see the whole picture. Operations room watches were split into four for non-exercise periods and two for exercise periods. The four-watch periods catered for twelve hours off during which a sailor could spend time working on or in other parts of the ship. During two-watch periods, a sailor did four hours on and four hours off during the day and six hours on and six off during the night. A sailor slept, showered, ate and then went on watch. During time on watch, a sailor would spend an hour on the radar display, an hour on the plotting table and then have a brew or relieve the air plot operator. In this way, the load and experience were shared around the operations crew. The operations room was illuminated with blue light and the ASW plotters used fluorescent pencils to highlight tracks on the compilation. I cannot remember the colour of the screens during my time in HMAS *Sydney*. These days every operator wears a headset so operations can be more easily controlled, but noise levels in the operations room still tend to rise.

HMAS DUCHESS

In those pre-NCDS days, information on many events that had occurred was not necessarily available to the whole ops room. The plotting board operators would be aware when any event had been recorded on the tracing paper. Understandably, under these conditions each operator would be unaware of the whole picture at any instant in time. This meant that some radar operators would not always, for example, realise the importance of some event point that may have occurred earlier. With NCDS, the whole operations picture can appear on any one display whether it be surface, ASW or airborne, at any position in the operations room. The operations room of HMAS *Duchess* had rather a high deckhead. Part of the operations room contained, amongst a lot of other equipment, two ARL10 plotting tables and some 'JC' – a type of radar ship-borne display – orange screened radar displays. Above deck, there was a 293 S-band radar antenna. The JC displays had fixed range rings and a switchable range selection of ½, 5 and 20 miles. Bearings were taken with a cursor that was manually rotated around the screen. A lot of training was given to operators on the use of the LINear and LOGarithmic settings on the amplifier on the display. By careful selection of either of these two capabilities, the operator could improve the chances of detecting

contacts in different weather and sea states. In another part of the ship, there was a 'B' scope that was used to train operators in tuning the radar system.

The operations room rules stated that only twenty minutes should be spent in front of a radar screen but invariably operators were there for the whole four-hour watch. The radar operator called out 'new contact' after having detected a new track and the operator at the plotting table made a Chinagraph™ pencil mark showing the position on the tracing paper. During 'action stations', Bakelite sound-powered headsets were worn. They were quite heavy and damaging to the outside of the ear. Even when talking to another operator via these headsets it certainly helped to raise one's voice thus adding to the general din in the room. Added to this there was, standing around the ARL10 plotting table, a gunnery officer, the tactical anti-submarine officer, the captain and his yeoman, a watch supervisor and his leading hand, trackers and a recorder. The lighting in the operations room was dimmed but not too much because the operators had to write and be able to read track reports written with coloured pencils on the plotting board tracing paper.

The plotting process was:
- find the track
- mark it on the 'scope
- call out the bearing and range of the track.

Experienced operators could call out new contacts plus their bearings and ranges at a rate of twelve a minute. These times included the more difficult task of plotting the points on the tracing paper and writing data upside down.

When tracking low-flying aircraft travelling at 500 or more knots, there was heavy reliance on information from the radars of other ships. The 293 radar was not good at tracking aircraft flying at under 2000 feet and within 18 miles. When tracking submarines in both good and bad weather conditions the 293 was equal to the capabilities of other radars of that era.

HMAS STUART

HMAS *Stuart* had JYA plotting tables, similar to the ARL10, but the operators plotted tracks on Perspex 'pavements' with fluorescent pencils. The lighting in the operations room was usually turned off but there was UV light over the tops of the JYA tables. This meant it was very difficult to see any other device in the operations room, unless it was backlit. Invariably, if an operator had spent four hours over the plotting tables, sore eyes would be the result. A positive side to using fluorescent pencils was that it made it easy for the command to follow the 'war' picture as it developed on the table. Unfortunately, the yellow and blue 'fluoro™' pencils supplied by the RAN stores system were not as good as the similar style pencils used by the Royal Navy (RN). Visits to RN ships always included an appeal for a few of their pencils.

HMAS *Stuart* had a longer-range radar (LWO-2) with good air-detect capability but was not so good for low-level detection. The radar screens (JUA) were still orange but the lighting remained either white or very dim, as the other devices in the operations room were backlit. The plastic 'pavements' were actually one foot square clear Perspex sheets. These sheets took the place of tracing paper for recording track movements. Eight of these were fitted onto the plotting table. At the end of each watch, these 'pavements' were replaced with new

ones. The ‘pavements’ removed were then copied onto tracing paper for record keeping. There were many differences between pre-NCDS operations rooms and the present-day areas. For a start, there is blue lighting and only one plotting table, a dead-reckoning table that is only used as an emergency tool. The noise level is well down on non-NCDS operations rooms. There are better quality headsets that make yelling almost unnecessary.

Other Recollections

All of the Type 12 Frigates (or Destroyer Escorts as they became known) were fitted with the Australian-designed IKARA anti-submarine missile and Royal Navy SEACAT anti-aircraft missile. SEACAT was optically guided and had no data connection the ship’s radar systems, whilst IKARA was comparatively ‘state-of-the-art’, had a radar guided airframe to drop it’s torpedo and was connected to the ship’s sonar system.

Going from an older ship to a DDG was like moving to a new world! Everything had different names – for example, the Operations Room was the CIC and HQ1 was DC Central. As a maintainer so much of the equipment was different and the handbooks were huge and had so much detail as to be almost incomprehensible. One of the fringe benefits was that access to the USN stores system provided a whole new range of tools that quickly became the envy of maintainers in the other ships. The range of systems and equipment fitted in the DDGs was awesome compared to the Type 12 frigates and the whole pace of life onboard reflected the enormous capability that these ships provided to the RAN.

Life in most DDGs in the 1960’s was centred around Vietnam deployments and operations with the USN. The ships rarely got to enjoy the more leisurely tropical operations of the Strategic Reserve based at Singapore - that was the province of the Type 12s and the Daring Class - but R&R at Subic Bay had its own compensations! The level of interaction and cooperation between the RAN DDGs and their USN counterparts was considerable and numerous Australia-American friendships developed from these deployments and the extensive time many sailors spent on course in the US.

CDSC

THE EARLY DAYS OF CDSC

Objectives and Roles

The NCS Project's defined objectives of CDSC were to provide support for combat data systems in service with major units of the RAN Fleet. This support covered the generation of software for operational programs, and the research and development of modifications to these programs and for new programs to meet the changing tactical requirements of the RAN. CDSC also provided for the training of both maintainers and operators of the shipboard equipment. CDSC was defined as being able to provide the centre of experience in the field of combat data systems hardware and software, and to provide advice on the implementation and planning of future combat data systems.

In order to provide appropriate shore support facilities for operational combat systems, CDSC was seen to need the following attributes and capabilities:

- a capacity for combat system integration
- off–ship test and evaluation
- crew–training, at CDSC and on–board
- ship equipment proof testing (grooming)
- mission support
- operational readiness support
- software upkeep and support
- system engineering support
- research, development, test and evaluation
- hot spares support
- repair (intermediate and depot level)
- supply support
- documentation support

Support for the operational software, providing the core fighting capability of the DDGs, was a core capability comprising two unique components. Firstly there was the autonomous development of the RAN NCDS program, which although based on JPTDS, was quickly to become an indigenous responsibility. Secondly there was the 'in-country' upkeep of USN supplied programs that were part of the DDG's weapons and sensor suites and which needed to interact seamlessly with NCDS. Thus with NCDS, CDSC worked independently but in concert with USN agencies regarding functionality and compatibility of software. With other programs sourced from the US (such as WDS), CDSC tested programs received from the USN for compatibility with NCDS and provided feedback on functionality or potential improvements to the USN support agencies.

The Garden Island Dockyard did not like the idea of CDSC installing NCDS software into the DDGs *and* dictating testing and acceptance methods – the acceptance authority was held to be the RAN Test & Assessment Unit (RANTAU). CDSC had to alter the thinking of both the Dockyard and RANTAU.

CDSC Groups

The Combat Data System Centre started out with six groups: Administration (Admin), Programmers (PROGS), Systems Engineering (SEG), Test and Development (TDG), Training (TRNG), and Operational Design (ODG); plus the embedded Civilian Support Contractor (sometimes regarded as a seventh group). Later, another group, the RAN Tactical Data Link Authority (RANTDL), was added to cope with the increasing demands of Link communications. All the groups worked closely together – so that, for example, SEG and TDG complemented one another in terms of system understanding and software related problems. This requirement was unlike that apparently existing in many other groups within the rest of the RAN that appear to work in splendid isolation from one another. The success of CDSC was due in no small measure to its success in everyone working together as a team. This was aided by physical proximity – the programmers were just a 'room divider' away from the program testing group, and the system engineers were the same distance from the training group. All the groups talked to each other and thus a huge volume of knowledge was developed by all in the understanding of NCDS relationships. As a parallel to this symbiosis of knowledge, the aircraft industry in general did not achieve the same relationship, albeit on a much larger scale, until the development of aircraft such as the Boeing 777 and the A380 Airbus. The 'Skunk Works', now run by Lockheed Martin, however worked the same way from its beginning.

Director of CDSC

The head of CDSC was styled the Director, a position filled in the early years by a succession of uniformed naval officers of CAPT rank, but later (1990 – 2001) by the APS civilian Mr Tony Bone. The Director of CDSC was responsible, administratively, to the Director General Naval Design for:

- the upkeep of operational software for ship and shore-based combat data systems and designated 'interfacing' systems;
- the review of new combat-equipment proposals to determine their impact on combat data systems and, where necessary, the conduct of pre-installation trials;
- the design and development of future combat data systems and the specification of 'interface' equipment;
- the provision of specialist advice to external authorities;
- the conduct of designated combat data system, equipment and software maintenance training courses;
- the conduct of DDG NCDS operator and team training courses; and
- the provision of in-service engineering support for combat data systems, equipment and associated maintenance software.

A Memorable Early Event

Several months after Phil Kennedy had become the (second) Director of CDSC, the Deputy Chief of Naval Staff (DCNS) invited him to attend a naval staff meeting, which normally took place every second Thursday. Once there, Phil was asked to explain how NCDS enabled HMAS *Perth* to communicate with the rest of the Fleet. Even though Phil's answer was based on his quite rudimentary knowledge of NCDS, after about five minutes it became obvious to Phil that the rest of the meeting did not understand even the basic concepts he was trying to explain. The DCNS suddenly said 'Speak English, for God's sake man'. The seamen of the RAN knew nothing about computers and the Navy as a whole did not really understand what they had in NCDS. Navy Office certainly did not understand the flexibility of software – and even today some senior managers still apparently believe that once you buy software it doesn't need to be maintained.

Early Triumphs

The RAN was credited by the US Navy for resolving the significant unreliability problems with the Radar Video Processor (RVP), and also for saving the Beacon Video Processor (BVP) from the US scrap heap. This 'saving' was achieved by demonstrating that a substantial redesign of the BVP operator's panel greatly simplified the operating procedures which were, at the time, way beyond the ability of normal people. LEUT Peter Bobroff RAN, whilst at CDSC, got the software working for the RVP. Phil Kennedy, by that time commanding HMAS *Perth*, was very pleased when his ship, taking part in RIMPAC, was picking up all the tracks before the 'Yanks'.

Early Personnel

The original CDSC team members were:

CAPT Peter Hutson RAN	Project team leader
Valerie Hucker	Project administration officer (whilst the team was located at Russell Offices)
CMDR Brian Spark RAN	first Director, formerly a member of the Royal Navy
LCDR Russ Glen RAN	'sort of' Head of SEG
Ed Goldsmith	civilian engineer
LCDR John Williams RAN	Head of the Operational Design Group
LCDR John Mathews RAN	Head of the Training Group
CMDR Tim Duchesne RAN	Submariner
Peter Mogg	Head programmer, recruited from CSIRO

THE EVOLUTION OF CDSC

This article aims to provide a general insight into the rationale for, and ultimate success of the Combat Data System Centre as a concept for providing integrated software and hardware technology support. The text is an extract from a paper entitled ‘Technology transfer, knowledge partnerships and the advance of Australian naval combat systems’ by CMDR Geoff Cannon RAN. The contribution of Dr David Stevens (RAN Sea Power Centre) in the final form of this article is gratefully acknowledged. The complete paper was published in ‘The Navy and The Nation’ produced by the RAN Sea Power Centre in 1995.

Establishment of the Combat Data System Centre

In the lead up to the introduction of NCDS the RAN had reassured its officers and sailors that although specialist training relevant to the new equipments would be necessary, ‘it is not revolutionary – and you won’t need a degree to operate or maintain the system’. This comment, however, presumably referred only to using NCDS at sea. Although the hardware interfaces were going to be common with the USN, numerous aspects of the software were going to be RAN specific, and, as software upkeep was an unfamiliar function, the Navy had already foreseen the need to set up a highly specialised facility ashore for NCDS support and programming. Under Captain P.G.N. Kennedy, RAN, the Combat Data System Centre was established in July 1974. The Director of CDSC remained a uniformed position until 1990, when the then Civilian Superintendent, Mr Tony Bone, took over. He remained Director until his retirement in 2001. To ensure that the Centre could adequately modify and test the NCDS program the Navy installed a suite of military specification equipment and staffed CDSC with a mixture of service personnel, Defence civilians, and contractor staff. The internal organisation was designed around several separate but integrated groups. Eventually these included an Administration Group, an Operational Design Group, a Programming Group, a Test and Development Group, a Systems Engineering Group, a Training Group, and the on-site contractor.

The use of separately contracted technical support was a notable development because the Navy’s weapons system maintenance was then focused on the Government-owned facilities at Garden Island, Williamstown and Cockatoo Island Dockyards. CDSC thus held a unique position within the RAN’s support infrastructure. Furthermore, although originally a hardware maintenance effort, the contractor’s task would eventually expand to cover both hardware and software support. Through a continuum of changing company ownership many contractor staff worked at CDSC for 20 years or more and so had vast corporate knowledge of NCDS development.

NCDS Development

The original JPDTS program employed a low-level CMS2 macro assembler language called ULTRA, similar to that used in all USN major surface combatants before the huge AEGIS Project took over in the 1980s. The derivate NCDS program was also based on the CMS2 operating system and in RAN service was initially labelled 4XXX. The first character listed in the designator indicates the processor that hosts the program. The second character is altered incrementally each time the program undergoes major development. The third character is altered likewise each time one or more modules is added or replaced during major development. The last character is changed

each time one or more patches is added to the program. The program provided a digital structure for the receipt and distribution of contact data collected from all ship sensors. It then displayed this for the command team as standardised symbology on top of the raw radar video. NCDS could also assign weapons automatically to counter a threat, and thus needed to interface with the two separate software programs which controlled the gun and missile systems. Since the USN provided these weapon control programs, all their development and testing occurred overseas. Similarly, many elements of the combat system remained fully supported by the USN. The lasting challenge faced by CDSC was to preserve the collaborative support arrangements for NCDS while maintaining indigenous software that worked seamlessly with the integrated weapons system programs.

Throughout their service, the DDGs were the RAN's most capable missile platforms and, after the withdrawal of the aircraft carrier HMAS *Melbourne* in 1982, they were invariably task group command ships. These extra demands, not faced by USN destroyers, meant that NCDS needed far more comprehensive functionality than its NTDS cousin. Fortunately, the continuing need to oversee program performance as well as to record activity for analysis, allowed CDSC to rapidly improve and refine its knowledge of the system. In addition, as users became more familiar with the technology it became plain that the operator requirements for the software—for example how NCDS displayed information to users—would change incrementally. This situation produced a software change management process involving both user needs and problem fixes, through which CDSC could fine-tune the features.

Software may never wear out, but command and control systems do not perform in a technological vacuum. Preserving the effectiveness of a tactical program in ever changing circumstances needs constant review. In responding to the combat lessons emerging from the Falklands War, for example, casualty modes of operation became increasingly important to allow ships to deal with battle damage and system degradation. Over time, CDSC applied a vast effort to maintenance and development of both the NCDS program and the ancillary simulation and test programs. The reward for such effort was the ability to respond rapidly to shipboard problems and create program fixes. A specific example of this occurred during the 1990-91 Gulf War. The following was taken from an E-mail sent by Captain R.T. Menhinick, RAN, Commanding Officer HMAS Anzac, to D. Stevens, 7 July 2004.

> '*While patrolling the northern Persian Gulf on 30 December 1990, Brisbane was operating in close proximity to USN and RN units all of whom were connected via a Link-11 data transfer network. The data link specifications of the RN units, in particular HMS Gloucester, were based on a NATO standard. Brisbane's was based on the USN operational specification. Gloucester had a recurring fault with her combat system which resulted in her leaving the Link network at irregular intervals, at which time in accordance with USN specifications, another ship, in this case Brisbane, would report her position. However, this action resulted in Gloucester's system crashing 18 times as this was not in accordance with NATO specifications. Brisbane reported the problem to CDSC and the software was changed within 18 hours and over New Years Eve. This permitted combined data link operations close to Iraq to continue. It remains to be seen whether the commercial support arrangements of today could match such an operational ability.*'

This activity, and a second rapid response program delivery earned the Centre a Maritime Commander's Commendation.

CDSC's unique role in providing technical support altered only slightly in its first two decades. Nevertheless, the broad concept of the Centre, and its supporting infrastructure, evolved to deal with new and changing needs. Perhaps the most significant development was, as

highlighted above, support for digital data link development, since one of the most important features of NCDS would be the ability to share near real time information between the ships and aircraft of an integrated force. The exchange of tactical data was essential for task force operations, but this added to the complexity of preserving a common and accurate tactical plot, given that corrupt or false data could easily confuse the picture if it were not closely monitored. Early efforts to in the mid-1970s to refine data link operations saw further extensive collaboration between CDSC and its USN counterparts. In a notable achievement, the first long-range data link transmission was successfully achieved from CDSC in 1976, while working with a USN warship off the Western Australian coast—a tribute to the determination and effectiveness of the relatively small Australian team. The early involvement of the RAN in Link-11 technology has since paid large dividends, and the extent of exchange of technical and operational information has undoubtedly improved RAN systems interoperability and hence tactical effectiveness when working with the USN.

Years of Expansion

By the late 1970s CDSC had already absorbed almost all aspects of naval combat system support, including the training of system operators, maintainers and managers. Instructors provided trainees with the most up-to-date information and the latter benefited from opportunities to use and be assessed on the actual combat system. The quality of technical support and management was also strengthened by military personnel undertaking instructional roles and developing their understanding of the system's design and functions. In truth, the Centre had achieved an effective synergy by co-locating and coordinating all key elements of combat system technical and operational support. This was a fortunate outcome, for the workload and customer base were about to expand significantly.
In 1976, after a protracted debate over proposals to build an indigenous light destroyer (DDL), the Australian Government ordered the first two FFGs (HMAS *Adelaide* and HMAS *Canberra*) followed by a third vessel (HMAS *Sydney*) the next year. US shipyards were again contracted for the task and the ships would be delivered to a largely standard USN configuration. The DDG experience, however, had given the RAN great confidence in the skills residing within CDSC, and the Navy determined that instead of the USN-installed WSP (Weapon System Processor) software the FFG would also use the Australian NCDS program.

CDSC carried out the work on the FFGs after the ships arrived in Australia, using the early DDG program as the baseline, but redesignated 5XXX to show that a different software version was hosting NCDS. Support for the original CMS2 program at CDSC had required a painstakingly slow punched card reader system to produce the code. To assist in development and debugging for the FFG program, however, CDSC transitioned to a 'high-level' version of CMS2, which used recognisable words in a sentence-like structure to trigger program functions. Also incorporated was a new USN compiler system called SHARE-7, which thankfully saw an end to punched cards.

With the FFGs came more UYK-7s and the next generation of military computer, the UYK-20 which, although not necessarily faster, used larger multifunctional cards with solid-state technology and more condensed capacity. NCDS did not use the UYK-20 but the computer did provide increased processing power for the FFG's weapon systems and sensors. Unlike the DDG configuration, the FFG NCDS program interfaced with a single weapon control program for both missile and gun engagements. Other differences between the programs centred on display technology, with the FFG version needing to provide greater amounts of information to the operators.

Subsequently the RAN ordered another FFG (HMAS *Darwin*) from the United States and built two more (HMAS *Melbourne* and HMAS *Newcastle*) in Australia, the final vessel entering service in late 1993. This extended delivery timeframe meant that the combat systems

installed in the last three ships differed in some respects from those in the first three. But, together with the DDGs, the purchase ensured that the RAN would manage nine front-line warships with similar combat system hardware and software technology. One of the many benefits of this commonality was the streamlining of training for officers and sailors, as well as more efficient collaboration within the development and support teams at CDSC.

As before, support arrangements remained heavily dependent on the USN for many aspects of the combat system. But CDSC continued to provide an effective source of 'in-house' knowledge for deciding the Navy's needs and implementing these within the NCDS software. The process cycle for turning a 'change requirement' (of whatever origin) into a fielded and proven system change requires a range of experience and expertise. The understanding of intra-system functionality and technical interfaces within CDSC enabled its staff to influence the USN's development of weapons system software programs. Indeed largely through this expertise the RAN came to be considered one of the more credible and influential partners in dealings with the US Foreign Military Sales (FMS) organisation.
Had the RAN acquired a replacement aircraft carrier from the Royal Navy or elsewhere in the 1980s, CDSC would have provided resources and expertise to support its combat system integration. As things stood, from the mid to late-1980s the CDSC team of experts was busy planning and implementing a substantial overhaul of the DDG combat system. This was the first attempt to manage locally a major combat system upgrade, but it was again incorporated into a broader 'DDG Modernisation Project'. The changes affected every aspect of combat system functionality, and included updating track data displays, and installation of the AN/SYS-1 autotracker to relieve the operators of yet another manual task. Moreover, all these developments had to be linked to the technical upgrading of the gun and missile fire control systems. To accommodate these changes CDSC had to completely rewrite the NCDS program, the new version being known as 6XXX. Although subsequently upgraded, this was the final version change for the DDGs and remained in use until the last vessel retired in 2001.

Commercialisation

As we have seen, contractor involvement at CDSC had been an integral part of the support infrastructure from the beginning. The contractors had changed over the years, and their task had expanded to encompass logistical support and direct technical assistance to Fleet units. Although based essentially on a 'specific tasking' rather than 'service provider' form of requirement, the contract retained sufficient flexibility to allow support for fixed long-term, as well as fluid short-term and short-notice activities. Because of the similar levels of knowledge possessed by CDSC staff and the on-site contractor team it was also possible to establish and sustain a high degree of interaction and integration between them. This professional working relationship thus sustained CDSC's capacity to effectively oversee the tasking of contractor resources.

CDSC was fortunate to retain the long-term expertise of its contractor staff. This stability was due largely to the specialist nature of the NCDS work, a productive technical environment, and the relative isolation of Canberra from other areas of Defence technical support. From this close working relationship many technical innovations evolved. Some projects reached fruition and others, rightly or wrongly, remained just good ideas.

One early and significant problem for engineering staff at CDSC was the lack of ship environmental data to test new and updated software. The military equipment supplied simulated inadequately many system inputs such as radar, pitch, roll and wind information, and the

contractor's team were frequently asked to design and build devices which allowed software testing to proceed as if in a ship installation. Such systems included the Weapons Control Console Event System Simulator (WESS) – a microprocessor-based device which sought to emulate all the FFG weapons systems beyond the weapons control console in the operations room. CDSC supplied further versions of this equipment to the tactical training building at HMAS *Watson*. Other simulation projects included a Link-11 noise generator, NCDS interface simulators, a gun system emulator and a Tartar missile simulator. Of even greater importance, however, was the work to develop major replacement components for existing NCDS equipment. Because of the high cost of many military specification replacement parts (and their unsure availability), it was at times necessary to release items for use in the Fleet, replacing those in the relatively benign CDSC environment with commercial quality substitutes. A prime example of this was the development of a replacement Double-Density Memory Unit (DDMU) for the UYK-7 computer by the contractor team – the project arose after increasing memory requirements for NCDS software created a need for more DDMU modules.

The issue of advancing commercial capabilities raises the question of the use of commercial off-the-shelf (COTS) technology. The military use of commercial systems is not new, but the incorporation of commercial standard equipment into systems normally needing military specifications is a relatively recent phenomenon. Perceived cost savings and speed of introduction have been major factors in the decision to use COTS equipment, but one of the most significant drivers has been the dramatic expansion of business computing. Consequently, commercial rather than defence needs have largely spurred technology development. Keeping pace with technological change has seldom been easy, but the RAN's infrastructure must be sufficiently flexible to adapt.

In the 1990s CDSC developed an important item of COTS equipment for NCDS in a cooperative effort with the Honeywell company. The RAN Standard Interface Device (RANSID) was a program loading and data recording unit which replaced unsupportable tape reading and printing equipment. RANSID was installed both in the DDGs and FFGs, and has most recently been modernised at CDSC for use in the FFG Upgrade Program (FFGUP)—indeed it is one of the few previous combat system elements remaining in the upgraded FFG. The issue of frequent modernisation is a particular facet of using COTS solutions, made necessary because advancing design often makes long-term support uneconomic. Other collaborative COTS projects undertaken at CDSC included the Seahawk helicopter data link simulator, produced with Computer Sciences of Australia in Canberra, and a simulator for the SLQ-32 electronic warfare system produced with Comptek Federal Systems in the United States. The latter project used a Macintosh PC to emulate combat system inputs to NCDS. All these examples illustrate the combination of specialised defence expertise with commercial capability, a form of partnership which was characteristic of CDSC's innovative professionalism.

The Introduction of New Combat Systems

The 1990s also saw CDSC installing the next (and last) generation of military computer for the FFG combat system, the UYK-43. Incorporating large multifunctional and reconfigurable components, the UYK-43 may be considered two computers in one. It was also faster than its predecessors, had built-in test and redundancy features and the ability to install commercial modules to interlink with COTS and so remain a highly capable unit. Installation of the UYK-43 required a major program change to exploit the new hardware enhancements. As a temporary measure CDSC delivered an interim NCDS version known as 7AXX to use the UYK-43 in a 'compatibility mode', which allowed the newer computer to emulate the functionality of the UYK-7. Completion of a full capacity or 'native mode' NCDS

program required a complete software rebuild using a new executive program (the USN CGN2). The Centre completed this extensive development, incorporating operational enhancements and problem fixes, into the final program product known as NCDS version 7CXX.

The Centre's final NCDS improvements involved the use of an ex-DDG display component, known as CIGARS (Console Internally Generated And Refreshed Symbology), to bring all FFGs to a similar configuration, as well as program changes to incorporate the latest data link message specifications. This innovative work required deep technical appreciation of the system hardware and software unique to CDSC; the low cost but high value of the change underscores the effectiveness of such in-service capability. As its title suggests, CIGARS provided for processing of data within the display console, work previously done in the NCDS computer. The changes improved symbology display times in the older FFGs and released memory capacity in the UYK-7.

Advances in information handling and display technology have obviously not ceased, with more capable sensors and more powerful data fusion techniques allowing the automated detection, classification and tracking of targets. At the same time improved data storage and display capabilities have provided much better analysis of the tactical situation. In the eight new ANZAC Class frigates the Navy introduced a new combat system known as the CelsiusTech 9LV 453 Mk3, which successfully incorporated many of these technological advances. Not only did this project expose the Navy to alternative combat system technology, but also it ushered in an era of commercial support for the managing of software. The decision to establish a combat support centre using the equipment scheduled to be installed on a later build vessel allowed the prime contractor and subcontractors to refine and test the combat system before installation in the first vessel, HMAS *Anzac*. This innovation played an important role in the delivery of *Anzac* in 1996, on time and with a fully functional combat system. Recognising the benefits of the combat support centre in systems integration, Defence has adopted a similar approach for other military procurements.

Another major advance took place in 1996, when the Director of CDSC was designated as the Australian Defence Force (ADF) Tactical Data Link Authority. Although the Centre had been the technical authority since the early 1990s it had not been responsible for operational policy and developmental advice. Thereafter, CDSC was responsible for interoperability assurance and tested all ADF combat systems against a known and mandated standard. This ensured that Australian data link systems would remain interoperable with Allied forces in accordance with Government policy.

The FFG Upgrade began in 2003 and with it the final move away from NCDS. Although NCDS will remain in *Adelaide* and *Canberra* until their departure from RAN service in 2006, the remaining four vessels will all have their NCDS replaced by a new locally produced system known as ADACS (Australian Distributed Architecture Combat System) by 2007. Based on commercially available software, ADACS has been developed locally by Australian Defence Industries. Significantly, the upgrade has also introduced the Navy to the next generation of data link, Link-16. This advance alone increases dramatically the quantity and quality of tactical information available within the combat system.

Future Capability and Technical Management

In 2000 the Navy adopted a new approach to capability management which saw seven Force Element Groups (FEGs)—based on ship types—created within Maritime Command. For many years CDSC had remained a component of the Directorate of Naval Technical

Services, but with its specific focus on FFG support the Centre came under the FFG Capability Element Manager within the Surface Combatant FEG. A separate Capability Element Manager was established for the *Anzac* class. This change in CDSC's status reflected the way different systems were being managed within Navy and within the new Defence Materiel Organisation. With the variety of combat systems in service in ships and submarines there was no longer a single entity that could meet Navy's requirements or oversee the introduction of technological improvements.

In keeping with the ongoing changes to Navy's technology management, the role of CDSC as a specialist combat systems centre has evolved into a technology governance agency oversighting the delivery of combat system capability through the Defence Materiel Organisation. The Directorate of Naval Warfare Systems now controls all ex-CDSC assets and resources, with a huge mandate to maintain credible customer awareness of all the warfare system technology utilised in Navy combatants.

Interestingly, the Navy's overall strategy for managing its operational assets has probably become far more closely aligned to the general industry model for asset management than might have been foreseen in the past. As the core customer of DMO, Navy has to understand and pursue a sound operating strategy for combat system technology. Navy must appreciate the strengths of having this separate but partnered technical support arrangement whilst protecting and evolving the crucial resources and infrastructure that will ensure Navy establishes viable requirements and maintains credible means to accept or reject products and services delivered. These resources are now far more fragmented and the infrastructure more diverse than was represented by CDSC but, in the end, the warfighting capability has to be there when needed.

THE BUILDINGS

The Combat Data System Centre was located in the light-industrial suburb of Fyshwick, in the ACT. The formal presence was established there in 1973. Originally, some thought had been given to the desirability of locating the facility in Sydney (probably at HMAS *Watson* on South Head), but the attraction of the (political) benefits of proximity to Navy Office proved too strong. In later years, the entrenched attitude of the many essential civilians who worked at CDSC precluded any possibility of a move away from Canberra.

The RAN required the CDSC support facility to be ready – including programmers, hardware instructors and to have all the military standard (Mil-Spec) equipment to be at least 'up-and-running' – before HMAS *Perth* returned to Australia from the US in 1974. Around February/March of 1973, the building at 84 Maryborough Street, Fyshwick (section 24, block 22) was occupied by CDSC. The choice of the location in Maryborough Street was made after rejecting four other sites in the area (all of which had fibro walls). The adjacent building at 86 Maryborough Street (section 24, block 21) was added in 1983, and CDSC's address became 84–86 Maryborough Street. Significant work was carried out to connect the two buildings and provide 'internal' access. In later years, most visitors were surprised to learn that what now looks like one building was originally two. The first building had formerly been a builder's showroom, and the second had been occupied by Pipeline Suppliers of Australia and a hi-fi component shop. Both buildings were extensively refurbished in 1997–98, and further internal changes were made to the DMO occupied area in 2005.

It was originally planned to rent the 84 Maryborough Street building for around three years and then move the CDSC equipment facilities to Sydney. The owners of the building apparently baulked when the project announced that a quarter of a million dollars worth of air-conditioning would have to go in before any technical equipment was installed. The government decided to issue a compulsory purchase order on the place so that installation work was not held up. A settlement was reached with the owners and work went ahead so that the military equipment could be installed. The equipment suite at CDSC was designed to replicate, as far as was possible, the combat system that existed on DDGs. Extensive modifications were required to the building to allow the creation of the equipment suites. Part of the work involved the installation of false floors for the ducting of cables and equipment services. During installation it was discovered that the floor of the equipment suites would not be at the correct height (because the false-floor jacks provided by the Americans were too short by several inches) to match the height of the corridors at the foot of each stairway. The solution was to insert, under each floor jack, an 'engineering grade' house brick before adjusting each jack to the required height. These bricks are still there.

When designing the requirements for CDSC, it was initially thought that just one classroom would suffice. It soon became obvious that several more classrooms would be necessary to cope with the increasing throughput of technicians and operators learning the intricacies of NCDS. As an interim measure, a temporary classroom was created in the lunchroom of Building 84. The on-site contractor (EMI), however, had a TV repair shop nearby at 135 Newcastle Street Fyshwick that was partially unoccupied. The RAN leased half of the building in which they were able to create extra classrooms. This allowed the training of NCDS people to expand to meet the growing demand by the Fleet and CDSC. Weapon Systems training was carried out in the US, whilst NCDS training was carried in Australia. LEUT Henry Burdon RAN and Don Loughhead (EMI) made several changes to the Newcastle Street premises and the Defence Department approved the building's transition to a training facility. Students and instructors created quite a path through the trees between

84 Maryborough St and 135 Newcastle St. The new training facility was adjacent to “Sasha’s” (a so-called massage parlour) and rumour has it that young NCDS trainees were often ribbed for going to the wrong building when reporting for classes. The Newcastle Street premises were also used to accommodate the SHARE7 facility, and the DDG Mod software contractor’s software team (C3). In 2008, these were now occupied by ATI.

When the 86 Maryborough Street building was acquired, work commenced to fit it out with classrooms and to accommodate the contractor and power generation facilities that would be moved from Building 84 to make room for the FFG equipment suite and a dedicated maintenance training suite for DDG and FFG instruction. On completion of the Building 86 facilities, the building at 135 Newcastle St was vacated by CDSC – the SHARE7 facility being moved to its final home adjacent to what was later known as the DDG Equipment Room.

The cost of the required modifications to the 86 Maryborough Street building was significant. Apart from the cost of installing air-conditioning where none had existed before, there was a large amount of internal structural work that needed to be carried out to provide a second floor to support the extra classrooms ‘upstairs’ in what was originally a large single ground-floor building. A sub-station size, street mains power transformer was added to support the overall electricity supplies to the new plant room at the rear of Building 86, which contained both main and back-up 60 Hz and 400 Hz alternators to support the military equipment in both buildings 84 and 86. These costs, plus the anticipated cost of reverting the building to its ‘prior to lease state’, meant that leasing the building was financially unattractive relative to an outright purchase, and that it was cheaper to buy the building.

The final configuration of two adjoining buildings allowed space for two major equipment suites – one to simulate DDG class ships, and the other FFG class ships. These suites allowed CDSC programmers to test modifications intended for the NCDS program that is part of each ship's combat system. A dual Link-11 data communication system was set up so that the centre could emulate two Link-11 sea-borne platforms communicating with one another.

In the late 1980’s, the CDSC buildings were sold and leased back in line with the government’s policy. Ownership changed again in 1998 as a pre-condition for approval of a much-needed extensive refurbishment of the aged office accommodation and building services – the sum involved was too substantial for expenditure on leased premises, so the Commonwealth resumed ownership.

In 2002 the DMO acquired the ADFTA organisation and gained occupancy of a portion of Building 84. With CDSC services being scaled back following decommissioning of the DDGs and implementation of the FFG Upgrade Project, the extent of space occupied by the DMO’s Tactical Information Environment – Integration Office (TIE-IO) gradually increased to the point where, in 2007, the vast majority of CDSC’s infrastructure was concentrated in Building 86. By this stage the demands for training classrooms had drastically diminished – all support for NCDS to the Fleet effectively ending in November 2007 when HMAS *Adelaide* ceased running prior to decommissioning.

THE EQUIPMENT SUITES

Whilst the upper or street level floor of the buildings at 84/86 Maryborough St were devoted to office space, classrooms and meeting rooms, the lower floor (at the level of the rear carpark on the sloping block) was largely devoted to the equipment suites and the associated power and chilled water plant rooms. The final configuration of two adjoining buildings allowed space for two major equipment suites – one to simulate DDG class ships, and the other FFG class ships – plus other equipment spaces. Each of the two main suites comprised two rooms – one as 'the suite' which mainly contained the operator consoles and emulated the functions of the ship's Ops room (even though it never actually was made up to look like one), and the other 'equipment room' that contained all the computers and switch gear and emulated the ship's 'NCDS Equipment Rooms' (DDGs) or RICER (FFGs).

More than simply 'emulating' a DDG or FFG equipment room with the necessary inter-unit connections, the equipment suites at CDSC could be reconfigured in an almost mind-boggling set of possible connections between the various computers, peripherals and other pieces of equipment, thus permitting a great variety of different configurations to be simulated and/or tested. This was enabled by banks of 85 connector, 5-way or 3-way, type 1299 manually operated switches and was detailed on the system drawings (copies of which appeared in all the suites) which allowed users to define which switches had to be set to what positions in order to achieve a certain interface. Whilst manipulating this switching was second nature to CDSC employees, it was, naturally enough, a source of continuous mystery to ships' crews coming to CDSC for training. Correct switch settings were essential for any required set of system interfaces – incorrect settings were the most common cause of the system not being able to be brought up. Over the years, type 1299 switches became somewhat temperamental – no doubt due to some of them having being switched numerous times each day for more than 20 years. On system malfunction at start-up, a common approach was to ratchet all the in-line 1299 switches back and forth a few times in the hope of restoring connectivity.

In order to achieve a system that allowed all the equipment to be 'everything to everyone', the CDSC equipment suites required over 10 miles of 2U-45 style (85 connector) cable and about 20 miles of cable of assorted other types. At their height of operation, the equipment in the suites was valued at $A 55 million.

One of the other spaces provided for a dedicated Maintenance Training Suite, where ET trainees could be presented with real equipment with a (seemingly never ending) series of simulated faults. The MTS was well equipped with AN/UYK-7s, AN/UYK-20s, a DEAC, OJ-194s, a CEG, a Mk-152, MK 95 I/O and a RDDS. Generally, simulated faults were not introduced onto equipment in the main suites (as these were used for testing of software before release to the Fleet), but was allowed on the PMEIC (SYS-1) as there was only one of these available at CDSC. Introduction to machine code programming for the UYK computers, an essential part of fault finding utilizing the diagnostic listings, required usage of the multitude of computers in the main suits and such were the demands on suite usage that many training classes started practical work at 5 am.

Finally, other spaces contained various pieces of other equipment, such as the Video Simulators (in lieu of real ship-borne radars) and various radios (HF and UHF), and also the programmer's Share7 system.

Initial Set-to-Work of the Suites

During February of 1974, CDSC received and set-to-work the four-bay AN/UYK-7 computer that was originally known as ‘TAC’ (short for ‘tactical’) and eventually became known as ‘B0/B1’. Before arriving at CDSC, this unit had been used at the USN’s Navy Engineering Facility (METC) at St. Paul, Minnesota, for RAN tasks. Whilst at METC, a greater part of engineering upgrade number 2 had taken place, but the balance of this change was carried out at CDSC. This computer set had been produced by Univac St. Paul under contract N00024-73-C-1234 (part of FMS case AT-LAM-P2). This four-bay AN/UYK-7 computer was used both as a ‘tactical’ software development computer and as the CMS-2 compiler machine. A story from the early days tells of when the power was to be turned on for the first time. There was a large gathering assembled, and ceremoniously the switch was turned on. Whoops! Nothing happened. The EMI team was rather embarrassed and team leader Norman Moorhen went all red, crept out to the plant room and quickly rectified the problem. Remember the maxim - ‘try it BEFORE you demonstrate to all and sundry’

From the early days at CDSC, this 'BO/BI' computer set served two purposes. Firstly, it was the host for the NCDS program. As CDSC was not a complete ship with all the associated suites and other peripherals, the NCDS program as used at CDSC required the simulation of these ship servers and other interfaces. Inputs from the SIM computer tested the real-world effectiveness of the NCDS program running in B1 (TAC). Another AN/UYK-7 computer, the ’super two bay‘ computer ‘A0/A1’, acted as ‘SIM’, providing simulation of the DDG fire control system, weapons simulation, and LSMC emulation programs. Several boxes were created by EMI that interfaced with the simulator system in order to simulate important switch closures that the NCDS system required when ‘acquiring a target’.

AN/UYK-7(V) B1, along with the Univac 9300 commercial computer, was also the host for CMS-2 operations. When used as a compiler, the Univac 9300 computer acted as a ‘front-end’ device, which converted CMS-2 code (in Hollerith form) to binary data to be read in as data for the compiler program. Included in the delivery along with UYK-7(V) ‘B0/B1’ was a USQ-20(V) universal keyset, an 8-bit commercial computer (the Univac 9300), two Univac 1710 punch-card machines, a Univac 1720 punched-card sorting machine and an SB-3495(V) ‘RDDS’ cabinet (switchboard signal distribution unit).

Installed Hardware

Apart from the AN/UYK series of computing equipment, the following listing shows of some of the Hughes and Raytheon (peripheral) hardware installed at CDSC:

CY-7325 - Cabinet, electrical equipment, including OU-91(V)2, CV3053, and CV3057 (CEG-1)
CY-7325 - Cabinet, electrical equipment, as per CEG-1, but also including CV3054 and CV3211 (CEG-2)
CY-7780 - Cabinet, electrical equipment, including AM-7050A, CV3053 and CV3054 (CEG-3)
CY-7325 - Cabinet, electrical equipment, including OU-91(V)3, CV3211, CV3053 and CV-3057 (CEG-4)
SM-441(V)4 - Simulator, Video signals - VSS-1 & 2
SM-441(V)2 - Simulator, Video signals - VSS-3
CV-2834 - Radar, Video processor - RVP
Mk72 Mod 14 - Signal Data Converter - aka SDC (DDG)
CV-2953A(P) - Converter, Signal Data - aka SDC (FFG)
SB-2780 - Switch board, Radar data distribution - RDDS
OJ-194 - Plan position indicator console / Multi-functional display - MFD or Console
OJ-197 - Operational summary console - OSC

TIMELINE OF SIGNIFICANT EVENTS FOR CDSC

1968

Approval given for Naval Staff Target 8/68 – Action Data Handling System for RAN.

1969

CAPT P J. Hutson RAN becomes Project Leader.

1971

Mr Tony Bone joins the Project. Tony eventually becomes a long-term Director of CDSC.

US Navy Chief of Naval Material designates the AN/UYK-7 computer; the CMS-2 NTDS programming language, and the associated peripheral equipment and displays as the USN's tactical digital standards.

1972

Cabinet approves the funding for introduction of automated C&C systems into the RAN – this includes the establishment of a shore support facility (to become known as CDSC).

CMDR B L. Spark RAN becomes first Director of CDSC.

HMA Ships *Perth* and *Brisbane*, still not fitted with NCDS, take part in SEATO exercise 'Sea Scorpion'.

1973

Naval Board endorses Project Directive 63 (PD63) – Naval Combat Data System.

The South Australian branch of EMI Pty Ltd is awarded a contract to manage the installation design philosophy for CDSC. Later, EMI is contracted to carry out the full installation and maintenance of all the US-supplied military hardware.

The building at 84 Maryborough Street Fyshwick is purchased by Defence for the establishment of CDSC.
Mr Michael Moorhen joins CDSC on completion his cadet engineering training. Mike eventually becomes a long-time head of the Test and Development Group.

1974

Numerous items of NCDS equipment arrive in country from the USA and are set to work at CDSC. These include the four-bay AN/UYK-7 computer 'B0/B1', a 2-bay and a 4-bay RD358 tape drive unit (to be used as part of the CMS-2 compiler system), a

DEAC (OJ-172) I/O device, and a Hughes TS-2460 test set (for the repair of OJ-194 circuit cards). There were eventually to be up to seven DEACs in use at CDSC, the last being removed in 2002.

LEUT Gordon Stone RAN posts in before being sent to Mare Island, California, for Displays maintenance training prior to becoming the first CDSC Displays instructor.

(Jul) CAPT Kennedy AO RAN becomes Director of CDSC.

(Jul) HMAS *Perth* sails for the USA to have NCDS fitted and Tartar digitised.

(Sep) Installation of NCDS commences on HMAS *Perth* at Long Beach, California.

Agreement signed in Washington to reflect the first stage of the planned purchase of two FFGs for the RAN. The first was expected to be delivered in 1981 and the second early in 1982.

1975

The US Navy's Model 3 PJTDS program is converted to become the RAN's 4XXX version of NCDS. Programmers at CDSC are working in two shifts.

Instructor LCDR Henry Burdon RAN runs the first AN/UYK-7(V) maintenance course (3 months duration) for crew of HMAS *Hobart*. The first Link 11 course is held at CDSC.

(Jun) Installation of NCDS is completed on HMAS *Perth*. HMAS *Perth* then receives her first version of NCDS software whilst alongside in Hawaii during return to Australia.

Mr John Currie, an APS programmer, goes to Dam Neck in the USA for 2 years for training in the NTDS program. John would continue at CDSC until 2007.

1976

HMAS *Perth* takes part in READIEX, a major exercise involving twenty-three ships, including USN ships *Oriskany* and *Long Beach*. HMAS *Perth* had a great success with NCDS.

A Mk152 Tartar computer system arrives at CDSC prior to being sent on to HMAS *Brisbane* for installation (in Sydney).

1977

HMAS *Brisbane* departs Sydney to attend the Silver Jubilee in UK.

HMAS *Adelaide* (FFG-01), originally built as FFG-17 for the USN, is laid down by Todd-Pacific Shipyards, Seattle, USA.

Mr Peter Bobroff arrives at CDSC.

(Oct) Installation of NCDS on HMAS *Brisbane* commences at Garden Island, Sydney.

(Oct) CAPT J.S. Dickson RAN MBE takes over as Director of CDSC.

(Nov) Installation of NCDS commences aboard HMAS *Hobart* at Garden Island, Sydney.

CDSC works to modify the 4XXX NCDS program to ensure compatibility with the new Link 11 message standard in the Model IV NTDS software prior to HMAS *Perth* participating in RIMPAC 78. Mr John Robinson, an APS programmer and eventual Head of Programming group, sails with *Perth* to confirm that the changes are successful.

1978

Sperry Univac delivers its 1000th AN/UYK-20 computer to the USN.

HMAS *Canberra* (FFG-02) originally built as FFG-18 for the USN is laid down at the Todd Pacific Shipyard Corporation, Seattle, USA.

Installation of NCDS on HMAS *Hobart* is completed at Garden Island, Sydney, and is then ‘set-to-work' in preparation for RIMPAC 78. During RIMPAC, the NCDS on *Hobart* is reported to be working more effectively than the NTDC on the USS *Constellation* (USN Carrier CV64) she was working in company with.

Three CDSC programmers travel to Rabaul, New Guinea, to meet HMAS *Perth* in order to sea ride back to Sydney and examine/fix a software problem with NCDS.

Peter Bobroff works on resolving many of the problems being experienced with RVP. His experiences and knowledge contributed to some of the USN upgrades to the RVP.

The RAN forms the DDG Update Project, deciding to modernise the DDGs with the aim of extending each ship’s life by at least ten years post-mod. The hull life of the DDGs was extended to approximately 35 years.

1979

The building at 135 Newcastle Street Fyshwick, within easy walking distance of CDSC, is leased to provide additional classrooms to cater for the increasing requirements of training the RAN’s NCDS maintainers and operators.

A review of the Structure & Management of CDSC is published. The review noted the necessity to examine the adequacy of CDSC's organisation for its current functions, and leads to the acquisition of the 86 Maryborough St building.

HMAS *Perth* is upgraded from burning furnace fuel oil to burning diesel fuel.

1980

HMAS *Sydney* (FFG-03) originally built as FFG-35 for the USN is laid down at the Todd Pacific Shipyard Corporation, Seattle, USA.

Gordon Stone rejoins CDSC as a civilian member of the Programming Group.

HMAS *Darwin* is ordered. CDSC is given two days to define additions to NCDS for this ship.

CAPT J S. Dickson RAN writes a paper *'Way ahead for CDSC'* which became CNSAC minute 20/79. This paper suggests that 40% - 50% of CDSC's total resource availability is being devoted to its Software Upkeep Task; and 25% to Training.

(Oct) CAPT A.M. 'Jerry' Carwardine RAN becomes Director of CDSC.

(Nov) HMAS *Adelaide*, the first RAN FFG, is commissioned.

1981

Thorn and EMI(E) merge to form the new company Thorn EMI(E) Electronics Pty Ltd. This company takes over the Support Contract at CDSC.

HMAS *Darwin* (FFG-04) originally built as FFG-44 for the USN is laid down at Todd Pacific Shipyard Corporation, Seattle, USA.

Mr Peter Mogg (Head of Programming group) makes his decision to leave CDSC and to form a software company called Compucat P/L in Fyshwick.

Admiral Sir Henry Leach GCB ADC RN (the First Sea Lord), together with RADM F. Lynam RAN, CDRE N W. Hudson RAN, and CDRE O'Farrell RAN (DGNOR) visit CDSC.

The USN awards Hughes Aircraft Company a $US400 million three-year production contract to produce a suite of AN/UYQ-21 command & control displays for use on Japanese, Spanish and US warships.

The Government gives approval for Phase 1 of the DDG Modernisation at an estimated cost of $A205 million.

1982

The first AN/UYK-20 computer maintenance course is held at CDSC.

Share/7 installation at C3 in Newcastle St. Fyshwick is commenced.

1983

Software changes for SYS-1 required for 6XXX DDG Mod and BVP pre-processing are started.

HMAS *Sydney* is commissioned.

A second Share/7 system is installed at C3 in Newcastle St.
(Oct) CAPT M J. Taylor RAN AM becomes Director of CDSC.

HMAS *Brisbane* experiences 'tombstones' on her OJ-194s during stressful loads in a Link environment – these are thought to be caused by ID conflicts.

1984

(Jul) HMAS *Darwin* is commissioned, bringing to four the number of FFGs in service with the RAN.

Software for DDG Mod is arriving from a number of sources – Minneapolis, WSC at Dahlgren, and C3 P/L in Fyshwick.

Programmer John Currie succeeds in splitting the Display (NCDS program) module into two sections, a move made necessary as the memory capacity of the AN/UYK-7(V) is insufficient for the new increased DS module.

Problems are experienced with the porting of the 4XXX DDG version of NCDS into the FFGs as 5XXX – these problems include poor tracking data being transferred between NCDS and the WCP, the 'sequence & tracking' process, and poor integration of RVP with NCDS. Most of these are resolved by early 1985.

Interoperability Link multi-platform trials are carried out between an FFG, a DDG, CDSC and a RAAF P3 Orion.

1985

Don Kiley, of Scientific Management Associates (SMS) in Crystal City, Washington USA, takes over from Faith Rawdon-Smith as overseer for the software support for CDSC/RAN.
The adjacent building at 86 Maryborough Street is acquired, and CDSC's address becomes 84–86 Maryborough Street. With the addition of Building 86, Training group is able to move in (out of Newcastle St).

Approval is given for the creation of a 'mini-system' at CDSC, a subset of the AIOTT suite. The mini-system included AN/UYK-7s 'E' (WCP/RANSIM), 'F' (WASP) and 'G' WSP/DDGTAC). This 'mini-system' became quite involved and was in use for a long time.

The RAN procures a Software Support & Training System (SSTS) for the AN/SLQ-32 equipment.

(Jul) HMAS *Melbourne* (FFG-05) is laid down at Williamstown Dockyard, Victoria, by Transfield Pty Ltd
A program review meeting was held between CDSC, NAVSEA and the Prime contractor for DDG Mod software in Washington to plan the NCDS DDG Mod Certification Test effort.

HMAS *Brisbane* commences DDG-Modernisation.

1986

The FFG Suite is established at CDSC.

The first AN/SYS-1 course is taught at CDSC.

1987

HMAS *Perth* starts her second modernisation period at Garden Island, Sydney, at a reported total cost of $A70 million.

The Chief of Naval Engineering, Rear Admiral R.R. Calder presents commendations to four members of CDSC in recognition of their dedication and commitment to DDG Mod.

Mr Anthony 'Tony' G. Bone becomes interim Director of CDSC (for 2 months).

CAPT N. Newnam RAN becomes Director of CDSC.

1988

By this year, six navies around the world have versions of NTDS installed in their own ships.

(Apr) Lead Ship Software Integration Testing (LSSIT) for DDG Mod is completed on HMAS *Brisbane*, with excellent results. The final checkout of the DDG Mod Combat System software occurs on *Brisbane* 2 months later.

CDSC commissions the US Navy Naval Sea Systems Command to produce a document defining the lessons learned from DDG Mod. The final report identified 23 major recommendations.

1989

HMAS *Newcastle* (FFG-06) is laid down at Williamstown Dockyard, Victoria.

Integration of the new 5XXX NCDS program with RVP/AN/UYK-20, and interfacing with AMD, is achieved.

The US Navy has 151 NTDS equipped ships.

The IKARA launchers are removed from HMAS *Brisbane*.

One of the contractor's commercial 32k memory units for an AN/UYK-7 computer is installed in HMAS *Sydney* to test its suitability for operation at sea.

1990

(Feb) Mr Tony Bone becomes Director of CDSC for a second (and somewhat longer) term.

(Aug) The Australian Government announces Australia's participation in the multi-national Naval Force formed in response to the invasion of Kuwait by Iraqi troops. HMA Ships *Adelaide, Darwin* and *Success* sail for the Persian Gulf 3 days later.

HMAS *Brisbane* is modified (in record time) to enhance its Air Warfare (AAW) capabilities by Garden Island Dockyard, Sydney prior to deployment to the Persian Gulf. HMA Ships *Brisbane*, *Sydney* and *Westralia* then sail for the Persian Gulf, the DDG and FFG forming part of the allied naval fleet's anti-air warfare screen.

A HUGHES Corporation proposal for a 'Colour Raster Workstation' upgrade to improve the NTDS OJ-194 Displays is reviewed by CDSC – the estimated cost being $A13 million dollars for 42 consoles. No action is eventually taken in regard to this offer.

1991

Both IKARA launchers are removed from HMAS *Hobart*.

Operation DESERT STORM commenced.

HMA Ships *Brisbane* and *Sydney* leave Dubai to return home to Australia.

The US Dept of Navy releases the Source Code for the Mk92 and NTDS systems to the RAN. This Source Code was applicable to both the DDGs and the FFGs.

AWASCo makes a bid to manage the RAN Stores at CDSC, which is rejected by RADM Hunt, RAN.

1992

A commendation from the Fleet Combat Direction Systems Support Activity, Dam Neck USA, for CDSC's support during Operation DAMASK is presented to CDSC by the Maritime Commander Australia.

HMAS *Melbourne*, the first of the two Australian built FFGS, is commissioned.

It is discovered that a number of Mil-Spec Electrolytic Capacitors, held in Naval stores at CDSC, are 20 years past their 'shelf-life'.

1993

USS Goldsborough, a USN DDG, is purchased by Australia for $A3.2 million dollars as a source of spare parts for the RAN's DDGs. Several items of Goldsborough's equipment are eventually utilized at CDSC.

An investigation is started into a possible DEAC (OJ-172) replacement.

Senator Ray (Defence Minister, Labour) approves the expenditure of $A13.682 million dollars for the purchase of ten AN/UYK-43 computers under MIS 1652 *'Provision of AN/UYK-43 Computers for FFG-7 Class Ships'*.

An AN/SLQ-32-Simulator is installed and tested at CDSC.

HMAS *Newcastle* (FFG-06) is commissioned as the sixth and last FFG.

CDSC is invited to produce a document showing the advantages and disadvantages as well as the impact and costs involved in its re-location to Sydney. The study revealed that it would cost well over $A1 million and a loss of CDSC services and productivity for at least a year.

1994

Helo Data Link Simulation (HDLS) software is delivered to CDSC from CSA P/L (based at Nowra) for test and evaluation.

A full re-configuration of the FFG Suite at CDSC is instigated. Around 50 new channel cable pairs are manufactured in the Workshop and laid in the FFG suite. RD358s no longer used, and several emulators are used for equipment related to NCDS.

Program support by MTASS, a more useful software tool than SHARE, is introduced.

MSSS documentation for SCP and the FFG version of NCDS is produced.

Gunnery tables are created for FFGUP.

The Mk152 Computer Life Extension (CLE) program is carried out at CDSC, and then on HMA Ships *Hobart* and *Brisbane*, by Roy Naboa from the USA.

Unisys and the US Navy commemorate the production of AN/UYK-43 computer serial number A1000.

The process of tendering for the manufacture of RANSID is begun.

1995

The letter of acceptance (LOA) for the purchase of ten more AN/UYK-43 computers is presented to ACMAT-N for his signature.

Stress testing of version 6CXX of the NCDS program is carried out at CDSC.

The manufacturing contract for RANSID is awarded to Honeywell Aust.

The Mk152 CLE program is carried out on HMAS *Perth*.

A training course in the Data Analysis and Reduction Processor (DARP) is held at CDSC, conducted by John Edwards of FCDSSA Dam Neck, USA.

The first AN/UYK-43 maintenance course is held at CDSC (Instructor LCDR Phil Walker, RAN).

1996

Environmental testing is conducted for new RANSID equipment

HMAS *Melbourne* sails for the Persian Gulf for Operation DAMASK VIII.

1997

NULKA AMD equipment is installed at CDSC for system integration testing.

USN support for the SHARE/43 programs formally ceases.

First billets established for the ADF Tactical Data Link Authority.

A major internal upgrade to the CDSC buildings (mainly the office and classroom spaces) is commenced. During this time, some staff were relocated to the upper floor of the 'BabyCo' building in Albany St, and some training courses were held in the classroom attached to the Transport Compound at HMAS HARMAN. The front entrance to Building 84 was also upgraded to meet OH&S standards.

1998

Both the 6XXX (for DDG) and 7XXX (for FFG) versions of NCDS are evaluated for the Y2K problem.

1999

CDSC becomes part of the (new) SCFEG – FFGCEM organization.

Ruggedised RANSID units are installed in the NCDS equipment room on the DDGs.

(Apr) HTDG Mike Moorhen suffers a major stroke and is medically retired.

HMAS *Melbourne* sails for the Persian Gulf for Operation DAMASK IX. Operation 'Tandem Thrust' takes place off the island of Guam. HMA Ships *Perth* (DDG-38) and HMAS *Sydney* (FFG-03) were amongst the participating Australian Forces.
(Oct) HMAS *Perth* (commissioned Jul 65) decommissions at Fleet Base East, Sydney.

2000

(May) HMAS *Hobart* decommissions at Fleet Base East, Sydney.

A Management Board is established at CDSC to deal with transition issues that might arise with the transition of CDSC activities to the Weapon Support Centre (WSSC) in Sydney.

2001

(Jul) Tony Bone retires and CMDR Geoff Cannon RAN becomes the (last) Director of CDSC.

The ADF TDL Authority becomes a separate Defence entity within CSIG.

CDSC representatives attend the inaugural IDLS conference in the UK.

CDSC staff visit IADS in Penang – the start of RAN TDL / ADF TDL advice assistance to the FPDA.

(Oct) HMAS *Brisbane* decommissions at Fleet Base East, Sydney, as the RAN's last DDG (and steam powered warship).

Two AN/USQ125 Link Data terminal Sets are installed at CDSC, followed soon after by their installation on all FFGs to replace the earlier AN/USQ-111s.

The SHARE System at CDSC is turned off for the last time.

The first international Link 11 interoperability test is conducted between CDSC and DERA, Portsdown, UK.

Commencement of first CDSC/ADFTA Office-to-Office agreement – highlighting the rapid expansion of ADFTA activities.

ex-HMAS *Perth* is sunk off Albany, W.A. to become a dive-site.

2002

CDSC produces an Operations plan to provide technical assistance to the FFGUP project whilst at the same time maintaining the support of current FFGs.

ex-HMAS *Hobart* is sunk off the coast of South Australia to become a dive-site.

2003

RAN TDL group established.

CAPT Beech USN (CO CDSA) visits CDSC in conjunction with inaugural CREAMS activity at HMAS *Watson*.

CDSC provides support to A.D.I. at G.I. for Helo Data Link software testing.

CDSC concludes the development of NCDS programs at Fyshwick. The focus of the TDG becomes the testing and acceptance of FFGUP combat system software.

The HODG and HSEG billets are transferred from Fyshwick to form the basis of a military staff for NWSA.

2004

(Nov) CDSC's 30th Anniversary dinner is held at the Wardroom on HMAS *Harman*. The dinner was attended by the CN, MC, CNE and the US Naval Attaché. Most of the former directors of CDSC and quite a few former staff members turned up for the event. An informal BBQ for families is held at CDSC the following day.

The ADF TDL Authority becomes part of the DMO TIE-IO organization.

2005

Version 7DCE-19 of NCDS is delivered to HMAS *Newcastle* – although development of NCDS was supposed to have stopped in 2003.

A refurbishment of the CDSC equipment suites occurs.

ex-HMAS *Brisbane* is sunk off the coast of Queensland to become a dive-site.

The US Navy certifies and deploys the latest version of its Aegis Weapon System aboard DDG-91 USS Pinckney. The new hardware and software eliminates most of the Mil-Std equipment and NTDS point-to-point interfaces associated with earlier Aegis systems.

CDSC's four-bay AN/UYK-7(V) computer, 'B0/B1' with 15 banks of 'core' memory, is removed from the DDG computer room awaiting disposal (scrap). The only remaining AN/UYK-7s are the two bay A0/A1 in the DDG suite and two single bay units in both the FFG equipment room and the MTS.

HMAS *Canberra* decommissions at Fleet Base West.

2006

Predicted end of FFG software and hardware support by CDSC.

Last FFG (NCDS) Systems course is held at CDSC for five students.

A team of five goes to Western Australia to retrieve the AN/UYK-43(V) computer, CSCP, CV-2953A and RANSID from the decommissioned HMAS *Canberra*.

The final CDSC groom of the NCDS OJ-194 equipment suite is performed aboard HMAS *Newcastle*.

A routine stock check reveals that the Storeroom at CDSC now holds 2823 line items, a reduction of nearly 50% since the decommissioning of the three DDGs.

CDSC is formally closed on 01 July, with its remaining functions being amalgamated into the Naval Warfare Systems Agency (NWSA) of Systems Command. CDSC was formerly part of Maritime Command. NWSA is required to continue CDSC's NCDS support functions until NCDS disappears from the RAN.

2007

NWSA is re-named Combat Systems Engineering Group (CSEG), a part of the Directorate of Navy Warfare Systems.

(Dec) HMAS *Adelaide*, the last NCDS fitted ship in the RAN, decommissions at Fleet Base West before steaming to Sydney for final disposal.

THE LATTER YEARS (AND ROAD TO THE END)

Recollections of CMDR Geoff Cannon, Director CDSC, 05 Jul 2001 – 01 Jul 2006

I joined CDSC in November 1996 as Head of the Systems Engineering Group, having recently come from being WEEO HMAS *Perth*. With a background of naval service encompassing communications engineering and service in Destroyer Escorts, my experience with NCDS was thin and had really only commenced with a Systems Course at CDSC in 1994 immediately prior to joining HMAS *Perth*. My association with CDSC was however to last almost 10 years and has undoubtedly become the singular most intensive and enjoyable part of my Navy career, with the latter period as Director particularly challenging but fruitful. I think my appreciation of, and indeed love for, CDSC over these past years has stemmed from the logical synergies of its makeup and the inherent effectiveness of the organisation that I quickly became immersed in. I gained considerable satisfaction from having the capacity to directly assist the operations of the ships at sea and, at the same time, be involved in the preparation of people and development of systems to cope with the continuing evolution of combat system technology. In the end it became my mission to ensure that the key elements of CDSC's past expertise were recognised and passed on to some future Navy combat systems organisation.

Overview of 1997-2000

CDSC was a thriving and dynamic centre of combat systems technology in the mid-1990s. My early recollections of that time include the holding of discussions between Tony Bone, Mike Moorhen, John Robinson and members of the FFG Upgrade Project team on a wide range of issues, plus involvement of those same CDSC icons in things like the tender evaluation processes for the ANZAC ship In Service Support. CDSC was a key player in the decision processes of the day concerning combat system technology but this was to steadily change as both FFGUP and the ANZAC Projects evolved independent and commercially based infrastructure for developing their combat systems. The three key military Groups (ODG, SEG and TRNG) were busy providing their specialist support to the Fleet – I can particularly recall the enthusiasm of HODG (then CMDR Richard Menhinick) in his endeavours to establish the ADFTA, the efforts of Ray Irvine in SEG to master the complexities of using SABTECH cards in RANSID, and the dynamic training schedule skilfully orchestrated by HTRNG (LCDR Richard Penalurick). The boffins of PROG were busy trying to create a full dual-processor capability for the AN/UYK-43 and their colleagues in TDG were dealing with Mk92 changes and the start of interoperability testing with the US. Our SERCO partners ably lead by Brad Carpenter and subsequently Pat Lynch were up to their eyebrows with hardware installations and repairs as well as helping with the CDSC office refurbishment: yes, in 1998 after 25 years or more we finally got rid of those orange curtains! To my mind CDSC accomplished a considerable number of major achievements during this busy period. The establishment of an ADF TADIL Authority (ADFTA) from within ODG was certainly a timely and crucial win for the ADF as this technology was rapidly advancing at an international level and, lead by Tony Bone as DCDSC, Australia gained membership of several key international bodies steering the way ahead for tactical data links (JICRB and MIDS I&I WG). The long-awaited installation of RANSID equipment that replaced the troublesome DEAC units was hard fought success and the use of non-militarised RANSID units to augment Tartar recording in DDGs was an added bonus. LCDR Ray Cairney managed all the final RANSID testing and installations. The key thing about RANSID was the massive amount of

experience it provided in the use of COTS equipment in ships; over the years we have learned so much about card specifications, uninterruptible power supplies and commercial obsolescence issues. With much assistance from SERCO gurus Ted Young, David Wellings Booth and Graeme Ward the project installed prototype NULKA (missile decoy) control equipment in the FFG Suite for NCDS interface testing. SEG have continued to provide in-service support for this remarkable indigenous system now fitted to both FFGs and ANZACs. The installation of AN/UYK-43 computers in FFGs was another major undertaking lead by the SEG Senior Engineer LCDR Phil Scott where, amongst other things, he had to convince the US connector manufacturer that there really was a production problem! As previously mentioned, the change of program executive for the FFG 7XXX baseline was a huge but ultimately successful undertaking necessary to access the fully capabilities of the new AN/-UYK-43 computers. Collaboration between SEG, TDG and SERCO produced the test/simulation unit for the FFG Helo Data Link which allowed functional testing without having the helicopter embarked. An excellent example of innovation was the use of display components from paid off DDGs to provide a CIGARS capability in the three older FFGs which ultimately brought the six FFGs to a common software baseline just prior to the commencement of the FFGUP program (life can be so ironic!). Two other examples of innovation from within the stalwart Training Group was the smooth introduction of NCDS operator instruction for FFGs at CDSC after the HMAS *Watson* facility closed and the ongoing reorganisation of the FFG Systems Course ably instructed at the time by LCDRs Don McLean and then Margot Schelling.

Working with the USN

There always seemed to be things going on between CDSC and the many NAVSEA organisations supporting the USN NTDS ships. The late 1990s was probably close to the last period of intensive program change at CDSC. We were working with Port Hueneme in California to acquire our upgrade of Mk92 WCP from ‘Rev R’ to ‘Rev S’ and there was also a prolonged discussion with NSWC Dahlgren over the R-17 baseline change to SLQ-32. A major change to NCDS software baseline was being developed in conjunction with our colleagues at the Combat Direction Systems Activity Dam Neck - CDSC was using the USN CGN-38 executive as the basis for the 7XXX program that would eventually operate in the new AN/UYK-43 computers. Further to this, the NAVSEA Commander had recently approved release of the USN Command Station display system - CDSC had secured the loan of a unit trialled in HMAS *Perth* and a joint project was established to develop an RAN version of this COTS technology for possible use in FFGs and ANZACs. Behind the scenes there was considerable cooperation with both NAVSEA and SPAWAR agencies on future TDL support arrangements as well as initial discussions concerning improvement to the way technology enhancements to combat system could be tested in shore test environment before deployment with the Fleet.

My first visit to our partner organisations in the USN occurred in 1998 when I accompanied HTDG Mike Moorhen to the US Navy Surface Warfare Center units at Port Hueneme (PHD) and Dahlgren, and to NAVSEA PMS380 in Washington. This travel marked the start of my association with people who had worked with CDSC over many years - Jim Taylor, Bob Boulter, Ken Moore, Mike Gorham, Ken Probe, Paul Delpopolo at PHD, Tom Hudson and Pat Brown, Charlie Munn at Dahlgren, Bob Flint, and Fred Kraus at PMS380. It was also the first of many times I had the pleasure of meeting and working with Don Kiley, CDSC’s ‘Mr Fixit’ in the US.

Travel overseas happened again the following year this time with HPROG John Robinson; the itinerary included a visit to Dam Neck at colourful Virginia Beach for discussions with people such as Glenn Bashford and Mary Kay Anderson on common FFG-7 combat system

support issues and Command Station. I also met up with our CDSC sponsored RAN Exchange Officer who was LCDR Larry Menon at the time. The scale of the military activities in the Norfolk area was then, and still is, quite awesome.
As HSEG I had become involved with DNWS CAPT Reg Cook and DGNER CDRE Peter Hatcher in the preparation of a paper on the requirement for a future Navy Systems Centre. After wide ranging discussions across the operations, engineering and support communities the paper presented a strong case for the establishment of such an organisation to CNSAC mid-1998: it was well received and further study was endorsed, but before this could happen the wider ramifications of RADM Shackleton's Tomorrow's Navy Team were implemented. The two key areas to impact on CDSC were the establishment of a Navy Systems Command and the creation of Force Element Groups. The impact of the organisational changes really started in 1999 – CDSC was moved from the Maritime Commander's direct line of management into the new Surface Combatant Force Element Group (SCFEG) infrastructure and placed under the control of the FFGCEM (the FFG Capability Element Manager). This change subtly downgraded the status of CDSC in line with the commercial nature of other combat system support arrangements, and established that the core responsibility of the centre, for its remaining life, would be the support of NCDS in FFGs.

The dormant DGNER plan to establish a Navy combat systems centre came back to reality after the Navy Systems Command was established and as Navy's in-service support arrangements with DMO came under more scrutiny. The need to define and regulate combat system requirements and capture the benefits of changing combat system technology reinforced the need for a Navy organisation to manage rather than undertake the functions of CDSC across all platforms. Discussions between SCFEG, DGNAVSYS, and FFGUP resulted in a new endorsement from the NCB for the centre to be created from the existing CDSC infrastructure with an initial focus on major surface combatant combat systems. It was logical that CDSC staff resources would have to be the basis of staffing such a facility but the requirement for the new Warfare Systems Support Centre (as it was then known) to be located in Sydney meant that a protracted disestablishment and relocation process would have to occur.

Typical of the vision of CDSC was the recruitment of Dave Fleshner who left sunny California in the late 1990s to join the fledgling tactical data links team at CDSC. Dave became a core member of ADFTA as it took shape and expanded, and his status as a well respected expert in the field was a significant asset to ADF.

Overview of 2001-2006

The decommissioning of the DDGs and the implementation of the Tomorrow's Navy Team recommendations that introduced the SCFEG concept also hit CDSC with staff reductions resulting from the diminished scope of NCDS support requirements. In a relatively short space of time CDSC lost over a dozen familiar faces: these included Mike Moorhen due to ill health, John Robinson to FFGUP, and even John Currie deserted us for a while! The loss of Mike Moorhen to CDSC was particularly tragic – he joined us as a junior engineer and his professional life was focussed on WCP and NCDS where he worked with many well-known identities from the past. Sadly his condition and convalescence has not allowed for a return to work and the loss of his wisdom and knowledge impacted across many aspects of our Navy business.

As the new century began CDSC played its part in ensuring all NCDS and WCP related programs are free of the dreaded Y2K bug! Work continued on the concept of the WSSC in conjunction with FFGUP and to assist this process an experienced consultant, Mr Clive

Constance, was engaged to assist CDSC and subsequently played a significant part in the production of a CDSC Transition Management Plan that covered all aspects of the road to eventual closure. With so much focus on the management of hardware and software technology CDSC organised a Software Support Manager's Conference in conjunction with the Defence Software Acquisition Reform Directorate. This forum provided a unique opportunity for the presentation and discussion of software development issues within Defence, including those associated with the WSSC.

In mid-2001 Tony Bone retired after 11 years as Director and having been involved in operations of CDSC since its inception. Such was the vision at the time that it was decided my HSEG CMDR WE billet would become DCDSC because the place only had a few short years to run! Indeed closure in 2005 appeared almost certain as all FFGs should, by then, have commenced upgrade and NCDS would be a thing of the past. As DCDSC I found myself extensively involved in attempts to progress the systems centre project as, despite high level endorsement, the detail of the transition was complicated by a continually variable expectation for the maintenance NCDS support at CDSC and a need to extensively redefine the system centre requirements following the withdrawal of FFGUP from the WSSC implementation team. The relationship between Navy and the DMO was very much in its infancy in those days and the understanding of 'who was doing what' was often somewhat grey! The early priority was to establish an initial group of NWSA positions so that some understanding of ADACS could develop within Navy. At CDSC a number of staff redundancies occurred to establish that core NWSA team in Sydney but the effect of these staff cuts was an increase in workload as the delays in the FFGUP program extended the timeframe for continuing all the necessary NCDS support activities.

As if this wasn't enough, CDSC was also assisting the growth of the new ADF Tactical Data Link Authority organisation by transferring key staff (Mike Kenderes and Sean Harvey) into the new team. These guys, together with Darren Lepp (also ex-CDSC) and Dave Fleshner, were the driving force behind ADFTA activities for many years. ADFTA was now managed by Defence within CIS and so was finally the recognised source of TDL expertise that CDSC had envisaged many years before.

Almost coincident with Tony's retirement was a visit to CDSC by the Commanding Officer of CDSA (Dam Neck) CAPT Dan Beach. For many years CDSA had been a close ally in the military software development and this visit was significant in that both CDSC and CDSA were in periods of reorganisation. CAPT Beach was a strong proponent for closer ties between the RAN and USN and from that positive position the RAN gained opportunities to become involved in many new areas of combat system operator training and interoperability testing. On the subject of allies, another notable personality who fostered a strong relationship from the USN to CDSC in particular was Jim Egeland. Jim held a senior civilian position within NAVSEA and for many years was effectively the local 'sponsor' for many combat system support activities undertaken in the US through the CDSC Operational Assistance FMS Case.

Still in the area of international cooperation, 2001 marked the first International Data Link Symposium which saw a gathering of TDL expertise from around the world to hear presentations and discuss technology developments in what is now known as the Tactical Information Environment. For CDSC, the event confirmed the rapid pace of evolution where new systems such as Link 16 were demonstrated and exciting new pathways of development became apparent. Coincident with IDLS, this time in the UK marked the first direct data link testing between CDSC and MOD Portsdown East and established the viability of long distance TDL connections: once again the RAN maintained its position in the forefront of the TDL evolution. For me, a stark recollection is of being in London at the time of the World Trade Centre attacks and the subsequent turmoil of international travel.

2002 was a particularly busy year for TDL and NCDS. CDSC had conducted extensive testing of new NCDS changes that fixed problems between concurrent Link11 and Link 16 network operations. With HMAS *Melbourne* in the Gulf urgently needing these enhancements, CDSC sent Mike Kenderes and LEUT Kym Fisher off as if with flak jackets and hard hats to install and test the required software, and send back the mandatory postcard. NCDS support was bolstered by the return of John Currie to the CDSC team - John had been a CDSC icon for so many years and his work as a contractor again symbolised the very close partnership CDSC has always enjoyed with Australian industry. John left to support Lockheed Martin's work on FFGUP in the US and then, when that all changed, returned to help us through the final years.

Another busy area of work was the expansion of tactical data link (TDL) activities in ADFTA, with SQNLDR Brian Warnock in the hot seat as HADFTA. With the departure of Tony Bone, Brian's unenviable task was to guide a raft of work aimed towards gaining the necessary authority for ADFTA to oversight TDL implementation in major projects as well as to establish the key network test and development activities associated with the implementation of Link 16. The current USN exchange officer with CDSC at the time was LCDR Mike Hill and during his extended tenure he provided exceptional service to the ADF through his experience and capability in the TDL operational environment. Such was the value of Mike's contribution to the TDL community that he was ultimately awarded a CDF Commendation for his service to the ADF.

In some ways 2002 marked the end of CDSC's dynamic ODG team. The DDGs were gone and the level of operational interaction with the FFGs for NCDS issues did not have the same intensity or requirement. CDSC was in the process of moving billets to Sydney in accordance with the Transition Plan and so ODG positions became the next logical area to be re-established in the NWSA. From these changes, however, came progress: come the start of 2003 LCDR Bob Thomas joined our team in Sydney to cover both CDSC and NWSA parts of ship, whilst in Canberra LCDR Ian McConachie joined CDSC to take the lead in establishing a new RAN TDL group that would specifically support operational and engineering TDL issues within the Fleet. With its mixture of origins from ODG and SEG the new group has quickly been established as a unique source of data link expertise within the ADF maritime arena. On an international level the third IDLS was held in Newbury UK, these events now being established as an annual event. The International Data Link Society was formed and, thanks to the high profile of CMDR Mick Stewart in his new Defence TDL portfolio, Australia was mooted as the venue for the 2005 IDLS. Two other highlights for me in the year were meeting with old friends of CDSC in the US, Faith Rawdon-Smith, Charlie Robbins and Glenn Bashford to gather background information for CDSC's 30th Birthday celebrations; and an opportunity to speak at the King Hall Naval History Conference where I had the honour of recounting the role CDSC had played in the establishment of combat system technology in Australia.

Another year passed and the uncertainties of FFGUP required CDSC to continue to revise plans to cease many support activities. With considerably diminished staff numbers 2004 saw CDSC still maintaining NCDS program development in conjunction with the release of a new version of WCP. Acquiring 'Rev T' from Port Hueneme had been on the cards for a while because much of its improved functionality and the fact that its code was similar to the Mod12 'Rev G' software used in FFGUP. The program did however have many significant changes requiring specific operational trials, and when these revealed some unexpected software problems the whole program release was shelved and it was back to the drawing boards for TDG to remove the 'Rev T' interface from NCDS.

A significant achievement this year was the resolution of debate concerning the future of the ADFTA and RANTDL. A plan for ADFTA to be moved into DMO within a new Integration Office for the Tactical Information Environment was accepted by Defence and an agreement covering the relationship with Navy's RANTDL was confirmed with the establishment of a Service Level Agreement that covers all areas of mutual support for TDL. Under DMO ownership the spectrum of issues covered by the TIE IO has expanded substantially and in many ways validated the original CDSC vision from many years before. Other important achievements were centred in the training arena. The first Mk92 training course to be conducted at sea in a deployed ship was planned and undertaken by LCDR Sean Leyden and CPO Len Harrison. As well, the first of a number of CDSC instructor billets were relocated to the CSMS for FFGUP combat system courses and to provide training development assistance in this critical area.

A major milestone late in 2004 was the celebration of CDSC's 30th Birthday. Pamphlets were printed to publicise the centre's history and achievements, and a range of memorabilia was produced, including a superb special vintage red wine sourced from the Canberra area. A dinner was held at HMAS *Harman* Wardroom on 4 November 2004 attended by CN, MC, CNE and the US Naval Attaché, as well as almost all the past directors of CDSC and a large number of staff from the past and present. RADM Chris Ritchie highly praised CDSC's contribution to the Navy's technical excellence and to the calibre of operational support provided over many years. CDREs (Retd) Peter Hutson and Dean Walkington provided interesting insights into CDSC's past and many anecdotes were shared. It was a night to remember and was followed by traditional CDSC BBQ the following day when many colleagues from the past braved poor weather to wander the corridors and reminisce.

In 2005 CDSC delivered to HMAS *Newcastle* (what was intended to be) the final NCDS program release with the necessary photographs, handshakes and certificates. Then, with further uncertainty regarding a final closure date, the final iteration of the CDSC-NWSA transition saga began. This plan abandoned the concept of closure and instead aimed to merge existing CDSC functions and resources with NWSA. To ensure continued delivery of support to SCFEG and MHQ a Service Level Agreement was drafted to cover all aspects of current and future support effort required from NWSA's expanded infrastructure. With many CDSC activities not being part of NWSA's future mandate it was logical to propose that the existing CDSC infrastructure could be continued whilst the NCDS services were required. Typical of these 'ongoing services' were the technical support tasks for RANSID, CIWS-PASS and NULKA MIMs that were an endless part of life in SEG, as well as the unique technical knowledge of gurus LCDR Glenn Bridgart and David Wellings Booth (Ginge) on the AN/UYK-43, SDC and Combat System Switchboard. These things demonstrated the ongoing commitment of CDSC in areas where no other plan for future technical support appeared to exist.

Another notable event was the hosting of IDLS in Sydney, the first time this prestigious conference had been held outside the US or UK. The new DMO TIE IO organisation held a high profile during the event and the ADF undoubtedly gained credibility of its efforts in the volatile area of data communications interoperability. July 2005 also marked the end of my 40 year permanent naval career but, with no relief posted and considerable work still to be done I stayed on at the DCDSC desk for another year. Another step in the transition plan occurred when LCDR Richard Penalurick retired as HTRNG and arrangements to transfer this position to the CSMS in Sydney saw LCDR Mike Larsen take over as OIC CSMS, whilst in Canberra LCDR Glenn Bridgart maintained control of the diminished Training Group at CDSC. The first FFG to decommission (HMAS *Canberra*) provided an opportunity for CDSC to remove and refurbish NCDS equipment for eventual installation in Sydney as part of the CSMS training facility for FFGUP.

Achieving Amalgamation

As 2005 drew to a close it was clear that CDSC could not maintain viable support for NCDS without some measure of certainty of employment for defence and contractor staff. It was also clear that NWSA would not be able to grow to manage the considerable burden of technical regulation for combat managements systems and software safety. A meeting between SCFEG and DGNAVSYS staff resolved to complete a Business Case for transferring CDSC into Systems Command and it was agreed that a Service Level Agreement would be established to document the scope of support required by Maritime Command from NWSA. The resulting Business Case argued for the transfer of all CDSC staff and financial resources on the grounds of transferring all extant combat system support obligations – hence CDSC would move as an entity retaining all necessary infrastructure to keep doing the expected tasks whilst being able to directly contribute staff resources to broader NWSA requirements.

In May 2006 a joint visit by DCDSC and DNWSA to the US cemented ongoing links to Port Hueneme, the Combat Direction System Activity at Dam Neck and to the FMS support staff of NAVSEA (SEA 63) in Washington. CDSC plaques marking the end of a highly successful 30 year relationship were presented and it was clear that NWSA would have many avenues of business with these organisations in the future.

With the approval of Maritime Commander the date of transfer was for 01 July 2006 and on that date the CDSC organisation was effectively subsumed within NWSA. Chief of Navy released a signal praising the work of CDSC and advising of its transfer into NWSA: the proud 30+ year history of the facility effectively drew to a close as its autonomous status as a centre of combat system technology ended. However, the heritage and knowledge base of CDSC lives on in its contribution to the growth of NWSA – over time, CDSC staff positions will migrate into an expanded NWSA organisation and, although physically smaller, a component of NWSA (including RANTDL) will continue to operate from the Fyshwick facility for years to come. On Monday 03 July 2006 a formal lunchtime ceremony marked the change of ownership and CDSC was duly received by its new owner, Mr Beng Ooi the Director NWSA. It is fitting time to close off the CDSC saga because now the focus for our team is a future under the NWSA banner. Proud as we are of our past all that is left for CDSC and NCDS is an end-game and there is a great deal more to be gained from reinforcing our NWSA identity and all the new opportunities and challenges that lie ahead in the management of all Navy combat systems.

For me, my long journey with CDSC finally ends on Friday 01 Sep 2006 when my current CFTS contract expires. The heroes of my recollections are the people who are today's CDSC team - Phil Battisson, Graeme Bick, Glenn Bridgart, Andy Chan, Rob Clarke, Will Cooke, Greg Coutts, John Currie, Leanne Eccles, Jason Evans, John Flage, Todd Gleeson, Al Giles, Glen Goodwin, Peter Gossip, Richard Grey, Andrew Horsfall, Bill Mann, Wendy McPhee, Dean Medlen, Ray Morse, Adrian Mullett, Milton Prell, Rick Riedel, David Slater, Beth Smith, Justin Stone, James Stratford, Lil Sutton, Bob Thomas, Sam Tuineau, Tien Ung, Graeme Ward, Craig Weller and David Wellings Booth who together represent the dozens of other familiar faces and names of others who have worked at CDSC over my time there. These are the folk whose companionship I will miss very much. I will handover to CMDR Peter Gorman the reins of a thriving new future for NWSA that includes all the richness of CDSC's past and its ongoing service to the current Fleet. I will walk away very honoured to have served with many excellent people and contributed to the service of my Navy in a unique place called CDSC.

The Groups

THE GROUP STRUCTURE

The increasing sophistication of combat and other systems on RAN warships produced a demand for a high level of both training and system knowledge to keep these systems fully functional. Several groups throughout the RAN did, and still do, conduct training and maintenance in parts of combat systems, but only at CDSC was the whole process brought together under one roof. The core of the support that CDSC provided was in the total coverage of the operational implications of software performance and hardware problems. In essence, although CDSC was internally organised into six 'groups', each dealing with a particular part of the support function, there was a close, almost intimate, relationship between the Groups that brought immense benefits in co-operation and mutual understanding. It would not be unreasonable to assert that it was this symbiotic relationship between the Groups that made CDSC unique within the RAN – and its eventual demise an irreplaceable loss of expertise in naval combat systems.

The six original Groups within CDSC were:

- Programming Group (PROGS)
- Test and Design Group (TDG)
- Operational Design Group (ODG)
- Systems Engineering Group (SEG)
- Training Group (TRNG), and
- Finance and Administration Group (Admin)

In later years, the RAN Tactical Data Link Group (RANTDL) evolved out of ODG and SEG as a group in its own right.

If a ship detected a significant hardware defect within its combat system, which limited the ship's operational capability or prevented it from completing its tasks, the ship's staff raised an Urgent Defect (URDEF) signal to Maritime Headquarters (MHQ), the stores agency, various other interested parties and to CDSC to alert everyone to the operational deficiency. MHQ then normally tasked CDSC to provide assistance to the ship's staff – this could take many forms, but NCDS/Link parts could be sent to ships anywhere in the world, and CDSC also sent one or more technicians to travel to the ship to assist directly in defect rectification.

Conversely, if a ship detected a problem with the software, they signalled CDSC with a Program Trouble Report (PTR) that listed the actions that led to the problem. CDSC was also able to receive a recording of the data as well as a printout of the Software Detected Error (SDE). Using the data the error/fault could usually be reproduced at CDSC using one of the on-site simulated combat systems. The Operational Design (ODG, who represented the system user's interests within CDSC), Programming (PROGS) and Testing (TDG) Groups would then work together to provide a temporary work-around for the problem. This work-around was signalled to the ship followed by a program patch to rectify the problem.

Operational Design Group (ODG) would receive Program Trouble Reports (PTRs) from the users in the *Fleet*. In-house discussion of the problem(s) would occur and a priority list drawn up of which PTRs to fix first and in what order. This order depended upon the degree of importance attached to the 'fix' by both the *Fleet* and the ODG/PROGs/TDG team members at CDSC. This close relationship between ODG, PROGs and TDG was one of the main achievements since the establishment of CDSC. Not only were delays minimised by having all these Groups co-located, but the gain in co-operation and mutual understanding was immense.

Requisite operator and maintainer training by Training Group (TRNG) was conducted in company with the resident experts in the other Groups who understood the fine detail of how the software and hardware were supposed to operate together to give the desired capabilities. The postings of instructors were generally long at CDSC (often a minimum of 3 years for IT officers, and often after many years sea experience for senior sailors), and following the associated extensive 'theory' learning the knowledge of many instructors were sought by other Groups as Subject Matter Experts.

CDSC has had a contractor team permanently located within the facility since its inception around 30 years ago. The contractor team is tasked with providing very specific DDG and FFG combat system knowledge. As well as maintaining the combat systems equipment at CDSC their extensive experience, from the defects they have witnessed and repaired, provided a valuable resource available to the all the ship combat system technicians. The contractor's team members and Systems Engineering Group (SEG) uniformed technicians worked very closely in such matters and often a combined team of experts would be called upon to assist the Fleet.

One measure of the relative effort put into the different aspects of CDSC's workings can be gleaned from the following table, which shows CDSC's resource estimates for 1982–83:

Activity	% Effort	Man Years
Software Upkeep	18	13
Projects	28	20
Training	24	17
Engineering & Maintenance	20	14
Management & Admin	10	7

FINANCE AND ADMINISTRATION GROUP (ADMIN)

The Finance and Administration Group was responsible for provision of adequate funding to meet continuing operating requirements of the Centre as well as the maintenance of the Centre and facilities.

In particular, the group was tasked with the preparation and submission of estimates and financial programs for a variety of administrative expenses such as travel, contracts, printing and publishing, office equipment and the payment of overtime etc. In conjunction with this, the group maintained an overview of the Centre's accommodation services and support facilities to ensure their effective operation.

Originally, although the principal tasks of the group surrounded the financial and budgetary processes, one of the four Admin staff members was the designated telephone switch operator (before installation of the automated PABX), while another maintained the technical publication holding stowed within the on site vault. This latter function was later transferred to the Systems Engineering and Operational Design Groups.

Group personnel were also involved in the equipment acquisition process specifically from the financial standpoint and subsequent foreign military sales (FMS) agreements and contractual matters relating to the support of both equipment and software. The FMS cases were largely directed at software upkeep requirements, but also included the acquisition of the MULTOTS equipment for Link 11 testing and the acquisition of the (initial) two AN/UYK-43 computers for assessment by the RAN.

CDSC maintained a unique FMS Case to provide support for shore based systems and activities as distinct from ship-fitted equipment. This was known as the Operational Assistance Case; although funded by CDSC, the USN support was authorised by Jim Egeland and expertly orchestrated by Don Kiley in Washington.

Peter Gossip joined the Admin Group of CDSC in February 1981, relieving the then Administrative Officer Chris Harrison, and still served as Head of the Support Cell to CSEG (the successor to CDSC) at the end of 2008.

PROGRAMMING GROUP (PROGS)

The Programming Group (PROGS) was established to review and make changes, when circumstances dictated, to NCDS. The request to make changes was initiated by the Test and Development Group (TDG) in response to a Program Trouble Report (PTR) received by Operational Design Group (ODG) from the Fleet. In the case of a high priority PTR, the programmers set to work immediately the PTR was received by CDSC. If the PTR had a lesser priority rating, TDG would verify, where possible, the urgency of the requested 'fix' and schedule resources accordingly.

The NCDS provided the ship's command team with the facility to monitor the air, surface and sub-surface environment. It could also facilitate co-ordination and control of the ship's weapon systems. Sensor data from the SYS-1, ASW, EW and Link-11 systems were collected, correlated and disseminated to the appropriate operator within the combat information centre (CIC), by the NCDS program. The DDG–NCDS program structure was divided into functional modules. The program structure was controlled overall by an executive operational module which communicated with system test modules and equipment test modules. Each module was designed to perform specific tasks or groups of related tasks as part of an overall system operation under the control of the executive.

The first thing programmers did, upon arriving at CDSC, was to attend a two-week programming course. This course was run for a long time by LCDR John Mathews RAN, who taught both the CMS-2 and Ultra languages. CMS-2 (Compiler Monitor System version 2) was a general-purpose programming language used almost exclusively for real-time and embedded applications for the US Navy, and hence by the CDSC programmers. All NCDS ship's Weapons Engineering officers (and other civilian and RAN personnel) also attended similar courses, as it was believed that they needed to be able to decode and debug (if necessary) the NCDS program listings that were provided to the ships.

When the AN/UYK-7(V) computers arrived at CDSC, programmer John Currie, who formerly had worked for Ferranti in Scotland, reflected that the AN/UYK-7(V) would not allow '*statisizing*', a feature considered normal on Ferranti-designed computers and which allowed the observation registers and Instruction activity in real time. Such a feature was considered essential for people developing software. It was understood, however, that the AN/UYK-7(V) was meant to provide a reliable computer that could survive in an operational military environment and was not considered as a 'development' machine. Later, CDSC programmers developed a software tool for taking a 'digital snapshot' of activities inside the computer as they occurred.

There was a real worry about the probability of all the programmers leaving *en masse*, which would have placed CDSC in a real pickle—temporarily. Experience had shown that a new programmer either stayed about two to two-and-half years and then left, or stayed for seven to eight years and often a lot longer. It took about two years for a new programmer to get to grips with the whole program.

The concept of NCDS program changes was new to both CDSC and the RAN in general. DI(N) LOG 10 was created by CDSC for the handling of the PTRs received from the fleet. Sometimes, there were concerns that the resources of CDSC were apparently channelled into the development of yet another program version rather than maintaining the existing one.
Concerning ship time, programmers (of both genders) who resolved PTRs, were to be sent to sea to observe the effects of their changes. On one occasion in the 1970s a ship's captain was adamant that a particular (female) programmer could not go to sea because the ship would be away from harbour overnight!

'**The Fragmented Origin of NCDS Software**' (extracted from an unnamed paper).

'VITRO, UNIVAC, CSC, FCCDSA, and HAC are five agencies that have contributed to the development of our present programme (NCDS). There were probably many others. Such diversity is transparent to anyone who reads the programme listing. The operational programme is divided into modules in order to make its various functions manageable and in order to try to develop conformity. Every module has certain identical basic operations and yet almost every module performs these operations differently! It is intended that all operations within the module be well documented with clear comments in order to facilitate understanding of its functions. However, the standard of these comments varies greatly from module to module and even within modules both in standard of English and in lucidity. It is possible to identify programmers involved by reading their personalities in the comments. Now the RAN is putting its stamp on the programme by further developments at CDSC. It could be argued that variety leads to vitality. However, in software, uniformity and certainty are most important and where it is necessary for varied ideas to stimulate programme development it is also most desirable to limit the number of programmers to a few competent individuals. Retention of such individuals should be mandatory for the duration of the life of the programme. Since this had not happened with NCDS, the programme is needlessly difficult to maintain and contains many weaknesses.'

TEST & DEVELOPMENT GROUP (TDG)

Test and Development Group (TDG) was established to create a series of tests to verify that the basic performance and reliability of the NCDS program was still intact after any changes were made by the programmers at CDSC. Operational Design Group (ODG) would receive Program Trouble Reports (PTRs) from the users in the fleet. In-house discussion of the problem(s) would occur and a priority list drawn up of which PTRs to fix first and in what order. This order depended upon the degree of importance attached to the 'fix' by both the Fleet and the ODG/PROGs/TDG team members at CDSC. This close relationship between ODG, PROGs and TDG was one of the main achievements since the establishment of CDSC. Not only were delays minimised by having all these Groups co-located, but the gain in co-operation and mutual understanding was immense.

Testing consisted of a number of steps – starting with the receipt of the software from the programmers. A confidence test was conducted to ensure the programme worked to an expected standard. Next, a verification and validation (V&V) process occurred. By this stage, it was assessed whether or not to continue with the testing or pass the programme software back to the programmers for any major problem rectification. The PTR re-tests were conducted ensuring that all PTRs, to be included in the release, were correct. RAN Checkout (RANCH) testing started the formal checkout process and set up the framework for the correct validation of the system. Normally, two software rebuilds were conducted during this phase with confidence trials in between each redevelopment of the software. Generally, any problems identified as major or most time-consuming would be identified and rectified first. This ensured that nothing 'snuck-up' on the development groups. V&V was conducted separately on the weapons systems and Link-11 aspects of NCDS. The final stage in the testing regime was the endurance test, in which the program was run continuously for a minimum of 24 hours, at maximum track load, in high, medium and low time frames. All alerts, problems or issues were documented and acted upon.

In practice, since the TDG personnel had extensive experience in the details of how (the current version of) NCDS would function in any given scenario, they were also involved at an early stage in discussions with Operational Design Group (ODG) when possible future modifications / changes to the program were being considered.

OPERATIONAL DESIGN GROUP (ODG)

Even after a version of NCDS had been extensively tested and released for Fleet use, it was never allowed to stagnate. The NCDS software was in a constant state of evolution – in response to changing operational needs, changing ancillary equipment, evolving standards, ergonomics (placement of VABs) and in response to shortcomings in performance and functionality. The entire development and change process was carried out in-house at CDSC, with the Operational Design Group (ODG) as the 'user's' conduit into CDSC.

Although Fleet were the users of NCDS, and hence usually only too aware of its shortcomings and areas that needed improvement, they did not often directly raise the need for changes. Most NCDS changes were in fact initiated by ODG. ODG was manned by combat system operators (RP/CSS/CSM) and Principal Warfare Officers (PWOs) who had previously served in DDGs or FFGs, and hence had worked in the CIC on board ships. Once at CDSC they would use their background experience to drive the necessary changes to the NCDS. ODG staff would work closely with CDSC programmers during both development and testing to ensure that software changes appropriately resolved the problems without creating new issues!

After identification, categorisation and prioritisation, changes to the NCDS were coordinated and designed through the use of a Program Change Proposal (PCP). These documents would be developed by ODG and reviewed from a technical perspective by TDG (Test and Development Group). The specification outlined exactly what was required for the functionality to be implemented, and included an outline of the functionality of the proposed change, identification of which program modules would be modified, details of the changes to the Variable Action Buttons (VABs), and identification of the necessary changes to the Program Operation Documents (PODs). The PCP was used by the programmers to design the code. Any peculiarities with the design would be sorted between the PROGS and ODG. After extensive testing by TDG, both on-site at CDSC and on board operational Fleet units, this new version of NCDS was certified fit for release to the Fleet.

ODG would normally be the first of the CDSC Group's to receive Program Trouble Reports (PTRs) from the Fleet. These would be reviewed and debated in-house to determine the most suitable resolution. ODG prioritised a list of PTRs to determine which PTRs and PCPs would need to be fixed or included in the next baseline release. This order depended upon the degree of importance attached to the 'fix' or proposal by both the Fleet and the ODG/PROGs/TDG team members at CDSC. This close relationship and inter-dependence between ODG, PROGs and TDG was one of the main reasons for the outstanding achievements of CDSC and combat system development.

ODG staff gathered information on combat system functionality from a wide variety of local and overseas resources, in particular the USN which continued to develop their NTDS software. CDSC maintained a PWO Exchange Officer at the Combat Direction System Activity (CDSA) Dam Neck for many years, the other 'half' of the exchange being a USN LCDR who served at CDSC with ODG as SOTSI (Staff Officer Tactical Systems Interoperability). In this way the concepts of system interoperability and its importance in multi-national operations were well appreciated.

The scope of ODG grew with the introduction of the Anzac Class Frigates (FFHs), where ODG staff applied their knowledge of known or common Tactical Data Link (TDL) and Combat System problems in DDGs and FFGs were similarly addressed in the FFH Combat System. ODG also provided support to the Anzac Ship System Program Office to assist with its design, system functionality and documentation review.

During the early 1990's, with both DDGs and FFGs being capable of sharing track data using the Link 11 network, the use of this information exchange gained increased priority as a result of lessons learned from the First Gulf War (CDSC's Maritime Commander's Commendation specifically concerned interoperability issues!) the significance of operator proficiency, equipment reliability, software specifications and overall system interoperability issues received greater attention. ODG developed and delivered the first dedicated Link 11 operator course (Force Track Coordinator (FTC) Course) which was subsequently used by the RAAF and New Zealand Navy Link 11 operators.

The services that ODG provided to the Fleet at CDSC, and the experience many people gained from working within ODG, have found their way into the broader Defence C2 community and this legacy of CDSC will continue to shape Australia's future C2 capabilities. Over the years, many of the ODG staff have moved into similar C2 / TDL areas within Defence and Industry, and have used their skills and knowledge to further develop the ADF C2 capabilities. Many of the ODG and TDG staff form the foundations of the ADFTA and have been associated with the development of the Tactical Information Exchange Domain (TIED), Network Centric Warfare (NCW) and Joint Interface Control Officer (JICO) concepts. Of special note, CMDR Mick Stewart (ex-Head of the ODG) was the force behind the TIED within the Chief Information Officer Group and was instrumental in the establishment of Joint Project 2089 – TIED. This project has the charter to invest in legacy TDL systems, which includes C2 systems, and TIED infrastructure to improve interoperability with the ADF.

RAN TACTICAL DATA LINK GROUP (RANTDL)

This group was the only 'new' one to be added to the original six groups at CDSC. It evolved out of ODG in response to the growing importance of Tactical Data Link networks.

In the late 1990's, interoperability between ADF platforms became a higher operational priority within Defence and the overall process of changing Link 11 Operational Specifications (OpSpecs) to meet cross-service operational requirement needed urgent attention. This was a time of considerable change with the ADF – Navy had imminent plans for decommissioning the DDGs; the FFGs being upgraded and commercially supported in Sydney; and the RAAF planning to acquire Joint Tactical Information Distribution System (JTIDS) Link 16 in the Air Defence Ground Environments (ADGE), Airborne Early Warning and Control (AEW&C) and F/A-18 Hornet aircraft. It was with these challenging circumstances in mind that the then Head of ODG (CMDR Richard Menhinick) pushed hard to evolve a multi-service organisation to manage tactical data links across Defence and the Australian Tactical Data Links Authority (ADFTA) was born. Initially, it consisted of three staff from ODG (CMDR Menhinick, LCDR Frank Martin USN and CPOCSM Jim Denton), and headed by Tony Bone (dual hatted as DCDSC and DADFTA). CDSC's long time network of US Defence contacts fostered the start of Navy's involvement with a number of international organisations focussed on data link interoperability and the support of data link systems. Further expansion of ADFTA was lead by SQNLDR Brian Warnock who, together with CMDR Mike Hill USN, provided the ADF with a greater appreciation of the TDL space nationally and internationally; knowledge of the tidal wave of new TDL capable platforms in the capability development pipeline; and the impact of introducing a new TDL (Variable Message Format (VMF)) into the Army. The organisation today is part of DMO and has grown to in excess of 50 staff (Joint service members, APS and Contractors) now led by Mike Kendares, himself an ex-CDSC staff member from TDG.

Back with Navy, the increasingly complex task of testing combat system message sets used in tactical data link networks involved ODG, SEG and TDG working together to acquire a Multi-TDL Test and Training Tool (MLST3) that would be used to test DDG, FFG and FFH software controlling data link messages. Interestingly, the first Link 11 test conducted by ODG/ADFTA, TDG and SEG staff using the new MLST3 suite was conducted with HMAS *Anzac* in Western Australia (WA) and at that time CMDR Menhinick was in Command. The results from this test were of sufficient significance to have ODG staff involved in addressing a range of TDL issues in the first FFH combat system upgrade.

Whilst these processes were being established, the attention of the international TDL community was already turning to newer and more complex data exchange systems such as Link 16 and Link 22. A vast amount of commercial resources started to focus on this 'new' area of technology and its emerging importance to the international defence community. Recognising this clear trend, CDSC amalgamated specialists from ODG and SEG to form the RAN TDL Group to provide a dedicated Navy support group for this now crucial tactical requirement.

The arena within which the developing and maintaining operational programs for combat systems now occurs has a totally different image. The task of retaining effective oversight of software functionality is increasingly difficult as viable testing processes rely more heavily on

modelling and risk management. Within these circumstances the emphasis on system interoperability continues to grow and the work of groups like ADFTA and RANTDL is of great significance.

Since its inception, ADFTA has subsumed the Australian Message Text Format (ASMTF – ex ADFORMs) support cell from RAAF Williamtown; acquired a Link 16 Network Design tool; taken control of the CDSC MLST3 suite and expanded it for Link 16 testing; conducted the first Link 16 test; secured another VMF Laboratory (by the Fyshwick Post Office); created a Land domain systems integration facility; developed a deployable Multi-TDL monitoring capability; built a TDL- Wide Area Network (WAN) for remote TDL testing; developed TDL message implementation support applications; and acquired Defence Network Modelling, Simulation and test systems. The emphasis on TDLs within the ADF is said to have introduced a whole new language, commonly referred to as: 'TADIL BABEL'. The vocabulary of this strange new way of communicating includes things like: TULIP, IOR, IER, PIR, PIDD, PRD, IRS, ALIMS, PLIMS, etc - fortunately all this is understood fluently by ADFTA and RANTDL staff.

As has been described here, the impact of TDL issues on the RAN was exponentially increasing in the late 90's. In ODG the focus on TDL was spearheaded by LEUT Kym Fisher, and supported by CPO Paul (Buck) Rogers, who devoted an enormous amount of time and energy on resolving ANZAC class Link 11 problems and regional Link 11 interoperability issues, including the provision of specialist TDL advice to the IADS organisation at Butterworth in Malaysia. When LCDR Ian McConachie joined in 2003 he was charged with establishing a dedicated TDL team at CDSC that would cover both operational and engineering aspects of these systems. This RANTDL element became the first 'new' group to be added to CDSC's infrastructure, but effectively took over the operational focus as all remaining ODG business was managed from the new NWSA organisation in Sydney, headed up by LCDR Bob Thomas. The RANTDL Group worked alongside the growing ADTFA organisation and focussed Navy's future TDL requirements that were being complicated by the emergence of Link 16 and Link 22, and emerging problems with ID correlation in a Multi-TDL environment.

With the ramp-up of ADFTA, the decommissioning of the DDGs, the creation of the Navy Warfare Systems Agency (NWSA) in Sydney, the delivery of upgraded FFGs and the establishment of the Anzac Class Capability Element Management in WA, ODG, along with RANTDL, has dissolved and been subsumed into the RAN Combat Systems Interoperability (CSI) Group – still led by LCDR Bob Thomas. This team now undertakes technical and operational activities supporting data link systems in the Fleet; provides support to ADFTA on maritime specific TDL issues; and on an international level, participates in Coalition Distributed Engineering Plant (CDEP) activities that aim to maximise combat system interoperability across Coalition partners.

SYSTEMS ENGINEERING GROUP (SEG)

The System Engineering Group (SEG) within CDSC consisted of a group of military personnel – mainly ET sailors and WE officers – whose principal job was to provide specialist advice and suggest corrective actions when ship's staff were short of ideas or lacked the specialist expertise when tackling hardware related system faults at sea. This was made possible by the vast amount of experience of 'at sea' maintenance conditions, and exposure to a diverse array of different faults and system breakdowns, these sailors generally had been exposed to before being posted to CDSC. The CDSC organisation could provide NCDS hardware / Link parts to ships anywhere in the world; this aspect of the job was managed by a dedicated team of Supply Branch specialists who ran the CDSC Naval Stores, and these also came under the SEG umbrella. SEG also managed the hardware aspects of the CDSC Maintenance Support Contract – HSEG was invariably the Hardware Maintenance Authority (HMA) within the contract documentation, and as such was closely involved with the contractor's maintenance staff downstairs in the workshop. Finally there was the USN FMS (Foreign Military Sales) side of things, where SEG provided technical oversight of, or advice on, the USN equipment, maintenance training, planned maintenance and modification status (ORDALTs, etc) for the fitted systems in DDGs and subsequently FFGs. HSEG maintained a close association with the USN NAVSEA Platform Managers (PMS380) and with the Weapon System Managers at Port Hueneme in California. CDSC also sponsored a LCDR WE Technical Liaison Billet in Washington; this position was initially focussed on the DDG Modernisation Project but in the latter years provided technical support for a wide range of joint RAN/USN activities.

The increasingly sophisticated navigational, communication and combat systems onboard Navy ships are not only very complex, but are critical to safe navigation and operational readiness. When a ship detected a significant hardware defect within its combat system, which limited the ship's operational capability or prevented it from completing its tasks, it required urgent rectification action. The ship's staff raised an Urgent Defect (URDEF) signal to Maritime Headquarters (MHQ), the stores agency, various other interested parties and to CDSC to alert everyone to the operational deficiency. The URDEF signal contained information about the system affected, the operational impact of the defect, a hazard/risk assessment, any parts required and a description of the defect symptoms and corrective actions undertaken as well as any assistance required. MHQ would often task CDSC to provide assistance to the ship's staff, and this assistance would generally take the form of either providing direct help to investigate and/or repair, or provide serviceable spares. More often than not however, SEG staff were the source for answers to innumerable questions about the equipment or about the interfaces between systems. CDSC's on-site simulated ship combat system suites could be used to compare symptoms and diagnose failures and many times various CDSC software and hardware experts would combine their talents to 'nut-out' a cause of, and workaround for, a particular system problem.

CDSC would often provide one or more of the SEG technicians to travel to the ship to assist directly in defect rectification. SEG maintained specialist billets to provide support for DDG and FFG systems; whilst there was commonality in NCDS components, the peripheral equipment varied considerably, even amongst the FFGs as they were built to differing flight configurations. In latter years, a team of technicians, Naval and Contractor, would visit ships to perform combat system 'grooming'. These activities were aimed at ensuring that the systems were working at their optimum. At the same time, every opportunity was taken to train junior technicians in some of the more complex or infrequent maintenance alignments.

SEG staff were extensively involved in a range of NCDS hardware projects over many years. Obviously the early years centred on growth of knowledge of the new DDG systems leading to the immense DDG Mod activity. As DDG Mod progressed, so did the acquisition of FFGs and their differing hardware and this, in turn, triggered changes to the CDSC system infrastructure, mainly evident in the addition of the new building (86) and the enormous upheaval that finally produced the expanded facility layout that essentially remained intact until the end. Some of the other hardware projects SEG were involved in over the years were: AN/UYK-43 acquisition and installation, NULKA integration, MLST3 acquisition, MULTOTS integration, RANSID design and installation, CMDSTN acquisition and installation, CIGARS reconfiguration, SLQ-32 emulator acquisition, CTD integration, GPS integration, HDLSS design and installation, VAB Panel upgrades, and the MK-152 Life Extension Program; a very incomplete list, to be sure.

A ‘snapshot’ of the 1998 activities of one SEG member lists the following:

- Involvement with Stanelite and ADI for the design of the GPS / NCDS interface as part of the installation of the Kelvin Hughes 1020 GPS into the DDG and FFG NCDS combat systems.
- Procurement of MLST3 equipment and start of the MLST3 testing team.
- Working with the Submarine project to review the Collins Class stand-alone LINK system. Conducting the safety inspection, installation inspection and acted as the Commonwealth’s representative at the testing of the LINK system.
- Working with the New Zealand Navy to test their LINK system, including design and set up of a network that enabled the LINK back to Australia.
- Provision of engineering expertise and technical support for the Mine Hunter Coastal Project's LINK system.
- Involvement with ANZAC MLST3 testing, including design of a system to provide connectivity into the contractor’s system for ANZAC LINK testing.

The SEG team structure started to rapidly change as the DDGs approached their pay-off dates. A flurry of activity centred on the sad task of recovering valuable equipment during ship disposal. The resources made available allowed SEG to provide staff dedicated to TDL systems; this was a very valuable commitment as the engineering aspects of TDL systems were not subsequently managed by any other area of Navy. Reorganisation of Navy’s logistics services resulted in the loss of stores personnel and the final era of CDSC substantial Naval Stores infrastructure was managed by SERCo. A number of staff positions were transferred to Sydney to help form the fledgling NWSA organisation and provide an ability to learn more about the FFGUP combat system as it evolved.

TRAINING GROUP (TRNG)

Project Directive 63 stated the need for providing maintenance and operator training for the operation and maintenance of NCDS for both the Fleet and people at CDSC. The actual words were:

> *'The introduction of a complex automated command and control system into the RAN imposes a necessity for training the personnel required to operate and maintain the systems. Thus, training is to be provided for project, CDSC, ship and dockyard staffs, either in Australia or overseas, in order that RAN personnel may become proficient in the operation and maintenance of ship and shore fitted NCD Systems.'*

Thus a Training (TRNG) group was formed to carry out these requirements. The first training course conducted was AN/UYK-7 maintenance in 1975. From 1979 until 1985, TRNG functioned out of the building at 135 Newcastle St Fyshwick until moving into the current site when the 86 Maryborough St addition was made to the original CDSC.

During the 1970s, RAN officers were sent on US Navy training courses where they absorbed/gleaned as much information and training notes/manuals as they could, so that on their return they could set up (similar) training courses here in Australia. Those original courses have evolved, with some no longer being taught (obsolete equipment etc.) but some of the original material (in much modified form) is still in use today by the instructors at Combat System Maintenance School (which has now taken over the residual maintainer training from CDSC). As new equipment was fitted to ships, instructors would attend overseas courses and return to CDSC to replicate what they had learned, but with an RAN focus. Some courses were originally contractor delivered (e.g. RANSID and MX-512PV) with the training group then assuming the responsibility for further course development and instruction. As in all courses, the Instructors had to keep pace with modifications and changed configurations, so that trainees were given the most accurate and up-to-date information as was possible.

The CDSC TRNG group taught hands-on courses in all facets of the combat system – including operation and maintenance of the various pieces of equipment that comprise the complete NCDS system, plus a 'global' understanding of the entire combat system for more senior personnel. Both officers and sailors were instructed – often in the same class. Training was offered for RAAF and RNZN as well as RAN personnel as there was much common equipment used by these different services.

The equipment maintenance courses were undertaken by technical personnel (usually 'greenies', but some officers and occasionally civilians were also instructed. Maintenance course lengths varied from one week up to the 14 week AN/UYK-7 maintenance course (old format). These courses were heavily reliant on access to class sets of the relevant manufacturer's Technical Manuals for the relevant piece of equipment. The ratio of theory to practical was usually one-to-one, and emphasis was placed on the diagnostic tools and techniques available for fault-finding. Practical sessions were carried out on examples of actual equipment in service, usually with 'training faults' added. Occasionally, the introduction of a training fault generated an actual fault.

The operator courses were designed to teach system-operating skills to the system users – the ships' operations room teams. There were distinct courses for DDG and FFG sailors, and these were offered at different levels.

Until the early 1990s, there were also programming courses designed to give selected personnel (usually DWEEOs) the training necessary to enable them to identify and report software problems. The courses taught the syntax of the programming languages used in the operational programs and covered, in detail, the overall program architecture and the more-important modules.

The idea of 'Systems' courses was originated back in the early 1970s by CMDR 'Orm' Cooper. He felt there was a great need for the 'greenies' and operators to understand and appreciate each other's problems and the advantages of each other's approach to NCDS. Eventually, systems courses were offered for both DDG and FFG ship classes. These were at two levels. The first was designed for the senior personnel involved with the NCDS combat system – both technical and non-technical. Usually, class members included Principal Warfare Officers (PWOs), senior 'operator' sailors, Deputy Weapons Electrical Engineering Officers (DWEEOs) and senior 'greenie' sailors. A following 'systems interface' course offered additional technical details for the technical personnel only. The major emphasis of this course was in providing insight into the possible 'work-arounds' available in the advent of any particular hardware failure. Whilst these courses were usually taught in the classrooms and equipment suites at CDSC, in one instance an FFG systems course was taught onboard HMAS *Canberra* at sea whilst the ship was conducting Operation RELEX II.

TRNG group was normally headed by a Lieutenant Commander of the Instructor branch – although there were periods when it was headed by a Commander, and others when it had no 'Instructor' head at all and was overseen by the Head of Systems Engineering Group. Demand for courses varied with the number of platforms utilizing NCDS. This reached a peak during the 1990s with all three DDGs and six FFGs in service simultaneously. In the late 1990s, the usage of the seven classrooms at CDSC over the 48 week instructional year was usually in excess of 65% occupancy – in other words, at any one time there would an average of almost five different classes being instructed simultaneously. Even in 2003, when only the FFGs remained, TRNG still had a staff of four officers and eight sailors to provide both operator and technical training.

The instructors were an integral part of the system support team at CDSC. Indeed, in many cases their knowledge has been called upon to assist in some of the specialised aspects of an equipment problem that may occur on a ship. A list of all the courses offered by TRNG group around the peak of its activity is provided as an annex. The choice of date for this annex listing means that several courses – such as the NCDS Programming course (last taught 1993) and the AN/USQ-125 Data Terminal Set Maintenance course (first taught 2002) – are not shown.

THE SUPPORT CONTRACTOR

The term ‘support contractor’ is used here generically, as there were in fact several contracts let, serially, by either open tender or sometimes sole-source. Even with a change of contractor, however, it seemed that they continued to employ the same staff – same people, different company logos on their dustcoats. This was very advantageous to the RAN, as the contract team members understood, from continuous exposure, just what was expected from them and the complexities inherent in CDSC’s operations. It would have been difficult to find, say, an experienced AN/UYK-7(V) trained maintainer ‘on-tap’ in the ACT – or, for that matter, anywhere in the country. The same could be said for lots of the other specializations needed at CDSC.

Flexibility with the contract engendered a healthy long-term relationship between the navy and the on-site maintenance team. The approach to letting the contract at CDSC was to specify the number of positions that were required and leave it to Industry to bid for those positions. Agreeing to require ‘N’ people to fill the contract allowed CDSC to have a say in a joint understanding with the contractor in how the centre should be manned and run. The view held by many of the on-site contractor team members was that they worked for CDSC but were paid by the company. In their eyes, the project was/still is more important than the company.

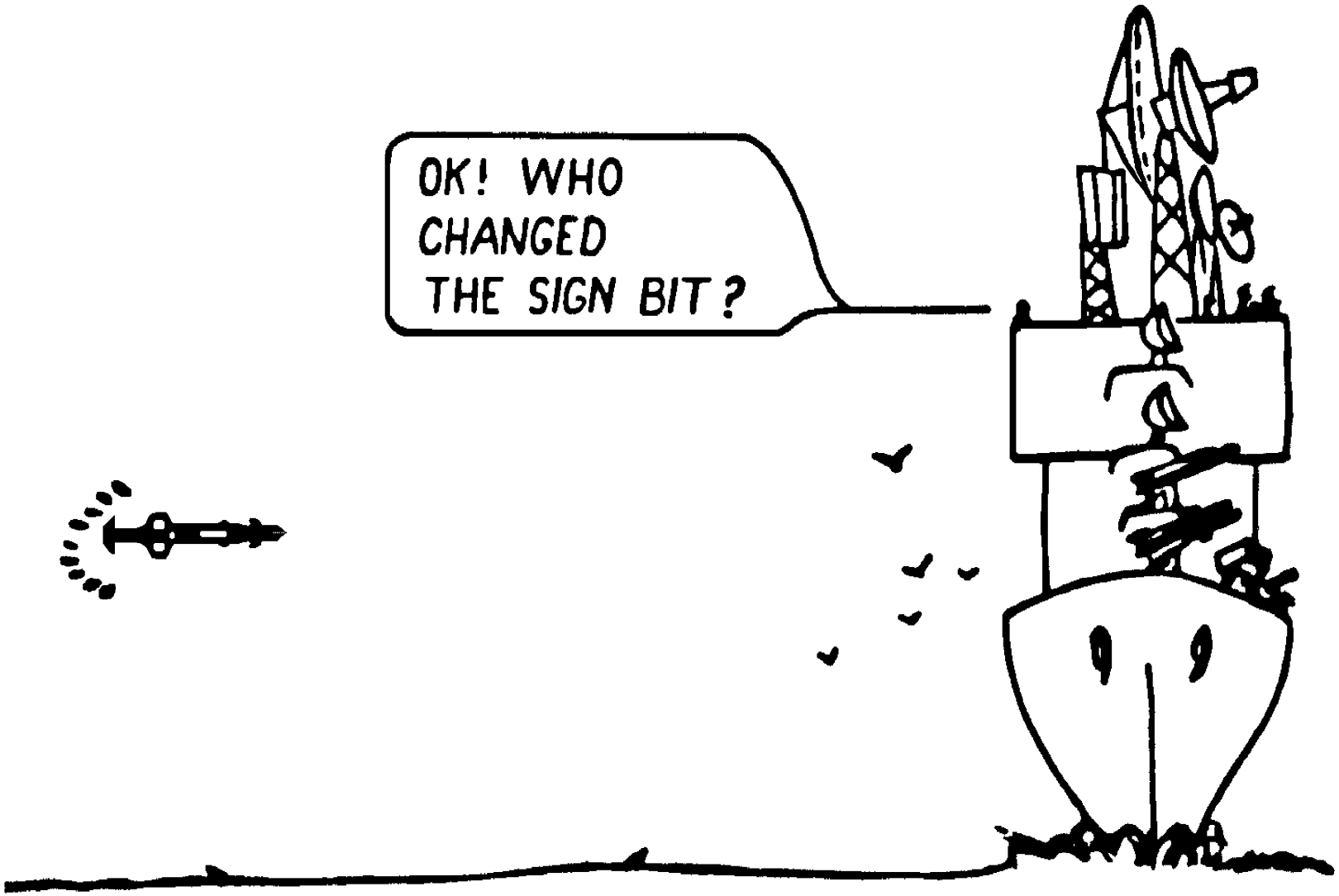
The following article is largely a contribution from Pat Lynch, one-time workshop manager for the on-site AWADI and then SERCo team.

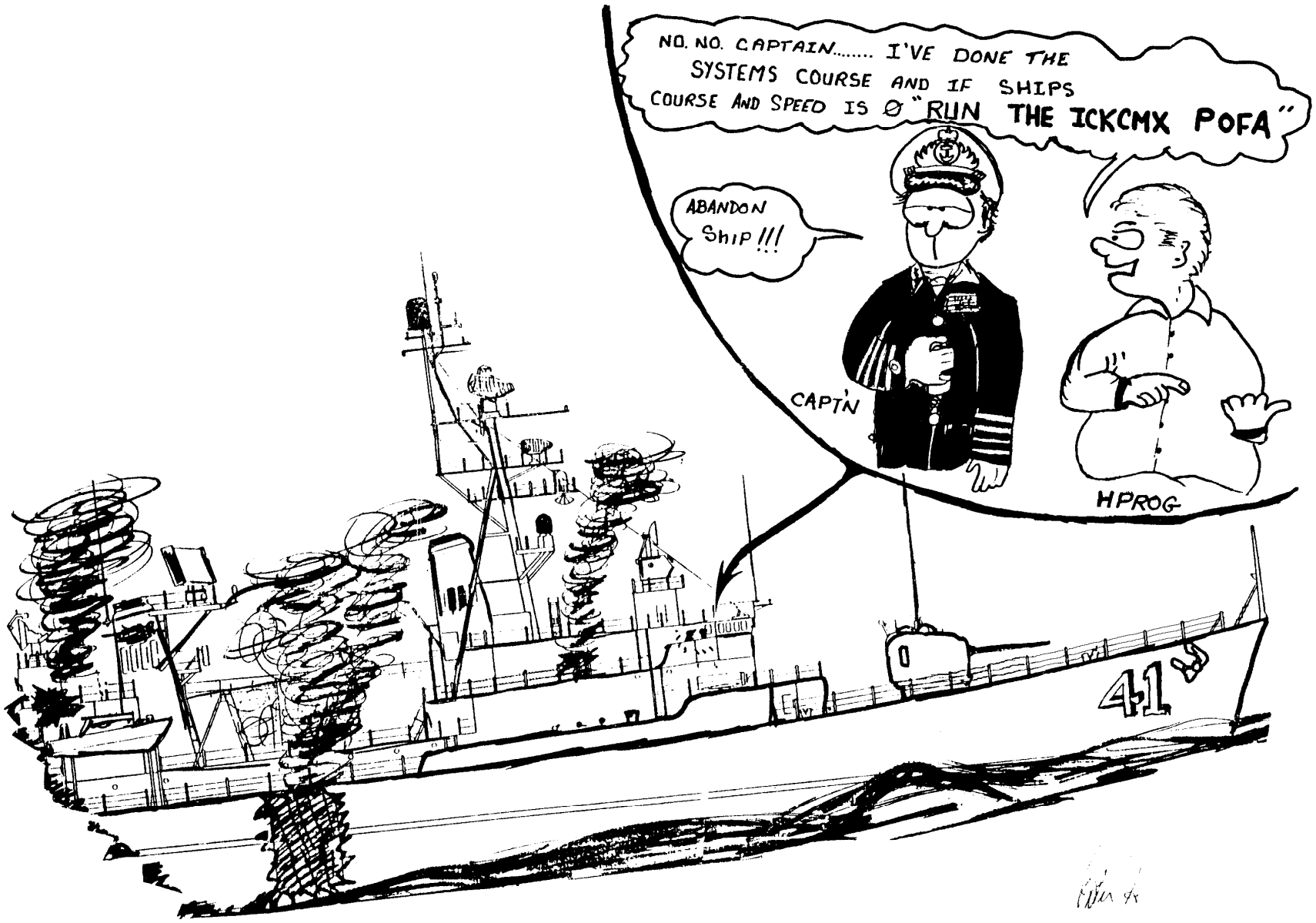
‘The contractor at CDSC has always played a significant role in the development of specialised systems as part of the NCDS support function. Because of CDSC’s isolation from the mainstream of defence activity, many tasks were carried out by the contractor, which might ordinarily be done by other Commonwealth agencies. The construction of a photographic darkroom from scrap materials, major repairs to electrical generators, and design and development of specialist test equipment were typical examples of the flexible approach the CDSC contract team has applied to its task.

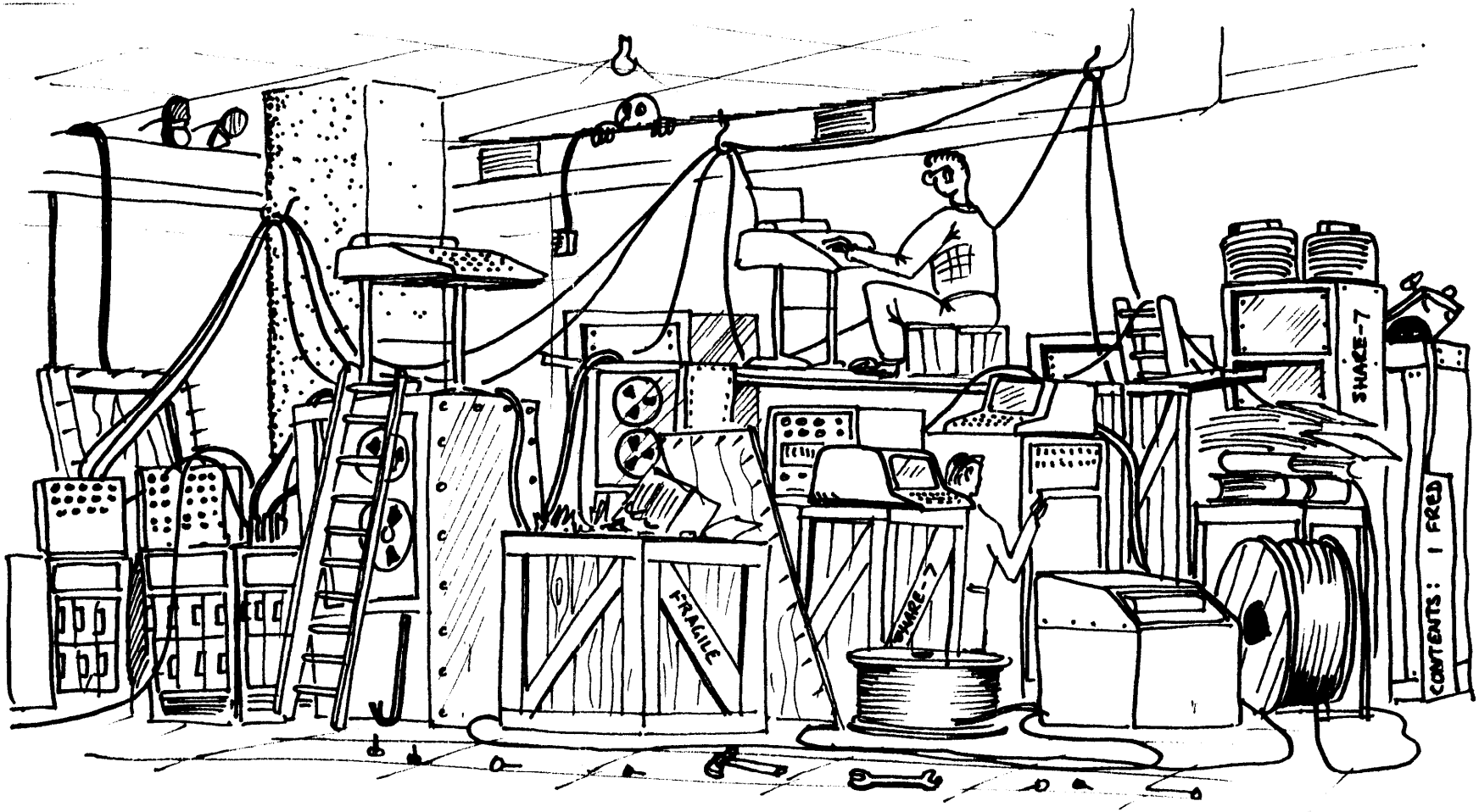
A major problem for engineering staff at CDSC, Fyshwick, was the lack of real ships for the testing of new and updated software. Many systems, such as radar, pitch, roll and wind information etc., were inadequately simulated by the military equipment supplied and the contract team were frequently asked to design and build devices that allowed software testing to proceed as if in a ship environment. Such systems included the weapons control console event system simulator (WESS)—a microprocessor-based device that emulated much of the Mk 92 weapons systems beyond the WCC. A further version of this device was supplied to the RAN establishment at HMAS *Watson. Another major simulator project supplied all ships parameters such as ship’s speed, course, direction, wind, sonar and other variables to the integrated circuit keyset central multiplexer, the signal data converter and other data-interface devices. Other simulation projects included a Link-11 noise generator; NCDS interface simulators, gun system emulator and a TARTAR missile simulator.’*

The contractor staff members were completely responsible for the concept, design and construction of these systems in addition to the continued maintenance and training associated with their use. Of even greater importance than these simulators, however, was the development of major replacement components for the existing NCDS.

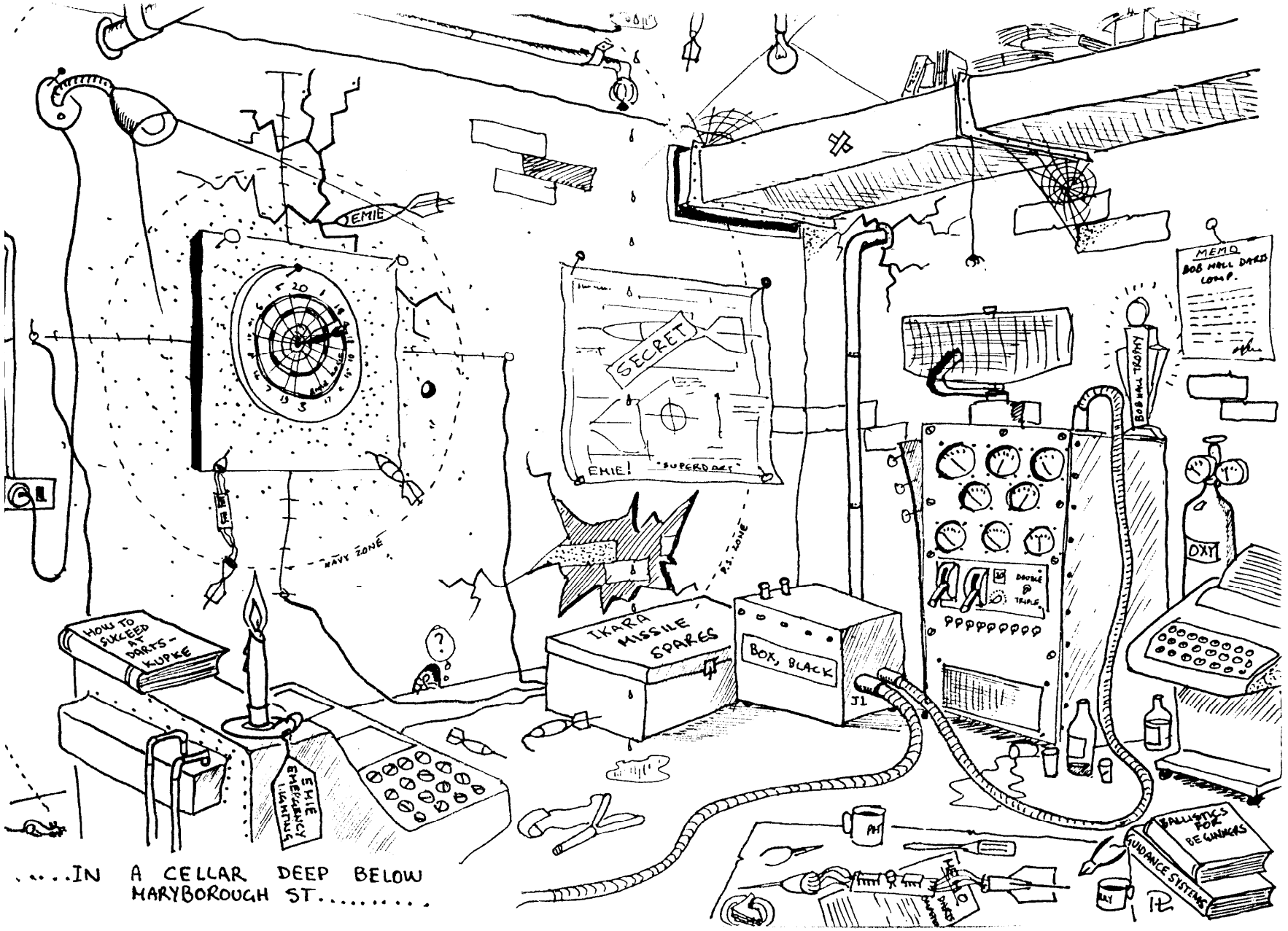
Pat’s Drawings


OK! WHO
CHANGED
THE SIGN BIT?

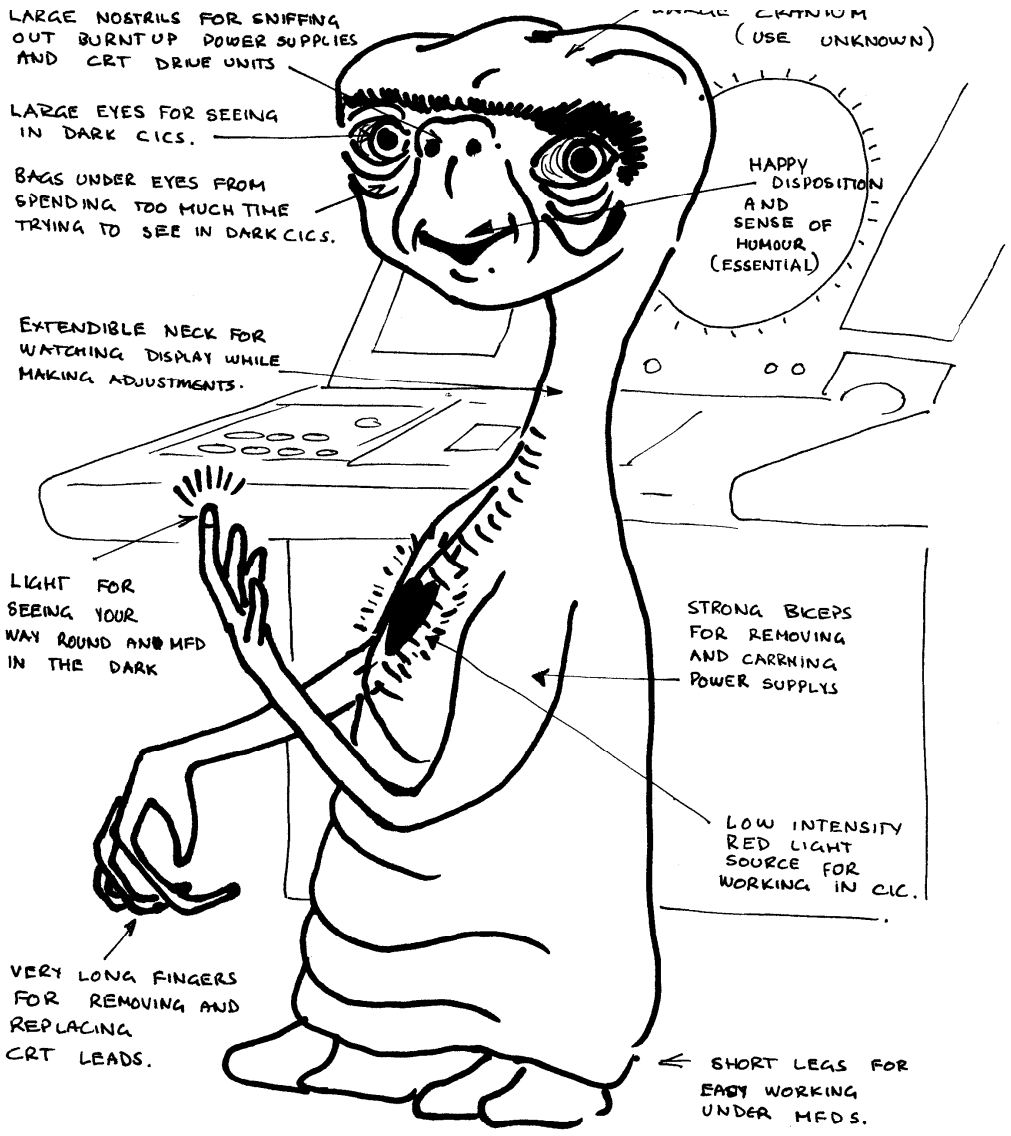

NO. NO. CAPTAIN..... I'VE DONE THE SYSTEMS COURSE AND IF SHIPS COURSE AND SPEED IS Ø "RUN THE ICKCMX POFA"
ABANDON SHIP !!!
CAPT'N
HPROG
41



"....THE TEMPORARY SHARE-7 INSTALLATION IS PROGRESSING OK..."

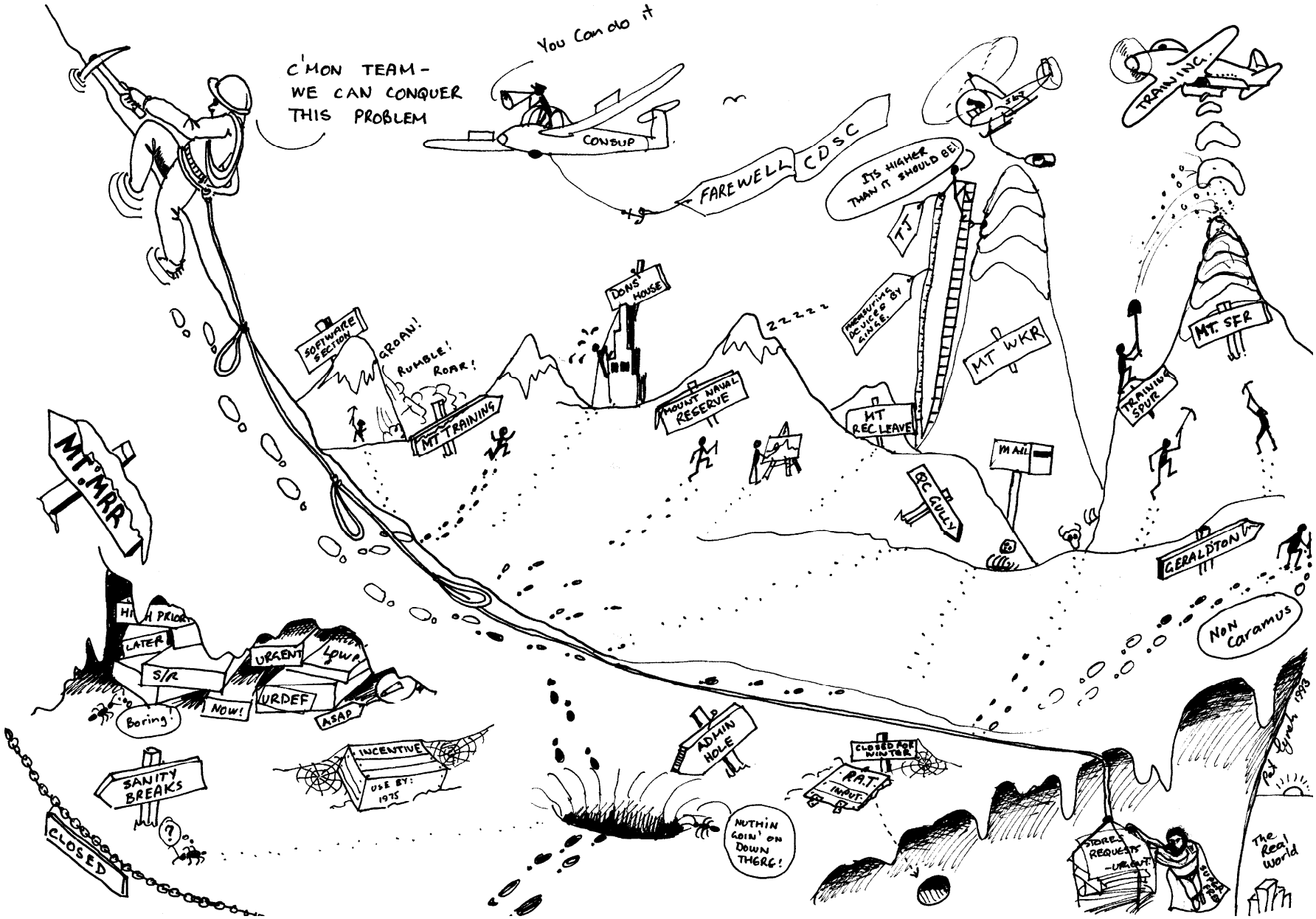


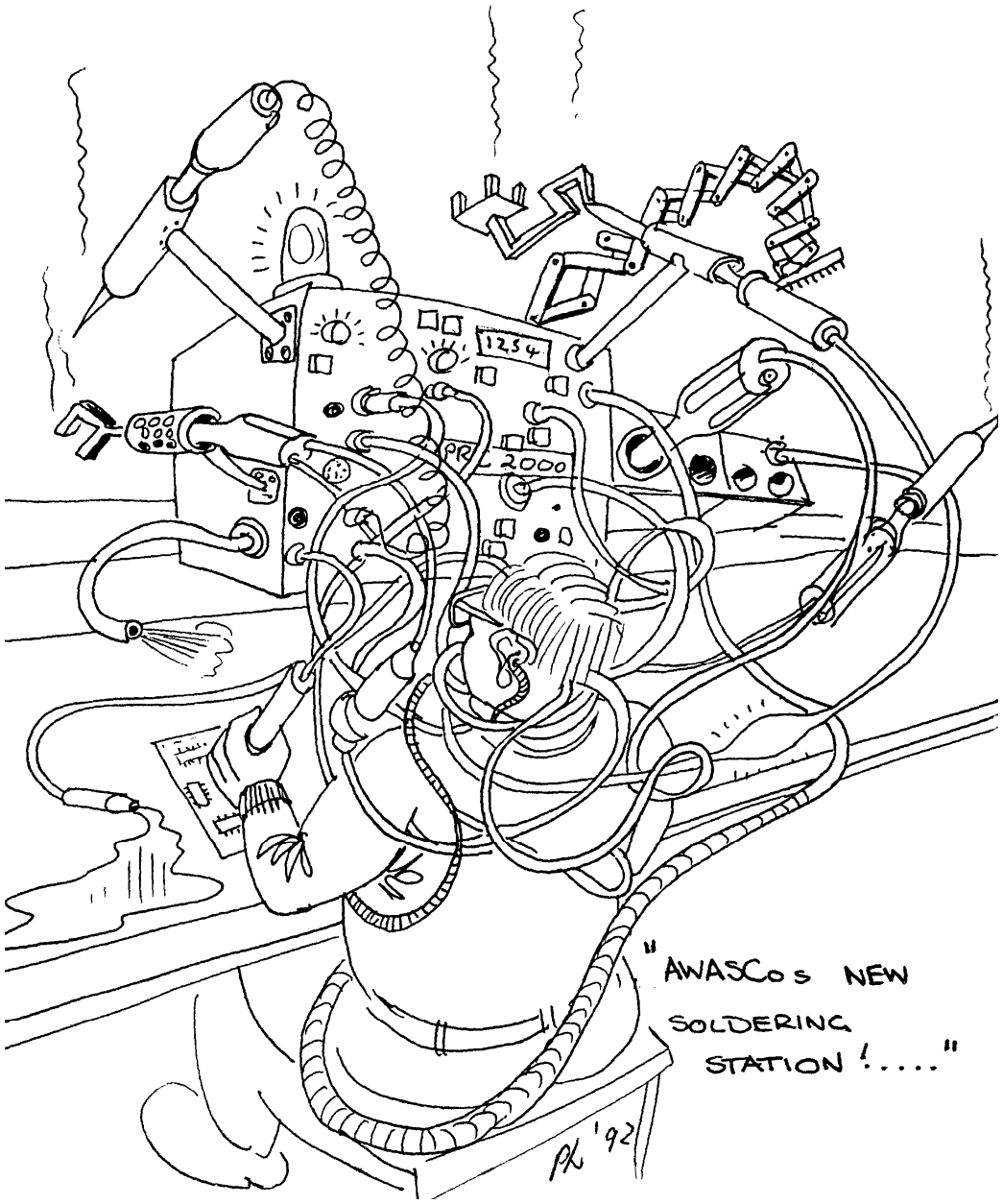
.....IN A CELLAR DEEP BELOW MARYBOROUGH ST.....

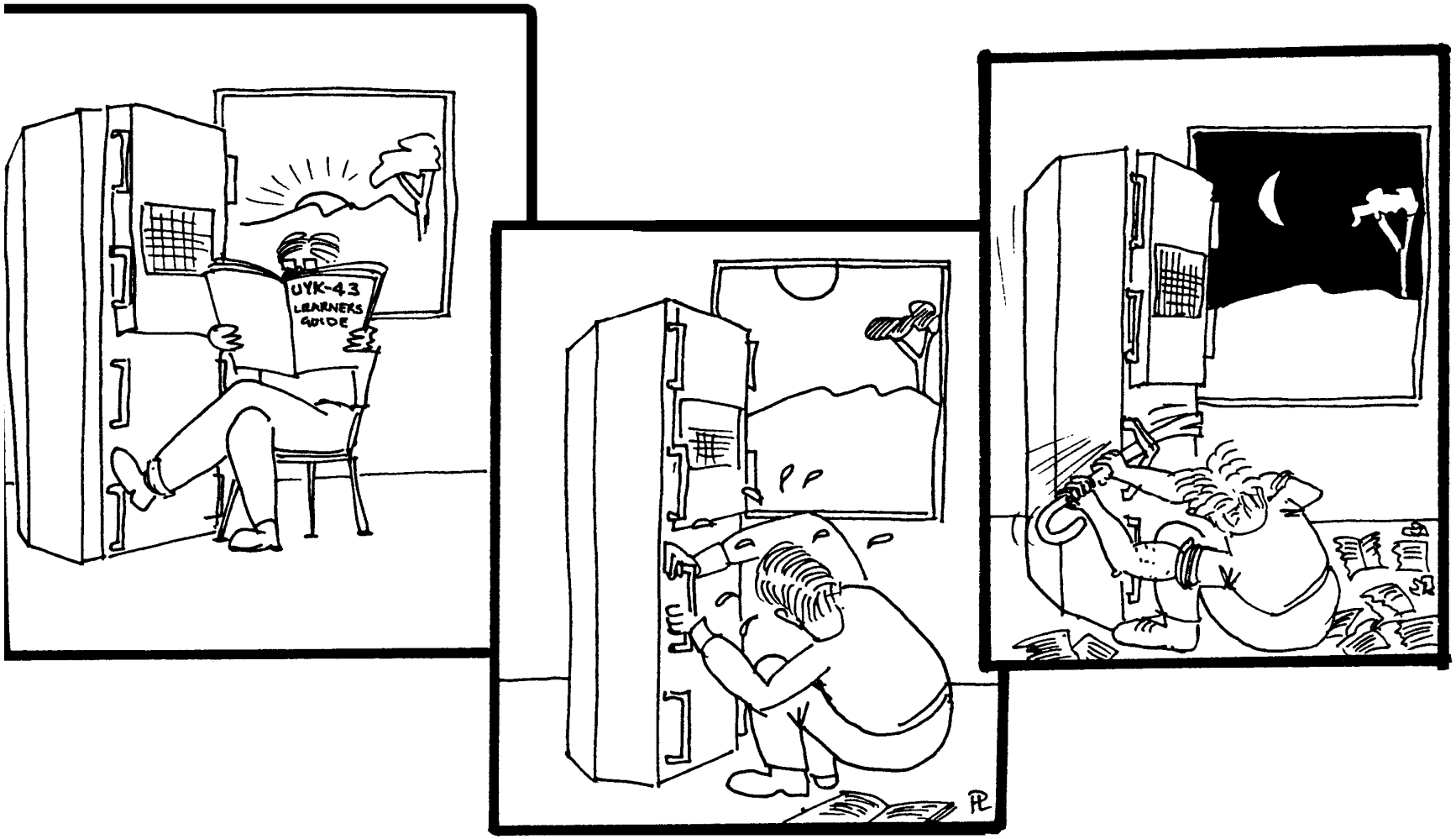


THE PERFECT DISPLAY TECHNICIAN

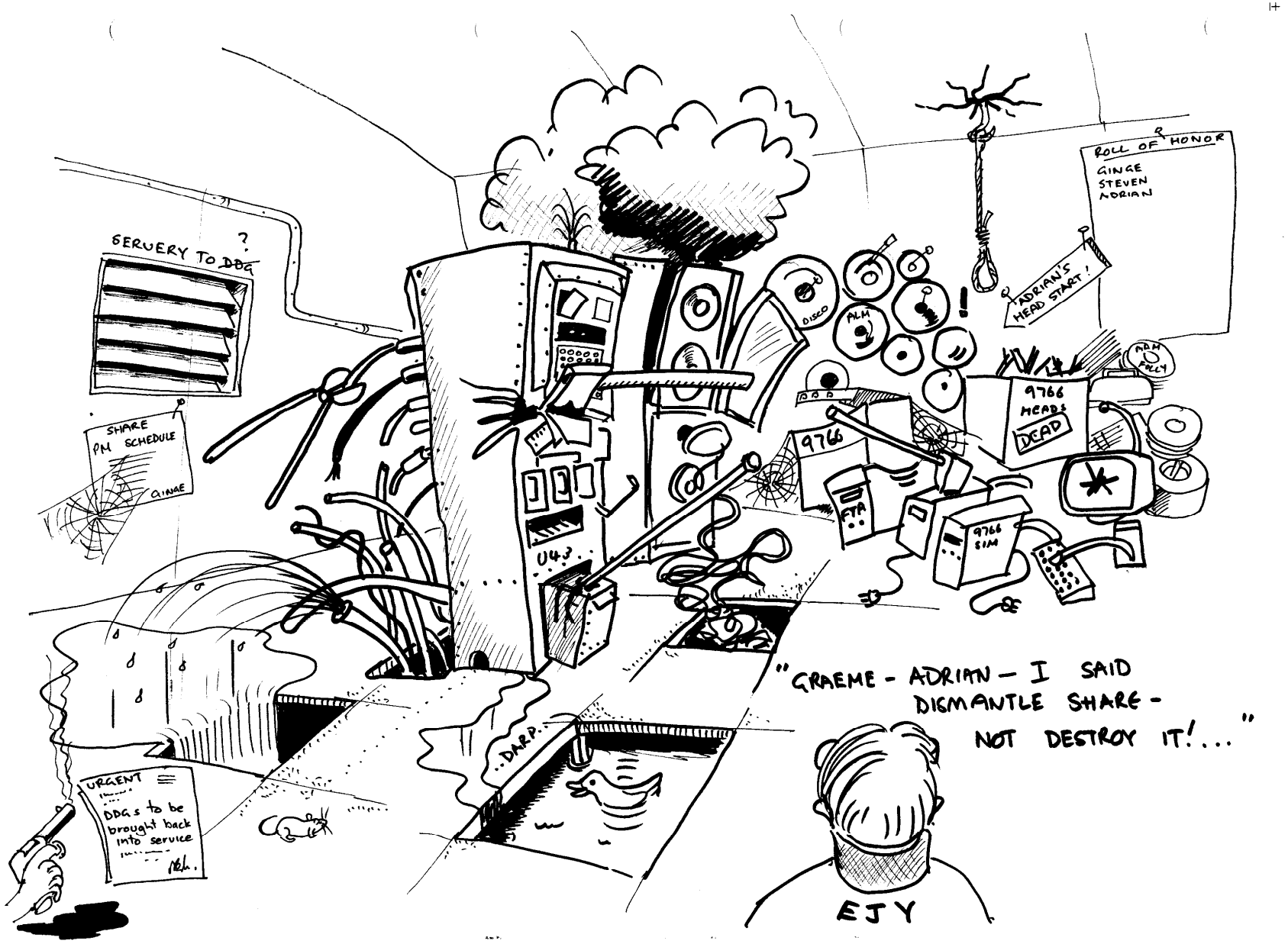
(LOOK FAMILIAR?)


C'MON TEAM - WE CAN CONQUER THIS PROBLEM
You Can do it
CONSUP
FAREWELL CDSC
SFR
TRAINING
ITS HIGHER THAN IT SHOULD BE!
TJ
REMOVING DEVICES BY ZINGE
MT WKR
MT. SFR
TRAINING SPUR
SOFTWARE SECTION
GROAN!
RUMBLE!
ROAR!
DONS HOUSE
ZZZZZ
MT TRAINING
MOUNT NAVAL RESERVE
MT REC LEAVE
MAIL
BC GULLY
GERALDTON
MT MRR
HIGH PRIOR
LATER
S/R
URGENT
4DWP
NOW!
URDEF
ASAP
Boring!
NON Caramus
SANITY BREAKS
?
CLOSED
INCENTIVE
USE BY: 1975
ADMIN HOLE
NUTHIN GOIN' ON DOWN THERE!
CLOSED FOR WINTER
R.A.T.
IMMUT.
STORES REQUESTS - URGENT!
The Real World
1993


12.54
PR-2000
"AWASCo's NEW SOLDERING STATION!...."
PK '92



....TECHNOLOGY INSERTION — HI-TECH LATCHES.....


SERVERY TO DDG ?
SHARE PM SCHEDULE
GRAME
URGENT
DDGs to be brought back into service
Nick.
DISCO
ALM 9
U43
DARP
ROLL OF HONOR
GINGE
STEVEN
ADRIAN
ADRIAN'S HEAD START!
9766 HEADS DEAD
9766
FTA
9766 SIM
"GRAEME - ADRIAN - I SAID DISMANTLE SHARE - NOT DESTROY IT!..."
EJY

Projects and Activities

THE DDG MODERNISATION PROJECT

This description is, in the main, based on notes created by CAPT Dean Walkington, RAN Rtd (Director of CDSC 1984–1987).

Background

At the time the RAN acquired the (new) NCDS hardware and software for its DDGs, the US Navy was already moving to a next generation of weapons and combat system configuration (both hardware and software). In 1978, the DDG Upgrade Project was formed to manage the implementation of the RAN's requirements to improve the DDG combat system (as originally fitted). The changes resulting from DDG Modernisation were very extensive, involving the installation and/or integration of six different computer systems.

DDG Mod was a complex project involving a US Foreign Military Sales (FMS) case for the supply of new hardware and the development of a new NCDS operational program. Although the US Navy let the contracts for software development, the development was divided between the US and Australia. CDSC became the technical authority, and the majority of the program testing was conducted by CDSC.

On 17 December 1985, the Australian Government's approval was given for phase 1 of DDG Mod, at an estimated cost of $A205 million. Subsequently, two significant FMS agreements were concluded with the US Government. These FMS agreements amounted to approximately $US217 million. They included provision of design services, equipment, installation material, software development, technical support and integrated logistics support data.

Expansion

The CDSC facility was expanded (by the acquisition and occupation of 86 Maryborough Street) to allow new software development and test suites. The contractor at the time was tasked with installing the new systems and modifying the control and switching for the old systems. New classrooms were established in Building 86 along with new power and support services. New operations room models were created to support current and future software support and training requirements. Three-shift utilisation of the software suites was initiated. Program management and review was continuous. Similarly, documentation review was carried out every step of the way. Software test, debugging and retest became a routine task.

New Systems

In terms of hardware fit and systems, DDG Mod involved the installation and/or integration of six different computer systems – Naval Combat Data System (NCDS), Beacon Video Processing and Satellite Navigation (BVP/SATNAV), AN/SYS-1 Integrated Air Detect and Track (IACT), Weapons Direction System (WDS, Mk13 Mod4), Missile Fire Control System (MFCS, Mk74 Mod13), and Gun Fire Control System (GFCS, Mk68 Mod19). Thus, the NCDS AN/UYK-7(V) had its memory capacity enlarged by the addition of some 'double-density film' memory modules (each 32K capacity) in place of original 'core' memory modules (16K each). The OJ-194 Multi Functional displays

were converted to include the CIGARS (Computer Internally Generated and Refreshed Symbols – part of the OJ-194 MFDs) modification, and an AN/UYK-20 computer replaced the gun system's analogue computer. The original DDG Radar Video Processor (RVP) for the tracking of air targets was replaced by the fully automated AN/SYS-1 integrated automatic detection and tracking (IADT) system whereby air tracks could be automatically passed to the NCDS processor. The 'SYS-1' hardware included a peripheral multiplexer external interface converter (PMEIC) and two AN/UYK-20 16-bit computers taking data from the AN/SPS52C and AN/SPS40 radars. SYS-1 could also 'talk' with the WDS Mk 152 computer when in NCDS casualty mode. Counting the new BVP/SATNAV processor, and the AN/SPS-52 radar pre-processor, the DDGs acquired five AN/UYK-20s during DDG Mod.

Partial list of new equipment purchased for DDG Mod

AN/SPS-52C 3-D air search radar, including AN/UYK-20 pre-processor
AN/SPS-67(V) 2-D surface search radar
AN/SPS-40C radar automation module
Mk13 Mod4 WDS, including Mk152 Mod7 computer
Mk74 Mod13 MFCS, including Mk72 Mod14 SDC
Mk13 Mod5/6 guided missile launcher system
Mk68 Mod19 GFCS, including AN/UYK-20 computer
AN/SYS-1 IADT System, including 2 x AN/UYK-20 computers and CV-3719 PMEIC
AN/UYK-7(V) film memory units
additional OJ-194(V)3 consoles with DDI and CIGARS
DDI/CIGARS field changes for existing OJ-194 consoles
AN/UYK-20 pre-processor for BVP/SATNAV
CV-2356/UYA-4(V) BVP

Software Changes

By and large, the RAN's DDG modernisation was based upon the US Navy's Combat System Upgrade. One exception to this was NCDS – the RAN's existing NCDS program was to be used as the basis for the new software. Thus, the pre-Mod 4XXX program, plus a selection of program change proposals, became the 6XXX baseline operational program for DDGs post- modernisation. The software development was to include:

- correcting known problems,
- increasing program reliability,
- changes to enable operation of the new combat system hardware, and
- changes to provide enhanced operational performance.

Software development was divided between the US and Australia, but the major test program was conducted by CDSC. Sperry, soon to be come part of Unisys, was contracted as the provider for the required upgrade software. They, in turn, used an Australian company, C3, as their local sub-contractor. The update to the NCDS software required in excess of six calendar years to complete. This included

program planning, CDSC hardware installation, software specification and related documentation development, and both land-based and shipboard interface and integration testing.

Software implementation took place through four taskings:

Task 1 covered the preparation of a software management plan, developing a baseline for the program change proposals, and the preparation of detailed implementation schedules.

Task 2 covered the preparation of the following specifications and draft documents:

- interface design specification for BVP/SATNAV to NCDS,
- modular system software specification (MSSS),
- combat system operational design document,
- program operating description, and
- system message book.

Task 3 covered the software development of program design and coding for NCDS and the BVP/SATNAV pre-processor, and then the interface testing and system integration at CDSC. This task also included the design and development of a new suite of simulation programs against which the post Mod software would be tested.

Task 4 was what is commonly known as lead ship software integration testing.

Certification of the final product involved the verification of each individual program module against the requirements of the MSSS, using a simulated environment. The MSSS was seen as the document that described the formal definition of the system requirements. The NCDS suite at CDSC was used as a test bed to ensure that the correct switches, VAB buttons and displays actually showed what was expected by the program design specifications. The certification for 6XXX started mid November 1985 and was completed in August 1986.

THE EVOLUTION OF NCDS 7XXX

The following article, which draws heavily on an article by PO Phil Smith who was then at CDSC and which appeared in the SCFEG publication, *Birds Away,* Issue 4 of September 2002, has been included to give some idea as to the changes that occurred from one version of an NCDS program to another.

By way of introduction, it needs to be explained that all NCDS programs were composed of a number (around 20 or so) of essentially independent software modules, each of which was responsible for one part of the program's overall function. Examples of these modules were:

- Display Module, responsible for the interface to the OJ-194 MFD consoles and hence the output of data to, and the receipt of inputs from, the NCDS operators;
- Converter Module, responsible for the interface to the analog/digital converter providing ship's parameters into NCDS;
- Tracking Module, responsible for the interface to the Auto Air Detect and Track (ADT) equipment being used; and
- Common Systems, used to provide a store for the data needed to be shared by two or more modules.

Furthermore, each particular version of the overall program was identified by a four digit alphanumeric NXYZ, where the numeric N was incremented when major changes were made; the first alpha X was incremented when system wide changes were made (usually involving three or more modules); the second alpha Y was incremented for localized changes were made (involving one or two modules only); and the third alpha Z was incremented when one or more 'patches' (minor modifications) were made (usually to only one or two modules).

When NDCS was first introduced into Australia, the DDGs were using a version 4XXX (where the 'XXX' in this case indicates that the three alphas are not being specified), the '4' being sequential to the USN version this was developed from. The introduction of the FFGs into the RAN from 1979 necessitated a major change to the program (as the FFGs used generally different peripheral equipment, had less memory capacity in their AN/UYK-7s, and were less capable than the DDGS), and this new version of NDCS for the RAN FFGs was designated as 5XXX. The advent of DDG Mod in the '80s saw the need for a major change in their program, and these new versions were designated 6XXX. The DDGs used versions of 6XXX from modernisation up until their decommissioning – the last version used being 6CEX. The FFGs, meanwhile, were using a version of 5XXX until 1997, when the main NCDS processor (computer) changed from an AN/UYK-7 to the more modern, reliable and increased memory capacity AN/UYK-43. This change in processor necessitated a major revision of their program, and the new versions were named 7XXX (starting with 7AAA).

The first series of 7XXX programs, those designated 7AXX, were written to utilize the AN/UYK-43 in the so-called 'compatibility mode', a restricted form of AN/UYK-43 operation designed to ease the transition from AN/UYK-7s. These allowed a significant improvement from the older 5XXX versions, as these previous versions were being severely limited by smaller memory capacity of the AN/UYK-7. The transition to the full AN/UYK-43 capability of 'native mode' was achieved by the 7BXX series, a series in fact only trialled at CDSC (attempting to use both CPUs of the AN/UYK-43 as parallel processors) and never released to the fleet. The Fleet's transition to native

mode operation was achieved by the release of 7CXX (actually 7CBB) from May 2002, a release which also included the Harpoon 8/9 upgrade and the OPSPEC 411.2/411.3 'toggle' that allowed operators to operationally change the OPSPEC of the Link 11 messages though Variable Action Button (VAB) actions.

The basic process for the initiation of a release of a system wide change to the NCDS program came in the form of a document called a Baseline Change Proposal (BCP). The BCP contained three main sections. The first section was a list of applicable Program Change Proposals (PCPs), which were generally were the major development focus. Second, a listing of other PCPs was included that was held at standby if progress on the primary listing created opportunities to include additional PCPs. Finally, there were lists of outstanding Program Trouble Reports (PTRs) whose 'fix' was to be included in the change.

The BCP that was to lead to the 7DXX versions was signed off by DCDSC on 18 June 2002. This consisted of eight PCPs in the primary listing, another 34 PCPs in the secondary listing, and the anticipated resolution of an additional 390 PTRs. The main purpose of this BCP was to develop an improved FFG NCDS program that interfaced with the new MK 92 Mod 2 WCP (Rev S) software. In addition, it included the full migration to OPSPEC 411.3 and improved Link-11 interoperability. Other enhancements included the automatic exercise areas, via VABs, both pre-canned for the Australian station, and the ability to create custom-made areas that could be saved and re-activated via VAB. That feature was ideal for RIMPAC and Persian Gulf operations and any exercise or operation outside the Australian theatre. Some other enhancements included modification to the processing filers for special points, resulting from another PCP raised directly from feedback from units serving in the Gulf, a redesign of the Helo Data Link track management, IFF/SIF operational specification (OPSPEC) upgrades and making the AN/SLQ-32 VAB array into a 'common' array.

The first version of 7DXX was sent from PROGs group to the TDG group in September 2002, when the 7DXX RANCH (RAN Checkout) test schedule began. A back-and-forth process between TDG and PROGs of testing, problem identification, problem rectification, and retesting was completed in July 2003, with sea riding tests and ship's staff trials. The 7DXX program was then officially delivered to the Fleet. It was envisaged that this would be the last version of NCDS, as once the FFG Upgrade (FFGUP) properly commenced there would no longer be a need for updated/improved versions of NCDS. With the delays in FFGUP, however, version 7DCE was delivered in March 2005 and version 7DDG (the actual last version) was delivered in October 2006. There are some who believe that this was arranged just so the very last version could have this particular designation.

NCDS PROGRAM COMPILATION

Compiler Monitor System version 2 (CMS-2)

> *Throughout the entire history of NCDS, the CDSC programmers used the Compiler Monitor System 2 (CMS-2) to assemble/compile the NCDS program code being created or modified. CMS-2 was created in a joint venture between the RAND Corporation and the USN circa 1974, and was a general-purpose programming language that came to be used almost exclusively for all real-time and embedded applications in the USN. The language had a conventional complement of imperative control-flow statements, but with peculiar syntax. Loop statements offered special exit/resume facilities – it was even possible to resume a loop after having exited it. CMS-2 also offered several kinds of index jump table statements (like FORTRAN's computed GOTO but more complicated). All new programmers to CDSC, no matter how experienced, first had to attend training in the CMS-2 and ULTRA-32 languages.*

Over a dozen implementations of CMS-2 were created in the 1970s and 1980s for various system architectures adopted by the US Navy. One major division was by the processor word size of the target military processor – CMS-2/M was for 16-bit machines and CMS-2/Y for 32-bit units. During a major software survey in 1995, it was found that over 14 million Source Lines of Code (SLoC) of CMS-2 had been written for US military systems. In our context, the CMS-2 compiler originally executed on a UNIVAC AN/UYK-7(V) computer, and later on an AN/UYK-43.

Originally, the CMS-2 compiling suite at CDSC consisted of an AN/UYK-7 computer, a front-end of a UNIVAC 9300 8-bit commercial computer interfacing with the UYK-7, two banks of UNIVAC RD-358 7-track tape drives, plus a printer, card reader, card punch, and two card punch memory units. From the operator's view, this was a typical punch card and tape drive based system. After being written in ULTRA-32 assembler language, the code for the NCDS program was punched onto decks of 12-row Hollerith code cards before being 'read' into the compiling system – the cards were of course punched by human operated card-punch machines. Supporting this, there was a large punched card sorter machine that could, using manually programmable 'patch-panels', sort the cards into any sequence one required. CDSC must have used thousands of boxes of punch cards during the creation of software changes. Each punch card was 6.9 "thou" (thousandth's of an inch) thick, and if the leading edge of the card was 'furry' then, often as not, the card reader device would cause the punch card to jam in the input causing a pile-up of punch cards (sometimes) onto the computer room floor.

The 'front end' (i.e. method of getting data into and from the CMS-2 system) was an 8-bit, Univac 9300 commercial computer system. This system included an inter-computer control unit (ICCU) F1095 that provided an 8 bit to 32-bit parallel two-way transfer device to interface the 9300 with the AN/UYK-7 (or other Univac processor types as required), and an electronics cabinet that contained a 16 K, 8-bit plated-wire memory – which never failed once in 20 years at CDSC. The associated tape drives (type 6c) were rather unreliable, whilst the printer was a reciprocating bar type driven by a hydraulic motor that used to leak badly.

The original AN/UYK-7 used at CDSC for the CMS-2 was the 4-bay B0/B1 unit, that did double duty as the NCDS processor when the suite was operating as a DDG C2 system.

The SHARE System

Following several years of using punched cards and printed paper for Input/Output as described above, the SHARE system was introduced. SHARE was a software package developed by the USN to support the software development for several classes of (originally) USN ships. Not only did SHARE dispense with the punch cards by allowing programmers to interface directly with the CMS-2 compiler using Zenith Z-19 VDUs (originally), it was a large-scale multiprocessor time-sharing system designed to support the requirements of many users simultaneously – these requirements could include program development, online debugging, program certification, language processor implementation and maintenance, information storage and retrieval, and document preparation and production.

The original SHARE was created for FCDDSA, San Diego, in California, but eventually there were many other US sites on military and non-military establishments. Several other countries, including Australia, (the then) West German Republic and Spain in turn built software development sites to include SHARE programming. Starting out as SHARE/7 using an AN/UYK-7 as the host processor, in later years it was upgraded in both the USA and Australia to SHARE/43 which used a dual cpu AN/UYK-43 as the processing element.

SHARE/7 was installed at CDSC in 1981 with a team from UNISYS coming to perform the 'set-to-work'. CDSC had two SHARE/7 systems – one at Maryborough St and the other at the former annexe across the road in Newcastle Street. Although it dispensed with all the Card Readers and Punches previously being used, SHARE was still dependant on (magnetic) tapes and drives. All the source data, however, was stored on CDC 9766 'washing machine' 300Mb disk drives. The Mil-Spec hardware performed well, but some of the commercial devices had their 'ups and downs'. With the advent of SHARE/43, the original CDC 9766 disk drives were pensioned off in favour of much smaller physically, but larger capacity, 10 GB hard drives. Their reliability was not as good as their forebears, and disk ‘stiction’ had to be overcome to get them going again when trying to re-boot the system after a prolonged shut down period.

SHARE closed down at CDSC on Friday, 23 November 2001. After that date, the CMS-2 compiler was hosted on an in-house CDSC LAN system.

SHARE Personnel

The following personnel were closely associated with the SHARE system during its operation at CDSC.

Peter Bryan	Original SHARE Programmer		
Ian Buckham	SHARE Lead Programmer	Sean Case	SHARE Lead Programmer
John Robinson	Head Programmer	James Stratford	Head Programmer
John Flaxman	Programmer	John Currie	Programmer
Glen Cunningham	Programmer	Rick Riedel	Programmer
John Dinsdale	Head Operator	Doug Jorritsma	Operator

Janelle Day	Operator	Tracey Mayberry	Operator
Stephen Thomas	Maintainer	David Wellings Booth	Maintainer

SHARE Rules

The following “Twelve Golden Rules” were for a long time on display in the SHARE/7 Computer Room:

1. Thou shalt not RE-BOOT except when the Archangel Operator permitteth thee.

2. Thou shalt not worship COMPILE to the exclusion of thy brother programmers, thy brother users, or the Archangel Operator. Likewise, thou shalt not worship unnecessarily or irreverently at the shrines of EDITOR or MAIL.

3. Thou shall submit thy jobs through the normal system except when thou hast many brothers awaiting thy results.

4. Thou shalt not forget the servants on the terminals and the spirits at their remote temples – it is most sinful to violate the inner sanctums of the system whilst they are at their worship.

5. Thou shall honour disc and tape files that thy days may be long in the temple of the mighty SHARE-7 giveth thee.

6. Thou shalt not steal, nor carelessly misplace thy brother's output from the holy printers; else he may steal or misplace yours.

7. Thou shalt not mount tapes without the permission of the Archangel Operator.

8. Thou shall love the Archangel Operator as if he were thy brother, for his word is law.

9. During thy time in the temple thou shall keep the temple clean and you shall not congregate around the High Altar.

10. Thou shalt not smoke within the temple of the discs less thou incur the wrath of the keeper of the disc temple who will bring a scourge of scorpions and evil things upon you for the rest of your life.

11. Thou shalt not worship any other god than the mighty SHARE-7. Left alone he will right all wrongs and show his servants the path to righteousness but should he falter thou shall call his divine Abbott to minister unto him.

12. Thou shall, in all things, show mercy to thy humble brother who knows not what to do.

SURFACE COMBATANT COMMAND STATION

CDSC received advice on the USN development of a ‘command decision aid’ for Major Fleet Units in the early 1990’s. The primary use of the equipment under development was to provide an improved level of tactical information to Ship’s Command Teams utilising data available from NTDS and the later ACDS combat data systems. CDSC monitored this project (known as Command Station) during routine technical visits and through technical liaison officers working in the US, and, as it became clear that this USN project offered potential benefits to the RAN, CDSC initiated a proposal for an RAN/USN Cooperative Development Project that was subsequently approved by the USN International Programs Office (IPO). CDSC then initiated a local trial of the Command Station Display System (CSDS) and in 1996 loaned USN equipment was installed in HMAS *Perth*. Although the system installed in HMAS *Perth* was an early (Level One) version it proved to be a valuable tactical aid to the ship’s Commanding Officer (then CAPT Geoff Smith) allowing a far more adaptable range of data displays than was available from an NCDS MFD. Development of CSDS continued and the USN installed a later version (Level Two) in LPA and KIDD Class Fleet units. In 1997 CDSC received approval for release of software source code from USN IPO – this allowed the RAN to start development of an RAN Command Station variant. In mid-1998, with sponsorship from DGMD, the Naval Business Forum provided funds to CDSC for the acquisition of hardware for a COTS development system and for programmer training on CSDS in the US.

Following the NBF funding, CDSC acquired and set-to-work USN Command Station hardware and undertook development of more generic software interfaces for this equipment to work with NCDS in both DDGs and FFGs, and potentially with the ANZAC SS2000 combat system. DNW undertook the preparation of a Minor Project Naval Staff Proposal for projected Command Station prototype installations in an FFG and ANZAC Class Fleet unit. CDSC commenced liaison with the ANZAC Project and CelsiusTech Australia (now SAAB Systems Australia) for development of a unique software interface that would allow a Command Station display on the prototype CTA SS2000 ‘COTS Console’. With DGMD sponsorship, CDSC also discussed development opportunities with the DSTO Combat System Research Centre and provided the Command Station interface specifications to this facility.

Despite considerable development work on the NSP, funding prospects and priority for Command Station diminished, and by mid-1999 the Minor Project action had stalled due to lack of money. After James Stratford returned from a demanding stint in the US learning about the CSDS UNIX operating system (and an unscheduled visit to Niagara Falls!), CDSC independently procured software to transfer (re-host) the Command Station source code from a UNIX to a WINDOWS NT environment. This work was undertaken to enable the Command Station software to be operated on much cheaper PC hardware rather than the UNIX workstations required for the USN system.

Unfortunately at this point money problems became more of an issue than the technical challenges, and with the likelihood of funding for hardware procurement diminishing, the demonstration of Command Station in CTA’s ‘COTS Console’ could not progress. At CDSC, work on the completion of the FFG NCDS interface and the software re-host to WINDOWS NT was also temporarily stopped due to programmer resources being prioritised for FFG Upgrade assistance and the 7BXX program. DNW and DGMD advised that no realistic solution to the money problem was available at that time so, with USN encouragement, CDSC continued the WINDOWS NT software re-host as the most viable way ahead should funding be possible. The re-host was also seen as a means of broadening opportunities to use Command Station with other ‘Command Decision Aid’ tools such as MTSS.

When HMAS *Perth* paid off in 1999 the CSDS equipment was re-installed in HMAS *Brisbane*; the system was operational but features like aeronautical information (airlanes, etc.) became less functional as data inputs from the US were no longer in a format suitable for that early Command Station variant. When HMAS *Brisbane* paid off in 2001 an option to install the equipment in an FFG was not seen as cost effective and the loaned hardware was returned to the USN for disposal. With no change in the likelihood of funding for the NSP all development work at CDSC ceased and CTA continued to independently produce and install the enhanced COTS console in the ANZAC ships.

CDSC's efforts to develop Command Station technology represented a low risk but highly effective opportunity to enhance the display of tactical and strategic information. The opportunity to undertake this work stemmed from the close technical association CDSC maintained with partner organisations in the USN. These links allowed extensive sharing of technology developments that offered improvements in capability with markedly reduced development timeframe and technical risk. Despite the fact that the project did not attain fruition, the strategic investment represented by the CDSC facility provided the RAN with 'state-of-the-art' in-house development capability on a par with major navies such as the USN and RN. The specific development effort for Command Station presented Navy with a potential opportunity to deploy a useful and useable system at sea within 12-18 months but, as always, priority for funding against the numerous project options holds the vital sway. Without the ongoing investment in resources and infrastructure at CDSC, and the close liaison maintained with the USN as a technology partner, the option would never have existed.

RANSID

Before 1997, all DDG and FFG combat system computers (NCDS, weapons and radar processing) relied on magnetic and paper tape drives (DEAC) for loading programs and recording data. These systems only communicated with one computer at a time were slow, unreliable and becoming harder to maintain. In response, CDSC devised the Royal Australian Navy Standard I/O Device (RANSID). The project began as a concept demonstrator in 1991 and struggled to get approval funding to develop the prototype. This system was to be based on commercial off-the-shelf technology incorporating standard Sabtech Pty Ltd commercial NTDS interface cards to communicate with the combat system computers. It was to act as a file server for four systems computers simultaneously, emulating various magnetic and paper tape devices. This allowed better data recording, faster computer loading and a more reliable system with less maintenance. The designer of the prototype RANSID, Chief Petty Officer (CPO) Ray Irvine, a member of SEG put in many productive hours perfecting the design and layout of his project. The RANSID prototype development was Ray's project for his Diploma of Engineering. After Ray's pioneering work, a contract was let by the RAN to Honeywell who produced the commercial and ruggedised RANSIDs. Once the contract was let the processor and VME bus drivers had to be rewritten as the contractor selected a different UNIX processor and VME interface card. The developed RANSID units had to be tested with all computer combinations for the DDGs and FFGs for all possible diagnostic and operational software. The challenge was to identify the tape formats for loading (as very little documentation was available and some dated to the mid 70s) onto RANSID. The RANSID units were installed in 1997 in both the DDGs and FFGs as well as at CDSC and at HMAS *Watson*. Ray received a Maritime Commander's Commendation in 1998 for his efforts and involvement in the concept, development, acquisition, testing and installation of the RANSID units.

SERCo (software) also played a significant role in the development and support of the RANSID system. They were responsible for developing software for tape drive emulation, diagnostic programs, data analysis software and various utilities. They were also responsible for configuring the operating system configuration system and developing installation procedures. When the hardware was updated in 2003, SERCo was responsible for evaluating the new hardware and updating all the software once again.

Innovative use of RANSID system has had other operational benefits for both CDSC and the Fleet. Before the 1990s, when a ship experienced an NCDS problem it would make a recording of the problem onto magnetic tape then send it back to CDSC for analysis (quite a problem when on deployment). CDSC would analyse the problem and develop a solution, then send a signal to the ship, containing the AN/UYK-7 or AN/UYK-43 computer machine code to be changed manually by hand – which was quite a laborious task and prone to errors. These days, using software developed by SERCo, a ship can record data on RANSID then instantly send it back to CDSC over the secret email network for analysis. After CDSC has developed a solution, a full operational program containing the corrections can be emailed back and installed ready for use. This process has been successfully used to provide immediate assistance to ships serving on operations in the Persian Gulf and elsewhere.

THE AUSTRALIAN UYK-7 SEMI-CONDUCTOR MEMORY UNIT

As part of the support contract, the on-site contractor at CDSC was occasionally asked to work on the development of components to replace or improve on those fitted as part of the NCDS system. Significant examples of this were the development of a replacement for the digital data indicator used with the UYA-4 Display system, and a programmable VAB (Variable Action Button) panel. The most significant, however, was the development of a replacement double-density memory unit (DDMU) for the Sperry-Univac AN/UYK-7(V) computer used on both the DDG and FFG class ships.

The UNIVAC DDMFM

The (only) memory units available with the original AN/UYK-7(V)'s were 16K 'core' modules, each providing storage for 16K of 32 bit words using ferrite cores as the storage medium. The desire for increasing NCDS capability lead to a need for increasing the memory capacity of the AN/UYK-7. UNIVAC responded to this requirement by the development and production of the Double Density Mated Film Memory (DDMFM) unit – so named as each module had twice the capacity of an original 'core' unit (now 32K words) and utilised 'mated films' of magnetic material as the storage medium. These units needed only relatively minor changes to the back-plane wiring of an AN/UYK-7 before they could be substituted for 'core' units. Unfortunately, although the AN/UYK-7's used on the FFGs used DDMFMs exclusively for their memory whilst those on the DDGs used a mixture of DDMFMs and 'core' units, the Mil-Spec DDMFM units proved in service to be significantly less reliable than the 'core' units they replaced. Not only were these units quite expensive (as Mil-Spec items usually are), but in the later years of AN/UYK-7 production, there was increasing uncertainty over their future availability as 'spares'. As a consequence, it was decided to investigate whether replacement substitutes using commercial quality components could be manufactured locally – with a view to using them in place of DDMFM units in the more benign CDSC environment and thus releasing the DDMFM units for service at sea.

The Development of the DDMU

Accordingly, a proposal was put to the contractor (EMI) in early 1985 to prepare a feasibility study for the local manufacture of equivalent 32K memory modules for the AN/UYK-7. Two EMI contractors, Barrie Boxshall and Pat Lynch, were assigned to the development task. By the end of 1987, the prototype units, known as commercial Double Density Memory Units, or simply DDMUs, had been designed, built and checked out in all CDSC systems. The development was not without its problems – the reluctance of Univac/Sperry–UNISYS to release design information on the original unit had a major impact on the development. Complete reverse engineering methods were resorted to and entailed the purchase of some expensive and (at the time) exotic test equipment – including a 128 channel logic analyser and digital storage oscilloscope.

A small production run of 15 units was approved and, with the help of local industry, the modules were built in the contractor's workshop. It may be noted that, to date, only a couple of very minor faults have been found in these units over almost 20 years of service. In 1988,

consideration was given to the possibility of using the CDSC DDMUs on ships, and subsequent sea trials aboard HMAS *Sydney* in mid 1989 confirmed that, with some minor ruggedising, the units were suitable for use at sea – at least as spares. In the same year, extensive environmental and quality tests were conducted by the Defence Science and Technology Organisation in Salisbury, South Australia, resulting in some minor changes to suit a harsher operational environment. In 1989, approaches were made to AWA Defence Industries (AWADI) regarding the manufacture of ruggedised units but the RAN did not proceed with this option.

US Navy Interest in the DDMU

The increase in tension in the Middle East around the 1990s prompted the US Navy and Marine Corps to inquire about the purchase of a large number of these memories. These modules would supplement the dwindling supply of spare parts in the US. It should also be noted that the original Sperry Univac DDMFM that the CDSC unit was designed as a replacement for was notoriously unreliable. An agreement was negotiated between the US Navy, the Commonwealth and AWADI for around 25 of the CDSC-developed units plus a tester module that the CDSC contractor had developed at the same time. Unit s/n 13 (!) was sent to the US in 1990 for evaluation by Crane NWSC, FCDSSA/Dam Neck, UNISYS St Paul and Dahlgren. The test unit suffered quite severe damage due to poor handling in transit *en route* to the US, and these handling problems were probably responsible for a few failures during the trials – several internal components were found to be broken upon its return to CDSC. The US Navy subsequently ordered the memories as emergency spares in support of Operation Desert Shield/Desert Storm. Pat Lynch, a member of the CDSC contractor team (then AWASCo), travelled to the US in the February of 1991 to demonstrate the DDFM to US Navy personnel at both Norfolk and the US Marine Corps at Camp Pendleton. Following this trial, the CDSC contractor worked with its parent company AWADI to produce 25 DDMU for the US Navy, to which they were delivered in August 1991. Again, Pat Lynch travelled to Norfolk, Virginia to provide training and checkout of the delivered equipment. It is not known if any of the units were ever used operationally by the USN, but several of these units were nominated as emergency spares in support of operations Desert Shield and Desert Storm.

Further Developments of the DDMU

During the early 1990s, the RAN approached AWADI to design a militarised version of the DDMU but after a couple of years of development problems and the imminent installation of AN/UYK-43s on FFGs, the project was abandoned. Another variant of the DDMU was the 128k-word unit – designed to give maximum AN/UYK-7 memory capacity in one memory module. One prototype (only) of this unit was designed and built by SERCo contract staff (Barrie Boxshall and Pat Lynch) and it was in continuous use until 1995 when an AN/UYK-43 computer replaced the AN/UYK-7(V) wrap-around simulation program (WASP) processor at CDSC.

VAB Panels and DDIs

Another major task the CDSC contractor was asked to develop was a replacement for the VAB panels used in UYA-4 display consoles. The original units employed a rather clumsy miniature film chip with various symbolic and text elements on it. When a particular legend for a button was required, a lamp shone through a portion of the film chip and the symbols were displayed on a small screen on the front of the button. Changing the symbology required a remake of the whole chip via a rather laborious photographic process. A newcomer to the

contract, Peter Holloway, was tasked with developing a replacement VAB panel using programmable electronic elements to simplify making the changes required after software development. A working prototype was 'bread-boarded' by Peter and later brought to production standard by Pat Lynch. Unfortunately, the quoted price to develop this further by an Australian manufacturer was considered excessive at the time and the project was abandoned.

The Mil-Spec digital data indicators (DDIs) at CDSC were considered to be of greater value elsewhere in the RAN and, in 1988, the contractor agreed to design and manufacture a prototype commercial replacement. In 1992, the production versions of the commercial DDIs were produced by Ansett Technologies. Several still remained in service at CDSC in 2006.

Recollections

FAITH RAWDEN-SMITH

Faith Rawden-Smith was a young civilian combat system engineer who worked with Captain Eric Swenson at the time the PD 63 team was in the US to acquire NTDS. This text is based on a discussion with Faith in Washington in 2002 and describes that crucial time when the approval was achieved:

'Organisationally none of this is going to make much sense to you because there wasn't even an FMS office when the proposal was put together for the original CDSC and NTDS. Eric's primary responsibility was all US Navy NTDS programs. The FMS was very much a sort of collateral duty and many of the bosses really didn't want to know too much about it.

There were a couple of political issues and I don't remember the details but obviously Tony would remember that about the end of '72 there was an election … not getting an aircraft carrier there was a lot of brinkmanship going on. Eric was in his usual mode of doing 100 million things at once. I didn't even know he'd been talking to the Australians. Eric called me into his office. I didn't even work for him. But, he thought I worked for him and he had on his desk piles of books – big thick ones from UNIVAC and HUGHES and a thin one on the Collins Radio. I think that Tony was actually in Eric's office. Anyway as I said he said I have a rush job for you. I want you to read these proposals and to come back to me by the end of the day to tell me if we should go ahead with this program or not to which I said 'what program? I'd had some experience with the Japanese and the Germans and there was some, there were a number of really fatal flaws in these documents! I couldn't do any more than skim through them and I said to Eric, around lunchtime, these have so many. You can't task me like this and he said, 'Well fix it'. He picks up the phone and he calls the UNIVAC office in Georgetown and tells them I was on my way down and I had the proposals and they were to put a typist at my disposal because I am going to re-write the UNIVAC proposal. Which was kind of news to me! I knew that the following day was a deadline I don't think I comprehended quite what a big deadline it was (thank goodness) because I would have been totally terror struck if I had been aware.

Anyway, the next morning I was to meet Eric in his office with the re-written proposals and give him the thumbs up for him to sign. Therefore, I go into Eric's office and as usual, he's doing three or four other things. He said, 'I need to be down at the Pentagon at 10 o'clock will you drive me?' This was one of my collateral duties! So, I said yes and I thought well at least there's a telephone in the car and I may be able to talk to Eric about the big remaining issues. In your dreams! We didn't even discuss it. I forget what we talked about but Eric had various other things on his mind and we get to the Pentagon and get to this imposing conference room. Eric was the junior military type. Everyone else were admirals – there was the Chief of Materiel FMS type and apparently this was one of several items on the agenda and I was sitting next to Eric praying I didn't fall asleep because I was so tired and they get to the Australian item on the agenda and the admiral asks Eric if he will back the proposal as it stands and Eric turned to me and said what do you think Faith do you think shall we go or not? I often wonder what would have happened had I said no! Tony went back with his deal. I think there were three Australians present on that visit in December of 1972. I was then given the chance to do a more considered re-write. Trying to get the UNIVAC, Hughes and Collins types to think more forward a bit because it was obvious that one of the things that had to be done was that there would have to be several US contractors to be in Australia for periods of up to a couple of years. Especially Minnesotans who will get to have two good summers 'down under'. At this time, the mindset was a little different – there were quite a few people who didn't want to go. I was starting

to have concerns. The main purpose for going to Oz in February '73 was to establish and agree on the scope of the job required and the secondary purpose was to go round with Tony to find a suitable site for a CDSC.

One of the things that had to be assessed was how much indigenous support was available in Australia and how much unique support would be required to be provided by UNIVAC, HUGHES and COLLINS contractors. We went to EMI and I felt that, whilst many individuals had a lot of knowledge, EMI did not possess the corporate knowledge required. It was Mike Moorhen who had the computer knowledge and he ran rings around the US team. It was your good fortune and ours that Mike had joined the project staff and of course he became a legend of CDSC. Oh his integrity was amazing for someone so young. There were kind of pressures that were on him. Also, he was the odd man out as he was sometimes the only sober one amongst us. Mike would have one beer and that's all he would have.

One of the things we were keen on to help these projects survive and be healthy was to ensure the development of some 'in-house' capability. There had been many trips, in both directions, which could be seen as the key to the success of CDSC. We had several people visit. There was Ed Goldsmith, who spent some time at Dam Neck because there hadn't been a 'Dam Neck' type facility in Oz before the advent of CDSC. The best way was to 'embed' someone in a US site to get some idea of how things were done.

Tony Bone and Phil Kennedy were the main Australian contacts; compared to the USN their responsibly was broader. Tony didn't really have any responsibility for the ships but he was really dedicated to CDSC, which had to get the program plus expertise to the ships. We also sent some US Navy types to CDSC but we did not always send our superstars; the calibre of people doing this was uneven. Ed Goldsmith was really good technically and I think Tony, when he selected people; he looked for their expertise and his assessment of their ability to learn.'

ED GOLDSMITH

Ed Goldsmith joined the NCDS project in 1970 and, together with a PWO LCDR John Williams, wrote the original tender specifications for PD 63, which were subsequently scrutinised by Dr Jim Adams and Dr John Wilson from WRE. Here he describes his early days with the project:

'During this very testing period, I came across a young English engineer, working in Naval Technical Services, one Tony Bone. He was gainfully employed evaluating naval technical recruits on their technical aptitude. Tony had previously worked on software development for the Polaris Project in the UK. I thought that Tony would like to work on a leading-edge project that had more meat on it than evaluating recruits. Tony jumped at the chance and joined straight away.

As part of the agreement with the US, the US Navy offered training positions in the US. Tony had already spent some time in the US so he offered to remain in Australia whilst I went overseas as part of the RAN team. Also travelling with the team was John Mathews who had an MSc in digital computing.

After John and I had completed our training on the USQ20/642B NTDS computers, we both joined the JPTDS section and here we found several programmers who were employees of the Computer Sciences Corporation (CSC) of America. In addition, there were several Univac programmers but it seems that they were involved in the peripheral devices that 'talked' to NTDS. The RAN modified the JPTDS program because the RAN's DDGs possessed different devices from those to which JPTDS normally related. The DDGs had 'IKARA', the EMI anti-submarine missile, more consoles, a radar video processor (RVP) and a video system simulator (VSS). The RAN was very insistent about having a VSS fitted to the ship. The reason was because although the training of operators was good at Norfolk, Virginia, where there were lots of aircraft and ships present off the coast, off Sydney or Perth there would (in the 1960s and 1970s) be far fewer targets to track.

Whilst at Dam Neck, a lot of testing was done of the JPTDS program (aka the Op Program). During this time, myself and others developed a series of operational functional checkout procedures (OFPC) that were used to test if the Op Program was doing that which it had been designed to do. In addition, the OFPC could be used to see if the crews responded in the way it was perceived that they should respond. I mentioned that I had taken part in a delivery of the Op Program to a US Navy destroyer and a few weeks later I was tasked, by Dam Neck, to lead a delivery team to the USS Towers. The captain of the USS Towers was not very happy about an Australian (foreign national) supervising a delivery of the US Navy's latest combat program to an American ship. Dam Neck insisted that everything was OK as regards the delivery. When the delivery team arrived at the dockyard where the USS Towers was berthed, the security people would not let me onto the base, as 'my name was not on the list (you can picture it!)'. The security people did not take kindly being reminded that I had been there a couple of weeks earlier doing exactly the same job. Anyway, after an hour or so, the Captain of the base was contacted and all was well.

After our team had installed the Op Program, the software checkout became interrupted due to a perceived intermittent hardware AN/UYK-7(V) problem. The ship's maintainer ran the diagnostics, which did not pick up the problem. 'The AN/UYK-7(V) is OK', he pronounced. I thought that this intermittent state would interfere with the software checkout but the local Univac office staff were resistant to my request for help. The failures occurred again and I thought that it was time to seek higher support. Earlier in the piece, when I first arrived at Dam Neck, I had met with Eric Swensen. He had declared his support for the RAN and I had left his office with the comment from Eric: 'anytime you need help, just call'. Now was an opportune time to test that support! I rang Eric and within ten minutes, there was a call from the head engineer of Univac stating that their best customer engineer was just getting on a plane and would be on-site 'asap'. The CE arrived and after some delving into the diagnostic program it appeared that the diagnostic did not check all facets of the AN/UYK-7(V). With some judicious patching to the diagnostic, the fault was detected and fixed. The software checkout proceeded to a satisfactory conclusion.

Whilst at Dam Neck, John Mathews and I became interested in the Link-11 specifications concerning the logic behind 'gridpad' function within NCDS. To cut short a long technical dissertation concerning gridpads, suffice it to say that Link would report one position where it had decided it was, which differed from the actual position perceived by the ship's navigator. The Link's calculated difference from that of the ship was due to a couple of terms incorrectly defined in the Link program. John and I reported this slight problem to the JPTDS programmers who it turned out were reluctant to change the error, even though they understood the problem, because NAVSEA had authorised all the software and the programmers didn't want to make changes without their consent. The upshot was that John and I made the changes to the RAN's version of the Op Program and everything was OK.'

This description illustrates the first of many unique Australian improvements to the USN software driving NCDS. The exceptional capabilities and professionalism of the evolving CDSC software team nurtured a very vibrant degree of interaction and exchange of ideas between the US and Australian personnel. This was to remain a unique facet of CDSC's relationship with it's USN partners over the many years to come.

CMDR CHARLIE ROBBINS, USN Retd.

Commander Charlie Robbins USN (Retd) was at CDSA Dam Neck in the 1980s. He has provided the following recollections about the RAN DDG Modernization project.

'I entered the RAN NCDS program when it was already established. We were in the middle of the DDG [guided-missile destroyer] upgrade effort. One of the things we discovered that we needed to place more expertise into CDSC than was available to get the project finished on time. We sent Ray Smouse down to assist, for two years. We perceived that the people who came from Australia were of a higher calibre than those who were sent to Australia. We needed to solve some problems at CDSC and we perceived that Ray was the ideal person to handle those problems.

Before coming to Naval Sea Systems Command (NAVSEA) at Dam Neck I had been a Commander USN at NAVSEA and I had worked closely with Ray. He had been involved in the early DDG program and he became FFG [guided-missile frigate] manager and 963 style destroyers whilst he was on active duty down there. He was also a US Navy Reserve Captain at the same time with a broad technical and managerial experience and he knew how to handle contractors including Unisys. We need someone with the right approach. Ray was the on-site US Navy representative and supported the DDG upgrade effort as a sort of facilitator; he had retired from the civil service and become a contractor with Comtek Federal Systems. He became the on-site representative to the Australian Navy and the US Navy vested him with authority of the US Government Navy representative on-site. He chaired Configuration Control Boards (CCB) meetings and he was there when there were teleconferences between Australia and the US.

Ray really provided the support that really shored-up the DDG-UP program and made a success of it. The worst problems were with the Unisys guys who were unwilling to communicate with CDSC. Ray went down and he could communicate in their language. You couldn't pull the wool over Ray's eyes. He kept everyone on the mark. This is how we achieved our schedule. The three marks of a successful project are that it comes in 'on-time', within budget and all the capabilities that were contracted and provided by the project. Before Ray went to Australia, the US Navy wasn't meeting any of those requirements. At the end of the upgrade, Ray had achieved all that was required of him and that should be remembered as a real achievement.

There were a bunch of unique individuals among the contractors who actually made it all work. Bruce Grevenow (Univac) was one. Bruce Grevenow was one of a bunch the people who actually made it all work. Bruce went down with me on the first trip to Australia and he was there (at CDSC) from Day One. The troika, if you will, was Tony, Bruce and myself. We were the three key people. Bruce's greatest challenge was within his organisation. He was given a lot of responsibility but no authority. The Univac people on-site in Australia did not work for him … there were other managers who lived in St Paul.

Ray went down there and was able to keep people in Oz informed as to whom was in charge there [in St Paul]. He knew which of us were in charge of what and he also knew who in Unisys at St Paul and what was going on there.

Another key individual was Harvey – the local Sperry guy. Harvey and Faith met three times a week and Harvey provided a vital insight to Univac, which she wouldn't have had any other way. What is really interesting though is because of what Harvey did we were far more successful than if he had not done what he did. The US contractors would tell the US Navy that everything was OK but behind the scenes Don Kiley was able to report that there were a series of program trouble reports (hi, med and low) in different colours that were being generated by CDSC. Then we would call Harvey.

One of the foundation stones of the whole effort of US Navy support, of CDSC, was to ensure that there was an indigenous software maintenance capability – so we had to establish a process whereby the ships could detect and evaluate software problems and report them back to CDSC, have them corrected and for there to be re-delivery to the ships any upgrades and program changes. We had to see that that process actually took place. Once we had the process running, it provided a vehicle for CDSC to access a pool of greater expertise. We could draw on the US Navy's expertise, i.e. Dam Neck, with DDGs 963s and FFGs to supplement the limited CDSC software database. The US Navy database was larger which provided a much larger resource.'

JOHN ROBINSON

John Robinson was one of the first people employed at CDSC. He worked there as a programmer, eventually being Head of Progs Group for many years before his departure in 1999.

'I joined CDSC in 1976, having just completed a part time Science degree of which Computer Science was a discipline studied. About two weeks from the end of the last (?) semester, our lecturer told us we were to study assembly language because the syllabus said so, but he told us not to worry too much as we would probably never run into it again. I spent a good part of my time at CDSC writing assembly language software – there were other things that lecturer didn't know too!

I was one of six programmers, three named Peter and three named John. Soon after I joined I started the Programming course, but about half way through (before we got onto the CMS-2 (High Level Language) part), I was reefed off and set to work investigating and resolving defects in the program we were updating for the DDG's. I never got to finish the Programming Course! At the time our first computer equipped ship was on its way back from the USA where it had undergone a major update. Our first job was to enhance the Command and Control software, NCDS, to allow for an extra operator console – we did the right thing and wrote the changes to accommodate any number of consoles, up to 256 I think! We also had to deal with a lot of defects in the delivered software. The changes were written in machine code (zeros and ones) patches as we didn't have the experience to re-compile the software at that time, and the process was very laborious and error prone anyway. I can't remember how many patches we wrote, but it exceeded a couple of hundred I think!

Somewhere in the middle of this the pundits in Computer Services Division, the fountain of knowledge in computing matters for Defence, discovered the U-Beaut software they were provided to translate from Honeywell code to COBAL for their new UNIVAC computers didn't work too well. Their solution to the problem was to drag in programmers from all over the department, give them a 2 week course in COBAL and set them to work writing software for personnel and pay systems. Fortunately our Director, Tony Bone, was able to persuade someone important that the work we were doing for the Navy was infinitely more valuable, so we escaped the net.

When all the defects we could fix were resolved, we took the software to the ship and spent a few weeks at Garden Island testing it all (and fixing further defects!). Some time later when the ship had completed its trials and was ready for deployment it was sent to RIMPAC, the big multi nation Naval exercise held every two years around Hawaii. Peter Bray and I were sent with the ship to nurse the NCDS program through the exercises, especially the data link that had been significantly upgraded. We were away for six weeks, mostly at sea, and had not much to do as the software performed very well indeed. During this time Peter decided to add a 'feature' that would allow operators to attach an alphanumeric tag to tracks so they could easily be identified. He wrote it all, many hundred statements, in machine code, and the operators were so keen on it they insisted it be accepted as part of the program. On one of our trips to HMAS *Perth we were to deliver software that got rid of the old bogey, the 'FOUR STOP' that caused the computer to stop when the software detected an error; or at least that was the plan! While I was loading the program, Peter Bryan was telling the Ops room crew about the changes and that if the software detected an error, the state of the computer would be recorded and relevant details printed out on the DEAC. We started the program, and*

within minutes the dreaded cry FOURSTOP was heard. The crew knew about one particular case where they could cause the computer to stop, and they wanted to see if we had fixed it – we hadn't!

When we had accumulated a large file of patches we had to translate the machine code patches into assembly code, re-compile all modules and build new system tapes. This took ages as the compiling system was slow (by today's standards) and took punched cards as its input, so we had to write the code on coding sheets and either punch the cards ourselves, or get our long-suffering operators John and Doug to do it.

About this time the decision was made to purchase some FFG's to replace the old destroyers. Peter Bray and I were sent to the USA for 15 months, He to Dam Neck for OJT on the CDS program, and me to Dahlgren for OJT on the MK-p2 weapons system software. My family and I moved to Fredericksburg Va, about 50 miles south of Washington DC where we had a pleasant stay absorbing a quite different culture (one day the South will rise again…). While in the States I spent an average of one week a month on travel, either to ships where we conducted Systems Integration Tests, to Long Island for MK-92 software tests, or to meetings all over. I was a member of the teams that conducted SIT on HMAS *Adelaide and* HMAS *Canberra at Seattle. When I returned from these trips I had to account for my advance by filling out relevant forms. Each time a very pleasant black girl (Delores?) would call me, and our conversation would take the following path:*

D: Mr Roooooobinson
Me: Yes Delores, what can I do for you?
D: Ah have yo travel form heah – you haven't filled in yo Social Security Number
Me: That's right
D: Wha not
Me: I don't have one
D: Wha not
Me: I'm an Australian
D: Don't yo all have Social Security Numbers in Australia
Me: No
D: Wha not
Me: Because everybody knows everybody
D: Peals of laughter

When I was getting ready to come home, I naively asked if I could take the simulation software used to test the MK-92 program with me, and my request was granted! (I found out much later that it should not have been, that probably there were hoops to go through and money to be paid). This software evolved into the WASP, the wrap around simulation system we used for testing software and training operators.

Not long after returning home and after we got the support systems up and running, it was decided to fit Link-11 to the FFGs. There was much arguing back and forth about the way to do this, but in the end I was able to persuade Mike Moorhen and Tony Bone that the best and least risk solution was to adapt the DDG NCDS program to run in the FFGs. NCDS was quite mature, more so than the equivalent

*WSP provided with the FFGs, and we had had more experience working with NCDS. We set to work adapting to different weapon systems (consoles were the same fortunately) and a different radar processor, but eventually we were done, off the ship (*HMAS *Adelaide) went to RIMPAC, and off I went with it! On the way we came across some American units and requested permission to join their Link. Back came the answer – you can't, you're an FFG. Quick as a flash Jerry Carwardine, the CO. signalled – ah, but we are an Australian FFG! We joined the link and everything went smoothly. A couple of highlights –* HMAS *Adelaide became the first RAN ship to fire a Harpoon missile using remote targeting from a New Zealand P3, the noise from the F-4 Phantom chase planes was incredible as they flew down either side of the ship, and some time later we found ourselves in the Blue Force fleet train and 'sank' most of them before they woke up we weren't on their side.*

The following years saw more changes – the DDGs were upgraded again, the software being produced by a contractor and was subsequently supported by other contractors, just after we had made it possible for all DDGs and FFGs to use a largely common program! The FFGs got their helicopters finally, and we integrated the helicopter data link into the FFG NCDS. I had earlier been a member of the tender evaluation team for the helicopter, looking at the software aspects of the purchase. Next came NULKA, the hovering rocket decoy. I was involved with and assisted the project staff with various software aspects of this project, and actually wrote the Interface Design Specification for the interface between the NULKA control system and the FFG NCDS. Major changes in the compiling system had occurred over the years, moving from the card based system to SHARE 7, the first multiprogramming, multi processing system, to SHARE 43 then to MTASS, a PC based system. The productivity improvement was enormous – it took about half a day (on a good day) to compile one module (of some fifteen modules) under the original system down to a matter of minutes to recompile the whole program AND build the object files. By then we had moved from tape based to hard drive based storage media.

In 1999 I left CDSC to work as a subcontractor to Lockheed Martin and later ADI Ltd on the FFG Upgrade project. My role was to assist in capturing the relevant capabilities of the existing FFG NCDS program, to help the software developers understand the NCDS environment and to produce requirements documents based on this capture.'

MIKE MOORHEN

The following is a transcript of an article written by Mike Moorhen, the then Head of TDG, and printed in CDSC's *Centrepoints* (an internal publication) in June 1992. Sadly, Mike was forced to retire in April 1999 due to ill-health, at a time when he was still comparatively young and had so much to offer to NCDS. Even more sadly, he currently remains unable to contribute further to combat systems engineering in general or even to articles like this one.

'This year marks the 21st anniversary of the NCDS Project and the 18th birthday of the CDSC facility. In that time CDSC has gone from supporting one ship one system (i.e., HMAS *Perth NCDS on return from Longbeach NSY in mid 1975) to the current NCDS family of eight ships and other sites such as* HMAS *Watson, with NCDS and multiple U.S. Navy sensor/weapon subsystems.*

The RAN was fortunate in acquiring the U.S. Navy NTDS technology, in the early 1970's, which has played a major role in the success of both RAN DDGs and FFGs.

Those early years were marked by an initial spur of innovation, driven by the need to change the U.S. Navy's Junior Participating Tactical Data System (JPTDS) version 1XXX to suit various RAN needs; the momentum has not slackened. An exciting time. However, new and better ways of operating and maintaining NCDS are continuing to be adapted to suit evolving operational needs, typical of any warship.

Central to its business of keeping seven (soon to be nine) ships at sea is CDSC's ability to continue to offer a high level of support and training. A critical part of this effort will be CDSC's ability to maintain a high standard and breadth of expertise in its staff and for CDSC to work effectively together as a whole. Improvements in communications within CDSC will go a long way to helping in this regard.

Software deliveries to ships have continued to grow at an ever-increasing rate requiring frequent ship visits alongside and at-sea. The TDG delivery crews are now experts at the one-day Canberra – Sydney – Canberra U-drive "quick drop" delivery and amazingly can even find their way around a ship. Several TDG staffers have even been in training to cope with the rigours of harsh terrain, such as going to Melbourne for FFG05 SIT testing. On balance, the close support provided by a number of CDSC Groups (ODG, SEG, and PROGS) to help with the multitude of ship visits this last eighteen months is much appreciated.

Much TDG time and effort continues to be spent on 'road testing' new NCDS computer programme updates from the Programmers "bike-shop". The TDG crew are busy learning the testing "road rules" of how to push the "'bike" to its limits with as few operator "crashes" as possible. Yes, at great personal sacrifice, they are even getting to know the joys and delights of "red-eye" and early morning test shift testing.

In regard to CDSC's future, there is considerable interest from the Maritime Commander in continuing DDG and FFG Fleet Support work and software updates that will be required for the remainder of our ship's in-service lives. While this, unfortunately, is often seen as the

less glamorous software maintenance work which is not on the cutting edge of today's technology, it does still require a very high level of specialist technical expertise.

However, for those who might be considering other employment, CDSC is presently at a "watershed" of a potentially much bigger effort, the FFG Progressive Update Program, which if approved, could involve CDSC in a major software design and development effort bigger than "Ben Hur". Take it from one who survived "DDG Modernisation"—it's likely to be "ripper"!'

TONY BONE

Tony Bone was involved with CDSC from it's inception through to 2001, when he retired as the long-serving civilian Director of the Centre.

'*I joined the NCDS Project, PD 67, in 1970 shortly after the Navy Board had approved the development of an automated C2 system using a Lytton computer and software to be developed by Weapons Research Establishment SA. The US Navy at that time was developing a C2 system based on the US Naval Tactical Data System (NTDS) for three USN DDGs. The USN offered this system to the RAN with the carrot that their C2 operational software would also be supplied. Coincidentally the RAN order would result in a major reduction in USN unit hardware costs by doubling the order. The Naval Board, following considerable effort, was convinced to change its previous approval in favour of the USN proposal – NCDS was conceived. It was at this time I first met Eric Swenson, "Mr NTDS" as he was known, a reserve Captain in the US Navy. Eric was a very remarkable, intelligent dynamic individual for whom there was no obstacle that could not be overcome. Early 1971 saw the establishment of the Foreign Military Sales (FMS) Case AT-LAM-P2 that, with an initial deposit of A$20,000, was sufficient to allow the USN to proceed to contract with its suppliers. The initial FMS case was modified in October 1971 to include hardware and software for CDSC. Faith Rawdon-Smith came into the project at that time at the behest of Eric. Her dedication and motivation were major contributors to the successful delivery of the materiel and services provided under Lam P2 for both CDSC and the ships. All that was left to do then was to find a building for CDSC, prepare it, recruit and train staff together with seeking the necessary approvals!!*

Selecting a site for the CDSC quickly became a hot topic. The preferred Navy location was HMAS *Watson, Sydney, but it was not an option due to scheduling constraints and the lack of available real estate (reserved for the Tactical Trainer). A "temporary" compromise was agreed to rent a site in Fyshwick ACT. Of the 5 buildings offered there only one was found potentially suitable. Even so substantial modifications to the building were required, the costs for which forced a change from rental to purchase. 1974 saw CDSC take shape including systems installation and set-to- work and staff recruiting. Sperry Univac was heavily involved led by as their Bruce Grevenow assisted by Morley Moe and Denny Drake among others. The Sperry Univac contribution was part of the FMS cases managed by both Charlie Thomas and Eric Swenson. Mike Moorhen was on the team and his father Norman Moorhen headed up the EMIE local CDSC support contractor. (EMIE's involvement had progressed from their involvement with the cancelled DDL Project). Training in the USA was underway for key personnel, Ed Goldsmith (C2), Mike Moorhen (weapons) and John Currie (simulation). Another invaluable contributor over the years was Don Kiley. His first employment after graduating was with a Company providing support to that part of the US Navy also involved with the RAN. He became involved with CDSC through supporting Faith Rawdon-Smith, a task which required a steep learning curve*

The first of the RAN DDGs, HMAS *Perth, received her digital combat system upgrade in Long Beach, California in 1975. (The three prime NTDS contractors, Hughes, Univac and Collins hosted a hospitality evening in Long Beach - it was surprising how many people from the East Coast had meetings on in California at that time!). The USN C2 software team installed the software on Perth followed by a delivery to CDSC. CDSC was now operational and ready to support Perth on her return to Australian waters six weeks later. Fit out of the remaining two DDGs was achieved in Garden Island Dockyard in Sydney with CDSC taking a lead role in C2 software delivery and final system*

testing. CDSC's role from then on was to be the focal point for the life cycle support of the Combat System software and the training of ship's operators and maintainers. Modification of the C2 system was, of course, the primary 'raison d'être' for establishment of the CDSC. The basic USN combat system interface design specifications were not changed and so software updates for the associated ship sensor and weapon systems could be incorporated as these were received from the USN under the DDG Follow on Support FMS Case. Updates from the US were however tested for compatibility with NCDS at CDSC prior to issue to the Fleet. Any deficiencies found in these software upgrades were forwarded to the US, usually with our proposed solutions to the issue. It's worth noting here that the interaction between CDSC staff and their USN counterparts was invariably a pragmatic exchange of views between equals; we were later described by someone in the FMS office as being the most technically demanding and outspoken foreign navy they dealt with!

The first big challenge for CDSC arose in mid-1977 as a consequence of a major Link 11 data link change which, unbeknown to us, was underway in the US. The Follow on Support Case provided advance notice of software updates for combat systems only so we first heard of this Link 11 change when the RAN representative returned from a RIMPAC planning conference. We realized immediately that a major software update to the RAN DDG's NCDS would be essential for them to be able to exchange Link 11 data with USN ships during RIMPAC 78. We were behind the eight ball from the outset as we had no details of this major change and, as so often became the case, releasability of USN specs became an issue that took some time to resolve. With much blood, sweat and tears our team delivered a NCDS "Model 4" Link program to HMAS *Perth the day before she sailed for RIMPAC. However, because of the limited testing period at CDSC, members of our civilian staff were approved to embark on the voyage to resolve defects as they arose. Perth's first RIMPAC was highly successful and in acknowledgement the Maritime Commander awarded a citation to CDSC, and Perth presented the Centre with her Pennant. Both were a tribute to the sterling efforts by CDSC staff for a job well done. To minimise the chances of similar interoperability problems occurring in the future liaison links were established with the US Navy's Centre for Tactical Link Interoperability (NCTSI) in San Diego and this close association was to serve the RAN and USN very well in the years to come.*

Charlie Thomas, the USN DDG FMS Case Manager, was also responsible for the RAN's FMS Case for our DDGs. He had had reservations about supporting a shore site under a FMS case for ship-fitted equipment and he determined that CDSC systems unique support requirements were not common with the ship-fitted systems and could not therefore be supported under the ship FMS Case. The Operational Assistance FMS case was established to provide for CDSC's shore support requirements for NCDS; it was initiated and managed by Faith Rawdon-Smith. The unique shore equipment at CDSC requiring support from the USN were placed under the "Op Assistance Case" (as it became known) and it provided links to the USN Fleet Support at Damneck,Va (USN DDG C2 software support) and the US Navy's Data Link Test facility (ICSTF) in San Diego.

The purchase of the FFGs for the RAN brought new challenges to CDSC. Although the FFG NCDS equipment was similar, sensor and weapon systems were different. A major upgrade to the Centre was required to cope with the expanded support requirement, including additional classrooms. As it was not possible to add another floor to the existing premises the building next door was eventually purchased. Four FFGs were built in the USA with numbers five and six in Williamstown, Victoria. Neither USN nor RAN FFGs were initially fitted with a Link 11 capability. CDSC got CNSAC approval to adapt the USN DDG NCDS program for the FFG and purchase Link 11 communication equipment. The significant effort by CDSC staff resulted in achieving a Link 11 capability for the FFGs in advance of the USN and a NCDS program 80% common between the two ship classes. The advantages were a single NCDS operator's course and the flexibility to post NCDS operators between ship classes without retraining.

The next major CDSC task was the upgrade of the DDGs in the mid 80s. This project followed the USN DDG combat system update except for NCDS. Sensor and weapon systems were replaced or modified requiring major changes to NCDS software and CDSC systems. With CDSC required to continue supporting the unmodified DDGs, the task of modifying NCDS software was arranged through FMS with Sperry Univac who had recently completed a similar task for USN DDGs (much to the displeasure of some CDSC staff!). Apart from training ship's NCDS operators and maintainers, the CDSC roles for the DDG upgrade were acceptance testing of NCDS software, combat system integration testing both ashore and on-board ship. These tasks were generally completed on time and within budget. (This success was in no small measure due to the expertise of both service and civilian staff at CDSC who expended hundreds of hours of effort in developing the NCDS software specifications and upgrade, test and integration, and in providing direct combat system support to the Fleet during the acceptance period.) Follow on support arrangements similar to those prior to the upgrade were put in place with the USN. Sensor and weapon system software continued to be supplied as we had deliberately minimised modifications to the US Navy's interface design specifications during the original planning for DDG MOD.

Co-locating operator and maintenance training and Fleet support engineering services with the software management functions also provided significant benefits. It provided a comprehensive and integrated overview of the total training requirement for the combat system and exposure to students of personnel who would be providing support to them in the future. Apart from their training role, CDSC instructor staff were also invaluable participants in CDSC teams that assisted the ships in the resolution of combat system problems. Their detailed knowledge of some areas of combat system hardware was invaluable.

The first Gulf War created challenges for CDSC. Our first challenge was the receipt of an 'Immediate' signal on a Friday night at 1715. The C2 system of a ship in the Coalition force (neither USN nor RAN) was shutting down due to Link 11 problems ostensibly caused by an RAN FFG. We were able to send a solution to the FFG within five hours that successfully overcame the problem. Subsequent analysis proved that we were consistent with the Link specification but it showed that ambiguities can arise as different Navies can interpret specifications differently. A second but unofficial report indicated the FFG may be causing issues for a US army missile system linking with an AWACS through which the FFG was also linking. Intensive investigations during and subsequent to the Gulf war failed to produce concrete evidence of the problem. These matters highlight the potential problems that can arise through the use of data links and the need for unambiguous data link specifications not only between platform computers but also the operator interface. In addition substantial investment is required to validate system interoperability at the single service, joint and combined levels and for the latter not just with the USA. It was around this time ADFTA was borne and I became two-hatted, to Navy for CDSC activities and Defence Central for ADFTA. I also established links with the Joint Interoperability Test Centre (JITC) in Arizona that was responsible for US joint interoperability testing; my objective was to find out how interoperable RAN platforms would be when directly tested against US Army, US Air Force, US Marine and "other" systems. These tests were complex requiring 12 months to organize and coordination with many facilities spread across the USA (timezone differences didn't help) tied together through compatible secure communications at JITC. The connection with JITC continued over the years not only to provide the system under test but to contribute to US testing.

The role of ADFTA was established as the ADF authority on tactical data links to provide the message set for implementation in ADF systems and to test the resulting product for conformance to the data link standard. The inclusion of Link 16 into ADF project requirements added a dimension to ADFTA activities. Link 16 is a significantly more complex data link than Link 11; it requires a test regime four to five

times larger than that for Link 11, use of pre-installed network designs (an ADFTA responsibility) and approval of the Civil Aviation Authority for its use (as it can operate at frequencies within the Air Navigation Band).

The US established a series of bilateral Agreements with Pacific nations which created the Command and Control Interoperability Board (CCIB). These Agreements were based on each nation funding its own work. From these involvements I formed the view a regional forum to manage interoperability issues should be encouraged; was not opposed to the idea of bilateral Agreements but a multi-lateral agreement would have (and would still) provide a basis to the more timely management of issues like common specifications and testing across southern hemisphere nations rather than just 'one-on-one' with the US. It was under the CCIB that I first met Ed Towers who was the US CCIB Secretary and Ed provided valuable support in our quest for regional interoperability although this goal is yet to be realised. The CCIB actually provided the means through which Australian forces could participate in US JITC test activities and this remains so to this day. I left CDSC before the ADFTA organization was fully established but I could see that the complexity and significance of interoperability issues would eventually predominate at the CDSC site; and so it has come to pass with the FFGUP Project slowly coming to an end and Navy's restructuring of combat system support concluding the saga of CDSC.'

CMDR RAY CAIRNEY, RAN

CMDR Ray Cairney, RAN was a CDSC repeat offender, with postings as:

- MK 152 Computer instructor and course developer: Jan 1983 – May 1984 (LS/ PO)
- DDG Mod Systems Courses and HSEG's helper: Jan – Dec 1990 (SBLT)
- Project Officer then Senior Engineer SEG: Feb 1996 – Oct 1999 (LEUT/LCDR)

'I was serving in HMAS *Perth as a Leading Seaman working Missile Computer in mid 1982. My Chief at the time was Frank Payne and he had been posted to CDSC to be the instructor of the first MK 152 Computer (Univac 1219) course to be conducted by the RAN. Frank knew I was due to come ashore and suggested I look at a posting to CDSC so that I could give him a hand with course preparation, etc.*

So I joined CDSC in January of 1983 just in time to see Bob Hawke voted in as Prime Minister. My initial task of assisting with course development quickly changed to becoming the primary instructor for the MK 152 course, which was to start later that year. The course was to cover all elements of the Missile Computer suite including the MK 152 Computer, the MK 95 I/O Console and the MK 72 Signal Data Converter (SDC).

It was a challenge for all concerned. We had all the course material from the US Navy, but as I reviewed the documentation I began to wish I'd paid attention a bit more in class when I completed the training at Mare Island in California some two years earlier.

CMDR Brian Taylor was HSEG at the time; LCDR Warren King was his deputy, LEUT Alan Weaver was the DDG expert with a young LEUT Peter Law working the FFG desk. As readers will see from the time line, 1983 was a season of growth for CDSC. DDG support was in full swing, the third FFG was commissioned, the repatriation of missile system training had begun and DDG Modernisation was gaining momentum. At the time, planning was well in hand to expand CDSC to the adjoining building at 86 Maryborough St. I was perhaps one of the more junior members of the SEG team. Aside from Frank Payne, the other senior sailors I recall included Roger Stewart, Greg Hajek whom I knew from Perth, one Chief Goodwin (Clem or John, the first name escapes me) and Ed Barton was in the store.

After the first course was completed I set to reworking all the course material into something a little more structured, and finished just in time for Mick Crossan to take the reins and for me to take flight (QANTAS) heading back to Mare Island for AN/SPG-51C radar training.

In 1990 I again joined CDSC. I had just completed SD Officer training and desperately wanted to get back onto a DDG. I was panelled for the full suite of DDG Systems Courses that were running throughout 1990 but there were lengthy gaps between courses so I was seconded to SEG during those times as the odd jobs SBLT. The systems courses were led by WO Mark Kirkpatrick (no relation to Slim Dusty I'm told). I found the learning quite exciting because my next ship would be the first time I'd serve on a modernised DDG. All three DDGs had been modernised by then, but we were now faced with the obsolescence of a number of key elements of the combat system. Notorious amongst these was the OJ-172 DEAC. The tape decks were wearing out, but at the time this was manageable. The teletype on

the other hand was a different matter. Parts for the various teletype machines around the ship were becoming hard to come by. The Model 35 KSR on the DEAC was no exception. CMDR Drew McKinnie was HSEG at the time and he asked me to investigate some options to replace the Model 35. With a lot of help from the maintenance contractors we managed to identify a commercially available teleprinter that could do the job. One of the key ingredients was the requirement for a 20mA current loop interface, and there were very few manufacturers who still made machines with such interfaces. So it didn't matter what choice we made for a teletype replacement, we would still be buying obsolescence. The brand name of the printer escapes me at the moment but it was much more reliable than the Model 35. Another printer on the way out was the Kleinschmidt that sat atop the MK 95 I/O Console. In time we managed to replace it with the same machine we used on the DEAC. The battle with obsolescence was perpetual as I was to find out in later years.

While I was attending systems courses someone found out that I once instructed the MK 152 Computer course, so I was roped in as a stand in instructor. It was interesting to find that they were still using the course material I prepared some six years earlier. I was quite chuffed about the fact that it lasted so long.

From there it was back to sea for me and I joined Perth again in January 1991 as the Missile and Guns Systems Engineering Officer. I was back at sea again in Hobart in January 1995 as the DWEEO, and during this time with the Fleet I got to see first hand Roy Naboa at work on the MK 152 Computer Life Extension program. Hobart had already been done, but during several visits to warship Perth I saw Roy and his off-sider doing great work giving the MK 152 a new lease on life.

After Hobart I returned to CDSC, this time as the Projects Officer in SEG taking over from Mike Simpson. I moved into the Senior Engineer billet when Mick Moran took over as HSEG which was just before Geoff Cannon joined for the first time.

At that time our interaction with the Navy Minor Capital folks was growing. The Interim Helo Data Link had just put to sea, and the RAN Standard Input/Output Device (RANSID) project was in full swing. RANSID was to be the end game to address the DEAC obsolescence. After much anxiety the minor project was approved, and Chief Ray Irvine did a remarkable job with the initial work on the software proof-of-concept before we were able to get a dedicated programming team on to the job. We made two variants of the RANSID both functionally the same, but one built to commercial standards for use ashore while the other was a ruggedised unit. I was fortunate enough to see RANSID join the Fleet while I was at CDSC, and the maintainers quickly came to like it (although it's more likely they enjoyed not having to fix the DEAC).

While we were busy finding a replacement for the DEAC the poor old MK 95 Console in Missile Computer was wearing out fast. From memory, we had already written software for the RANSID to emulate the MK 95 but there weren't enough ruggedised units in the project to replace the MK 95 units in the three DDGs.

The expected remaining life of the DDG meant that securing additional funds to procure additional Ruggedised RANSID units to replace the MK 95 Console was most unlikely, and because we didn't think we would get approval to replace a piece of military equipment with commercial gear, it was decided to install the commercial RANSID alongside the Mk 95 Console in the Missile Computer room to augment (replace) the MK 95. Doing so had the dual benefit of providing a reliable alternative to the MK 95 but also, because RANSID could emulate the DEAC and the Mk 95, it provided a very fast alternative load device for the AN/UYK-7 in NCDS.

Once again we had a great team in SEG. Geoff Cannon was running the show, Pete Dowton joined as the LINK expert, Phil Scott took over as the Project Engineer and Sonia Richards was with us for a while as the equipment suite maintenance engineer until Nigel Smith joined the team. Marty Collins and Dick Emery spent most of their time playing table tennis as did Ken Eccles and Mick Baker, but together they made a most valuable contribution the operational availability of the Fleet combat systems. There was seldom a day where we weren't helping an FFG or a DDG with a defect or a software problem. We even had to send Marty Collins and Phil Scott (with a broken arm) to Pulau Tioman to help fix an FFG SDC. CDSC finally got shot of me in late 1999 when I joined Brisbane as the decommissioning WEEO.

However I managed to stay connected to the place. I took up the position as the RAN exchange officer (FFG Combat System Software Support) at the Combat Direction System Activity (CDSA) at Dam Neck in Virginia Beach in December 2002. CDSA and CDSC have had a strong relationship over many years. The Dam Neck position is primarily to foster combat system interoperability. In years passed this manifested itself as Tactical Data Link interoperability firstly with the DDG combat system, then with the FFGs. As the configurations and the usage profile of the RAN FFG began to diverge from its USN cousin, the need to maintain TDL interoperability between the two nations' FFGs became less important. What remained important was the need to stay abreast of combat system developments in the USN, particularly as they related to interoperability. I was particularly fortunate to be involved in a Distributed Interactive Simulation training experiment called CReaMS (Coalition Readiness Management System). CReaMS was essentially a simulation based training system that could allow geographically dispersed training environments (including warships) to be virtually co-located to take part in a war-game training scenario. On one occasion we had a training scenario running on computers at Dam Neck or Dahlgren, an Arlie Burke DDG in San Diego and the FFG trainer at HMAS WATSON playing in the scenario. It was an excellent way to experience what other navies are doing when it comes team training and interoperability.

There is no doubt that I have treasured and lasting memories of 84 Maryborough Street. What I learned there and the people I met there have influenced me greatly over the years. The capability that CDSC brought to the RAN will not be easily replaced.'

Bits and Bytes

COMMON ACRONYMS USED AT CDSC

AAW	Anti-Air-Warfare
ADACS	Australian Distributed Architecture Combat System
ADFTA	Australian Defence Force TADIL Authority (see TADIL)
ADMIN	Finance and Administration Group at CDSC
AEGIS	Later USN replacement for their NTDS C2 system
AIOTT	Action Information Organisation Tactical Trainer
AWADI	Amalgamated Wireless of Australia Defence Industries P/L – joint venture company
BITE	Built-In Test Equipment
BOT	Beginning of Tape
C2	Command and Control (system)
C&C	Command and Control (function)
C3	C3 Pty Ltd – a joint-venture company between EMI(E) and Unisys
CCAEP	Computer Control Action Entry Panel – part of an OJ-194
CDSC	Combat Data Systems Centre
CIC	Combat Information Centre
CIGARS	Console Internally Generated And Refreshed Symbology
CMS-2	Compiler Monitor System version two – USN assembler language
COTS	Commercial off the Shelf equipment
CPU	Central Processing Unit
DARP	Data Acquisition & Reduction Processor
DCDSC	Director of CDSC
DDG	Guided Missile Destroyer
DDI	Digital Data Indicator
DDMFU	Double Density Mated Film Memory Unit
DEA	Data Exchange Agreement (with the US)
DEAC	Data Exchange Auxiliary Console – an OJ-172
EOT	End of Tape
FCDSSA	Fleet Combat Direction Systems Support Activity – San Diego USA
FCS	Fire Control System
FFG	Guided Missile Frigate
FMS	Foreign Military Sales
'greenie'	Electronics Technician, RAN
G.I.D.	Garden Island Dockyard – Sydney

GFCS	Gun Fire Control System
HADMIN	Head of the Finance and Administration Group at CDSC
HODG	Head of the Operational Design Group at CDSC
HPROG	Head of the Programming Group at CDSC
HSEG	Head of the Systems Engineering Group at CDSC
HTDG	Head of the Test & Development Group at CDSC
HTRNG	Head of the Training Group at CDSC
IFF	Identification Friend or Foe
I/O	Input/Output function
ICKCMX	Integrated Circuit Keyset Central Multiplexer – an OU-95/UYK on DDGs
ILS	Integrated Logistics System
IOC	Input Output Controller
JPTDS	Junior Participating Tactical Data System (USN)
Kb	kilobyte = one thousand and twenty four decimal bytes
LSMC	Launcher System Missile Console
Mb	megabyte = 1000 decimal kilobytes
METC	US Navy Engineering facility at St. Paul, Minnesota, USA
MIS	Minor Item Submission
MSSS	Modular System Software Specification (spoken as ‘MS cubed’)
MTASS	Machine Transferable Support Software
MTF	Mean Time to Failure
MTS	Maintainer Training Suite at CDSC
NAVSEA	Naval Sea System Command – USN
NCDS	Naval Combat Data System (RAN)
NTDS	Naval Tactical Data System (USN)
NSWC	Navy Surface Warfare Centre – Dahlgren USA
NWSA	Navy Warfare Systems Agency
ODG	Operational Design Group at CDSC
OPFCO	Operational Procedures Functional Checkout
OSUM	Operational Software Upkeep Management
OTS	Operator Training Suite at CDSC
PD 63	Project Directive number 63
PMEIC	Peripheral Multiplexer External Interface Converter – a CV-3719/SYS-1 on DDGs
POFA	Program Operational Functional Appraisal
PTR	Program Trouble Report
PROG	Program Group at CDSC – also a member of the PROG Group
RANTDL	Royal Australian Navy TDL Group

READIEX	Readiness Exercise
RHI	Range Height Indicator
RVP	Radar Video Processor, a CV-2834
SATNAV	Satellite Navigation
SDC	Signal Data Converter, a CV-2953A(P)/UYK on an FFG
SDTN	Ship's Data Transfer Naval – Canadian version of NTDS
SEG	Systems Engineering Group at CDSC
SERCo	Name of last hardware/software contractor at CDSC
SHARE	A system which supports multiple users writing and/or modifying software code
SHARE/7	SHARE system hosted on UYK-7 computer
SIF	Selected Identification Feature (of IFF)
SOAP	RAN Naval Stores assessment team
SPAWAR	Space & Air Warfare – USA
SQT	System Qualification Trial
SSTS	SLQ-32 Simulation Training System
TADIL	Tactical Digital Information Link
TCS	Total Combat System
TDG	Test & Design Group at CDSC
TDL	Tactical Data Link
TRNG	Training Group at CDSC
TTB	Tactical Trainer Building at HMAS *Watson*
UYA-4	Version of general purpose, Mil-Spec Data Display (US Army/Navy nomenclature)
UYK-7	Version of general purpose, Mil-Spec Computer
UYK-20	Version of general purpose, Mil-Spec Computer
UYK-43	Version of general purpose, Mil-Spec Computer
VAB	Variable Action Button – part of Computer Control Action Entry Panel on a Display
VSS	Video System Simulator
WAP	Wrap-around Processor
WASP	Wrap-around Simulation Program
WCC	Weapons Control Console
WCP	Weapons Control Program
WEEO	Weapons Electrical Engineering Officer
WESS	WCC Event System Simulator
WRE	Weapons Research Establishment (now part of DSTO)
WSC	Weapons Support Centre – Dahlgren USA
WSSC	Warfare Systems Support Centre – G.I.D.
XS	Enter Executive State Instruction – CMS-2 software language

CHIEF OF NAVY ORDER 285/74

UNCLASSIFIED
285/74—Naval Combat Data Systems—Establishment of the Combat Data System Centre

1. The first major RAN digital computer assisted Command and Control System will be fitted in the DDGs and the initial installation in HMAS *Perth* will become operational by mid 1975.

2. The Naval Combat Data System (NCDS) Project is a directorate within the Naval Technical Services; however, it has responsibilities through the Naval Staff for the systems operational capabilities.

3. To support the operational, test and diagnostic computer programmes the Combat Data System Centre (CDSC) has been established in Canberra. The CDSC, a component of the NCDS Project, is administered as part of the Department of Defence (Navy Office).

4. The CDSC contains compilation equipments and a full ship system. By the end of 1974 a maintainer training facility and the computer equipments of the Digital Tartar Fire Control System will be installed.

5. The prime function of the CDSC is to support and develop RAN operational computer programmes and, from early 1975, training for operators and maintainers. In the longer term it is intended that the CDSC will provide computer programme support for the Digital Tartar System.

6. Access to the CDSC, which is located at 84 Maryborough Street, Fyshwick, ACT 2609, can be arranged by telephoning (062) 95 3922.

7. Correspondence should be addressed to:
The NCDS Project Director,
Department of Defence (Navy Office),
CANBERRA, ACT 2600.

(N341/8/4)

COMMENDATIONS FOR CDSC

Commendation by Flag Officer Commanding Her Majesty's Australian Fleet – 1978

Flag Officer Commanding Her Majesty's Australian Fleet commends the staff of the Combat Data Systems Centre, Fyshwick, Canberra, for their outstanding competence and sustained effort in achieving the accelerated implementation of the NCDS Model IV program into the Fleet.

Originally it was intended that RAN DDGs should become capable of Model IV operation by the end of 1978. However, in July 1977 advice was received that the US Pacific Fleet would be capable of Model IV for RIMPAC 78, a major exercise to be held in 1978. If HMAS *Perth* were to achieve compatibility with The US Navy units for this valuable Link 11 operating opportunity, a major acceleration of the planned implementation date would be necessary, requiring program delivery to HMAS *Perth* by February 1978, in order to test the system before deploying.

The delivery date was achieved and the performance of the NCDS Model IV throughout RIMPAC 78 was successful and reliable. Such an attainment, involving a vast compilation task in a drastically reduced time frame reflects highly on the competence, professionalism and devotion to duty of the civilian and uniformed members of the CDSC staff, all of whom can feel justifiably proud of their achievement.

Neil E M^{c}Donald
Rear-Admiral, RAN

Commendation by Maritime Commander Australia - 1981

The Maritime Commander Australia commends the Combat Data System Centre for its outstanding professionalism and devotion to duty during Operation DAMASK.

The service provided to HMA Ships *Brisbane* and *Sydney* in the form of software support and problem resolution reflected well on the professionalism of our ships, men, and support services. Additionally, the highly competent and dedicated work undertaken by CDSC, in the delivery of the new NCDS baseline 5XXX to HMA Ships *Adelaide* and *Darwin* prior to their deployment to the Gulf, again demonstrated the continued exemplary software support being provided by the Combat Data System Centre to the FFG and DDG classes of ships.

The initiative, professionalism, and dedication demonstrated by the staff of the Combat Data System Centre in support of Operation DAMASK are an example to others and in the finest traditions of the Royal Australian Navy.

R A K WALLS
Rear Admiral, RAN
Maritime Commander Australia

CN SPEECH TO CDSC 30TH ANNIVERSARY DINNER – 04 NOV 04

Ladies and gentlemen, Commander Geoff Cannon, good evening. I've got the hard slot to tell the truth tonight because I'm the fifth speaker and you've already had your coffee and cheese so there is no part of the meal left to look forward to. But looking at the sea of both familiar and unfamiliar faces before me today reminds me of the numerous accomplishments that CDSC staff have made, and are continuing to make for the Navy of today.

I am asked to talk about the strategic value to Navy and the involvement with industry.

- 87 DOA – Self Reliance.
- CDSC has given us independence.
- The ability to play effectively at the high end and in 2 wars in the Gulf, many significant RIMPACs, Crocodiles, Tandem Thrusts.
- Best anecdote – First Gulf War. BRISBANE Link 11 interface problem. Brit type 42. Rob Elliot, CPORP Hans 'Fingers' Tench. Fixed in 24 hours, USN, RN did not believe it possible.
- CDSC has lead the way in data links for ADF. This interoperability – so important today.
- Collocation of NCDS training centre removed the temptation of *Sasha's*– good for our reputation.
- CDSC has been an unsung national asset.
- Know we had an international reputation. When I was MC Tony Bone always wanting to go overseas to preserve it.

An area of early innovation by CDSC was its involvement with tactical datalinks. As a result of this, the RAN is one of the most experienced Link 11 navies. Today, our advanced appreciation of interoperability issues stems from great work done by CDSC over a long period, but particularly in the late 1990s when Richard Menhinick lead the charge top establish an ADF Tactical Datalink organisation.

The effective relationship that CDSC has maintained with its counterparts in the USN has provided much valuable advice and information over the years, with respect to the inevitable changes in combat system technology, the necessary infrastructure changes over the years, and the expansion in CDSC's roles and functions.

Getting the NCDS hardware and software products right is the aim but of course not the big picture. To achieve this, the people have to generate ideas, produce and test programs, keep a complex facility operating, respond when needed, train and advise, argue and convince to generally make it happen. This has been one of the strengths of CDSC, being a one-stop shop for the control of almost all the combat system support processes. All of the functions necessary for this have been done by you people here, and because you got it right, Navy has achieved outstanding capability and reliability from NCDS.

From its inception, CDSC has been aided by a contracted commercial team. You have always had a unique and expert pool of knowledge and experience that comes from your blend of military, civilian and contracted staff. The on-site contractor arrangements at CDSC are an excellent example of Navy and industry working together. SERCO is successor to a sequence of companies who served CDSC very well.

First it was EMI Pty. Then the name was changed to THORN-EMI, then to AWA, then to AWA Defence Industries, then to AWASCO, and finally to SERCO.

Navy is indebted to the many contractor staff who have worked at CDSC, in many cases for as long if not longer than any Defence personnel! The cooperative spirit that has and continues to exist at CDSC is an example of how combat system support might be accomplished in the future, if under differing arrangements.

CDSC has worked with a wide range of Overseas and Australian companies in the maintenance of combat systems, development of technology concepts or management of Navy's interests in the expanding tactical data link infrastructure within Defence. The list is substantial and over time has included ADI, ATI, Boeing, CDM, CEA, Comptek, Compucat, CSA, DRS, Honeywell, Hughes, Lockheed-Martin, Northrup-Grummen, Raytheon, Rockwell-Collins, SAAB, SERCO, Sperry, Tenix, UNISYS, UNIVAC and others. The breadth of interaction with industry, both nationally and internationally, continues to grow but it is a healthy sign that many of our Australian commercial partners have Navy background in their genes and in their teams. Today, Navy's continued work and mutual understanding with industry ensures that we have better and quicker solutions.

But from a collaborative planning process between Maritime Command and Navy Systems Command comes a revised combat system management infrastructure that retains the value of past experience but fits the new mould. This will be known as the Navy Warfare Systems Agency. NWSA will take the best of the past and transform it with the present to achieve the best for the future – a centre of combat system expertise for all Navy combat systems.

If CDSC is regarded as a major success, which it is without doubt, then each person here has played a significant part in that achievement. The majority of you here tonight have moved onto other jobs, moved on outside Navy. But rest assured that your participation in combat system support at CDSC continues to bear fruit for Navy and Australia's national security.

Well done to everyone who has been involved with CDSC over the past 30 years of excellent service. You have done yourselves and your Service very proud.

VADM C. Ritchie AO RAN
Chief of Navy

FINAL SIGNAL ON CLOSURE OF CDSC

R 300211Z JUN 06 ZOJ1
FM CN AUSTRALIA
TO RAN ALL SHORE 1/3
RAN ALL SHORE 2/3
RAN ALL SHORE 3/3
SHIP SPT UNITS
AIG 3600
AIG 3602
INFO RAEWFE/AUSTNAV WASHINGTON
RHMCSYY/AMEMBASSY CANBERRA
RAYWAJ/DMO MARITIME
RAYWAJ/ADFTA
BT

UNCLAS
SIC Z4P/Z4I/W2Q
SUBJ: AMALGAMATION OF CDSC WITH NWSA

1. ON 01JUL06 THE RAN COMBAT DATA SYSTEMS CENTRE (CDSC) WILL TRANSFER FROM MARITIME COMMAND TO NAVY SYSTEMS COMMAND AND BE SUBSUMED WITHIN THE NAVY WARFARE SYSTEMS AGENCY (NWSA).

2. ALL CURRENT ACTIVITIES AND RESPONSIBILITIES OF CDSC REMAIN EXTANT WITHIN NWSA AND WILL BE MANAGED UNDER A NEW SERVICE LEVEL AGREEMENT COVERING SUPPORT SERVICES TO THE FLEET. POC FOR NCDS AND TDL ISSUES ARE UNCHANGED. CURRENT NCDS SUPPORT (HARDWARE/SOFTWARE TRAINING) WILL CONTINUE TO BE MANAGED THROUGH THE CDSC FACILITY.

3. NWSA WILL CONTINUE TO EXPAND COMBAT SYSTEM REGULATION AND TECHNOLOGY MANAGEMENT SERVICES USING THE ADDITIONAL RESOURCES PROVIDED BY AMALGAMATION OF CDSC.

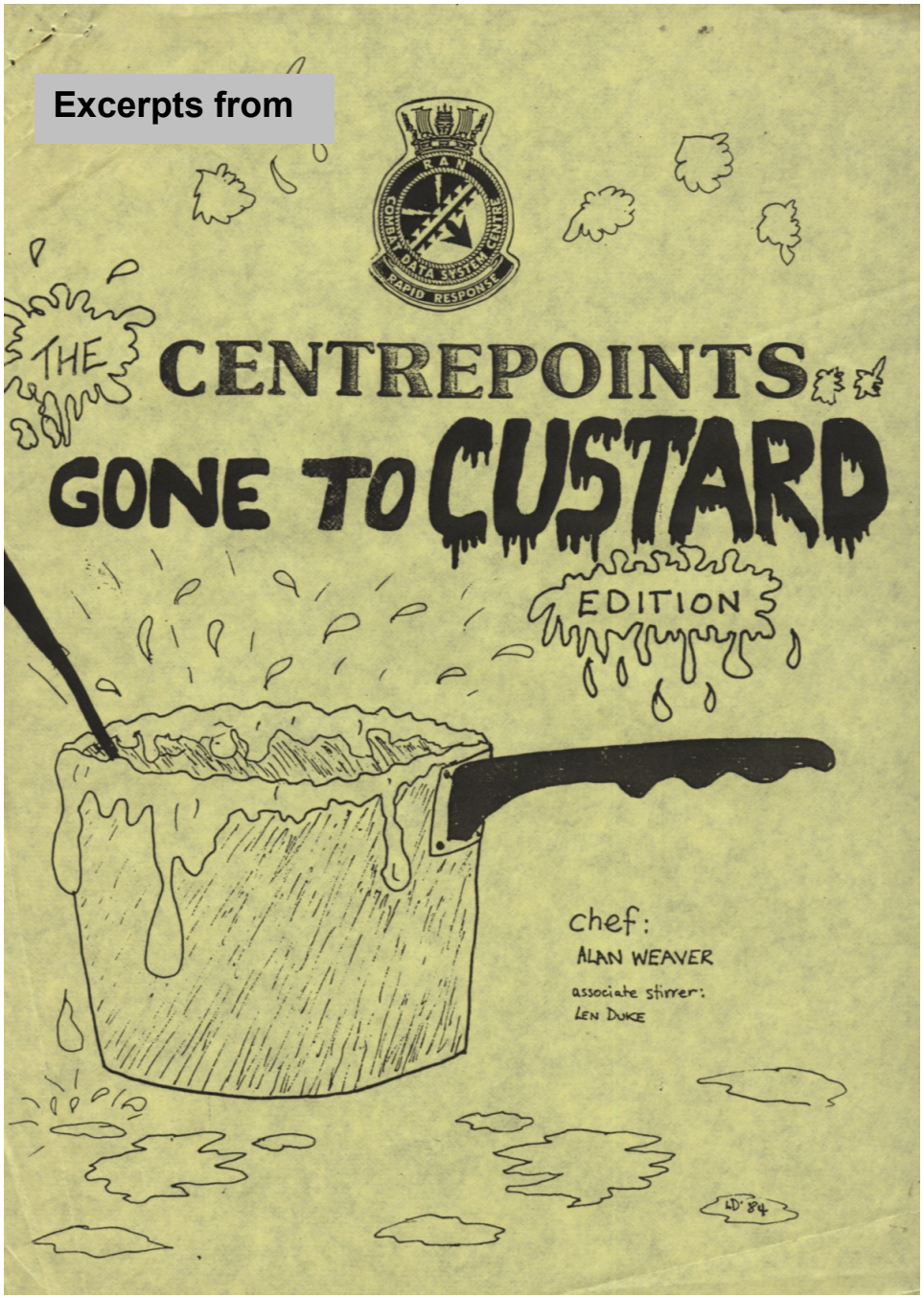
4. THESE CHANGES MARK THE END OF SOME 30+ YEARS DURING WHICH CDSC HAS

BEEN A CENTRE OF EXPERTISE FOR NAVY'S COMBAT SYSTEM TECHNOLOGY PROVIDING ALL ASPECTS OF SUPPORT INFRASTRUCTURE INCLUDING MANAGEMENT OF OUR VERY IMPORTANT AND VALUABLE RELATIONSHIPS WITH MANY USN PARTNERS. WHILST THIS WORK HAS BEEN PREDOMINENTLY NCDS ORIENTATED CDSC HAS ALSO BEEN EXTENSIVELY INVOLVED IN THE ESTABLISHMENT AND IMPLEMENTATION OF TACTICAL DATALINK SYSTEMS WITHIN NAVY.

5. CDSC HAS PROVIDED EXCELLENT SERVICE TO THE RAN AND UNIQUELY CONTRIBUTED TO THE BIRTH AND DEVELOPMENT OF COMBAT SYSTEM TECHNOLOGY IN AUSTRALIA. THE PROUD HERITAGE OF CDSC LIVES ON IN ITS AMALGAMATION WITH NWSA. CONGRATULATIONS AND WELL DONE TO ALL WHO HAVE SERVED AT CDSC.

BT

Excerpts from



FOREWORD

A great deal has happened at CDSC in the six months since the last edition of CENTREPOINTS and the time is now ripe to review recent events and bring you up to date on what lies in store in the immediate future.

During the past half year, in addition to the Centre's ongoing and routine responsibilities, we have seen the DDG 6XXX program delivered to the Fleet and also the introduction of the FFG 5XXX program. Both of these have been demonstrated to be definite improvements and for the first time permit a considerable degree of software compatibility between the two classes of ship.

Link 11 has been installed in the first RAN FFG (well before the USN, who have not yet achieved the same goal in their early FFGs) and the link will be fitted in the other two FFGs by the end of May.

At CDSC itself the Share 7 equipment is now installed and running in its permanent, revamped quarters on the lower floor and work is well underway on modifying the building next-door so we can expand into it. The biggest project of all, DDG Mod, is continuing to gather momentum and will present us with many challenges for a long while to come. All of these activities are in the main proceeding very satisfactorily despite a greater than normal changeover of staff, both civilian and service, during the period.

Between now and the end of the year equipment ordered as part of the DDG Mod software development task will start arriving and will have to be installed and set-to-work. It is also probable that we will gain another suite of equipment which will effectively give us a second CIC and permit greater efficiency in operator training and software testing and development. Whether or not this eventuates depends on approval being given to the transfer of AIOTT equipment at HMAS *Watson* to CDSC and such a decision is expected in the fairly near future. By the end of the year (or soon after) the building next-door should be ready and classroom training will then be conducted there. Others to move will be SEG, EMI, stores and also the contents of the plant room. Meanwhile our investigations into a new generation NCDS are continuing and I am hopeful there will be significant advances in this area during 1984.

So it has been, and will continue to be, a busy year. After only six months as Director I have been impressed by the scope of CDSC operations, the level of activity and expertise and the cheerful attitudes of all who work here. This magazine helps to give an insight into some of these areas and hopefully will keep us all better informed as to what is going on around the Centre.

Please note that the Editor is always on the lookout for contributions and would appreciate your input for next time.

Have a happy and relaxing Easter and drive carefully. (This last sentence to be read in the past tense if the Editor fails to meet his Maundy Thursday deadline!)

EDITORIAL

At long last – the edition everyone has been waiting for (or so they tell me!). In fact this could be described as being the edition you have when you're not having an edition: but more seriously, this marks my first time as editor of the illustrious "CENTREPOINTS" magazine and I hope you won't be disappointed.

Many people believed that the “new” CENTREPOINTS would resemble a hybrid of “Playboy” and “MARTIAL ARTS WORLD” magazines – I know some people will therefore be disappointed! However, all is not lost, for I’m sure everybody will get a kick out of the Centrefold that’s been included in this special edition; besides, it just wouldn’t be Easter without the Bunny!!

Some of you may already have raised eyebrows over the cover design (thanks Len!), but in all fairness (and cruelty) it generally reflects some of the Centre’s more aspiring achievements over the last few months …. I refuse to be more specific – there’s no such thing as editorial immunity – or so HSEG continually reminds me!!

It is the Easter Season once again however, and I would take this opportunity to wish everyone a Happy Easter and thank everyone for the support of the Okinawa Goju Ryu Karate Club raffle (AHA!! Share/7 has learnt Japanese!! –sub-ED) – and I might add that it’s drawn at the end of the month, so if you haven’t got a ticket yet I’m on 233 (or 240!).

As a final commercial word I extend a vote of thanks to GREG WYMARK (man of BIG letters) on behalf of all at CDSC for his efforts over the last two years as Editor of this highly-esteemed journal. If Greg would like to attend my Karate Dojo at any time I can thank him for the honour of being “selected” as his successor in such an onerous task – personally! In closing, I need not remind anyone that this is your CENTREPOINTS: it will only be as good as the support that it is afforded.

TDG TRIVIA

Not much has happened in the personnel line-up, with the temporary transfer to CS Division of BRUCE COLMAN being the only ripple in an otherwise smooth operation.

(You didn’t mention LEN! – Ed)

(We try not to think about that …. –TDG)

At the time of going to paper, a new starter has just arrived. Welcome to PETER LENNOX, the new Draftsman. Don’t believe all those rumours, Peter, they are all understatements!

MIKE STUDWICK has kept up his visits to the Fleet, and is still waiting for his sea-legs to be supplemented by a sea-tummy. Rumours that his favourite tune for humming on OPFCO is “It’s Not East Being Green” are, sorry to say, true. Mike refused to pose for our photographer beside the mound of bags containing listings for the latest software delivery, and made remarks about being jealous of the height of the pile.

MIKE MOORHEN has developed a devil-may-care attitude to the dreaded Work Reporting Sheets … how does “BEEN AT MEETINGS” emblazoned in 7cm-high letter across the column sound to you?

JOHN ATKINSON has almost regained his refined English accent, and now only drawls “gawdamn” twice a day as practice for any further trips abroad. The trip was really a pilgrimage, as while at Dahlgren, John visited The Tomb of the Original Bug. This unfortunate insect is framed on the wall, still sticky taped to the page of the system log listing the fault caused by the said moth jamming open a relay.

(With luck, the article on Bug#1 will appear in this issue.)

Turning over a new leaf and branching out into the field of Botany, HARBANS MANKU has been experimenting with the tea leaves and their effect on the vines in his planter. This has led to a slight misunderstanding: we are not, and never will be, changing the group name to Triffids, Daisies and Gladioli!

As any fool (including me) knows, our glorious acronym stands for TEA DRINKING GROUP. Only one infidel left … will somebody please tell ALAN CLARK what coffee does to the central nervous system?

But to tell the truth, all the above is lies.

HAPPY EASTER!! .. and if you drink tea, don't drive without going first!!

MAINTENANCE TEAM MURMURS

Well there have been quite a few movements in the Thorn EMIE team since the last issue. As reported in that issue both BERNIE CUMPER and JOHN EVANS departed; Bernie due to husband Richard's posting to the "back of beyond" at Puckapunyal and John on retirement to devote more time to all those pastimes he'd dabbled in.

In addition ROD FREDERICKSEN left to join ACTEA in a training management role and JOHN WICKENS departed for greener pastures in the electronics industry.

New starts this year are TONY CALDWELL who joined us from the local electrical industry to take over the many technical services functions; BILL MANN from the tracking industry (yes another one!) who after a couple of display courses will work on the display group; JOHN GOODWIN, ex-SEG, who is currently with displays but will pick up on the DDG Mod gun, SYS-1 and the WDS systems; and GWEN CURTIS who has capably taken over the team secretary position.

PROG GROUP

HELLO – SHARE-7
GOODBYE – TRACY MAYBERRY.
GOODBYE – BILL DONAGHUE.
GOODBYE – KEVIN TOWSON
GOODBYE – ANNE ARCHER
GOODBYE – GORDON McNAIR
GOODBYE – PETER ANDERSON
GOODBYE – GRAHAM SQUIRE
HELLO – JENNIFER ARCHER

THE FIRST BUG

(From “Dahlgren’s Participation in the Development of Computer Technology” by Ralph A. Niemann)

One event with historical significance that happened during the checkout of the MARK II at Harvard was the saga of the bug (moth). The source of an error in computation by the operating technicians was finally traced to an inoperative relay that was caused by a moth wedged in between one of the relay contacts. The moth was removed and taped to the daily computer log with appropriate remarks. From that time on, operators and staff referred to locating an error in the program or in the computer as ‘debugging’ the program. This is a term now in common use by computer personnel, and it is believed that the terminology originated because of this event at Harvard on the MARK II computer. The daily log book at Harvard with the moth still attached to the appropriate page is now in the museum at NSWC (Dan Neck).
THINGS THE TALKING CURTAIN HEARS …….
A recent conversation between two female staff in Admin: “I like Commanders, they’re so easy to operate.”
And then they try to say they were discussing switchboards! No wonder our three-stripers all smile so much……

Extract from an Admin Circular:
“… a new cleaning roster which now also includes the microwave oven.”
Does next year’s model have a digital clock and power steering?

SEG SEGMENT

We at SEG welcomed in the New Year with new hopes, aspirations and resolutions – most of which have already been thwarted or forgotten! It seems now that nothing has really changed, including the fact that no-one (save the Boss) really knows what’s going on – maybe that’s why he is leaving?

However, all jokes aside – a few changes on the personnel side since the last issue ……. CHAD WEBBER finally realised his dream (escape from CDSC!) and joined HMAS ADELAIDE early January. We understand his barber shop is doing a roaring trade. Not so here at the Centre – for Chad’s relief is no barber. Barbarous, maybe. But cutting anything more that a fast exit or corners is strictly out. We talk of course of the ubiquitous Chief ROGER STEWART – something of a cross between Roger Moore and Rod Stewart! Welcome aboard Roger – it’s nice to see you at work occasionally.

Also new to our midst is ‘big’ MICK CROSSAN who is gearing up to relieve RAY CAIRNEY as Tartar Mk-152 Computer maintenance instructor. Mick is easily recognisable by virtue of his stature when compared with other members of SEG. On reflection there could be one exception! (I wonder if there’s such a thing as Editorial immunity??) We trust you’ll enjoy the work Mick! Ray, incidentally, has been selected for Tartar 51C Radar maintenance training in the States commencing in April. Half your luck Ray.

Last month saw the departure of well-known bastion of CDSC public relations in the form of LCDR WARREN KING. Warren (HSEG Afloat) will always be remembered for cultural injections into the daily affairs (we use the term lightly) of the SEGarian empire. His love of cricket and horses served as an example to many of us – needless to say the ship’s company of HMAS SYDNEY will be eternally grateful. Before he left us Warren decided it was time to instil a sense of pride within the various CDSC factions. He chose, in an inimitable way, to

introduce individual mottos for the Groups, in keeping with the Centre's acquisition of its own crest. For those who didn't catch the mottos, they are faithfully reproduced on the back page of this issue! (see below – Ed)

Latest 'acquisition' of the Group takes the form of SBLT 'BOB' PINE. Despite his looks Bob has been 'around' for some time. Having joined the RAN as an apprentice back in '69 (another 3-decade sailor – or is that decayed sailor?) He joins us from HMAS ADELAIDE, where he spent the last few months as Deputy WEEO. His credentials are suspect to say the least – he owns a place in Richardson and appears to know AL WEAVER pretty well from years back – what more can we say?

On the work front (and 'front' is the correct term to use) things have been reasonably quite in SEG over the last few months. It all started back in January when our 'Prince of Darkness' decided to take in the USA before handing in the towel shortly after his return (its all relative as they say). CMDR TAYLOR insists that it was a 'working' trip and 'sheer hell' in Hawaii at that time of year. It seems that the trip may have given HSEG a new lease of life, because he has decided to take a shot at life without the lease and move on to greener pastures (…. upon enquiring as to the destination of Commander Darth Taylor, our intrepid GREG HAJEK was informed – 'He's going to C3 – P.O.!)

All in all it's shaping up to be a big year for SEG. Already we have plans well underway to annex the building next-door and the equipment to cement the already solid EMI relationship is pouring in. It is a knowing person who recognises the smile on HSEG's face when he's asked each morning WATS-ON today Sir? However it's all in a good cause – even if it is ours! We look forward to a rewarding year, when the Centre will mature almost beyond the imaginings of those who first envisioned its presence.

On a parting note we wish to thank everyone for their support and understanding throughout 1983 and indeed 1984. Especially AIOTT, without whose help (and equipment) all this would not have been possible!

COMPUTER LANGUAGE

As the computer gradually takes over the world, an increasing number of unfortunates are being forced to come to terms with the language used by computer programmers. Learning this language is about as easy as trying to teach a Zulu to speak Strine, so I have thoughtfully provided a few definitions to help you along the way:

VDU:	A diseased sheep
BIT STRING:	An abbreviated jockstrap
DEBUG:	De ting killed wid de pressure spray
EMULATE:	A tardy bird
EXTERNAL SORT:	Mistress
EXCHANGE SORT:	End of the affair
CORE:	Strewth!
BALANCED MERGE:	Sex on a tightrope
FLOW ANALYSIS:	Test for diabetes
MARKOV CHAIN:	Used to tie up Pavlov's dog
MICROFICHE:	Plankton

MEMORY PROTECTION:	Diary
MONSTABLE:	Accommodation for one horse
SYNTAX:	Royalties paid by the brothel madam
DATA SOURCE:	Makes fiche and chips taste better
REMOTE VDU:	A diseased sheep in Western Queensland

TRAINING TITBITS

Captain Shimmin. The big news from training is the confirmation in the rank of captain of HTNG. Congratulations to Captain Shimmin!

Tomcat Terry Biggles Butler. (The reader is invited to ask NEIL HAINES about the name). It seems like Terry had only just arrived (July 83 actually) when he departed the Centre recently. Whilst at CDSC he was a constant source of financial advice and inspiration (Aristotle Butler?) and even had time between real estate deals and SD selection boards to run an FFG Operator's Course. Having survived the rigours of a jungle survival course he delivered a snow job on the selection board and was selected as an SD candidate. He leaves for the UK in April. Good luck with your UK training Terry, and all the best in your future career.

Neil Haines. We welcome CPORP Neil Haines to TNG. He replaces Terry Butler as the FFG Operator's Course Instructor. Neil is rather proud of being a three decade sailor, having served in the RAN in the 60s, 70s, and 80's. In recent years he has served in HMAS PERTH where he ran the Captain's boat aground, spent 8 months at CDSC (in ODG) and then commissioned HMAS CANBERRA where he spent two years. Neil comes to CDSC with excellent credentials – he doesn't deal in real estate, but does drive a Porsche 911T!

Displays. Display, process, display, process etc …… life for training's over worked and underpaid (???) display instructors goes on in its usual unrelenting way. RICHARD was somewhat disappointed that DIK (Smith) didn't call while passing over Australia. However, this was more than compensated for by his resounding success with the spray-painting of his boat and car and the magnificent restoration to 'Serviceable' of the newly acquired COLOUR TV (found in an OFF COLOUR place). John's bulldozer is finally fully operational and Wattle trees all over Australia are literally shaking in their roots. The outstanding success of his kitchen (see last issue) has led to another major construction nearing completion – his veranda. So, if you missed the non-existent kitchen tea, wait for the veranda warming! But enough is enough as the sometime bearded (just can't afford razor blades) young lad from TDG is often wont to put it, the Dick and John show rolls on.

Bridges and Bells. January saw Chief Player (Bridge) and Master of traditional Oriental Massage finally acquiring a post to exercise his talents. With swords drawn, under the command of Captain Shimmin, officers from CDSC saluted LCDR CLIVE COOPER and his lovely wife Ann as they passed under the Bridal Arch on Saturday January 28. All training staff wish Clive and Ann the very best for the future.

Software. The new year saw the passing of an era. DENNIS HART has moved to greener pastures-again! (HMAS CRESWELL) – to be replaced by a little known yet stout hearted fellow, WARWICK BRASH (better known as Wayne, Warren or Whatsizname for those with poor memories). Once again we run a one man show, a solo act, a one man band, which only goes to emphasise the loneliness of the long distance Software Instructor. It is understood that the little fellow has a set of Wilson 1200 LTs for sale at a song.

Yes he is, no he is not, yes he is …… well, anyway Greg managed to convince the present editor that he was leaving CDSC and managed to shed responsibility of CENTREPOINTS at last. Well done Greg!

ODG

A change in leadership of the Ops Design Group has been just one of a number of personnel changes since last November. CMDR JOHN MACDONALD had been absent from the Centre attending 'Commanding Officer Desig' courses for a few weeks before his final send-off late last year. He has taken Command of HMAS YARRA. CMDR DENNIS FITZPATRICK has taken up the position of HODG, having joined us from HMAS ADELAIDE where he spent 18 months as Executive Officer and one-time Commanding Officer. We trust his stay with CDSC will be as enjoyable and rewarding.

LCDR Naylor (USN) is also new to the Group, having relieved LCDR DAVE LIND. Dave has joined the mighty battleship 'New Jersey' for a stint as Assistant Ops Officer. Anyone requiring some old fashioned power and glory should dial B-B62 anytime! Closer to home however the bulkheads surrounding the section now look quite bare since Dave removed the last remnants of the 'ODG White House' – no longer are we looked upon by the R.R. effigy or forced to listen to 'Stars and Stripes Forever' from Dave's music box. All the best Dave!

Still on the personnel scene – Senior Wran CHRIS PEARCE (now Chris Graham) left us and the Navy last December but didn't seem to get far – she now works across the way with the C3 company. Meanwhile, Chief MICK PERRY is getting ready to leave us (and Australia in fact). Mick has been 'selected' to join new-ship 'DARWIN' in the USA – life sure is K-9! More about Mick later (it will be safer if he leaves first!).

On the work front, the section's main activities have been related to the FFG 5XXX Link program and OPFCO. You may recall that LCDR MARK PROCTOR and Chief LINDSAY SCULLIN were sent aboard HMAS ADELAIDE a while back – just to keep PROGS honest!

CDSC ALTERNATIVE MOTTOS

DIRECTOR	-	L'ETAT, CEST MOI (I AM THE STATE)
SUPERINTENDANT	-	AB OVO, AD FINUM (FROM THE BEGINNING TO THE END)
ADMIN	-	VIRGINIBUS PVERISQUE (FOR MAIDENS AND YOUTHS)
TRNG	-	FONS ET ORIGO (SOURCE AND ORIGIN)
TDG	-	CORRIGENDA (THINGS TO BE CORRECTED)
PROGS	-	AD LIBITUM (AT LEISURE)
EMI	-	CHEVALIER D'INDUSTRIE (KNIGHT OF INDUSTRY)
ODG	-	BEAU IDEAL (IMAGINED STATE OF PERFECTION)
SEG	-	HORS DE COMBAT (OUT OF CONDITION TO FIGHT)

…….suggestions by LCDR WARREN KING (SEG Afloat)

DIRECTORS OF CDSC

CMDR B L. Spark RAN	10 Dec 71 to 08 Jul 74
CAPT P G N. Kennedy RAN	09 Jul 74 to 20 Oct 77
CAPT J S. Dickson MBE RAN	21 Oct 77 to 29 Oct 80
CAPT A M. Carwardine RAN	31 Oct 80 to 16 Oct 83
CAPT M J. Taylor RAN	17 Oct 83 to 11 Nov 84
CAPT D G. Walkington RAN	12 Nov 84 to 31 Aug 87
Mr A G. Bone, Dept. of Defence	01 Sept 87 to 08 Nov 87
CAPT N. Newman RAN	09 Nov 87 to 31 Jan 90
Mr A G. Bone, Dept. of Defence	02 Feb 90 to 04 Jul 01
CMDR G. Cannon RAN	05 Jul 01 to 02 Jul 05
CMDR G. Cannon OAM RANR	08 Aug 05 to 01 Sep 06

PERSONNEL OF CDSC

The following list of personnel who have served at CDSC over the years has been compiled from such records as still exist and from personal memories. The editors are aware that there are probably a considerable number of omissions and other errors in this list – these are greatly regretted, but are unfortunately inevitable at this time. Ranks of RAN personnel, plus postnominals, have been omitted.

First name	Family name	Service / Employer	CDSC Section	Notes
John	Abraham	C3		
Don	Agar	RAN	TRNG	sometime HTRNG
Lee	Agar	RAN	ODG	
David	Akeroyd	RAN	TRNG	
David	Anderson	RAN	TRNG	
John	Anderson	APS	TDG	
Kelly	Anderson	Sperry (USA)		Share/7
Marty	Anderson	UNIVAC (USA)		original hardware installer
Peter	Anderson	APS	PROG	
David	Anthoney	APS	TDG	
Dolores	Aranda	C3		
Anne	Archer	APS	PROG	
Jenny	Archer	APS	PROG	
Barry	Armstrong	RAN	TRNG	
John	Ashcroft	APS	TDG	
John	Ashe	USN	ODG	
‘Jack'	Atchinson	APS	TDG	
Jason	Augur	RAN	SEG	
Mick	Aylward	RAN	SEG	
Ian	Baker	RAN	SEG	
Michael	Baker	RAN	SEG	
Steven	Ball	APS	ADMIN	
Jess	Ballew	USN	TRNG	
John	Balsillie	RAN then C3	TRNG	

Vasantha	Banagala	APS	TDG	
George	Banic	RAN	TRNG	
Ian	Barndt	APS	PROG	
Richard	Barrott	SERCo	PROG	
Warren	Barrow	RAN	TRNG	
Tim	Barter	RAN	SEG	
John	Barton	RAN	ODG	sometime HODG
Ed	Barton	RAN	Stores	
Steven	Basley	RAN	SEG/TRNG	
Phil	Battisson	RAN	RANTDL	
Tania	Beaumont	RAN	ODG	
Daryl	Beckman	Sperry (USA)		
Chris	Beer	APS	ADMIN	
Tom	Beggs	RAN	TRNG	sometime HTRNG
John	Belford	RAN	SEG	
Thomas	Bell	RAN	ODG	
Alma	Belli	Contractor	Cleaner	
Colin	Benbow	RAN	Stores	
Jess	Benning	SERCo	Workshop	
Hazel	Berg	C3		
Rod	Besant	C3		
Dave	Betts	RAN	SEG	
Graeme	Bick	RAN	TRNG	
Tim	Binns	RAN	Stores	
John	Birch	APS	PROG	
Errol	Bird	RAN	TRNG	
Karl	Blackman	RAN	SEG	
Mick	Blagge	RAN	Stores	
Peter	Blenkinsopp	RAN	ODG	
Steve	Bloomfield	RAN	SEG/TRNG	
Peter	Bobroff	APS	SEG/PROG	
Walter	Boch	Comptek (USA)		

Peter	Bodey	RAN	TRNG	
'Bill'	Bogart	RAN	TRNG	
Rod	Bolam	SERCo	Workshop	
‘Tony’	Bone	APS		longtime Director
John	Booher	Sperry (USA)		DDG Mod program manager
Barrie	Boxshall	EMI(E)	Workshop	ex RAAF, ex Orroral Valley Tracking Station
Janice	Bradshaw	APS	ADMIN	
Warwick	Brash	RAN	TRNG	
Peter	Bray	APS	PROG	
Martin	Brean	RAN	Stores	
Glenn	Bridgart	RAN	TRNG	last HTRNG
Helen	Bridges	EMI(E)		
Matt	Brletich	Sperry (USA)		Share/7 program manager
Pat	Brown	Comptek (USA)		
H.A.	Brown	APS	PROG	
Linda	Brown	RAN	Stores	
Peter	Bryan	APS	PROG	
Anne	Bryan (Forbutt)	APS	ADMIN	
Ian	Buckham	APS	PROG	
Warwick	Budd	C3		
Henry	Burdon	RAN	TRNG	sometime HTRNG
Don	Burningham	RAN	SEG	
'K.T.'	Burr	RAN	ODG	
Terry	Butler	RAN	TRNG	
Robert	Butterworth	RAN	ODG	
Ray	Cairney	RAN	SEG	
Tony	Caldwell	EMI(E)		
Lesley	Callan	APS	ADMIN	
Geoff	Cannon	RAN	SEG	sometime HSEG and last Director
Danny	Caputo	Comptek (USA)		
Brad	Carpenter	SERCo	Workshop/Office	ex RAN
Andy	Carr	Sperry (USA)		

Mathew	Carroll	RAN	SEG	
Joe	Carroll	RAN	TRNG	
‘Jerry’	Carwardine	RAN		sometime Director
Shane	Casboult	RAN	SEG	
Sean	Case	APS	PROG	
Harvey	Casey	RAN	SEG	
Kathleen	Cave (Heelan/Walker)	APS	ADMIN/TDG	
Marco	Cerlenizza	RAN	SEG	
Michael	Challen	RAN	TRNG	
Ray	Chambers	RAN	TRNG	
Ray	Champley	RAN	TRNG	
Andy	Chan	APS	TDG	
Alan	Clark	APS	TDG	
Paul	Clarke	RAN	SEG	
Rob	Clarke	RAN	SEG	
Liz	Clocherty	RAN	TRNG	
Joel	Close	RAN	SEG/RANTDL	
Tom	Coker	Comptek (USA)		
Marty	Collins	RAN	SEG	
Clive	Constance			contractor support for transition plan
Bob	Cook	APS	PROG	
Mark	Cookingham	US Public Service		Share/7 set to work
John	Coombes	RAN	SEG	
‘Orm’	Cooper	RAN	SEG	first HSEG
Clive	Cooper	RAN	TRNG	sometime HTRNG
Steve	Copeland	RAN	TRNG	
Michael	Cormack	RAN	SEG	
	Courir	RAN	SEG	
Greg	Coutts	SERCo	Workshop	
Sean	Cox	RAN	TRNG	
Joel	Crandle	USN		succeeded Eric Swenson
Mick	Crossan	RAN	SEG/TRNG	

Bernadette	Cumper	EMI(E)	On-site office	
Glenn	Cunningham	APS	PROG	
John	Currie	APS then contractor	PROG	long time worker at CDSC
John	Cusack	APS	PROG	operator
Wayne	Damm	RAN	SEG/RANTDL	
Terry	Danaher	SERCo	PROG	
Harvey	Danielson	UNISYS (USA)		
John	Darlington	RAN	ODG	
Chris	Davidson	RAN	SEG	sometime HSEG
Col	Davidson	RAN	TRNG	
‘Scotty’	Davidson	RAN	ODG	
Tony	Davis	RAN	TRNG	
Lex	Davison	RAN	TRNG/RANTDL	
Kim	Daw	RAN then C3	SEG	
Christine	Day	APS	PROG	
Janelle	Day	APS	PROG	
Don	De Rota	SERCo	Workshop	
Scott	Deacon	RAN	SEG	
Jenny	Deal	RAN	ADMIN	
David	Dearing	APS	ADMIN	
Sandra	Dearing	APS	ADMIN	
Ian (Stan)	Deas	RAN	TRNG	
Rob	Denise	SERCo		
Jim	Denton	RAN	ODG	
Diane	Devereaux	RAN	TRNG	
Andrew	Devereaux	APS	PROG	
‘Jim’	Dickson	RAN		sometime Director
Phil	Dieckman	EMI(E)	Workshop	
Stewart	Dietrich	RAN	ODG	
John	Dinsdale	APS	PROG	
Phil	Dodson	APS	ADMIN	
Arnold	Doering	UNISYS (USA)		

Lisa	Donne	C3		
’Bill’	Donoghoe	APS	PROG	
Peter	Dowling	RAN	SEG	
Peter	Dowton	RAN	SEG	
Kerry	Drager	RAN	TRNG/ADMIN	
Denny	Drake	UNIVAC (USA)		
Phil	Draper	RAN	ODG	
Mark	Drummond	RAN	TRNG	
Tim	Duchesne	RAN		
Claire	Duggan (Werner)	RAN	TRNG	
Len	Duke	APS	TDG	
Dale	Dunn	USN	ODG	
John	Dunne	RAN	TRNG	
Kevin	Durick	APS	TDG	
Fred	East	RAN	Stores	
Ken	Eccles	RAN	SEG	
Leanne	Eccles (Gallagher)	SERCo	On-site office	
Ian	Edgar	EMI(E)	Workshop	ex RAAF
John	Edwards	RAN	ODG	
Peter	Egan	APS	PROG/SHARE	ex RAN
Jim	Egeland	US Public Service		replaced Faith Rawdon-Smith
Chris	Eggleton	RAN	SEG/TRNG	
Robin	Ekins	RAN	ODG	
Fatena	El Masri	RAN	SEG	
Carolyn	Eldridge	RAN		
Rob	Elliott	RAN	TRNG	
Kirby	Ellis	RAN	SEG	
Rob	Elphick	RAN	SEG	
Dave	Elsey	APS	PROG	
James	Emery	RAN	SEG/TRNG	
Craig	English	RAN	TRNG	
Bernie	Ephick	C3		

Janelle	Evans	APS	ADMIN	
John	Evans	EMI(E)	Workshop	
Paul	Faichney	APS	ADMIN	
David	Falls	RAN	Stores	
D.	Farlie	RAN		
Glenn	Farrant	RAN	TRNG	
Don	Farrell	SERCo	PROG	
Don	Farrow	C3		ex RAN
Mick	Finlayson	RAN	SEG	
Kym	Fisher	RAN	ODG	
Dennis	Fitzpatrick	RAN	ODG	sometime HODG
John	Flaxman	APS	PROG	
David	Fleshner	SERCo	PROG	ex USN
Glen	Ford	APS	TDG	
Rob	Forsyth	RAN	TRNG/ODG	
Arthur	Fowler	RAN	TRNG	
Bruce	Fox	RAN	TRNG	
Paul	Foyster	RAN	SEG	
Tony	Franklin	RAN	SEG/TRNG	
Rob	Frederickson	SERCo		ex RAAF
Robert	Frost	AWASCO	On-site office	
Chris	Frost	RAN	ODG	
Kathy	Fuhrman	APS	ADMIN	
Brad	Fuller	RAN	SEG	
Neale	Fulton	C3		
Phil	Gaha	RAN	SEG/TRNG	
Kevin	Gallegos	EMI(E)		
Jenny	Gallegos (Tandy)	SERCo	On-site office	
Riano	Garguillo	RAN	ODG	
Dave	Garth	RAN	Stores	
Neil	Garvin	RAN	SEG/TRNG	
Max	Garwood	RAN	SEG/TRNG	

Patrice	Gassin	C3 then SERCo	PROG	
Dave	Gaul	RAN	ODG	
Ross	Gibbons	RAN	TRNG	
George	Gibbs	APS	SEG	
Christopher	Gibbs	C3 then SERCo	PROG	
Neill	Gibbs	APS	TDG	
Sue	Gibbs (Murphy)	APS	ADMIN	
Stewart	Giesel	SERCo	PROG	
Alan	Giles	RAN	TRNG/RANTDL	
Russ	Glenn	RAN	SEG	sometime HSEG
Eammon	Glennon	APS	TDG	
Rob	Glover	RAN	TRNG	
Paul	Goldsborough	SERCo	PROG	
Ed	Goldsmith	APS then C3	TDG	first HTDG
Les	Goodridge	RAN	SEG/TRNG	
John	Goodwin	EMI(E)		ex RAN
David	Gordon	APS	ADMIN	first HADMIN
Peter	Gossip	APS	ADMIN	last HADMIN
Frank	Graham	RAN	TRNG	
Christine	Graham (Pearce)	RAN	ODG	
Danny	Gramm	RAN	SEG	
Richard	Gray	APS	ADMIN	
Wayne	Gray	RAN	SEG	
Wade	Green	RAN	ODG	
Tom	Grendzinski	UNIVAC (USA)		
Narelle	Grennard	SERCo	On-site office	
Bruce	Grewenow	UNIVAC (USA)		
Dennis	Gribble	RAN	ODG	sometime HODG
Mick	Grigg	RAN	SEG	
David	Grimes	APS	SEG	
Andy	Groome	RAN	TRNG	
Charles	Guscott	RAN	SEG	sometime HSEG

Kasdon	Haantjens	SERCo	Workshop	
'Sid'	Habens	RAN	TRNG	
Neil	Haines	RAN	TRNG	
Greg	Hajek	RAN	SEG	
Bob	Hall	RAN	ODG	
Brian	Hall	RAN	ODG	
Rita	Halton	Contractor		Cleaner
Geoffrey	Ham	RAN	ODG	
Jeremy	Hamlyn	RAN		LAN Manager
Sarah	Hancock (Wright)	RAN	SEG	
Grant	Hannan	RANR	SEG/TDG	
Mark	Harris	RAN	ODG	
Christopher	Harrison	APS	ADMIN	sometime HADMIN
Lenny	Harrison	RAN	TRNG	
Dennis	Hart	RAN	TRNG	
Christine	Hart	APS	PROG	
Michelle	Hart (Hines)	RAN	Stores	
Sean	Harvey	APS	TDG	went to ADFTA
Jerome	Hayes	RAN	SEG	
David	Hazeltine	APS	PROG	
Ross	Heazlewood	RAN	TRNG	
Kerry	Hemsley	APS	PROG	
Don	Henk	Sperry (USA)		
Herman	Hensley	USN	TRNG	
Harry	Higginbotham	EMI(E)	Workshop	ex Orroral Valley Tracking Station
Bevan	Hill	RAN	TRNG	
Brian	Hill	RAN	SEG/TRNG	
David	Hill	RAN	Stores	
Mike	Hill	USN	ODG/RANTDL	
Pauline	Hill	C3		
Robbie	Hill	USN	ODG	
John	Hillman	APS	TDG	

Warren	Hogg	RAN	SEG	
Peter	Holloway	SERCo		ex RAN
Robert	Holmes	Sperry (USA)		Share/7, DDG Mod project engineer
Kirk	Holmes	RAN	Stores	
Steve	Hood	RAN	Stores	
Chantelle	Hooper	RAN	TRNG	
Kev	Hooper	RAN	TRNG	
Andrew	Horsfall	SERCo	On-site office	SERCo manager at end of contract
S.H.	Hosking	APS	PROG	
Mark	Hotham	RAN then APS	TRNG/TDG	
John	Howell	RAN	SEG	
Craig	Howell	C3		
Craig	Howlett	APS	PROG	
John	Huelin	RAN	TRNG	
Arthur	Hutchcraft	RAN		
Geoff	Hutchins	RAN	SEG	sometime HSEG
David	Hutchinson	RAN	SEG	
Peter	Hutson	RAN		original project officer for NCDS
Carol	Hyke	Sperry (USA)		DDG Mod
Ray	Irvine	RAN	SEG	
Kavatha	Jagarlamudi	APS	ADMIN	
Stephen	James	RAN	ODG	
Joe	Jarema	APS	TDG	
Tina	Jarema (Parkes)	APS	PROG	
Tony	Jeffs	RAN	ODG	
'Gerry'	Jelli	US Public Service		Share/7 software
Tony	Jenkinson	RAN	SEG	sometime HSEG
David	Jenner	RAN	SEG	
Danny	Jensen	RAN	TRNG	
Rainier	Jessurun	RAN	ODG	sometime HODG
Lloyd	Johnson	RAN	ODG	
Glen	Jones	APS	ADMIN	

Clare	Jones	RAN	SEG	
Richard	Jones	RAN	TRNG	
Graeme	Jones	RAN	ODG	
Shane	Jones	RAN	ODG	
Doug	Jorritsma	APS	PROG	
F.	Junakovic	APS	TDG	
Paul	Kable	RAN	ODG	sometime HODG
Anthony	Kaczmar	APS	TDG	
Peter	Kalkman	C3		
Helen	Keen	RAN	Stores	
Andrew	Keenan	APS	TDG	
Mike	Kenderes	APS	TDG	went to ADFTA
Mike	Kennea	RAN	ODG	
Phil	Kennedy	RAN		sometime Director
David	Kent	RAN	TRNG	sometime HTRNG
Ed	Kenworthy		PROG	
Margaret	Key (Berry)	APS	ADMIN	
Don	Kiley	Northrop (USA)		
Ed	Killibrew	UNIVAC (USA)		DDG Mod
Larry	Kimura	Hughes (USA)		Displays installation engineer
Bob	King	RAN	SEG	
Robin	King	RAN	TRNG	
Warren	King	RAN	SEG	sometime HSEG
Dale	Kirgan	RAN	SEG	
Mike	Kirkpatrick	RAN	TRNG	
Nick	Knight	RAN	TRNG	
Greg	Koehler	RAN	SEG	
Majda	Krevatin	APS	ADMIN	
Richard	Kroll	Sperry (USA)		Share/7 programmer
Michael	Kummerow	SERCo	Workshop	
Geoff	Kupke	EMI(E)	On-site office	
Dave	Lane	RAN	ODG	

John	Lane	RAN	ODG	
Stuart	Langdown	APS	ADMIN	
Jennifer	Langley (Small)	RAN	TRNG	
Leanne	Langton	C3		
Amir	Lapiz	SERCo	PROG	
Geoff	Lau	APS	PROG	
Peter	Law	RAN	SEG	sometime HSEG
Hans	Lawatsch	SERCo	Workshop	
Don	Lawn	C3		
Marc	Lawrence	RAN	SEG	
'Lex'	Lawther	RAN	SEG	
R	Lenard	APS	TDG	
Peter	Lennox	APS	TDG	
Darren	Lepp	RAN	ODG	went to ADFTA
Darrel	Lett	RAN	TRNG	
Lee	Leverington	SERCo	Workshop	
Sean	Leydon	RAN	SEG/TRNG	
David	Lind	USN	ODG	
Christine	Locke	APS	ADMIN	
Andrew	Lockhart	RAN	TRNG	
Mark	Loram	RAN	TRNG/TDG	
Don	Loughhead	EMI(E)	Workshop	
Geoff	Lowe	RAN	TRNG	
Tom	Lucas	RAN	SEG	
Simon	Luck	RAN	TRNG	
Wayne	Lundquist	Sperry (USA)		Share/7, and DDG Mod Program Manager
Pat	Lynch	SERCo	Workshop	
John	MacDonald	RAN	ODG	sometime HODG
David	Mackie	RAN	SEG	
Steve	Maddison	RAN	TRNG	
Harbans	Manku	APS	TDG	
Bill	Mann	SERCo	Workshop	ex RAN

Wes	Mannering	RAN	Stores	
Brian	Mansell	RAN	ODG	
Brian	Mansfield	C3		
John	Marchant	RAN	TRNG	
Neville	Marshall	RAN	ODG	
Alan	Marsters	RAN	TRNG	sometime HTRNG
John	Martens	RAN	TRNG	
Frank	Martin	USN	ODG	
Karen	Mason	Sperry (USA)		
Alan	Masters	RAN	TRNG	
John	Mathews	RAN	TRNG	first HTRNG
Clinton	Maughan	RAN	TRNG	
Chris	Maxworthy	RAN	SEG	
Tracey	Mayberry (Fiddes)	APS	PROG	
Tom	McCarty	Sperry (USA)		Share/7
Bruce	McClure	APS	TDG	
Ian	McConachie	RAN	RANTDL	first HRANTDL
Barrie	McConchie	APS	PROG	sometime HPROG
Mick	McCourt	RAN	SEG	
Michael	McCrave	USN	ODG	
Stewart	McDermott	RAN	TRNG	
Mal	McDonald	C3		
Bobby	McFerran	RAN	TRNG	
Dave	McGee	RAN	TRNG	
Phil	McGuire	RAN	SEG/TRNG	sometime HSEG
Michael	McKay	APS	TDG	
Tracy	McKeith	RAN	Stores	
Drew	McKinnie	RAN	SEG/ODG	sometime HSEG, HTRNG & HODG
Euan	McLaren	RAN	TRNG/SEG	
Denny	McLaughlin	UNISYS (USA)		UNISYS Rep. in Canberra
Don	McLean	RAN	TRNG	
Darryl	McLean	RAN	Stores	

Roger	McMurtrie	C3 then SERCo	PROG	sometime HPROG
Gordon	McNair	RAN then APS	ODG/PROG	
Irwin	McNally	USN		originator of NTDS specs
Pat	McNamara	APS	TDG	
Fiona	McNaught	RAN	Stores	
Peter	McPentland	C3		
Wendy	McPhee	APS	ADMIN	
Geoff	McPherson	RAN	TRNG	
Richard	Menhinick	RAN	ODG	sometime HODG
Larry	Menon	RAN	ODG	
James	Meredith	RAN	ODG/TDG/ODG	
Kevin	Mewett	APS		UYK-43 acquisition project manager
Joe	Mewett	RAN	ODG	
John	Michael	Contractor	ODG	
Frazer	Milan	RAN	Stores	
Danny	Milczarek	APS	ADMIN	
Gary	Miller	RAN	TRNG	
Darren	Miller	APS	PROG	
Tony	Millevoi	C3		
Sonia	Milson	RAN	Stores	
Ed	Mitchell	APS	SEG	
Robert	Mitchell	C3		
Denny	Moe	UNISYS (USA)		Share/7 hardware
Morley	Moe	UNIVAC (USA)		
Peter	Mogg	APS	PROG	first HPROG
Stephanie	Moles	RAN	Stores	
Rob	Moore	RAN	SEG	
Harold	Moore	EMI(E)	On-site office	
Norman	Moorhen	EMI(E)	Workshop	ex RAF, original support contract team leader
Mike	Moorhen	APS	TDG	longtime HTDG
Mick	Moran	RAN	SEG	sometime HSEG
Jim	Morgan	USN	ODG	
Peter	Morris	RAN	SEG	

Ray	Morse	SERCo	Stores	
Beau	Moylan	RAN	ODG	
Christina	Muhldorff	SERCo	Stores	ex RAN
Michael	Muir	APS	TDG	
Tony	Mullan	RAN	TRNG	
Adrian	Mullett	SERCo	Workshop	
Larry	Murphy	USN	TRNG	
Patricia	Murphy	C3		
Peter	Murphy	APS	PROG	
Julie	Murphy	RAN	Stores	
Tim	Mussared	RAN	SEG	sometime HSEG
John	Myatt-Bocarro	RAN	SEG/TRNG	
Roy	Naboa	US Public Service		Mk152 Life Extension Program
Derek	Nankivell	RAN	ODG	
Olen	Naylor	USN	ODG	
Dave	Neal	USN	ODG	
Lindy	Newcombe	APS	ADMIN	
Nick	Newman	RAN		sometime Director
Jason	Nicholas	RAN	TRNG	
Steve	Nichols	RAN	ODG	
Darren	North	RAN	TRNG	
Mark	O’Brien	RAN	TRNG	
Kevin	O'Connell	RAN	ODG	
Jim	O'Connor	RAN	ODG	
Owen	Offler	RAN	SEG	
Tammy	Oldfield	C3		
Mark	O’Leary	RAN	SEG	
Gary	Olsen	USN	ODG	
Daniel	Ominski	RAN	ODG	
John	O'Neill	RAN	SEG	
Steve	Onus	RAN	TRNG/SEG	
Bert	Ottway	RAN	Stores	
Jo	Paddison	RAN	TRNG	

Gavin	Palmington	RAN	Stores	
Ian	Pantours	RAN	TRNG	
Keiran	Parker	RAN	Stores	
Les	Patakay	RAN	ODG	
Geoff	Patch	SERCo	PROG	
James	Pateman	RAN	TRNG	
Frank	Payne	RAN	TRNG	
Reg	Pearson	RAN	TRNG	
Adrian	Pearson	RAN	ODG	
Richard	Penalurick	RAN	TRNG	sometime HTRNG
Wayne	Pengilly	RAN	TRNG	
Don	Pennell	APS	PROG	
Adrian	Pentland	RAN	TRNG	
Paul	Peters	RAN	SEG	
Rodney	Peters	APS	TDG	
Louise	Peters	RAN	Stores	
Andy	Peyton	C3		
Douglas	Phelps	Sperry (USA)		Share/7 programmer
Bob	Pine	RAN	TRNG/SEG	
Ken	Playford	RAN	SEG	
Philip	Pocock	APS	ADMIN	
Fred	Pollum	APS	PROG	
Richard	Portnoy	USN	ODG/RANTDL	
Dave	Poterach	RAN	SEG	
Lee	Pourier	US Public Service		Share/7
Liam	Price	RAN	SEG	sometime HSEG
Mark	Proctor	RAN	ODG	
Matt	Provost	RAN	SEG	
Tim	Pyatt	RAN	SEG	
Jim	Raleigh	RAN	ODG	
Al	Rankins	RAN	TRNG	
Faith	Rawdon-Smith	US Public Service		NTDS combat system engineer

Bob	Reid	RAN	ODG	
David	Reid	RAN	ODG	
Keith	Rendell	EMI(E)	On-site office	
Vivien	Rhodes	APS	ADMIN	
Geoff	Rhodes	C3		
Sonya	Richards	RAN	SEG	
Keith	Richardson	SERCo	Workshop	
Sue	Ridge-Cooke	APS	PROG	
‘Rick’	Riedel	RAN then APS	TRNG/PROG	mainly PROG
Andy	Riley	RAN then C3	SEG	
G.	Risko	USN	TRNG	
Tom	Rix	EMI(E)	Workshop	
Lincoln	Roberts	RAN	ODG	
Charlie	Robbins	USN		NAVSEA
John	Robinson	APS	PROG	sometime HPROG
Rod	Robinson	RAN	Stores	
Kevin	Rochford	RAN	ODG	
Christine	Rogers	APS	ADMIN	
John	Rogers	Sperry (Aust)		
Paul	Rogers	RAN	ODG	
Neville	Rooney	RAN	SEG	
Brenton	Ross	APS	PROG	
Roberta	Rossely	C3		
Dennis	Rowe	AWADI	On-site office	
John	Runge	RAN	TRNG/SEG	
Mick	Rusten	RAN	SEG	
Chris	Ryan	APS	PROG	
Sarah	Sandwell	RAN	ODG	
Steve	Scally	RAN	SEG	
Margot	Schelling	RAN	TRNG	
Dan	Schueler	RAN	TRNG	
Bob	Scott	Contractor	SEG	

Greg	Scott	RAN	TRNG	
Phil	Scott	RAN	SEG	
Tim	Scott	RAN	ODG	
Wally	Scott	RAN	ODG	
Lindsay	Scullin	RAN	ODG	
Mark	Seidl	RAN	SEG	
David	Shackleton	RAN	ODG	
Sarah	Shanks	RAN	TRNG	
Mick	Sharp	RAN	SEG	
'Artie'	Shaw	RAN	TRNG	
Paul	Sheather	RAN	SEG	
Mervyn	Shelley	APS	PROG	
David	Shilton	APS	PROG	
Ted	Shimmin	RAN	TRNG	sometime HTRNG
Mick	Simpson	RAN	SEG	
George	Simpson	USN	TRNG	
Alan	Sinclair	APS	PROG	
Neil	Smeaton	RAN	TRNG	
Al	Smith	RAN	TRNG/TDG	
Greg	Smith	USN	TRNG	
Lee	Smith	USN	TRNG	
Nigel	Smith	RAN	SEG	
Phil	Smith	RAN	ODG	
Ray	Smouse	US Public Service		NAVSEA
Bob	Sorenson	RAN	SEG	
Brian	Spark	RAN		first Director
Jim	Stapleton	RAN	ODG	
Greg	Steel	RAN	Stores	
Peter	Stehn	RAN	ODG	sometime HODG
Peter	Stein	RAN	PROG	
Gary	Stenull	Sperry (USA)		Share/43 installer
Pat	Stevens	APS	ADMIN	

David	Stevens	RAN	ODG	
Denis	Stevens	APS	TDG	
Roger	Stewart	RAN	SEG	
Mick	Stewart	RAN	ODG	sometime HODG
Stefan	Stirzaker	SERCo	PROG	
Jennie	Stirzaker (Richards)	SERCo	PROG	
Gordon	Stone	RAN	TRNG	
John	Strapps	APS	TDG	
James	Stratford	APS	PROG	last HPROG
Mike	Strudwick	APS	TDG	
Bryan	Sullivan	C3		
Lillian	Sutton	SERCo	On-site office	
Eric	Swenson	USN		originator of NTDS specifications
Andrew	Swann	RAN	SEG	
Richard	Tareha	APS	PROG	
Rod	Targa	RAN	SEG	
Brian	Taylor	RAN then C3	SEG	sometime HSEG
Mike	Taylor	RAN		sometime Director
Simon	Taylor	RAN	TRNG	
Shane	Taylor	RAN	Stores	
Annette	Taylor (Herbert)	C3		
Hans	Tench	RAN	TRNG/ODG	
Dean	Thiele	RAN	TRNG	
Bob	Thomas	RAN	ODG	
Robert	Thomas	RAN	TRNG	
Charlie	Thomas	USN		DDG support
Glenn	Thomas	SERCo	On-site office	ex RAAF
Stephen	Thomas	SERCo	Workshop	
David	Thompson	APS	PROG	
Bill	Thorpe	RAN	ODG	
Adam	Threlfell	RAN	ODG	
David	Tillotson	APS	PROG	

Nicole	Tillotson (James)	APS	TDG	
Peter	Topley	APS	PROG	
Kevin	Townson	APS	PROG	
Siobhan	Trainer	APS	ADMIN	
Don	Tredinnick	Sperry (USA)		
Trevor	Treloar	RAN	TRNG/SEG	
Peter	Trotter	APS	TDG	
Christine	Trubee	SERCo	Stores	
Dave	Trudgian	RAN	ODG	sometime HODG
Derek	Trushell	EMI(E)		ex RAAF
Ngongo (Sam)	Tu'ineau	SERCo	Workshop	
Ray	Turner	EMI(E)	Workshop	
Clem	Turner	RAN	TRNG	
Paul	Tyack	RAN	Stores	
Tien	Ung	APS	TDG	last HTDG
Michael	Uzzell	RAN	TRNG	
Mike	Van Balen	USN	ODG	
Leo	Van Vliet	RAN	TRNG	
Phil	Varley	APS	PROG	
John	Waghorn	RAN	TRNG	
Phil	Walker	RAN	TRNG	sometime HTRNG
Dean	Walkington	RAN		sometime Director
Dale	Wandersee	UNISYS (USA)		UYK-43 support
Graeme	Ward	SERCo	Workshop	ex RAN
Graham	Warner	APS	ADMIN	
Alan	Weaver	RAN	TRNG/SEG	
Robert	Webb	RAN	SEG	
Chad	Webber	RAN	SEG	
David ‘Ginge’	Wellings Booth	SERCo	Workshop	ex RAF, longest serving staff member at CDSC
Jeff	Wells	RAN	ODG	sometime HODG
Dennis	Wheeler	RAN	ODG	
David	Whitcomb	US Contractor		Share/43 programmer

Peter	White	RAN	SEG	
Bill	Whitfield	RAN	ODG	
Greg	Whymark	RAN	TRNG	
Greg	Whyte	RAN	SEG/TRNG	
Len	Whyte	C3		
John	Wickens	EMI(E)	Workshop	ex RAF
Sarah Jane	Wickstead	APS	PROG	
Karen	Wilcox	RAN	TRNG	
Tony	Wilkins	APS	ADMIN	
Shane	Wilkins	EMI(E)	Workshop	
John	Williams	RAN	ODG	first HODG
Rob	Williams	Sperry (USA)		Share/7
David	Wilson	RAN	TRNG	
James	Wilson	RAN	SEG	
Simon	Wilson	APS	PROG	
John	Winiecki	Sperry (USA)		Share/7 installation
Graham	Winter	RAN	TRNG	
Susan	Woods	Sperry (USA)		Share/7 programmer
Lloyd	Woodward	RAN	ODG	
Simon	Woolrych	RAN	ODG	sometime HODG
Wendell	Wosmek	UNIVAC (USA)		UYK-43 installer
Paul	Wozniczka	UNISYS (USA)		UYK-43 support
Jim	Wright	USN	ODG	
Luke	Wright	RAN	Stores	
Sarah	Wright (Hancock)	RAN	SEG	
Ted	Young	SERCo	Workshop	ex RAAF
Brendon	Zilko	RAN	ODG	
Menze	Zwerwer	RAN	SEG	

Note that although only one employer has been listed in the table above, many of the longer serving support contractor staff have in fact worked under a variety of contract providers – EMI(E), AWADI, and SERCo – as employers

UNIVAC NTDS/NCDS COMPUTERS

The following provides an almost complete listing of the UNIVAC Mil-Spec computers that have been used in NTDS/NCDS, showing their development and hierarchical relationship.

Equipment name	Cycle Time	Word size (bits)	Memory size (words)	Development period	Notes
AN/USQ-17	8 μsec	30	32 K	1957-58	Prototype for NTDS
AN/USQ-20	8 μsec	30	32 K	1959	Improved reliability over USQ-17
CP667	2 μsec	32	128 K	1964	Only one unit built
CP642	8 μsec	30	32 K	1960	Built for testing only
CP642A	8 μsec	30	32 K	1962	One Production Machine only
CP642B	4 μsec	30	32 K	1962-64	Used at HSK for Apollo Project
CP789 '1218'	4 μsec	16	32 K	1962-63	Used for BVP to NTDS interface, also Apollo Project
CP848 '1219'	2 μsec	18	64 K	1965-66	Used for MFCS and GFCS
CP855	2 μsec	30	115 K	1965	Used on Apollo Project
AN/UYK-7(V)	1.5 μsec	32	256 K	1966-69	Main NTDS/NCDS computer
Univac 1600	1.5 μsec	16	64 K	1970	Early AN/UYK-20 design
AN/UYK-20	0.75 μsec	16	64 K	1973-74	Used for SYS-1, GFCS, etc
AN/UYK-43	0.3 μsec	32	256 Meg	1970-90	Replacement for AN/UYK-7

PROGRAMMERS EXCUSES

The following is from the Programmers Excuse List**,** by David Tillotson, SHARE programmer at CDSC, which appeared in the *Bosun's Call*, Volume 2, Issue 1 (1995).

In order to conserve paper all queries to the Programming Group regarding software will now be answered with a single letter, keyed to the following list:

a. That tape is onboard one of the ships (we think).
b. The Director will give his response soon (don't hold your breath).
c. Testing is being done by TDG (don't hold your breath).
d. We're not promising that before Christmas/Easter/Australia Day
e. We did it that way for 5XXX.
f. It may be logical but …
g. It got lost in the computer.
h. The decision was made to make a decision.
i. SHARE/43 was down for maintenance/backups (again).
j. It's near the specification.
k. There is a lack of visibility of that item on the network.
l. That's an interpretation of the specification, not a change!
m. It was before my time.
n. You can't change history.
o. It's not well specified in the area concerned.
p. The report is imminent/has been given to Admin for distribution.
q. I'll just have to chase that up (don't call me, I'll call you).
r. That will be a simple software change.
s. I'll organise that within the coming month (or so).
t. The specification must be wrong.
u. This is somewhat dependent on hardware issues (it's all SEGs fault) .
v. A way ahead is still being determined (don't hold your breath).
w. That's pretty easy; we'll just get the PCC to look it up.
x. They are practically up to date now.
y. It's very difficult when you start dealing with people.
z. We've seen the weakness & we're doing something about it (honest!).

Your co-operation in the use of the new system will be appreciated.

NCDS ON SUBMARINES

As part of the project to introduce a digital C2 system into the RAN, Peter Hutson and his project team had also been trying to develop a combat system for Oberon-class submarines. Being able to use an AN/UYK-7(V) and its associated displays in more than one platform would have shown an agreeable economy of scale.

Quoting Ed Goldsmith:

'The tender went out for a set of combat systems. The tender included one for each of the six Oberon class Submarines and three DDG class destroyers. The American system offered was considered far too expensive. The British Ferranti computer seemed to be going down a dead-end path as far as future evolution went. Similarly, the American Litton system was good but was seen as limited at the time. The best system, as perceived by the Project Team, was the Dutch "Daisie"' system that possessed a reasonably standard 32-bit computer which was well supported. The display system was considered superior to the Hughes system.

When considering the US equipment purchase, which included the double-bay AN/UYK-7(V) computer, space considerations within "O-Boats" required the two bays of the AN/UYK-7(V) computer to be placed back-to-back instead of side-by-side. Univac, the manufacturer of the AN/UYK-7(V) computer said that it could not be done – so the Oberon class submarines did not get an AN/UYK-7(V)-driven combat system.'

As stated above, this alternative turn of events did not eventuate.

CDSC SOFTWARE

During the life of CDSC, the following software packages were among the many programs that were either directly sponsored by, or otherwise supported by, CDSC. 'Direct sponsorship' refers to programs that were written and fully maintained by CDSC (and owned by the RAN), whilst other 'support' was provided for USN programs for which CDSC was the RAN's informed customer.

DDG

DDG NCDS

NCDS Operational Program versions 2XXX -> 6CXX
Maintenance programs (POFAs various)
Utility programs for tape handling
Diagnostic programs for UYK-7 computer
Simulation Control programs

DDG BVP/SATNAV

Operational program 1AXA
Test program BVP SDC POFA
Simulation (WASP/WSS PGM 331K)
Diagnostics for Mk 152 Computer (Univac 1219)
Test programs ICPIT and Mk95 - IOC
Utility programs
Launch Simulation program 2SXX

MFCS Mk 74 MOD 13

Operational program PGM-262M03
Diagnostics programs
Test program - CTASC
Utility programs for tape copy and data reduction

GFCS Mk 68 MOD 19

Operational program
Simulation program (ACS)
Diagnostic programs for UYK-20 computer
Test programs - RD358 POFA/ICPIT
Utility programs (e.g. GFCS UPAK)

AN/SYS-1(V)3

Operational program PV.10.17
Simulation program WASP/RSS
Diagnostic programs for UYK-20A computer
Test Routines for USH-26 Maint/ICPIT
Utility (AN/UYK-20 UPAK)

AN/WLR-1H

Operational program

FFG

FFG NCDS

Operational programs 5XXX -> 7DDG
Maintenance program (POFAs)
Utility program (UPAK)
Test/Diagnostic programs
Simulation (FFG WASP)

FCS Mk 92 MOD 2

Operational programs - WCP Rev R and Rev S
Utility program (UPAK)
Data Display (DD)
Hardware Maintenance program (HMP)
Scenario Generation program (SGP)

FFG RVP/ADT

Operational program
Utility program
Test program (RVP ADC POFA)

AN/SLQ-32

Operational program Rev. 17
SDT Diagnostic

HWS

AN/SWG-1A Operational program

CIWS

Phalanx CIWS Mk15 Mod 1 Operational program
Phalanx CIWS Maintenance program

MISCELLANEOUS

AN/SQS-15 Operational program
FFG Tracking Comparison Test (TCT)

RANSID

RANSID Operational environment
RANSID Diagnostics

IHDL

Interim Helo Data Link Operational program
Helo Data Link Simulation System

DIAGNOSTICS

OJ-194/197 Diagnostics
AN/UYK-7(V) Diagnostics
AN/UYK-20 Diagnostics
AN/UYK-43(V) Diagnostics

MISCELLANEOUS

LMS-11
SSTS Environment Generator
SHARE-43 programs
TRIM3 Assembler/SYCOL Compiler
MTASS
AMD FCS Operational program
Mk95 I/O Replacement Operational program
Command Station Operational program
TESS
MULTOTS
Whittaker DLS
MX512P DLS
VAB Replacement
SABTECH NTDS Interface

For some of the programs that were directly sponsored / authored by CDSC in the late 1980's, the following list indicates the number of lines of source code for each.

Program	**Ship class**	**Lines of source code**
NCDS 6XXX	DDG	$215\,000_{10}$
NCDS 5XXX	FFG	$151\,000_{10}$
BVP/SATNAV	DDG	$17\,800_{10}$
SCP – Simulation	DDG	$116\,000_{10}$
WASP Mk92 Sim	FFG	$33\,000_{10}$
GFCS Mk68 Sim	DDG	$64\,000_{10}$
WDS Mk13/4 Sim	DDG	$72\,000_{10}$
Launcher Sim	DDG	$10\,000_{10}$

CDSC PROVIDED TRAINING COURSES

The following is a list of the various training courses that were being conducted by Training Group at CDSC, circa 1997. In those days, the seven training classrooms at CDSC each had an average annual occupancy rate of around 70%.

AN/SLQ-32 Operator
AN/SYS-1 Operator
AN/ SYS-1 Maintenance
AN/USH-26 Operator/Maintainer
AN/USQ-76 Data Terminal Set Maintenance
AN/UYK-20 Operator/Maintainer
AN/UYK-7 Introduction
AN/UYK-7 Computer Maintenance
AN/UYK-43 Operator/Maintainer
CO/XO Designate (module thereof)
Collins Link Introduction
DDG Combat Systems Manager
DDG Surface Weapons Co-ordinator
DDG Systems
DDG Systems Interface
DDG Radar Video Processor Maintenance
Displays Maintenance – CIGARS
Displays Maintenance – non-CIGARS
FFG Combat System Manager
FFG Systems
FFG Systems Interface
FFG SDC CV-2953A(P)/UYK Maintenance
Force Track Co-ordinator
ICKCMX Maintenance
Mk152 Computer Maintenance
Mk72 Tartar SDC Maintenance
Mk74 Tartar System
Mk92 Mod 2 FCS Familiarisation
Mk92 Systems Engineering
PWO Phase 1 (module thereof)
RAAF FTC
RANSID Operator/Maintainer
RVP FC4 Maintenance
WEAC (module thereof)

THE CIVILIAN SUPPORT CONTRACTORS

There have been a variety of companies awarded the contract for the maintenance of the CDSC equipment, and also to provide software and administrative support. In time sequence, these have been:

EMI(E) Pty Ltd
THORN-EMI(E)
AWA
AWA Defence Industries (AWADI)
AWASCO (a joint venture between AWADI and SERCo Australia)
SERCo Australia

Photographs

J. Westendorf

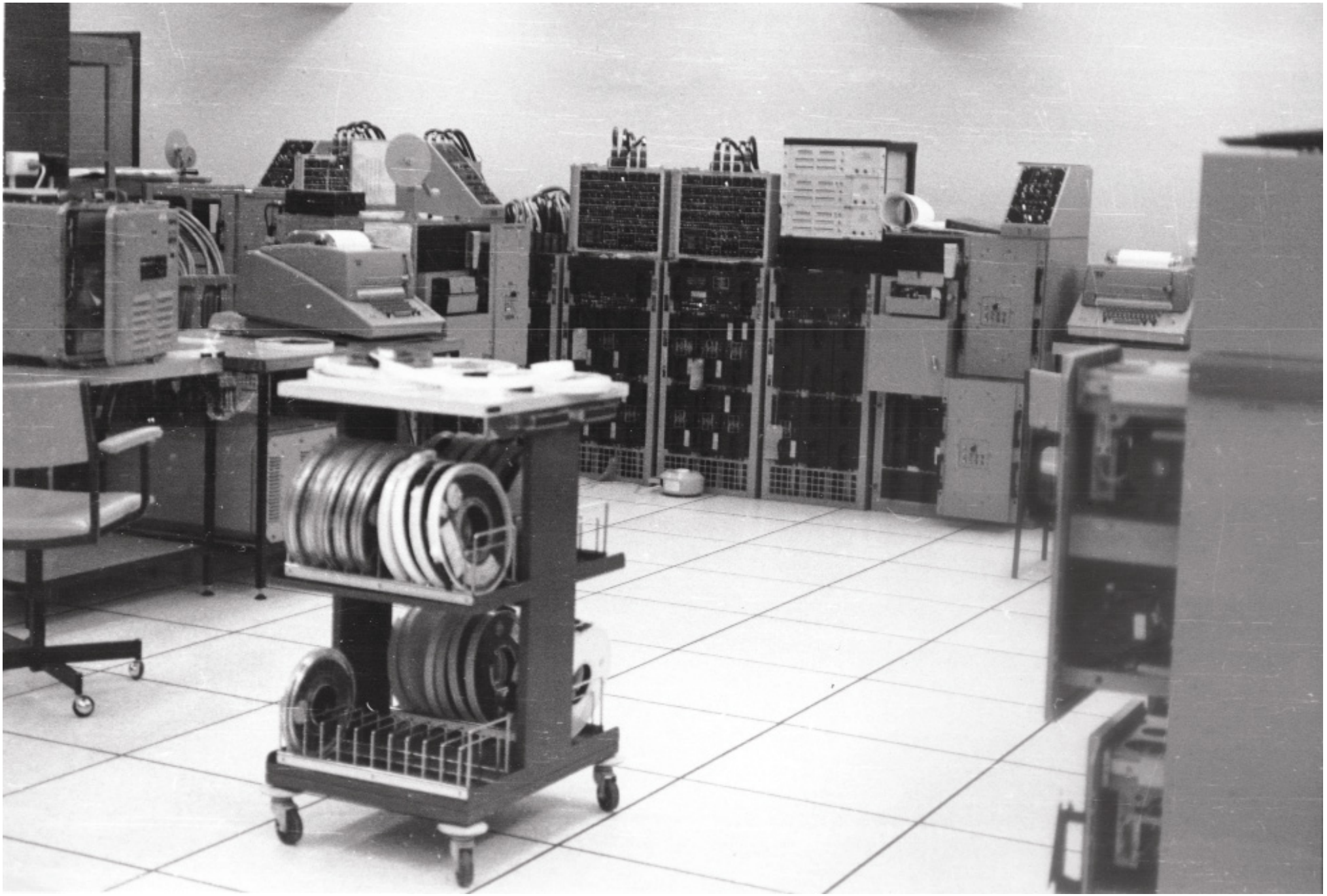
Australians Visit Dahlgren

Members of the Royal Australian Navy (RAN) visited NSWC Dahlgren on 14 March to discuss the Mk 92 software support for the Australian FFG-7 class ships.

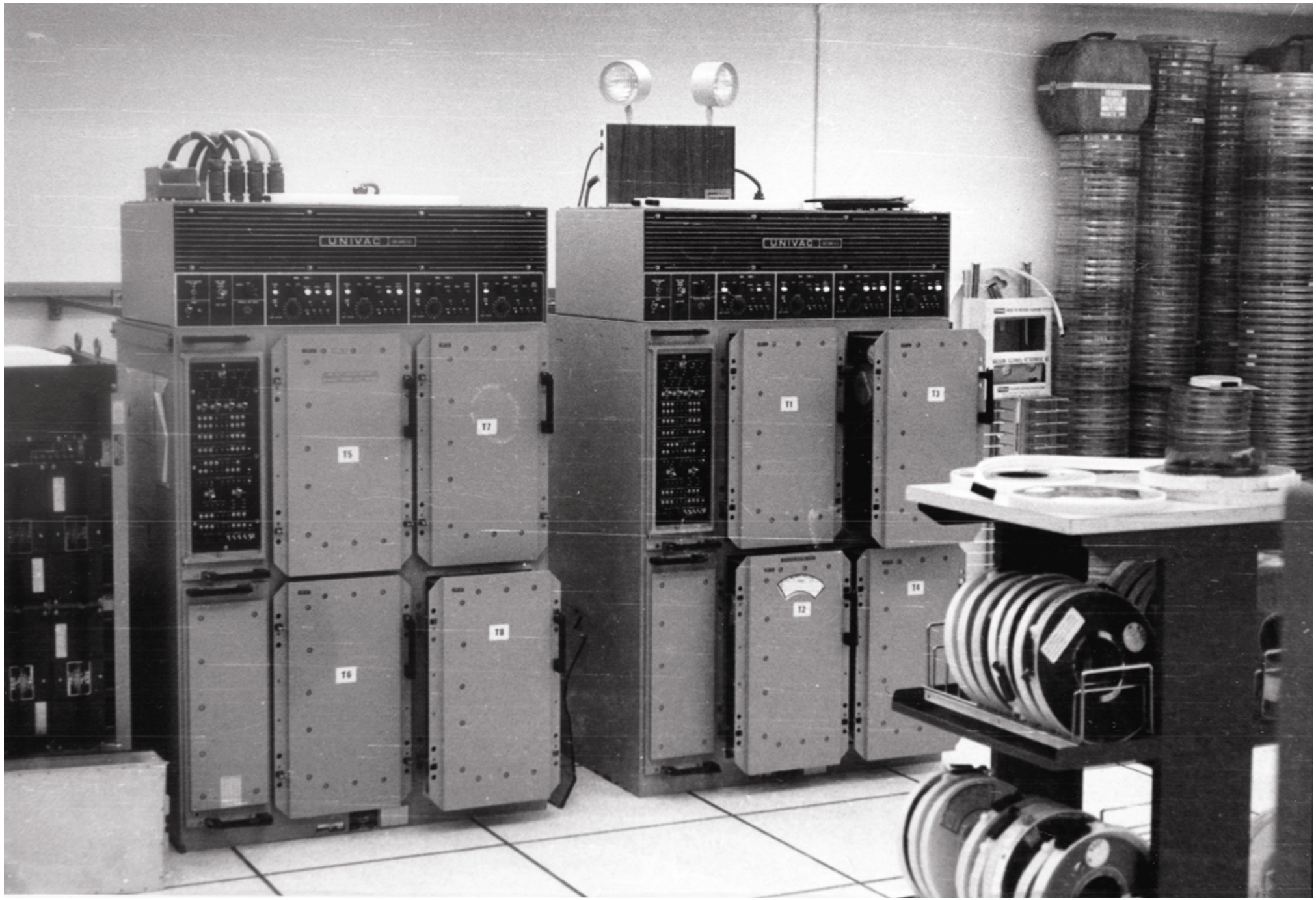
The Mk 92 Project Office (N534) will provide life-cycle maintenance of the Mk 92 fire control system computer programs for the four Australian FFG-7 class ships, including program certification, system integration testing prior to ship delivery, and configuration management.

Shown *(at left)* chatting with CAPT Paul L. Anderson, USN, NSWC Commander, are *(left to right)* Michael Palko (N534); CAPT Jim Dickson (RAN); LCDR David Gaul (RAN); and John Robinson (Australian Department of Defence, currently detailed to the Mk 92 group (N53) for 15 months).


THE MANY FACES OF CDSC



DDG equipment room – early days



DDG equipment room again – and we had some reel-to-reel magnetic tapes!

Group at commissioning of SHARE/7

CMDR Henry Burdon at decommissioning of Univac 9300

Peter Gossip, Tony Bone and John Robinson (at handover to NWSA)

Mike Moorhen – after retirement,
with Chief of Navy Commendation on wall

CMDR Geoff Cannon in the Director's chair – so much for retirement!

John Currie – and not a Tim-Tam in sight

Rear wall of DDG equipment room, 2004

DDG suite, 2004 (as modified for Force Track Coordinator training)

FFG equipment room, 2004

FFG suite, 2004

Banks of 1299 switches for FFG suite and MTS – everything could be connected

An OJ-172 DEAC in the DDG equipment room

Pat Lynch working on the Mk95 IO console of the Mk152 computer in the DDG equipment room

The new and the old – AN/UYK-43 (right), next to DDG Mk152 fire control computer

In 1997, the building was stripped for refurbishment – goodbye to the omnipresent orange curtains (front of bldg 84 pictured)

CDSC staff, 2004

Sometimes we got hungry – Pizza lunch, 2007 (and another use for the table tennis table)

and sometimes we relaxed – Melbourne Cup day, 2003

Lunchtime touch footy squad (supported by SERCo)


SEGites at yet another social event

SERCo team at celebratory lunch after achieving ISO 9000 accreditation, 2003

Pondering the future! (Heads of Group meeting, 2004)

Behind every system is a pile of paper work (SEG)

Steve Thomas working on one of the two original AN/UYK-43s

Meeting between CDSC and NAVSEA staff during DDG Mod

Memorabilia board at 30th birthday dinner (HMAS HARMAN wardroom)

30th birthday dinner group

Head Table at the 30th birthday dinner

another table at the 30th birthday dinner

LCDR John Martens on AN/UYK-7 maintenance course in the MTS – the instructor has left his brew mug

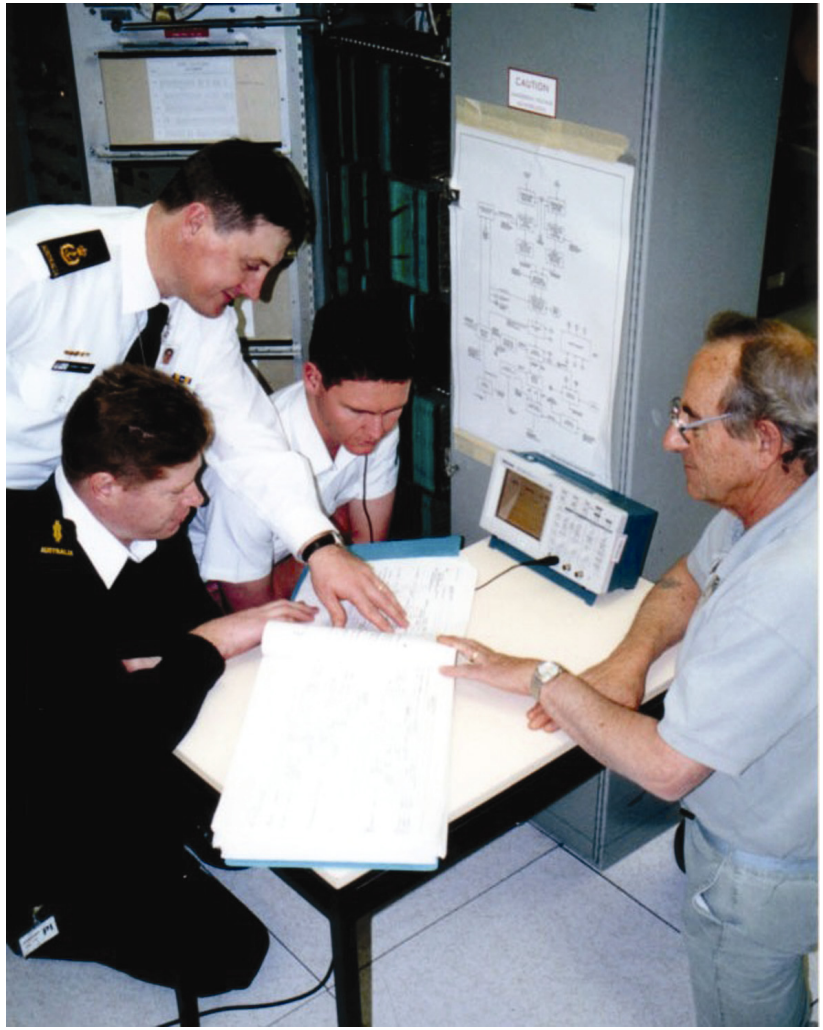
Equipment sometimes ate people:

AN/UYK-7 in DDG equipment room

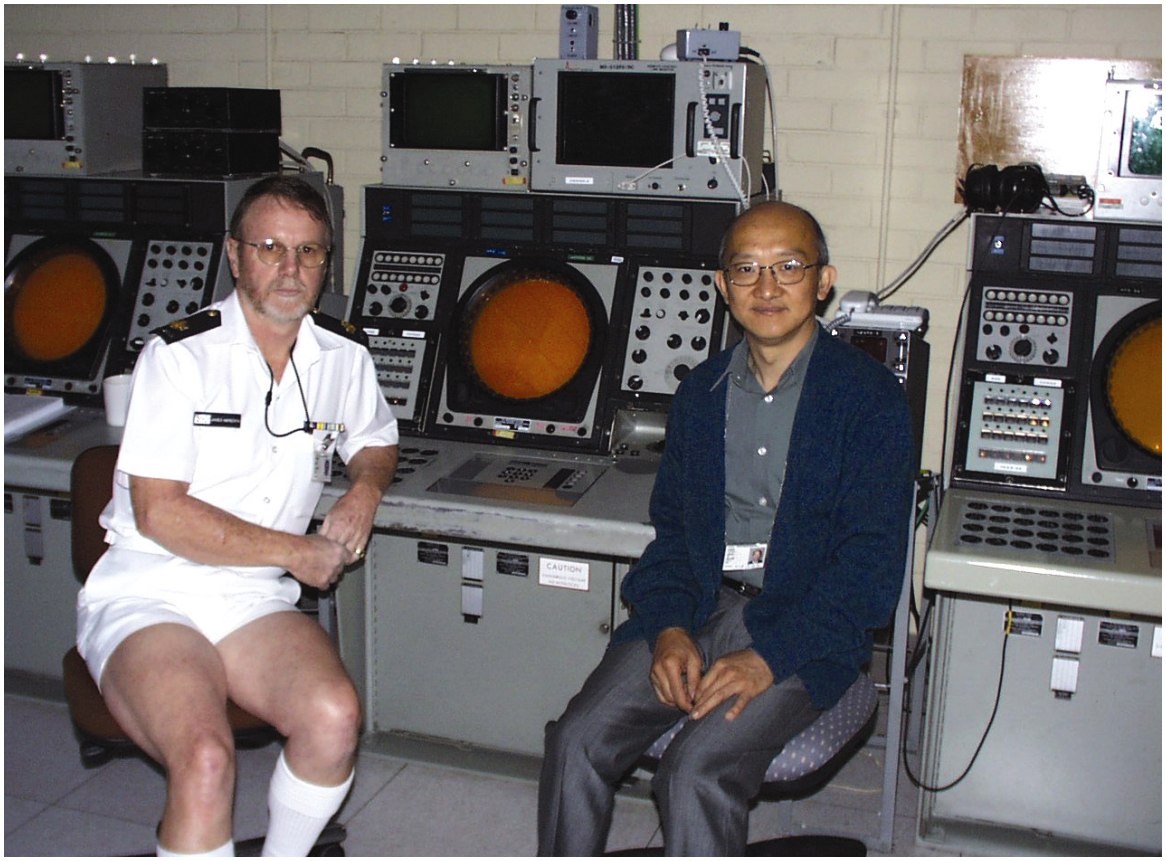
OSC in FFG suite

Graeme Ward at Link-11 Data Terminal sets

The civilian contractor maintained the RANSID software (Andrew Horsfall)



Bill Mann (right) and CPO ‘Dick’ Emery with Displays class



WO ‘Shorty’ Meredith and Andy Chan (TDG) in the FFG suite

Staff (supposedly) at work in the FFG suite – PO Warren Hogg, PO Wayne Pengilly, LS Greg Scott and LS Dan Schueler

Delivery of the last NCDS program to HMAS NEWCASTLE, 2005
CMDR Geoff Cannon, Tien Ung, CAPT Trevor Jones, LCDR Mel Barnes and LEUT Chris Davidson

The end – Handover of CDSC to NWSA, July 2006 – CMDR Geoff Cannon and Beng Ooi (Director of NWSA)