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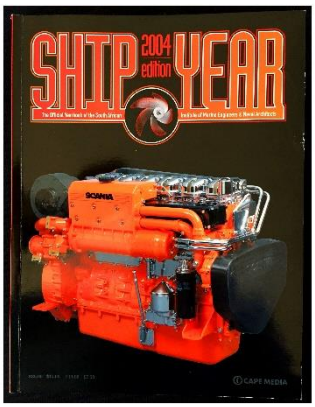

ELECTRONIC MILITARY INFORMATION IN THE SA NAVY: AN AFFORDABLE SOLUTION

ABSTRACT

In the context of electronic information systems in a Naval environment, this paper presents a specific case, where available technology has been utilised and developed to provide a cost-effective logistic support solution for an operational need of the SA Navy. This requirement was to have cost-effective logistic resources (i.e. technical manuals, training packages, etc) to support the operating and maintenance functions of the SAS OUTENIQUA, one of the SA Navy's Combat Support Vessels.

Considering previous era's military acquisitions and sometimes costly approaches, as well as the current budgetary constraints, it was vital from the outset to focus on the cost of ownership of the system to be acquired, to ensure that the fielded system (and equipment) could be supported affordably within the projected budgets (in medium to long term). Cost of ownership considerations must also be applied to the life cycle of logistic products put in place to support operational systems and equipment. Therein, amongst other advantages, lies the rationale for going the electronic route in implementing a solution to the operational and support information needs of SAS OUTENIQUA.

From the outset, the support objectives of the SA Navy, as well as trends with respect to electronic documentation within industry and the military were known, understood and embroidered on to ensure a synergised and supportive approach with the new Naval acquisitions in progress (with the aim to provide complementary, affordable solutions for "other" existing Naval vessels e.g. SAS OUTENIQUA, SAS DRAKENSBERG, etc).

The solution implemented for SAS OUTENIQUA is an integrated system, comprising Interactive Electronic Technical Manuals (IETMs), on-line training packages and related electronic information modules. The system provides access to on-line relational information, with dynamic cross-relational features to other data sources, where the transition from one to the other is affected in a seamless, interactive manner.

This paper presents the rationale of this development/acquisition: its similarities and synergies with the electronic documentation system being delivered with the new Corvettes; its many benefits and advantages in the operational environment; its ability to link to other databases (e.g. OSIS); and its future opportunities (based on lessons learnt), to effectively satisfy logistic support needs across varying operational environments and scenario's.

INTRODUCTION AND BACKGROUND

During 1993, the SA Navy procured a large cargo vessel with roll-on-roll-off (RORO) and ice breaking capabilities from a foreign supplier. The vessel was renamed SAS OUTENIQUA (OTQ), and put into operational service as a Combat Support Vessel. The OTQ was acquired as is, and from the outset presented her new owners with significant logistic support challenges. In parallel with an exercise to determine and define the received logistic support package, a technology transfer process was put in place, whereby selected ships officers and shipyard guarantee engineers were contracted to remain in South Africa, to transfer relevant technologies to the SA Navy and assist with the translation of documentation and tallies, from Russian to English.
It is important to note that throughout this process, OTQ was an operational vessel, used in support of SA Navy mission requirements. What was evident from this operational experience of the End Users and support personnel, was that associated technical documentation was not always traceable to “systems” and equipment onboard. This made it extremely difficult and time consuming if not in many cases impossible, to source pertinent documentation for corrective and preventive maintenance and training purposes. Other pertinent factors were that OTQ, like vessels in any navy, has a significant turnover of staff at all levels, as well as there being an ongoing transformation process in the SANDF (thus further emphasising the need for accurate technical support information that is focused, and easy to find and use).

This paper focuses primarily on the technical documentation aspects of the developed electronic information tool provided as the affordable solution to OTQ’s operational need. The other modules are however overviewed within the context of the entire system. This approach is pertinent however, as the technical documentation forms the core of the delivered electronic information system.

PROJECT OBJECTIVE

The project objective (to meet OTQ’s significant operational and support challenges), was to provide cost-effective logistic support products/resources (i.e. affordable and effective technical manuals, training packages and training material). To achieving this, there was a need to integrate with existing logistic products, as well as identify and rectify shortfalls in an affordable manner. In this regard, there was a requirement to convert the existing documentation (Russian translated and other) into paper based technical manuals in accordance with SAN Policy, utilising the SA Navy Standard for Technical Manuals (RSA-MIL-SPEC 53). Developed training packages were required to be in accordance with the SA Navy Standard for Training Packages (RSA-MIL-SPEC 334).

Given the somewhat fuzzy support baseline available to OTQ, System Management and shore based support organisations; together with the prevalent budgetary constraints; the challenge and brief was to provide an affordable, effective solution to the operating, maintenance, and training needs of SAS OUTENIQUA.

SYNERGY WITH OTHER PROGRAMMES

Involvement in the development of logistic support for the new SA Navy Patrol Corvettes provided exposure to other technologies and practices, which led to opportunities to exchange ideas and practices between the two programmes. Work on the development of the Naval Logistic Management System (NLMS) and Interactive Electronic Technical Manuals (IETMs) for the Patrol Corvettes thus provided opportunities to implement and test certain envisaged IETM approaches for the Corvettes, in advance on the OTQ project. This is specifically pertinent with respect to the Maintenance IETM concept for the Corvettes. Certain approaches initiated under the OTQ project are likewise being fed back to the electronic information development effort for the Corvettes.

The benefit of having certain key members of the Clients project team (i.e. SA Navy and Armscor) participating on both programmes, further facilitated the gains made in this regard,

and has ensured that the electronic initiatives of both programmes are in sync. This is important, as SAS OUTENIQUA is the first SA Navy Vessel to have electronic documentation (i.e. IETMs and an integrated electronic information system), available on a ship wide basis.

A COST EFFECTIVE SOLUTION

1st Steps

As always the case, to determine where one is going, one first has to find out where one is. The OTQ effort started with an assessment of existing available technical documentation and training packages. The resultant assessment reports provided the basis to scope and cost the work required to be done.

At the outset, it was necessary to organise the existing documentation into logical systems, in line with how the ship was configured, operated, and maintained. These "systemised" Technical Manuals were provided to onboard and ashore staff in hard copy format, to address the requirement for easy access to relevant technical support information. This first delivery to the Project Logistic Officer prompted the following response, as his office space was steadily diminished, and he put his feet up on the seemingly endless volumes of books: *"Surely there must be a better way than all this paper?"*

This simple, seemingly innocuous statement, in conjunction with the comprehensive Technical Manual Report that included costed options covering both hardcopy and electronic documentation, opened the door to the electronic solution that was implemented. The electronic Ship Information System was conceived around this need for easy to use, easy to find relevant technical documentation and support information.

A cost analysis for paper development and publishing, verses electronic development and publishing, indicated as much as a 30% saving in favour of the electronic option. Considering the additional benefits of the electronic approach (as detailed in this paper), a recommendation and proposal was made to the Client project team to go the electronic route, with access via the ship's onboard LAN. The SA Navy approved a "prototype" development, and the Ship Information System was born.

Ship Information System (SIS) Overview

Figure 1 provides a functional overview of the Ship Information System (SIS), used as the basis for the development of the individual SIS modules. It must be noted that the SIS development evolved over time, as new concepts were introduced, tested, and implemented.

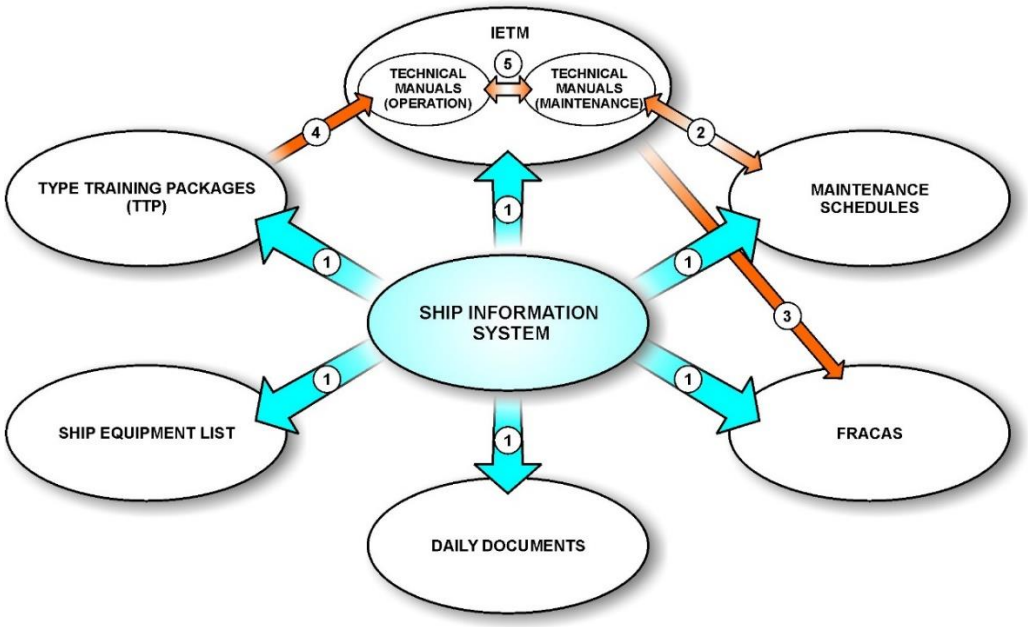

Figure 1: Ship Information System, Functional View

The SIS is an integrated information system, comprising the following modules: IETMs (Operating and Maintenance), Type Training Packages (TTPs), Maintenance Schedules, Failure Reporting Analysis and Corrective Action System (FRACAS), Ship Equipment List and Daily Documents. These modules are identified as “primary” and “secondary functions” in the relevant paragraphs that follow.
The interfaces between SIS modules numbered in Figure 1 are as follows:

a. Interface 1 (Blue) – Main interfacing between the SIS and its modules.
b. Interface 2 (Brown) – Interfacing from the Maintenance IETM via URLs to the Contents Page of related Maintenance Schedules. A link is also provided from maintenance schedules to relevant Maintenance IETMs.
c. Interface 3 (Brown) – Interfacing from Maintenance IETMs to the opening page of the FRACAS Module.
d. Interface 4 (Brown) – Interfacing from TTPs to relevant Operation Technical Manuals (one way interface).
e. Interface 5 (Brown) – Provides two way interfacing between Operation Technical Manuals and Maintenance IETMs, as applicable, via menu functions.

The approach followed was to utilise, to the maximum extent feasible, existing information, which through available technology (e.g. scanning, OCR and electronic tagging languages) has been made available in electronic, and in many cases, interactive form (using the principle of creating information once, and using it many times). An example of this approach is that the IETMs and TTPs use the same source files in creating their separate publications.

IETM Development (Primary Function)

First Approach

The initial focus of the project was the successive upgrade of existing Technical Manuals (TMs) following a typical RSA-MIL-SPEC 53 approach. This led to early realisation by the development team that a cheaper approach was possible (but would require the blessing of the Client). This realised in a rapid approach of emplacing all relevant original TMs onboard the ship in an electronic, if somewhat limited form. In this, the existing hardcopy documentation structured in “systems” was scanned, converted to *.pdf files, and loaded onto the initial version of the SIS as is, in the fledgling Interactive Electronic Technical Manual (IETM) module.

Available Technologies

With regard to electronic documentation, it is necessary to distinguish the relevant differences between the electronic tagging languages utilised, as related to the classes of IETMs. The new Corvettes will be delivered with Class 3 IETMs, utilising Standard Generalised Mark-up Language (SGML). Class 3 IETMs are typically SGML-tagged documents, with some level of added intelligence and hyperlinking through a linear structure. For “single vessel” classes like SAS OUTENIQUA, this approach is prohibitive in terms of high costs for required infrastructure, resources and capability, in both the acquisition and operational (upkeep) phases of the system life cycle. Alternative approaches are invariably required in order to reap the many advantages of utilising electronic documentation in a cost effective manner. Class 1 and 2 IETMs, as in the route followed with the IETMs for OTQ, are typically page turners and scrolling documents, with indexing and some hyperlinking. In this regard, Hypertext Mark-up Language (HTML), Extensible Mark-up Language (XML), and Portable Distribution Files (pdf) were used, which are less expensive to create, and easier and more cost effective to maintain. Limited data base interactivity was achieved to spare parts information required in text (currently in the development module only). Future expansion to an on-line database for spares information is possible.

LinkOne Development

A further development was the introduction of LinkOne, which is a software package that enabled the integration of various TMs for complex and simple equipment into one unique, electronically accessed software application. It was proven that the existing Russian TMs that had been scanned and converted to *.pdf could be converted to HTML, and published by the LinkOne software, thus providing a cost effective system that provided flexibility, good

functionality, and could be updated easily and cost effectively. LinkOne is now used for publishing all original existing technical documentation (operating and maintenance), and for enhanced / newly developed “operating” information. It enables text information in HTML to be used as source information. The LinkOne Viewer provides instant access to the information in LinkOne Books.

For this, all existing System Technical Manuals (STMs) were converted by OCR process, so that editing and updating of information could be done. This was necessary so that identified shortfalls in the original Equipment Technical Manuals (ETMs) could be addressed in the STMs that were being upgraded. In parallel, priority systems for mission success were identified by the SA Navy. The “operating” documentation for these systems was converted to an editable form (OCR process), reviewed and updated as necessary in conjunction with the Client and OTQ end users. This information was then converted to HTML, and loaded onto the SIS (LinkOne) on a piece meal, system by system basis, as LinkOne Books, in line with the priorities and available funding. The basic structure of documents remained as per the original documentation.

Standard features of the Operator TM Module include: opening books, tailoring the look to individual requirements, searching, filtering, printing, adding user “Notes”, and linking to associated publications, as applicable.

Documentation Structure

The concept of having a high level Ship Information Manual (SIM) tracing down to lower level, more detail documentation, was brought across from the Corvette Acquisition Programme. Figure 2 depicts the typical documentation structure on the IETM Module of the SIS.

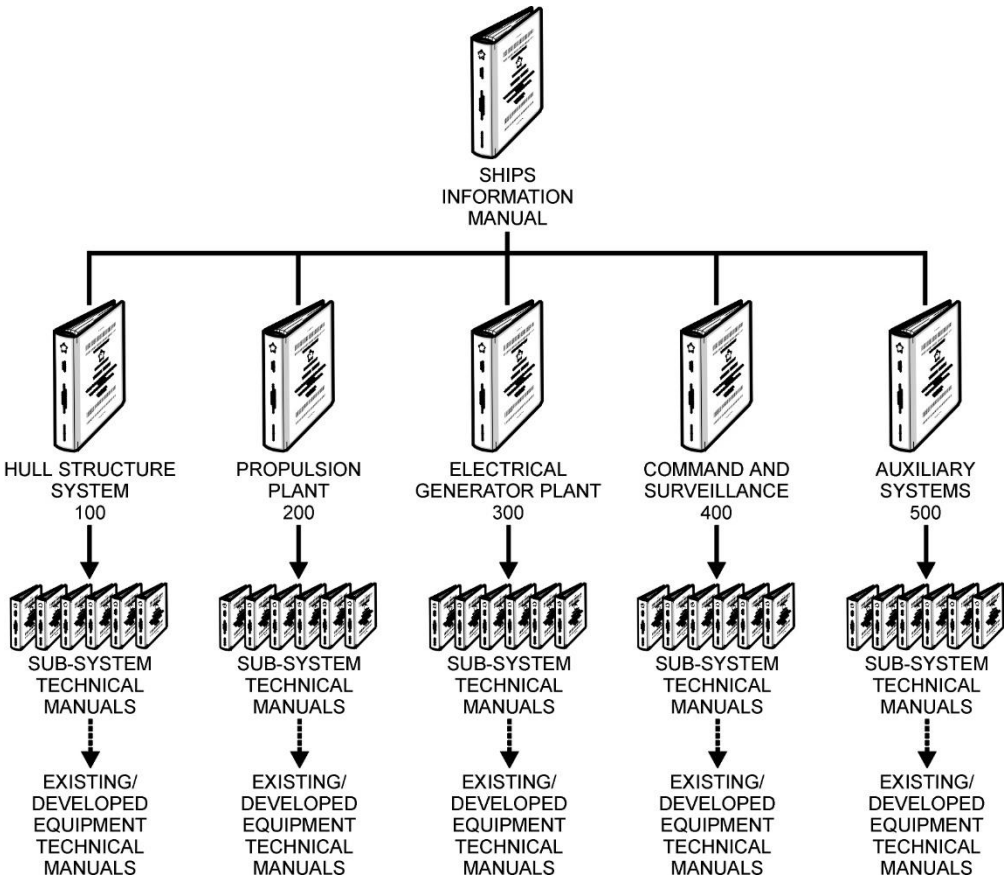

Figure 2: Documentation Structure

A major benefit of this structure (once the content and associated electronic linking have been validated), is that it provides a virtually fool proof guide for new and existing ship staff to find information. In this regard, one can drill down in a structured, logical way, from the high-level ship and system overviews and deck layout diagrams included in the Ship Information Manual

(SIM), to the more detailed operating and technical information in the STMs (and original suppliers ETMs). The deck layouts in the SIM furthermore provide good visibility to the equipment on the ship, on a deck-by-deck, and compartment-by-compartment basis. See following Figures 3 and 4 for examples.

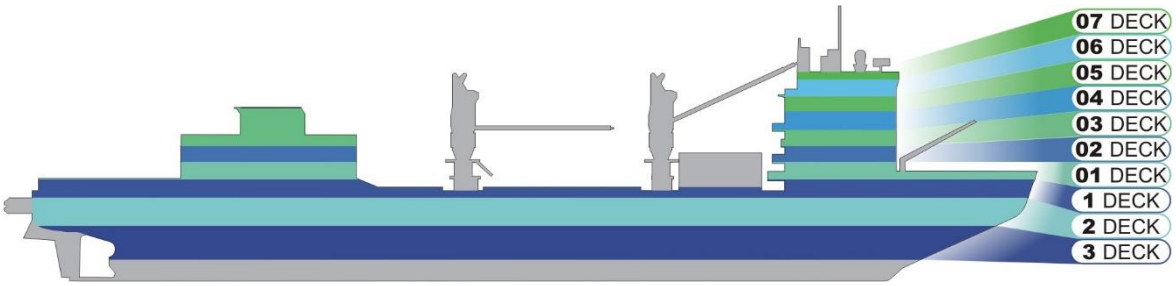

Figure 3: Deck Layouts (Ship View)

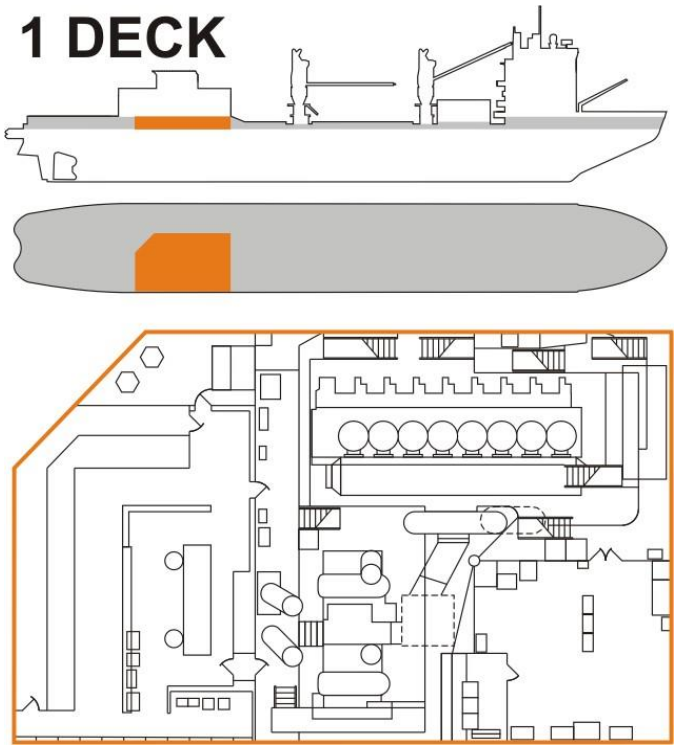

Figure 4: Deck Layout (Compartment View)

The concept of the Deck Layouts is an OTQ development that is being taken up in the development of the SIM for the Patrol Corvette, as the Ship Information Manuals developed previously for the German and other navies did not contain such overviews.

Maintenance Information

The concept (at variance to the MIL-STD approach) of having all information necessary for individual maintenance tasks available in a single file, was introduced from the Corvette programme. This concept of individual data modules was developed for OTQ, as a demo and accepted by the SA Navy for use on the prototype SIS. The Maintenance information was developed using XML with a format style sheet.

The individual task oriented maintenance “modules’ contain the following information:

a. Introduction (with overview of task, and location illustration).
b. Fault diagnosis (by link to a fault diagnosis table).
c. Pre-requisites (in terms of warnings, cautions, etc).
d. Tools and test equipment required.
e. Consumables required.
f. List of required spares (with NSN's).
g. Removal and Replacement Procedures.
h. System setup and checks (or link to relevant IETM (original information)).
i. Link to applicable Maintenance Schedules (as required i.e. for Preventive Maintenance tasks).
j. Link to FRACAS module (database) (for Corrective Maintenance tasks), for failure recording.

Maintenance Schedules (Primary Function)

The Maintenance Schedules module contains the Maintenance Schedules developed by the SA Navy, converted from MS Word documents (*.doc) to HTML. These HTML files were then converted into LinkOne Books, and loaded onto the SIS. Access to the Maintenance Schedules is either via the SIS Opening Window (see Figure 5), or by URL (from each Maintenance Task in the Maintenance IETM).

Type Training Packages (Primary Function)

The Type Training Packages (TTPs) on the SIS evolved away from a straight forward RSA-MIL-SPEC 334 approach (where significant development of new source information in the form of curricula, Lesson Plans and presentation material would have been required at considerable cost), to on-line TTPs (based on the VirtualBookTM software package). It was determined that the same electronic source files used for the TMs on LinkOne, could be used for the TTPs in VirtualBook (i.e. essentially the same source information created under the Operator IETM is modified to have a training slant, and can be referenced directly from the various TTPs under a self-training scenario on the ship).

The cost benefits achieved with this approach were considerable, for example, the first Operator TTP for a system cost approximately 30% less than what the curriculum and Lesson Plan (excluding any training material) would have cost by strictly following RSA-MIL-SPEC 334, and producing paper based training material.

The VirtualBook^{TM} software package enables text information in XML to be used via the LAN for self-study training in a structured manner, under the control of the relevant onboard specialist / supervisor. In this regard, the self-study training is supervised w.r.t. progress, history, feedback, and testing. This is ideally suited to a single vessel class like OTQ, that has no dedicated shore based training facility. The VirtualBook Viewer provides instant access to the information in VirtualBook Publications (Books). The main functions are:

a. Opening and closing Books (with bookmark feature).
b. Navigation through open books.
c. Interacting with the training material.
d. Using the study aids.
e. Communicating with the instructor (via the LAN).
f. Monitoring Student progress.
g. Adding personal "notes", and cross-references / bookmarks to facilitate navigation.
h. Searching either books (including any personal notes), or added bookmarks.
i. Printing (including pages with personal notes).
j. Self-Test / Exams.

FRACAS Database (Primary Function)

The Failure Reporting, Analysis and Corrective Action System (FRACAS) was developed to facilitate the electronic capture and transfer ashore, of specific failure related data. This initiative piggy backed on the available SIS, as a natural progression, supported by the seeming reluctance of military maintenance personal globally to filling out paper based fault reports. In

the module, information is captured on faults that have occurred, as well as their rectifications. This includes time relevant aspects such as: time of failure, time taken to repair, date and time of repair, and other related data to facilitate the analysis process. This data is transferred in magnetic media format to the relevant SA Navy shore based maintenance organisation (TUS), for analysis and corrective action purposes.

The FRACAS Database module was developed using Microsoft Access. It has the following main functions:

a. Open FRACAS Form (for data entry).
b. View FRACAS Process Flow.
c. Trend analysis (e.g. failures per equipment, equipment with the highest failure rates, longest downtime, etc.), to facilitate the shore based analysis process for corrective action, as applicable.
d. Print FRACAS Forms (as per SA Navy format requirements).
e. Print Summary Forms (including trend analysis).
f. Database administration.

Ship Equipment List (Secondary Function)
The Ship Equipment List module contains the SA Navy developed Equipment Lists for the various equipment comprising the systems on OTQ. These Equipment Lists were converted from MS Word documents (*.doc) to HTML, included in LinkOne Books, and loaded on the SIS. The selection of the relevant Equipment List is by standard URL (e.g. Mechanical Equipment List, Electrical Equipment List, etc).

Daily Documents (Secondary Function)
The Daily Documents module was developed to enable designated ship's staff to place information on the SIS (e.g. Daily Orders, Telephone Lists, Notices, Menu of the Day, Government Regulations, etc), for viewing at the various ship workstations. In this regard, ship appointed staff develop the documents using MS Word, convert them to *.pdf, and place them on the network, linking through to the SIS (using Adobe Acrobat) for viewing at workstations.

Ship Information System (SIS)

The SIS development is based on Visual Basic. The SIS Opening window was developed so that all modules can be accessed via single click "buttons" (see Figure 5).

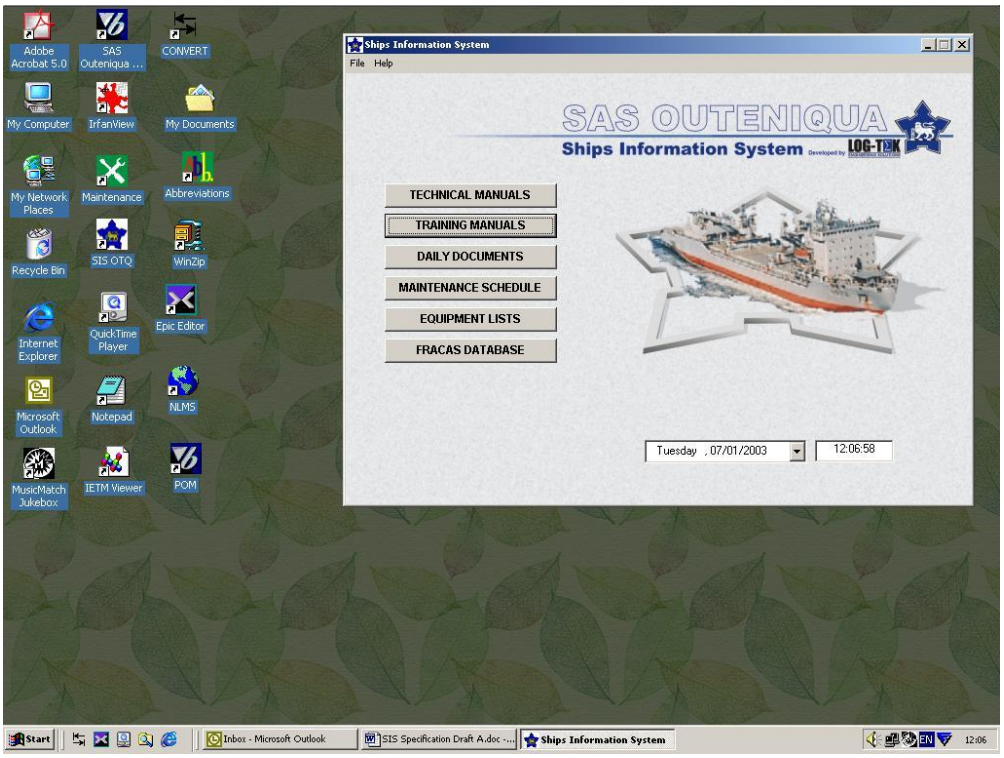

Figure 5: SIS Opening Window

The SIS Opening Window also has access to an Administrator Window that provides an administrator function, including Path selection for SIS modules, Add/Remove Manuals (TTP Module), Lock Administrator and Security functions.

Training was, and is provided to ships staff on an ongoing basis, as required.

A high degree of interactivity has been achieved in the development of the SIS and its modules. In addition, a multi-media approach has been used, with many different types of existing documentation incorporated into the system (e.g. text, diagrams, engineering drawings, digital images, panoramic views, etc). It is possible, given the need, to affordably include movie-clips (e.g. to demonstrate an important complex procedure).

BENEFITS AND ADVANTAGES

The SIS provides an affordable integrated solution to the need to provide easy and quick access to effective onboard operating, maintenance, and training information. Many benefits and advantages have already been discussed in the preceding paragraphs. The following are also relevant, or are emphasised from previous points:

a. Significant cost benefits over the traditional, MIL-STD paper based approach, throughout life cycle of the system and vessel.
b. Provides the ship with a useful and quick means to promulgate relevant documents such as Daily Orders, new Government Regulations, etc on a ship wide basis (Daily Documents module).
c. Linkage to “other” databases is possible (e.g. a LinkOne: OSIS Interface Set-up sector was designed and proven, for future interfacing to the SA Navy’s Operational Support Information System (OSIS)) (interface not currently active).
d. Information is quick, easy, and affordable to develop, promulgate and re-issue (e.g. load new CD).
e. Information is quick, easy, and affordable to amend (i.e. electronic information, based on principle of create once, use many times).

f. On screen warnings and cautions are used w.r.t the use of the SIS, and have to be "acknowledged" prior to continuing, thus providing "safety" hold points for consideration by users.
g. The on-line Type Training Packages (TTPs) are used in a controlled "self-study" scenario onboard the operational ship, in off-duty, or pre-determined training slots.
h. The TTPs negate the need for a formal shore based training establishment (ideal for single vessel classes).
i. TTPs use essentially TM information, therefore reducing the risk of variation between training and technical support information, as well as facilitating configuration control.
j. Failure data captured electronically on the FRACAS module could also be used in the support optimisation process by the OTQ project team (i.e. support optimisation is one of the wider project objectives).
k. Provides an ideal platform for early developing, testing and proving of certain concepts of the Naval Logistic Management System (NLMS) for the Corvettes, and in return, provides several useful concepts for implementation on that programme.
l. The OTQ electronic approach is in harmony with approaches used on the new Corvettes, but uses more affordable technology, resources, and infrastructure.
m. The option exists to use the SIS for "bridging" training for Corvette joining personnel, prior to the full implementation of the Corvette NLMS.
n. The SIS affordably utilises, in electronic form, numerous forms of original and existing hard copy information, with the resulting benefits.

It is important to note that the LAN and computer systems used to affect the SIS operation on a ship wide basis must be configured at the required minimum "specified" state w.r.t. capacity, processing capability, speed, etc. This is important to ensure the effective operation of the system, and to prevent the effectiveness of the system being reduced, or possibly nullified.

CONCLUSION

Based on the SIS experience, interactive electronic information utilising a multi-media approach is the way to go. The Client and End Users love it, and others who know of it but do not have it, want it.

Based on lessons learnt in the course of this initiative, numerous growth options have been identified. One such development that could be investigated is the use of a free to use publisher and viewer for the Operator IETM, forgoing the need for LinkOne. This may be possible, as the achieved know-how together with the use of available technology, can support this growth, while still provide the same level of functionality. An advantage of this further development would be that the SIS would be independent of reliance on a foreign application (i.e. a purely RSA solution to a South African challenge). Further developments pending are the introduction of an Illustrated Parts Identification Catalogue, and the use of Ship Information Manual information (e.g. deck and compartment layouts) to develop a useful, proactive Damage Control Plan for the ship.

The option to upgrade the IETMs on OTQ at reasonable cost to SGML Class 3, if this was required, was confirmed at the outset of the prototype initiative. This is however very unlikely, given the degree of functionality and end user satisfaction achieved with the more affordable technology utilised in the current SIS development. Regarding functionality, the OTQ IETM functionality has been set as the minimum standard for the Corvette IETMs.

A particularly important aspect to note, is that this development would not have been possible without a knowledgeable, participative and forward thinking Client (the SA Navy), who were prepared to take risks by being open minded and flexible in seeking an innovative, affordable solution to their needs. The role of the Client in this regard cannot be understated. In this scenario, a "prototype" SIS that best utilises original and developed information in an affordable, electronic form has been realised.

The project was basically a "work-in-progress", with continuous close liaison between the supplier development team, Client project team, OTQ System Management, ashore support organisations and ship end users. The specification was written after the fact, to baseline and

for acceptance of the electronic information tool that had been developed. This scenario provides confidence that the system can be tailored to meet varying operating and support needs, in different operational environments.

This paper has presented the integrated Ship Information System (SIS), as currently installed on OTQ, as a working example of an affordable strategic solution to the information needs and challenges of an operational Naval vessel (and fit for roll out across other single, or limited vessel classes). The current state with this initiative is that the ship is extremely satisfied with the installed system, the Functional/Technical Specification (including Acceptance Procedures) has been approved (base lining the deliverable), and the acceptance of the "beta" system has been successfully conducted. The "prototype" SIS is now being "formalised" within the SA Naval operational environment (via the ECP process), for probable use on other vessels (with the ECP accepted, and in progress).

The future opportunity for the Ship Information System and its modules, collectively or individually, is to effectively satisfy operational and logistic support needs across varying operational environments and scenario's, on wider basis, in the confidence that it presents an adaptable, effective, easy to use and affordable South African solution.

ACKNOWLEDGEMENTS

The supplier development team on the OTQ project was a teaming arrangement comprising the following companies:

Log-Tek Engineering Solutions:	ILS / Project Management. Baseline Maintenance (PBS, EC's, etc). Develop and Produce Technical Manuals. SIS Development (excluding TTP Module). FRACAS Development.
IQS Solutions / EduFlex:	Develop and Produce Training Packages (TTP Module).
Marine Technology:	Engineering activities and inputs.
GENNAN:	RAM Modelling and spare determination activities and inputs.

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RSA-MIL-SPEC 334	Specification For The Development Of Training Systems For The SA Navy.
LTE 30/10/001/55	Technical Specification For The Ship Information System (SIS) As Installed On SAS OUTENIQUA.