The CMIS solution for Tenix's M113 Program

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Our project knowledge revolves around CMIS

MRP = Mfg. Resource Planning
CAD = Computer Aided Design
LORA = Level of Repair Analysis
RAM = Reliability & Maintainability
LSA = Logistic Support Analysis

CMIS

LORA

MRP
Production
Procurement

RAM
Relex
Opus

CAD

ACAD

CATIA

LSA

TECHNICAL PUBLICATIONS

TeraText

SGML
Scope

- Some introductory comments about Tenix
  - History & experience with large, complex projects
- Critical issues relating to management of project data, information and knowledge
- A new project allowed us to embody our understanding with the latest product lifecycle management technology
- Focus on how we have extended the core technology to encompass content management
Company started as AMECON with building warships (Marine Division)

- $A 7 BN ANZAC project to build 10 frigates for Australian (8) and New Zealand (2) Navies
- Signed Nov. 1989 - 8 ships already delivered
- Project Protector - preferred tenderer for new ships for NZ
Tenix Group / Tenix Defence

- One of Australia’s largest private companies, with defence and commercial clients in Australia, New Zealand, Fiji, Philippines, USA and Europe
- Defence is largest of 6 business units, it includes:
  - Marine (defence & commercial shipbuilding, logistic support, etc)
  - Land (rebuilding as new 350 M113’s, other heavy vehicle work, logistic & base support, etc.)
  - Aerospace (systems integration, logistic support)
  - Electronic Systems (systems design, integration, related software)

(http://www.tenix.com/)
Some Land Division jobs

M113A1 "Upgrade"

(Another country in the region recently procured around 100 new LAVs for approx. $600 M)

- The Australian Army M113A1s were originally brought into service during the early 1960's.
- The purpose of the M113 Upgrade Contract is to improve protection, mobility, communications and firepower.
- Tenix is turning 350 "well used" hulls into new state-of-the-art vehicles with totally new technical data packs for a contract value of $A 391 M.

(Another country in the region recently procured around 100 new LAVs for approx. $600 M)
Requirements for safe & effective operation of all products we build

- Capability when the client needs it
  - **Reliably** does what it is supposed to
  - **Available** for service when needed
  - **Maintainable** - problems can be fixed when they arise
  - **Supportable** - critical needs available in supply chain
  - **Operable** within limits of human knowledge & capacity

- **Health, safety and operational knowledge issues**
  - **Heavy/complex engineering systems can kill!**

- **Life-cycle cost**
  - **Minimise** acquisition cost
  - **Minimise** documentation, support & maintenance costs
  - **Facilitate** "lean maintenance" philosophy
Major quality issues in delivering tech data and knowledge

- **Client’s operational knowledge delivery goals**
  - **Correct**
    - Correct information
    - Consistent across the fleet
  - **Applicable/ Effective**
    - Applicable to the configuration of the individual ship/vehicle
    - Effective for the point in time re engineering changes, etc.
  - **Available**
    - To who needs it, when and where it is needed
  - **Useable**
    - Readily understandable by humans
    - Readily managed & processed in computer systems

- **Supplier’s knowledge production and usage goals**
  - **Fast** - **High quality** - **Low cost**
  - **Eliminate rework!**

- **Total configuration management is the answer**
What we are building on

• ANZAC SHIP PROJECT
  – experience!
  – Lessons learned

• ARCHITECTURE GOALS FOR A LARGE PROJECT
Tenix/ RAN architecture for managing ANZAC Ship technical data and content

TeraText
Content management

Crossbow
Validates and integrates/Normalises data across 15 legacy systems

CSARS
Provides corrective feedback from AMPS into supplier/Navy knowledge development activities

AMPS
Navy's maint mgmt

15 legacy systems!

DOCO CONTENT MANAGEMENT
- PRODUCT DATA MANAGEMENT
  - Product Model
  - CAD / Drawing Mgmt
  - Config Mgmt
  - Eng Change
  - Workflow
  - Process Control
  - Doco Revision & Release

PRODUCT CONFIG MANAGEMENT
- Product Model
- Drawing Mgmt
- Config Mgmt
- Change Request
- Workflow
- Process Control
- Doco Revision & Release

UPDATE CONFIG
- UPDATE MAINT DATA / PROCEDURE
- MAINTENANCE MANAGEMENT
  - Schedule
  - Resource Reqs
  - Procedures
  - Completion
  - Downtime
  - Resource Usage

DOCO CONTENT MANAGEMENT
- released doco change
- doco change order

MRP SYSTEM
- Plan
- Fabricate
- Assemble

ECO
- change effected
- config change

M A N U F A C T U R I N G

LOGISTIC ANALYSIS TOOLS
(prime)

LSAR DATABASE

RECORDING REPORTING ANALYSIS TOOLS
(prime)

shared systems?

SUPPLY SYSTEM

Analysis & optimisation

maintenance history

orders

receipts

ECO
- change request

change mode

doco change

change task

change effected

config changes
The M113 challenge

- Coherently manage all data and **documents** required to support the M113 fleet through life
  - Engineering data (well known solutions for this)
  - **Technical data and publication content**

7 variants

~25 builds

350 vehicles
The CMIS solution for Tenix's M113 Program

Big enough project to support current best practice
Knowledge is our most important asset

• Data and documentation are the most important assets to the company

• CMIS is the custodian AND guardian of the Company’s data and documents
  – Secure Vaults and Stores
  – Encrypted
  – Access control

• CM II compliant
  – Only recognized commercial CM doctrine
  – Qualified by Institute of CM
Background

• Contract: All CM in M113 Project according to
  – TRAMM (Technical Regulation Army Maint Mgmt)
  – MIL-STD-973 (Configuration management)

• Other standards
  – Naming follows H6 (US Fed Item Name Directory)
  – NATO Commodity Codes forms part type

• Rule: CMIS manages all tech data for all projects
  – Engineering data
  – Source documents
  – Technical Publication content

• **No part released until all metadata correct**
CMIS was conceived as an "umbrella" system

- Single user interface
- Data normalization applies to all project data and document components from the start
- Common workflow management environment
- Single point:
  - electronic signoff
  - engineering change management and tracking
  - cost and schedule control
- The umbrella covers everything!
Overview

- CMIS provides primary user interface
- Two major modules
  - PDM – product data manager – Matrix10
    - Configuration management
    - Workflow process
    - Object management
  - ANZAC experience proved value of content management
    - Authoring activities delegated from Matrix10
    - Configuration management of elements within documents
    - Paragraph version management & reuse
    - Authoring in S1000D - deliver any required structured/unstructured format
Configuration management

SOME QUOTES:

The source of all data generated starts at the concept phase of the product and grows with the product!*

Configuration management is a discipline not an overhead!*
Configuration Management

• Very distinct phases of CM
  - Development
  - Production
  - In service

• Analysis of data types has determined two distinct types
  - Objects
  - Content

• To manage these we require two distinct processes
  - CM of objects - provided in Matrix10 PDM environment
  - CM of content - delegated to TeraText
Configuration Management

- Baseline management for each engineering phase
- Principles
  - Items (like Systems) have a lifecycle within the engineering phase.
  - Items are “promoted” to the next phase through approval only.
  - Items are NEVER deleted – they have “history”.

Diagram:
- Preliminary
- Review
- Release
- Obsolete
Focus on:
Document and content management

It is configuration management of “blocks of text”

It is configuration management to the lowest level inside a document!
What is a document?

- The entire history of all versions?
- Each set of variants?
- Each separate version?
- Each rendition – SGML, HTML, PDF?
- Each component
  - volume, chapter, division, warning …?

**TeraText uses the Document Management Alliance model which concurrently supports all of these concepts and provides a framework for managing them**
What is TeraText:

- Embodies world wide state-of-the-art in information systems research in a commercial product
  - Fully web enabled text database system (not relational)
  - Data compression for CPU efficiency and speed
    - High performance compressed/inverted file indexes
    - typical index ~ size of text
  - Real-time simultaneous indexing/search/retrieval
  - Very sophisticated search engine works against index
  - Standards based
    - XML/SGML/RTF/PDF etc.
    - Z39.50, MARC, etc.
  - Distributed architecture
  - Scalability to multi-terabyte data, 10,000's users
- http://www.teratext.com
Content Management in the M113 Upgrade

This is the Work File System

Save

WEB Protocol

Content Management in the M113 Upgrade

Storage and Dis/assembly Rules

Document  Fragment  Chapter  Section

PDF  Graphic  Fragment

Edit

M113A
- AMBULANCE
  - Maintenance Manual
    - Volume1
  - Users Manual
    - Section1
    - Section2
  - Chapter1_Vehicle
    - Brake System
    - Drive System
    - Fuel System
    - Hydraulic System
    - Suspension System
SGML-Content management: Storing XML directly

Parser/Processing engine
- indexing
- querying
- versioning
- doc management

Document/data operations

Content
Attribute
Structure
TeraText:
Web interface overhead

- User Interface Module
- XML/SGML Parser
  - Workflow Enactment Service
  - Metadata Support
  - Document Version Manager

- TeraText Application server
  - Application Workflow
  - XML Engine
  - Document Manager

- TeraText DBS
  - XML Engine
  - Content query
  - Object Management Repository

- HTTP/HTML
- Z39.50
Managing document technical data

- Authoring process for controlled changes to authored content
- Achieves
  - Consistency (via standards base, DTD and EDD)
  - Reuse
Technical manuals and data modules are managed with CMIS lifecycle process in the same way as any other configuration items.
We are addressing the content management challenge by...

- Adopting a long term view of the content
- Ensuring the document model supports authoring at the document, component and fragment levels
- Truly sharing (reusing) common texts vs rekeying common texts
- Direct sourcing of PDM data into parts lists tables
- Supporting auditable review processes and version control
- Using tools and content model to assess impact of change
- Building documentation set using industry standards and tools
- Using COTS authoring tools
- Applying industry standards for long life content
What real world problems are solved?

• The in-service life for an APC is many decades
  - Most documents contain configuration sensitive content
  - File system does not track the changes through time
  - Lifetime of a word processor format is about 5 years
  - DMS does not provide point-in-time support
  - **TeraText Content Management System manages versions and provides point-in-time search across versions**
  - **SGML (~XML) is essentially unchanged since 1986**

• Many versions of each manual, changes to individual vehicles etc, leads to many hundreds of documents
  - DMS typically limited to about 100,000 pieces
  - **TeraText Content Management System scales to many hundreds of thousands of documents and millions of configuration sensitive components**
What real world problems are solved?

• About 80% of content is common to all manuals
  - DMS only manages whole documents and does not know what is common to other documents
  - *TeraText Content Management system manages the components that make up the document*
  - *Reuse, don't rewrite!*

• Only small component may change in a document
  - DMS or file system requires whole document to be stored again
  - *TeraText Content Management System stores common components once and tracks versions of components as well as whole documents*
  - *Know "where used"*
What real world problems are solved?

- May need to strip out classified material for unclassified users
  - static documents don’t allow for changed details
  - *TeraText can strip out elements on-the-fly*
- Need to support hypertext link management
  - a word processor alone cannot validate links between multiple documents
  - *TeraText manages links and link validation*
- Need to support collaborative authoring of large documents
  - *TeraText allows whole documents or individual components to be edited*
The cost/benefit equation for content management vs DMS

Cost

Time

Initial document set

Proliferation of configurations

In-service maintenance

Traditional DMS

CMIS

Note: CMIS cost is for first project only.
Our major success factors to stay ahead of the competition

• In the starting blocks
  – Complex project with no legacy systems
  – Limited budget emphasised need to work smart
  – Management willing to try new solutions

• Success on the track
  – **Knowing what was possible/practical**
    • Leveraging prior successes
    • Continuing R&D to track technology with specifications
  – **Project controlled by end-users who had to deliver physical and knowledge products**
  – **In-country application implementation and interfacing expertise**
Thank You!
Now, what does it look like?
ILS Data tab in Tree View

User Name: super

15004514 rev A: Properties

- Part Family
- Design Responsibility: Tenix Defence - Land Division
- ECO to release: ECO-2011-0042
- ECO Effectivity Date: 7/6/2004 11:00:00 AM
- State: Release
- Part Type: 7650-Drawings and Specifications
- Part Name: 15004514
- Revision: A
- Policy: EC Part
- Owner: Corporate
- Originated: 19/06/2003 10:47:35
- Modified: 14/07/2004 12:15:58
- Description: POWER CONTROL BOX INSTALLATION
- Vault: eService Production
- Type: X
- Material Category: Unassigned
Browser based - we could be doing this anywhere in the world!

- Note that we are working on an end-user PC
- The only reason the presentation isn't live is that
  - Our development environment is on an isolated server.
  - No one "plays" with live data!
# Data Modules associated with Hardware

Part 15004514 in the eMatrix PDM

### 15004514 rev A: Data Modules

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</table>
Data Module Graphics associated with Part 15004514 in the eMatrix PDM
Online View of Data Module retrieved from the Tenix CMI SI TeraText Repository

Annotation points

POWER CONTROL BOX

TECHNICAL DESCRIPTION

1. The Power Control Box (PCB) is located in the rear of the vehicle. Its function is to serve as reverse polarity protection, battery charge monitoring and charge level control. It has a four position switch fitted on the lid for seasonal/location battery discrimination.

2. The PCB is supplied with power from the vehicle batteries.

3. The PCB controls are integrated with the Voltmeter Box (VB) for access capability. The VB acts as a metering medium, status indicator and contains a manual override switch. The VB measures/indicates the:
   a. average level of the parallel connected auxiliary and starter batteries.
   b. auxiliary battery voltage when the interconnector is open.
   c. the alternator voltage if the engine is running.

4. The VB has the following status indicating lamps:
   a. reverse polarity for the auxiliary battery.
   b. reverse polarity for the starter battery.
   c. power OK indicating lamp shows if power is present at the PCB and the VB.
Option to retrieve previous versions of a Data Module from the Tenix CMI SI I TeraText Repository
Facility to check a Data Module out of the TeraText repository for editing and launch it in the editor of choice [currently FrameMaker], convert it to SGML and check it back in to the repository [Check-in].
Tenix modified FrameMaker to use the TeraText Interface.

The CMIS option on the tool bar accesses functions to help authors find and insert:
- Warnings, cautions and notes
- Data module references (links)
- External source publication references (links)
- Data module graphics, and
- to save the data modules in SGML format.
POWER CONTROL BOX

TECHNICAL DESCRIPTION

1. The Power Control Box (PCB) is located in the rear of the vehicle. Its function is to ensure protection, battery charge monitoring and charge level control. It has a four-position, season/location battery discrimination.

2. The PCB is supplied with power from the vehicle batteries.

3. The PCB controls are integrated with the Voltmeter Box (VB) for access capability. The medium, status indicator and contains a manual override switch. The VB measures in:
   a. average level of the parallel connected auxiliary and starter batteries.
   b. auxiliary battery voltage when the interconnector is open.
   c. the alternator voltage if the engine is running.

   Issue
   
   Issue Type = New
   
   Issdate
   
   Year = 2004
   Month = 7
   Day = 13

Doc: 15004514-equipdesc-001.fm 100%
13. If in the silent running condition, with the interconnector in the open condition the electrical supply. The auxiliary battery will continue to supply the electrical load of the vehicle if the battery is completely discharged.

**CAUTION**

UNDER CERTAIN CONDITIONS IT IS POSSIBLE THAT THE STARTER BATTERY WILL DISCHARGE THE AUXILIARY BATTERY AS THE AUXILIARY BATTERY IS DISCHARGED AND THE VEHICLE IS RESTARTED. THE VOLTAGE OF THE RUNNING ALTERNATOR AND NOT A TRUE BATTERY.

The vehicle engine is started the FCB monitors the output voltage of the alternator. When the alternator voltage reaches a predetermined level, the interconnector will connect the auxiliary and starter batteries in parallel and allow recharging of the starter battery. Certain indication lamps that act as a reverse polarity indication device for the auxiliary start supply. Indication lamps will illuminate and show a reverse polarity condition exists.

**CAUTION**

UNDER CERTAIN CONDITIONS IT IS POSSIBLE THAT THE STARTER BATTERY WILL DISCHARGE THE AUXILIARY BATTERY AS THE AUXILIARY BATTERY HAS THE LOWER VOLTAGE. THE EFFECT OF THIS IS TO CAUSE THE VEHICLE TO STOP AND FORCE THE CAR TO BECOME A PASSENGER CARRIAGE.
services the PCB and the VB and is protected by a glass screw in type "R" fuse located on the V2.

Three 50A fuses are contained inside the PCE for circuit protection. There are two spare 50A fuses in the hub of the PCB. These protect the...

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**Figure 1. Elevation Stop Sensor Wiring Harness**

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19. Consideration has been given to different seasonal conditions and locations that will affect the installation...
COMBAT TURRET SYSTEM

EQUIPMENT OVERVIEW

1. The turret is electrically driven and electronically controlled to allow for precise movements. The weapon, when fitted to the turret, will traverse the turret is controlled by a hand held controller. The hand held controller controls the elevation of the weapon. Switches on the hand held controller determine the elevation of the weapon.

2. The turret traversing and elevation motors have a manual override capability.

3. The turret has its own electrical distribution system from the electrical system of the vehicle.

4. The turret contains navigational systems and internal/exterior communication systems.

5. The turret has access to one weapon that can be supplied by an external munition. Spent rounds can be collected in a ammunition dispenser.

6. A crew commander's sight (CCS) daylight gunner's sight is located at the turret and laying accurate weapons firing.

7. The turret has an external armour in addition to the normal turret hull protection.
5. The turret has a choice of two weapons that can be supplied by an ammunition chute from a ready round tin and the spent rounds can be collected in an ammunition discharge bin.

6. A crew commanders sight (CCS) day/night gunnery sight is located in the turret to aid the commander in locating a target and laying accurate weapons firing.

7. The turret has external armour in addition to the normal armour.
15007925-equipover-001 rev 1: Operations

Operation to Perform

- View on line
- Open in external viewer
- View previous version on-line
- Open previous version in external viewer
- Open existing check-out file
- Check-in
- Cancel Check-out
COMBAT TURRET SYSTEM

EQUIPMENT OVERVIEW

1. The turret is electrically driven and electronically controlled to allow the crew commander to rotate the turret in a controlled manner. The weapon, when fitted to the turret, will traverse in the same controlled manner. Traversing the turret is controlled by a hand held controller. The hand held controller also electrically/electronically controls the elevation of the weapon. Switches on the hand held controller also fire the weapon.

2. The turret traversing and elevation motors have a manual method to traverse the turret and elevate the weapon.

3. The turret has its own electrical distribution system from the Electrical Control Box for electrical services.

4. The turret contains navigational system and internal/external communications systems.

5. The turret has a choice of two weapons that can be supplied by an ammunition chute from a ready round bin and the spent rounds can be collected in an ammunition discharge bin.

6. A crew commanders sight (CCS) day/night gunnery sight is located in the turret to aid the commander in locating a target and laying accurate weapon firing.
Capturing contextual knowledge with links and annotations in the ANZAC Ship Project

- Explicit and implicit links encode contextual knowledge
- Links are 2-way connections
- **Annotations are the key to converting implicit contextual knowledge to codified explicit knowledge**
Annotations

- Annotations provide the key to capturing context
Annotations in CMI S

Data Module Annotations

- Permanent
- Internal Review
- External Review

Internal Review Annotations

This requires some more work

Add Annotation:
Annotations in CMIS

Data Module Annotations

- Permanent
- Internal Review
- External Review

Internal Review Annotations

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<td>Wed Jul 14 18:10:18 2004</td>
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This requires some more work

Add Annotation:
Technical Manuals list page identifies and shows lifecycle status of manuals produced for the selected vehicle.
# Tracking document work

![Tracking document work](image.png)

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Generating a deliverable document

• The Technical Manual is generated as a background process.
• When the generate manual process has been completed an email is sent to the manual owners group.
Technical manual delivery files are stored in 3 formats: on-line, PDF and SGML
TECHNICAL MANUAL

M113AS4 APC

Maintenance Manual

ABR-33812
Issue 0.1, 14/07/2004

Publication Sponsor: Tenix Defence Land Division
TECHNICAL MANUAL

M113AS4 APC

Maintenance Manual

ABR-33912
Issue 6.1, 14072004
Publication Sponsor: Tenix Defence Land Division
SGML version and the associated graphic elements are delivered in a ZIP File.
MatrixOne Innovation Summit 2004

EXTRA SLIDES
Our latest best practices:
Land Division

• Domain expertise in:
  – Design and manufacture of Armoured Personnel Carriers
  – Upgrade of military vehicles
  – Design, manufacture, modification and repair support of all kinds of major military vehicles
  – Civilian support, armoured & heavy vehicle maintenance, warehousing at military sites

• Present major vehicle projects
  – Australian Army M113 project
  – ASLAV Phase 3 Project
Configuration and knowledge management architecture goals for a large project

- Product and textual data are **structured** and are managed as content.
- Production mgmt data is **transactional** and is managed as records and fields.
- Goal is to manage all project data within a single configuration management umbrella.
SGML-DMS:
The traditional approach

Document/data operations

Parsing Engine
fragment/coalesce

Full Text Indexing Engine
Content

Relational Engine
Relation

Attribute, Structure, Content
Traditional DBMS: Web interface overhead

Web server
- HTTP/HTML
- CGI/ISAPI
- CGI/Java...
- Custom
- Omnimark/Perl...
- ODMA?
- Custom

Application logic
- WAPI
- Custom

XML engine
- Custom

Document Manager
- ODBC/CORBA...
- Custom

Object Manager
- SQL

SQL

RDBMS
- SQL

Workflow
- Custom/WfMC

Content Query
- Custom
- SQL

SQL