3.2 The NCDO history from the Perspective of MIL Systems Engineering Inc. (5)

This story might best be told by looking at what the NCDO work did initially for Canadian Industry, and how it placed the Industry in a position to expand into previously virgin areas of Navy business.

The Federal budget over the years had a marked impact on the Navy's ambitions and capabilities. Sometimes there was adequate funding and at other times vice versa. The 1990's were particularly lean years for the DND Budget, and in the mid 1990's the Department of National Defence (DND) sought to maximize the usage of its uniformed manpower for duties that *only* such people could perform, such as manning warships, flying combat aircraft and combat ground forces where such personnel may be needed to be sent into harms way. DND set up a program named Operation Excelerate, which aimed at this objective. On the Naval side, MIL Systems Engineering Inc., the then current holder of the MDDO Contract and the inheritor of the original NCDO design team set up in Canadian Vickers in 1949, was well positioned to assist in the Operation Excelerate concept, and the following extracts from its Proposal **(5)** well illustrate the expertise it had accumulated over the preceding 46 years and the forward thinking of its workforce. The material is presented in the manner it was briefed to DND at that time, and was intended to present not only MIL Systems Engineering's willingness to be involved in the Operation Excelerate activity but its credentials for doing so. This approach was summarized in the submission covering letter.

The material that follows is taken from that Proposal and outlines the experience of MIL Systems and its potential to provide the Navy with its expanded needs as defined in Operation Excelerate. It also described the Company's marketing efforts to export its technology and experience that had been built up over the years, in an effort to provide a sustainable business base.

The export market for warship design services proved to be virtually nil since all developed Countries had an enormous NIH factor (Not Invented Here) so did not contract offshore for their defence industry requirements when they had their own indigenous capability, and the developing Countries bought completely equipped (usually used) warships from the developed Countries and leaned towards their previous colonial powers where they existed. Canada's surfeit of used warships was nil and it was not a previous colonial power, so that market was non-existent. Countries such as the USA, the UK, France and Italy had very well developed indigenous Navy experience in both the design & build of new ships and in the availability of used ships; they were also previous colonial powers. Nevertheless, MIL Systems Engineering pursued the export market in niche areas in which it had become competent and enjoyed limited success, but the national market was not big enough for a self-sustaining business.

Consequently, if no large corporate entity (such as le Groupe MIL which was owned by le Societe Generale de Financement of the Quebec Provincial Government, Department of Industry) was intent on maintaining the Company then its future was less than assured, and the lack of capitalization plus the retirement of the original NCDO workforce did not favour any entrepreneurial investment in the essentially non- existent Canadian Navy market

The opportunity presented by DND's Operation Excelerate provided hope, so the following presentation was made to the Navy via the Snr. ADM MAT office. A briefing was presented to DND (ADM. MAT & DG MEPM) but no short-term action resulted to Industry. Many years later a Support Contract was put out to tender and was responded to by MIL Systems Engineering, but was awarded to Seimens Westinghouse of Toronto. The award was challenged in Federal Court and after more than a year of review was ruled to have been inappropriately awarded and that MIL Systems Engineering should have won the competition and was to be compensated! The original contract was never withdrawn and MIL Systems Engineering was never awarded a contract to do work.

Many of the charts used in the original Proposal are used hereafter, but where some did not scan well into my computer they have been redrawn unchanged as to content. Also, pictures of ships, etc. have been added to make the (historical) reading more attractive. The commentary has also been added to provide the "raison d'etre" for the individual charts as given at the time of the Presentation and as influenced by later events.

SUBMISSION LETTER

MIL Systems

MIL Systems Engineering Inc.
200 - 1150 Morrison Drive,
Ottawa, Ontario, Canada
K2H 9S9

LtGen. Fischer
Snr. ADM (MAT)
Dept. of National Defence
MGen. G. R. Pearkes Bldg.
101 Colonel By Drive
Ottawa, Ontario
K1A 0K2

13 June, 1995

Ref: JRW 13,979

SUBJECT: COOPERATION WITH INDUSTRY
AN ECONOMIC DISCUSSION FOR THE SUPPORT OF
DG MEPM'S SHIP CLASS DESKS

Dear Sir:

I attended the COPWIN seminar on 30/31 May last and am writing to you in response to the invitation you made during your opening address with respect to the fact that you wanted to hear from Industry.

The attached document titled "COOPERATION WITH INDUSTRY MIL SYSTEMS" has borrowed the COPWIN logo which appeared on the cover of the two daily agendas, and responds to your invitation.

The thrust of the document is in line with DND's Operation Excelerate objectives (see Sect. 2).

MIL Systems has been serving the Navy continuously since 1949. During the ensuing 46 years MIL Systems has grown up with, and has at times been the initiator of, the Navy's engineering and technical documentation system. Clearly this has entailed interfacing with a multitude of naval personnel as their appointments were rotated, and in the process the work was discharged in a manner which induced the Navy to continue to direct the work to MIL Systems, although during the years 1972 to 1981 the work was competed and MIL Systems won it every time (see Sect. 5).

The Navy has therefor in essence nurtured MIL Systems and indeed invested heavily in the company. On the other hand the company has spent its own funds on forward-looking R&D in anticipation of requirements that the Navy may have been looking at (see Sect. 5). Also, during that time MIL Systems has been Design Agent for every warship and is unique in its

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MIL Systems Engineering Inc.
Member of the MIL Group

Certified by
Professional Engineers
Ontario

knowledge of all the Navy ships, including the Canadian Patrol Frigate which MIL Systems designed under contract to SJSL (an often overlooked fact).

To the point, then.

1. DG MEPM is contemplating a Ship Class Desk organization (see Sect. 2).

2. MIL Systems has all the capability and the proven experience required for the support to all Class Desks for all work other than that which a uniformed sailor is required for, such as fighting the ship, etc. (see Sect. 8 which includes a provisional WBS with cross-indexing between tasks and DND/MIL Systems as implementor).

3. MIL Systems major presence is in Ottawa, close to DND HQ, and has a presence at each of the east and west coast Navy dockyards as well as at Quebec City near the Navy Reserve HQ (see Sect. 8).

4. MIL Systems has been audited by Lloyd's and recommended for certification to ISO 9001 which is DND's defined new quality standard and we expect our formal certificate about 30 days from now (see Sect. 4).

5. There is clearly economic advantages to having one organization supporting ALL the Ship Class Desks in that only one contractual and performance interface exists between DND and Industry, that common methodology and bulk purchasing would be used for ALL ships logistics support, that uniformed personnel can move from one ship class to another without the need for training on "another" logistics system, etc. It would also benefit from "post service" employment (option) for retiring specialist DND personnel.

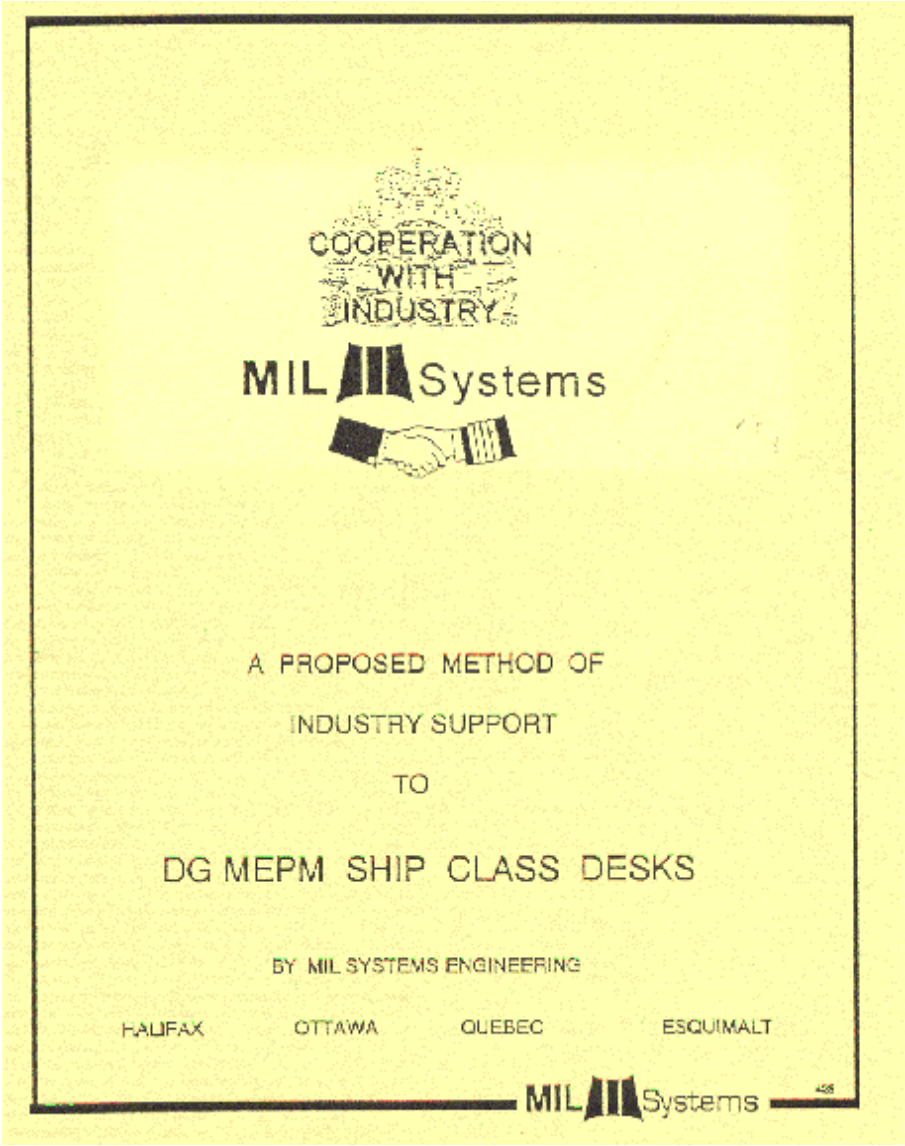
I would appreciate the opportunity to brief you on this document of which the index is attached, and will make myself available at your convenience. I am sending a copy of the document to Cmdre. Gibson, DG MEPM as a courtesy since it is his area in which we currently provide engineering and data support services through the MDDO contract and which is contemplating reorganizing to the Ship Class Desk concept.

Thank you

Yours very truly

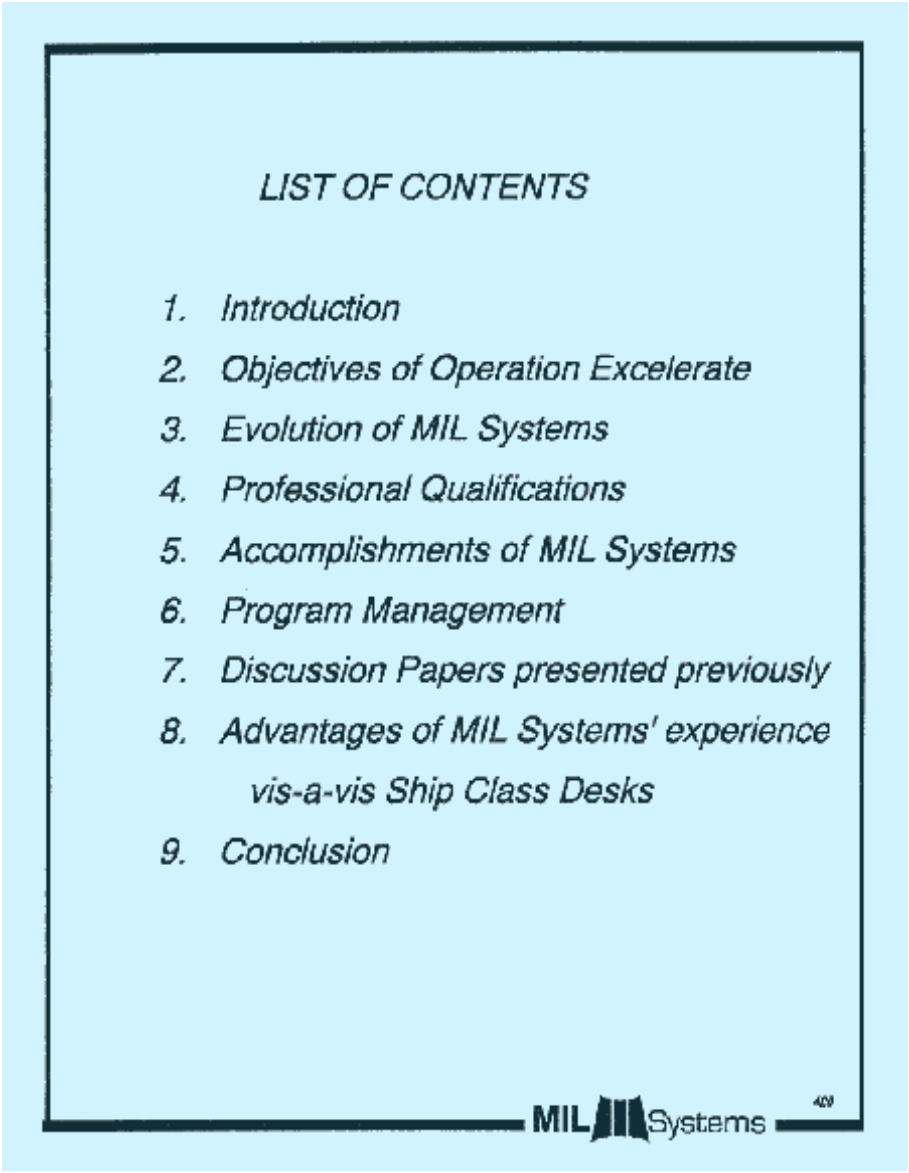
James R. Williams
President & C.E.O.

MIL Systems



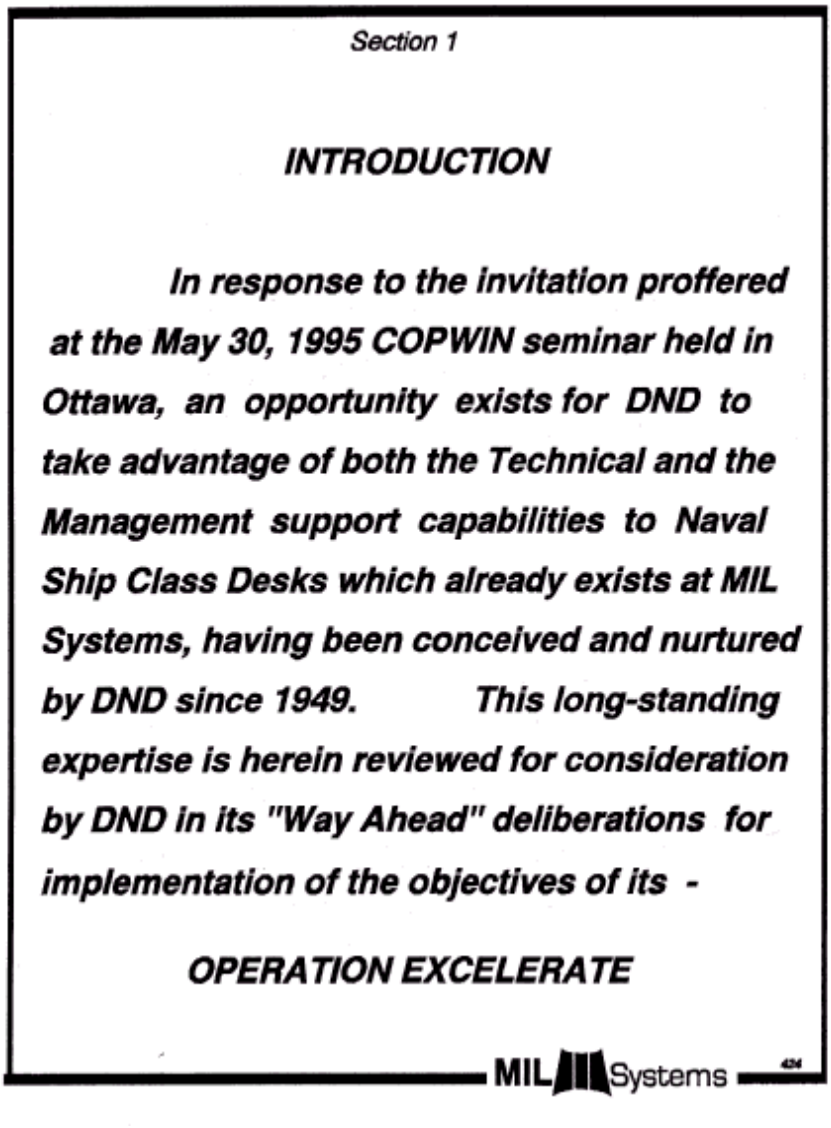
This was the cover of the Proposal.

LIST OF CONTENTS

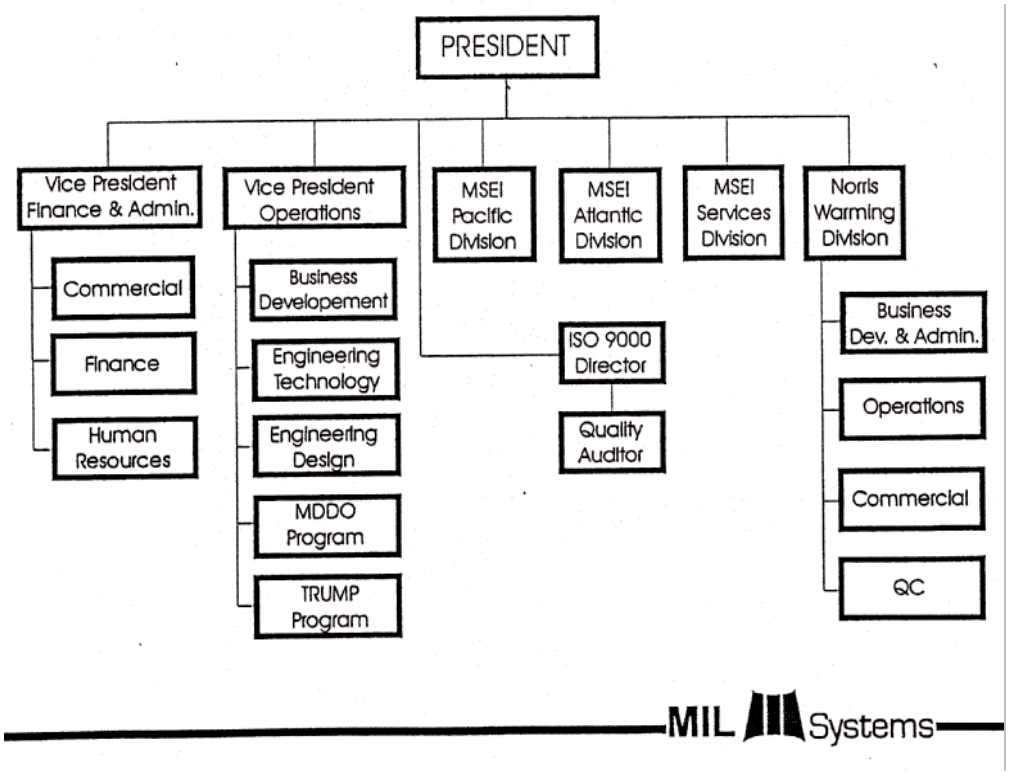


The Proposal content was intended to pose all possible questions and to provide their answers from MIL Systems' viewpoint. It was considered that the Company had a unique capability based on both an impeccable history and its innovative marketing thrust which was primarily aimed at helping the Navy to be aware of solutions by a Canadian Company to some of its problems, both materiel and process.

1. INTRODUCTION

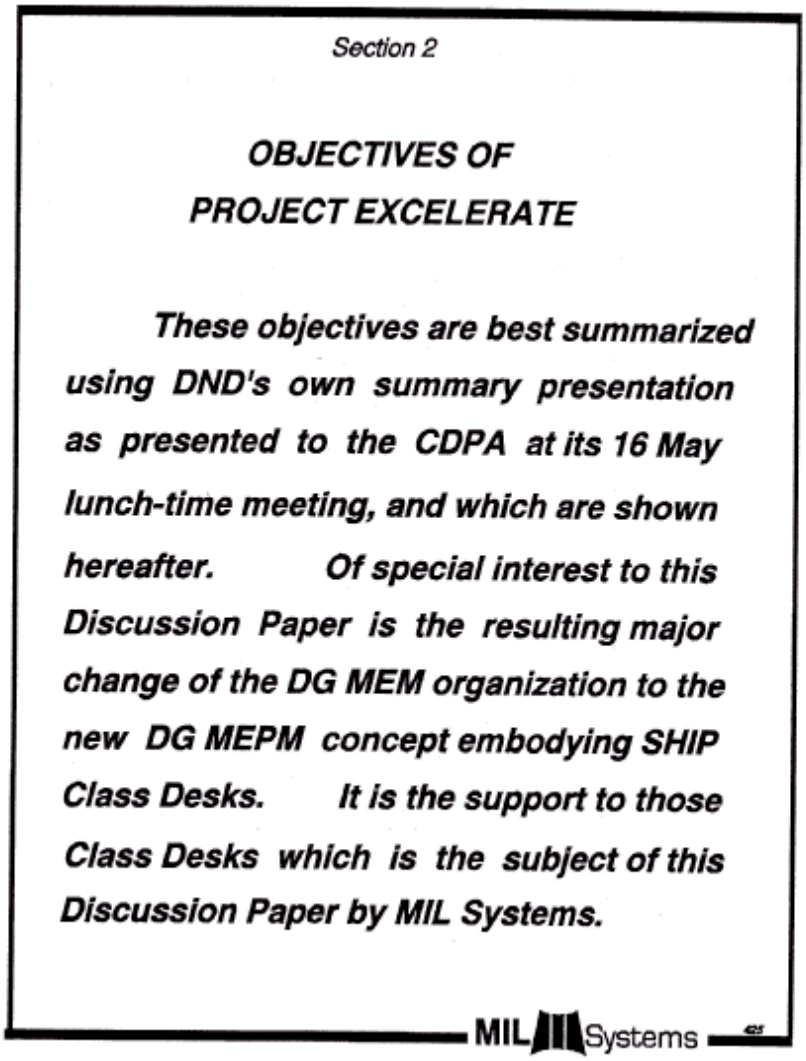


The Introduction was intended to focus the reason for and timing of the Proposal based on the presentation given by DND to Industry at large. The MIL Systems Engineering Proposal was aimed at its traditional area, the Canadian Navy element of the Canadian Forces.

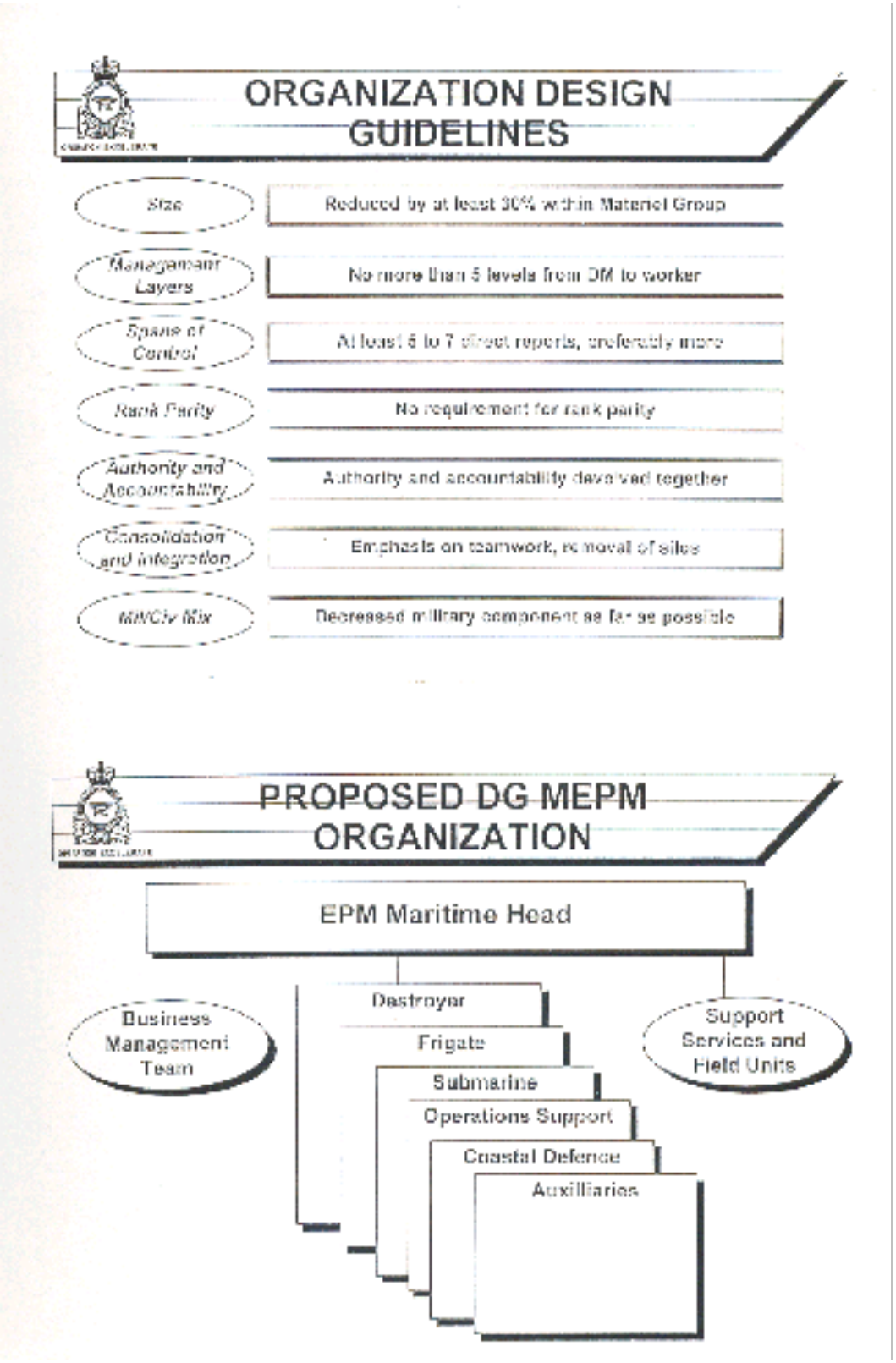


These two charts showed the location of existing MIL Systems Engineering offices across Canada, and the organizational structure of the Company. The main workforce was located in Ottawa due to the proximity of DND HQ in order to facilitate face-to-face communication with DG MEPM and his staff. Offices were also located essentially "outside the gate" of both the east coast and the west coast dockyards. Also located in Ottawa were two subsidiary companies, MSEI Services and Norris Warming. These two operations covered (a) the **LCMM** specialities of documentation and minor personal service contracts, and (b) **HVAC** system designs, supply and maintenance (Heating, Ventilation & Air Conditioning).

2. OBJECTIVES OF OPERATION EXCELERATE

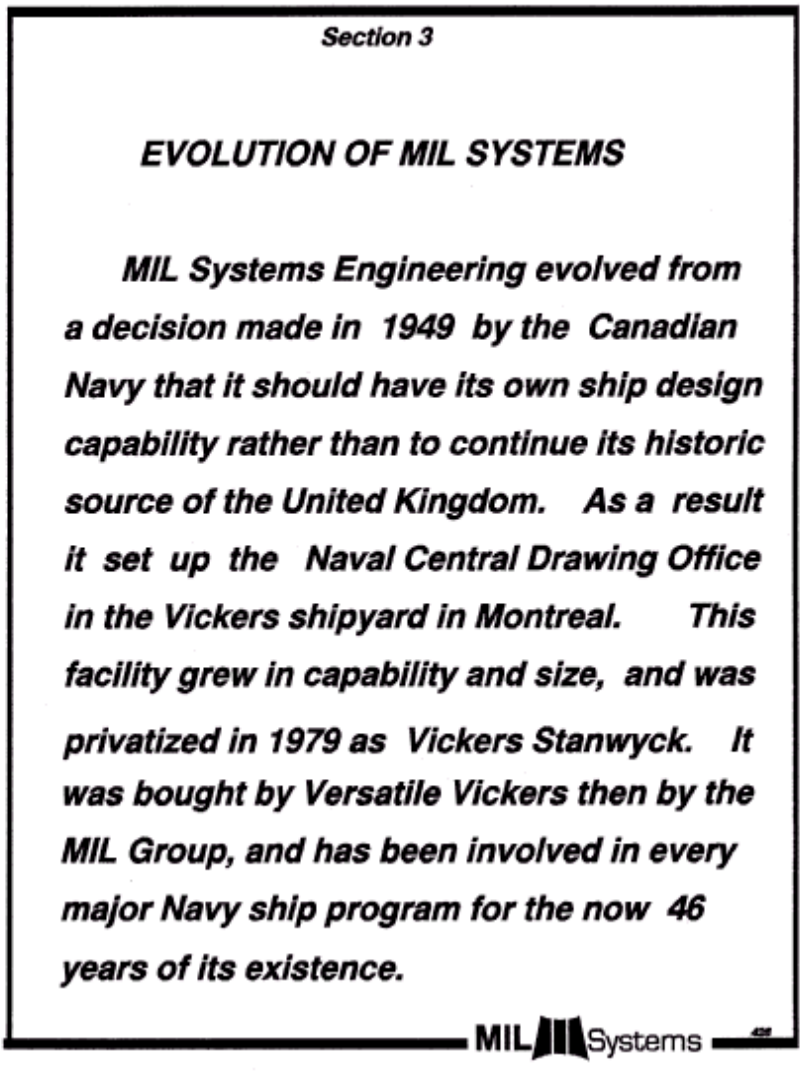


The thrust of the Proposal was to focus MIL Systems Engineering's capabilities into a format best suited to satisfy the stated requirements of Operation Excelerate.

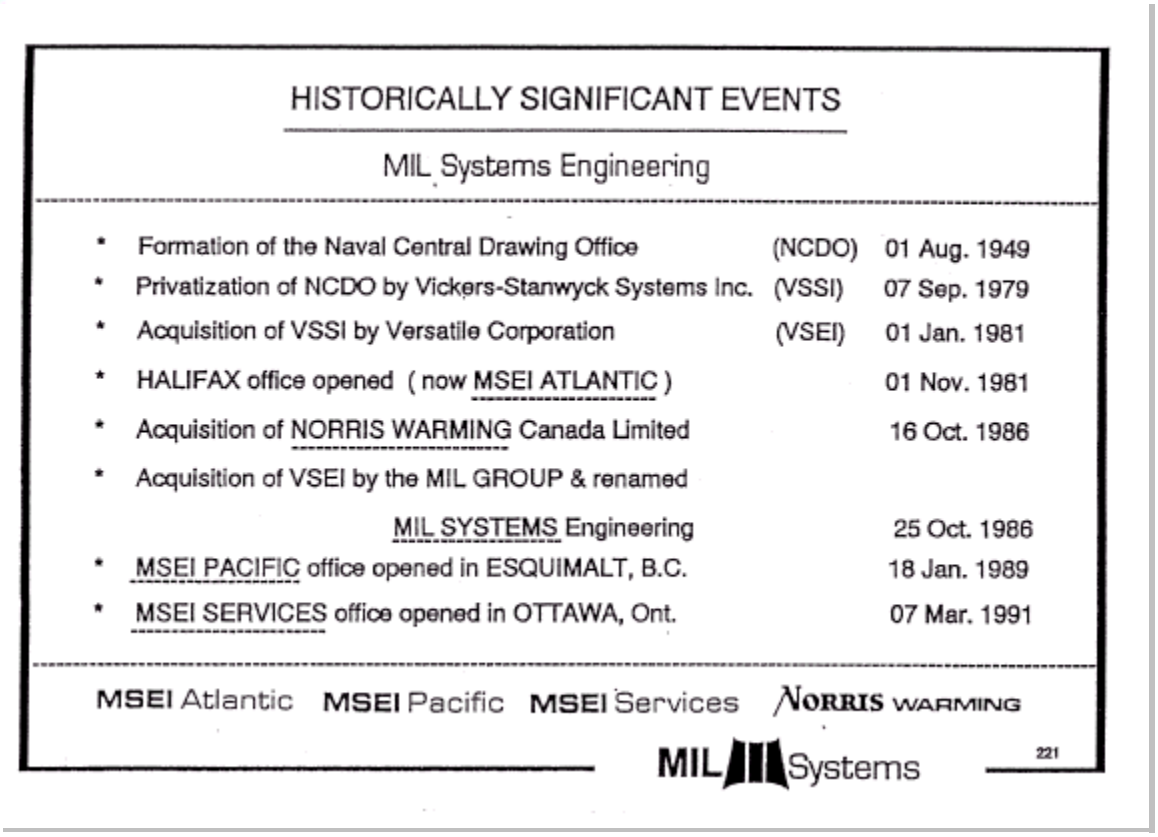


The MIL Systems' copies of these DND charts were of original poor quality

3. EVOLUTION OF MIL SYSTEMS

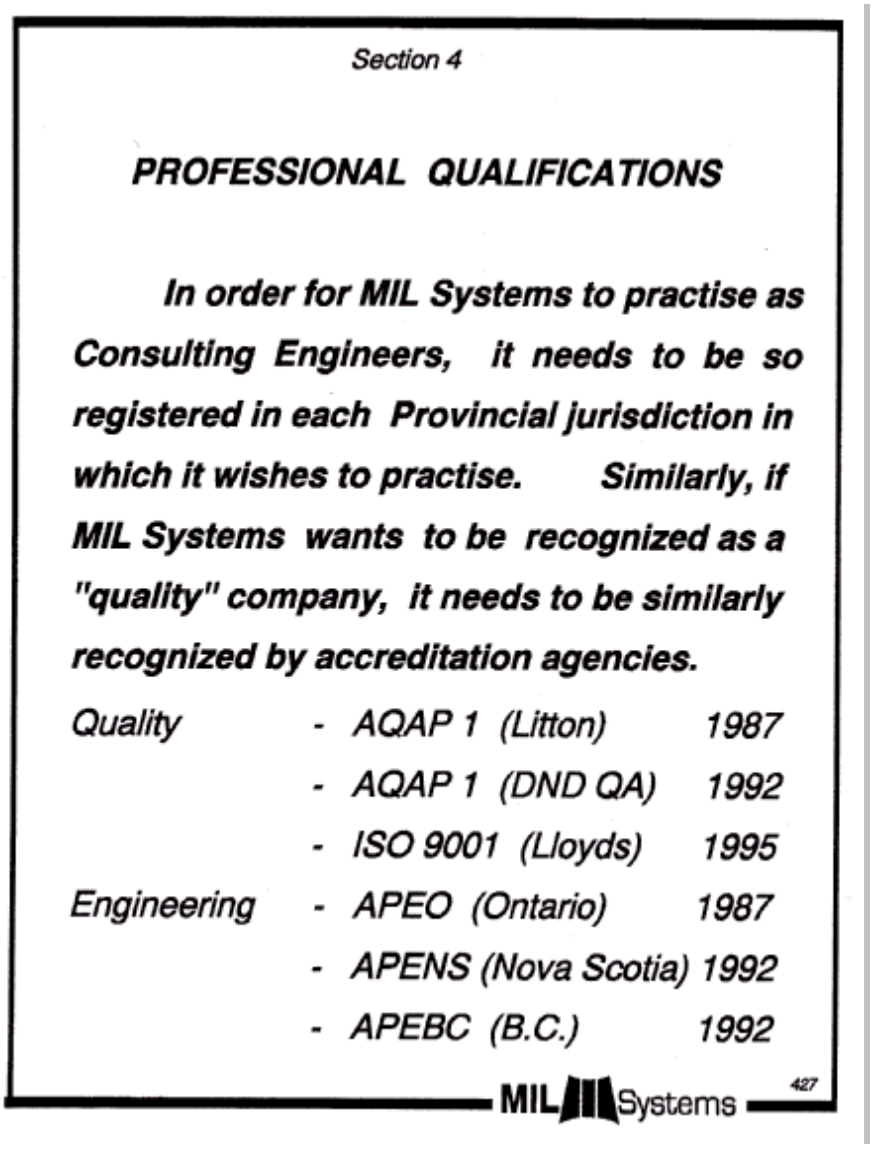


The credentials of MIL Systems Engineering were important to state since they had been built up over some 46 years of continuous service to the Navy, during which time many Navy personalities had been involved with the Company. Also, there had been four corporate names involved as the Company worked its way through the cut and thrust of competitive business. The result was a transition from what was originally a design and drawing office set up for and monitored closely by Naval personnel, to a modern corporate entity which had proven itself to be competitive and to have grown its technical and management capabilities to the point where it could well handle the role defined in Operation Excelerate by DND. It was essential to get these facts on the table for the current personalities involved in the management of DND, particularly in ADM.MAT and MEPM.



When the MIL Group (le groupe MIL, of Montreal) bought the east coast assets of Versatile Corporation, it included the three major shipyards on the St. Lawrence River, viz; Davie near Quebec City, Marine Industries Limited at Sorel and Canadian Vickers at Montreal. It proceeded to close down all but Davie. MIL Davie and MIL Systems Engineering established a close working relationship for both commercial and naval ship design, build and conversion, and in the process MIL Systems had an office in the MIL Davie shipyard. This office was originally set up to provide a face-to-face link between MIL Systems and MIL Davie to facilitate Production Engineering liaison during the TRUMP build program (Davie converted all 4 DDH 280's to TRUMP configuration) and was intended to grow to service the new Canadian Coast Guard Headquarters in the event that became a requirement.

4. PROFESSIONAL QUALIFICATIONS

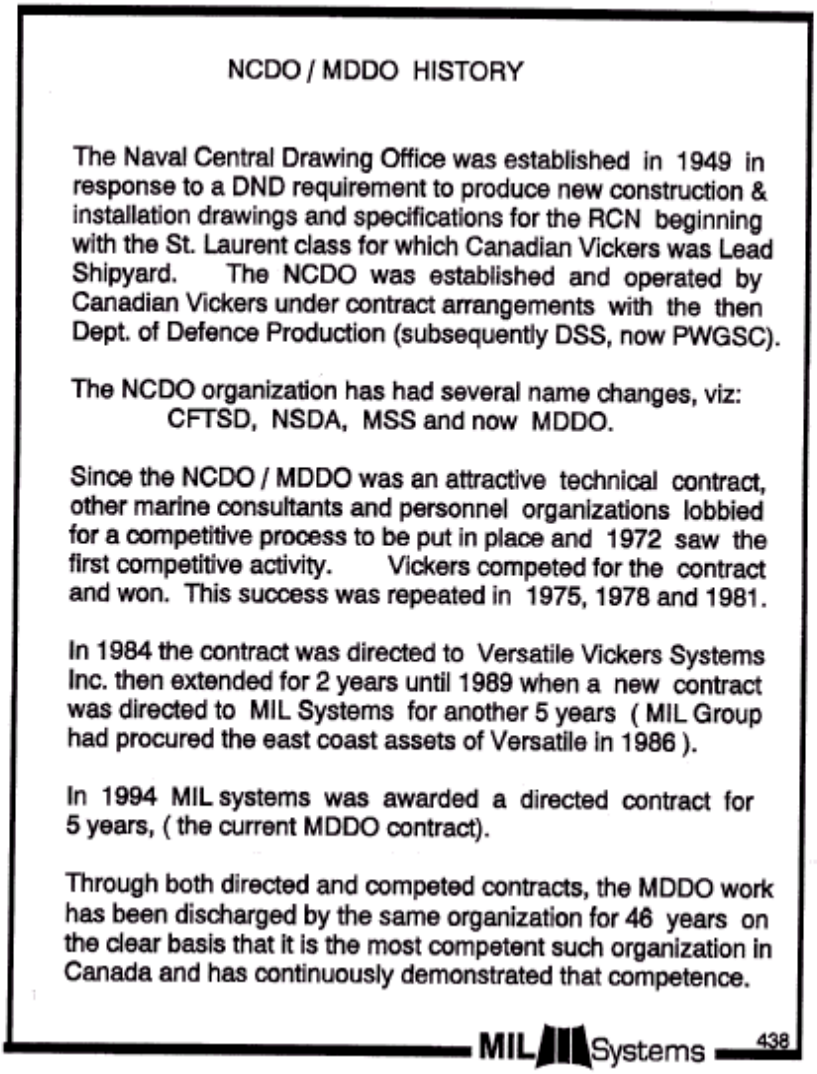


It was of course necessary to be able to practise the profession of engineering as a legal entity in the Province where the work was to be done, and for the Company to be recognized by certification as to the Quality level of not only its work but also its complete operations. This required a growing complexity of quality certification by both DND and the international community; for the latter MIL Systems Engineering chose to be certified by the most stringent authority in its business, Lloyds of London.

5. ACCOMPLISHMENTS OF MIL SYSTEMS

In most areas of life, when you have something to be proud of it is acceptable that you identify it, and so Section 5 was devoted to telling DND what we had done, starting with the unbroken service to the Navy via the NCDO to MDDO contracts. As a paper elsewhere in this Study, by Bill Craig, states, there was an evolutionary change in the methodology of ship design from pencil and paper and engineering tables aided by the slide rule, through mechanical calculators to electronic calculators to scientific calculators to ever more complex computer technology, and the consequent emergence of more and more powerful software such as CAD, etc. All these facets allowed work to be done more quickly, more accurately and above all to avoid the problem of clashes in ship areas between trades competing for room in the same spaces.

NCDO/MDDO HISTORY



NCDO / MDDO HISTORY

The Naval Central Drawing Office was established in 1949 in response to a DND requirement to produce new construction & installation drawings and specifications for the RCN beginning with the St. Laurent class for which Canadian Vickers was Lead Shipyard. The NCDO was established and operated by Canadian Vickers under contract arrangements with the then Dept. of Defence Production (subsequently DSS, now PWGSC).

The NCDO organization has had several name changes, viz: CFTSD, NSDA, MSS and now MDDO.

Since the NCDO / MDDO was an attractive technical contract, other marine consultants and personnel organizations lobbied for a competitive process to be put in place and 1972 saw the first competitive activity. Vickers competed for the contract and won. This success was repeated in 1975, 1978 and 1981.

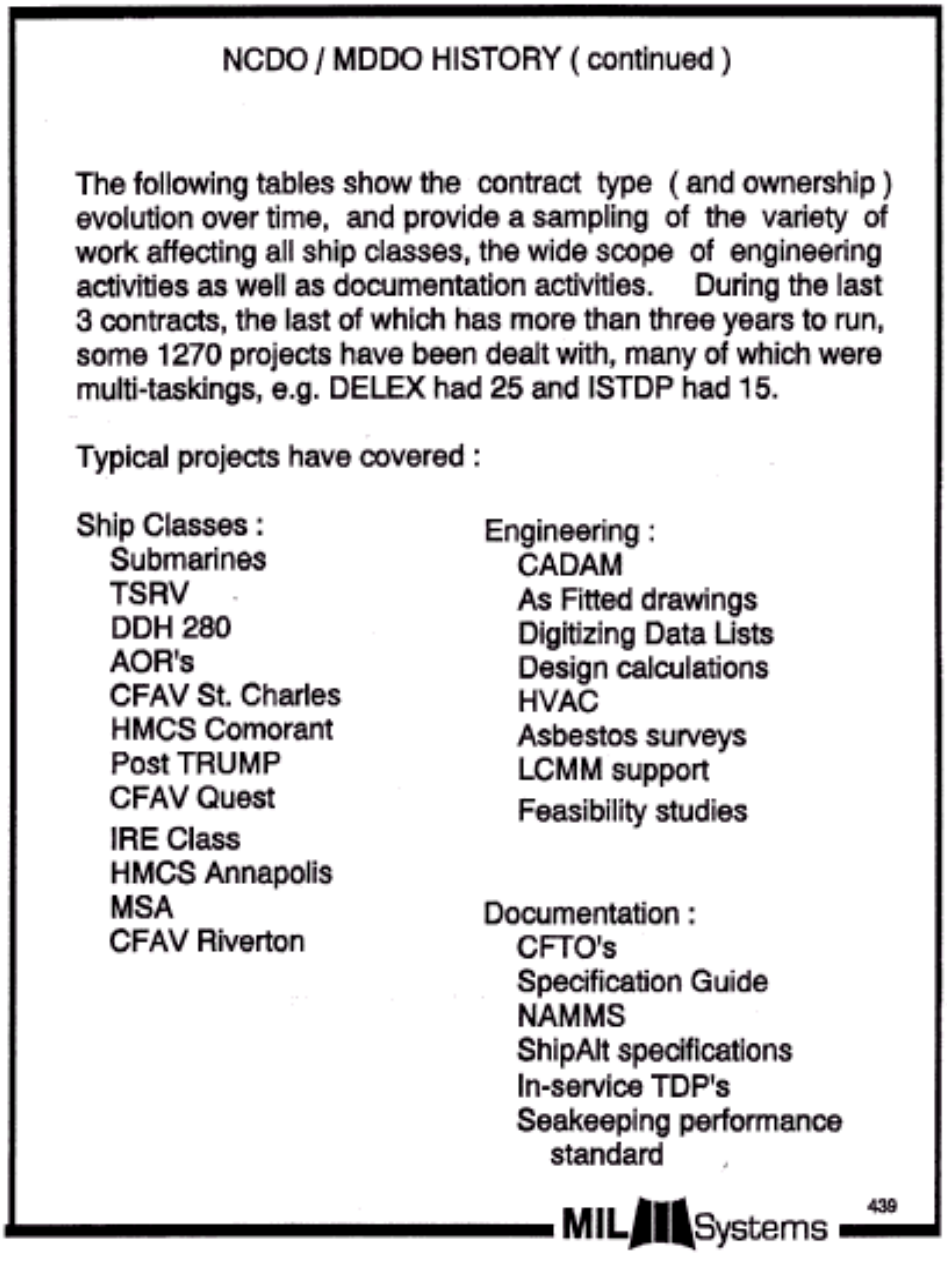
In 1984 the contract was directed to Versatile Vickers Systems Inc. then extended for 2 years until 1989 when a new contract was directed to MIL Systems for another 5 years (MIL Group had procured the east coast assets of Versatile in 1986).

In 1994 MIL systems was awarded a directed contract for 5 years, (the current MDDO contract).

Through both directed and competed contracts, the MDDO work has been discharged by the same organization for 46 years on the clear basis that it is the most competent such organization in Canada and has continuously demonstrated that competence.

MIL Systems 438

This subject is dealt with through the eyes and from the memories of some of the original NCDO staff (now retired) elsewhere in this study by such people as Tom Campbell, Dave McKenzie and Alex Patterson, et al, so will not be embellished further here.



The reference to “Typical Projects” in the chart shows the diversity of work both by type and by Ship Class covered by NCDO/MDDO contract taskings. The major conversion of the DDH 280 to TRUMP and the design of the CPF were performed under separate contract, from Litton Canada and Saint John Shipbuilding, respectively. The Crown ultimately reclained the Litton contract and the work finished under direct contract by the Crown to MIL Systems Engineering.

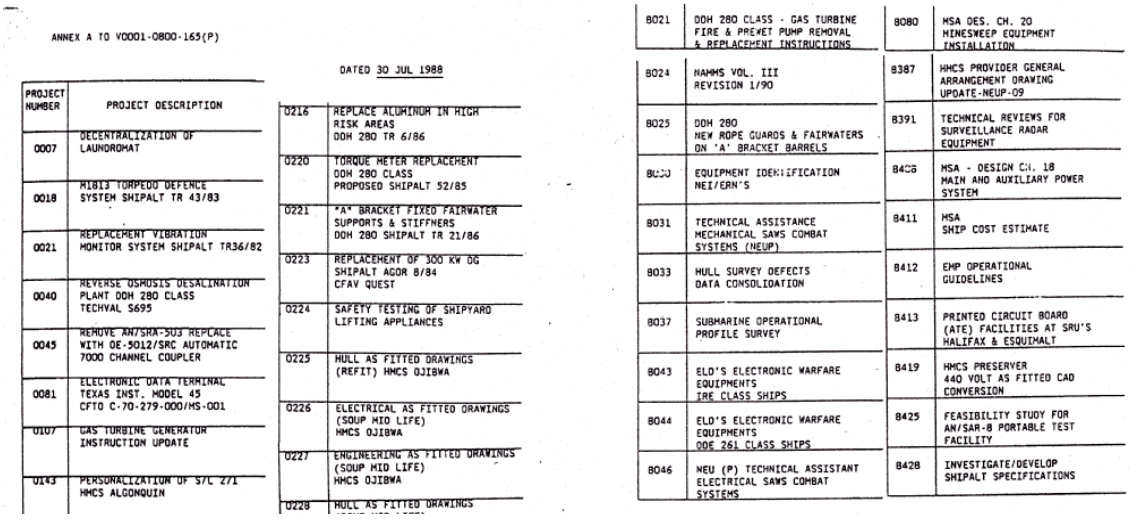
MDDO CONTRACT DETAILS
1949 - 1998

YEARS (INCLUSIVE)	*TYPE OF CONTRACT*	*NAME OF CONTRACT*	*CONTRACT HOLDER*
1949-51	Directed	NCDO	Canadian Vickers
1952-54	" "	" "	" "
1955-57	" "	" "	" "
1958-60	" "	" "	" "
1961-63	" "	" "	" "
1964-66	" "	" "	" "
1967-69	" "	" "	" "
1969-71	" "	" "	" "
1972-74	Competed & Won	CFTSD/NSDA	" "
1975-77	Competed & Won	NSDA	" "
1978-80	Competed & Won	MDDO	Vickers Canada
1981-83	Competed & Won	" "	" "
1984-86	Directed	" "	Versatile Vickers
1987-88	Extended	" "	MIL Systems
1989-93	Directed	" "	" "
1994-98	Directed	" "	" "

MIL Systems

The above chart is self- explanatory, as is the following listing of a sample of the taskings worked on under the NCDO/MDDO contract. They make interesting reading, and were symptomatic of the larger Navy of the post war era until the end of the 20th century when new ships came on line to replace the many "rusted out" old ships, many of which have been usefully employed as sunken wrecks in controlled sea space on both the east coast and the west coast of Canada for the sport of amateur aqualung diving.

SAMPLE LISTINGS FROM LAST 3 MDDO CONTRACTS



ANNEX A TO VC001-0800-165(P)

DATED 30 JUL 1988

PROJECT NUMBER	PROJECT DESCRIPTION
0007	DECENTRALIZATION OF LAUNDROMAT
0018	M1813 TORPEDO DEFENCE SYSTEM SHIPALT TR 43/83
0021	REPLACEMENT VIBRATION MONITOR SYSTEM SHIPALT TR36/82
0040	REVERSE OSMOSIS DESALINATION PLANT DDH 280 CLASS TECHVAL S695
0045	REMOVE AN/SRA-503 REPLACE WITH OE-5012/SRC AUTOMATIC 7000 CHANNEL COUPLER
0081	ELECTRONIC DATA TERMINAL TEXAS INST. MODEL 45 CFTO C-70-279-000/MS-001
0107	GAS TURBINE GENERATOR INSTRUCTION UPDATE
0143	PERSONALIZATION OF S/L 271 HMCS ALGONQUIN
0216	REPLACE ALUMINUM IN HIGH RISK AREAS DDH 280 TR 6/86
0220	TORQUE METER REPLACEMENT DDH 280 CLASS PROPOSED SHIPALT 52/85
0221	"A" BRACKET FIXED FAIRWATER SUPPORTS & STIFFNERS DDH 280 SHIPALT TR 21/86
0223	REPLACEMENT OF 300 KW DG SHIPALT AOR 8/84 CFAV QUEST
0224	SAFETY TESTING OF SHIPYARD LIFTING APPLIANCES
0225	HULL AS FITTED DRAWINGS (REFIT) HMCS OJIBWA
0226	ELECTRICAL AS FITTED DRAWINGS (SOUP MID LIFE) HMCS OJIBWA
0227	ENGINEERING AS FITTED DRAWINGS (SOUP MID LIFE) HMCS OJIBWA
0228	HULL AS FITTED DRAWINGS
8021	DDH 280 CLASS - GAS TURBINE FIRE & PREWET PUMP REMOVAL & REPLACEMENT INSTRUCTIONS
8024	NAMMS VOL. III REVISION 1/90
8025	DDH 280 NEW ROPE GUARDS & FAIRWATERS ON 'A' BRACKET BARRELS
8030	EQUIPMENT IDENTIFICATION NEI/ERN'S
8031	TECHNICAL ASSISTANCE MECHANICAL SAWS COMBAT SYSTEMS (NEUP)
8033	HULL SURVEY DEFECTS DATA CONSOLIDATION
8037	SUBMARINE OPERATIONAL PROFILE SURVEY
8043	ELD'S ELECTRONIC WARFARE EQUIPMENTS IRE CLASS SHIPS
8044	ELD'S ELECTRONIC WARFARE EQUIPMENTS ODE 261 CLASS SHIPS
8046	NEU (P) TECHNICAL ASSISTANT ELECTRICAL SAWS COMBAT SYSTEMS
8080	MSA DES. CH. 20 MINESWEEP EQUIPMENT INSTALLATION
8387	HMCS PROVIDER GENERAL ARRANGEMENT DRAWING UPDATE-NEUP-09
8391	TECHNICAL REVIEWS FOR SURVEILLANCE RADAR EQUIPMENT
8406	MSA - DESIGN CH. 18 MAIN AND AUXILIARY POWER SYSTEM
8411	MSA SHIP COST ESTIMATE
8412	EMP OPERATIONAL GUIDELINES
8413	PRINTED CIRCUIT BOARD (ATE) FACILITIES AT SRU'S HALIFAX & ESQUIMALT
8419	HMCS PRESERVER 440 VOLT AS FITTED CAD CONVERSION
8425	FEASIBILITY STUDY FOR AN/SAR-8 PORTABLE TEST FACILITY
8428	INVESTIGATE/DEVELOP SHIPALT SPECIFICATIONS

From the top, left, reading down, this hard-to-read chart shows:

Decentralization of Laundromat.
M1813 Torpedo Defence System ShipAlt.
Replacement Vibration Monitor System ShipAlt TR36/82.
Reverse Osmosis Desalination Plant DDH 280 Class TechVal S695.
Remove AN/SRA-502 Replace with OE-5012/SRC Automatic 7000 Channel Coupler.
Electronic Data Terminal Texas Inst. Model 45 CFTO C-70-279-000/MS-001.
Gas Turbine Generator Instruction Update.
Personalization of S/L 271 HMCS Algonquin.

There were 104 such Taskings shown in the original chart in the Proposal. The last of which was:

Iroquois Class In-Service Baseline TDP – Structural Drawings Phase II.

Some fundamental processes/procedural road maps were necessary in order to coordinate tasking activities, and the charts on the following 6 pages are symptomatic of some of these requirements.

TYPICAL PROGRAM SEQUENCE/ACTIVITIES

PHASES / ACTIVITIES	PROGRAM DEVELOPMENT	RESPONSE	IMPLEMENTATION	IN-SERVICE	DECOMMISSIONING
ENGINEERING	- OPERATIONAL ANALYSIS - FEASIBILITY STUDIES - CDR/RFP DEVELOPMENT - MARKETING SUPPORT	- TECHNICAL PROPOSALS - PRELIMINARY DESIGN - TRADE-OFF STUDIES	- CONTRACT/DETAIL DESIGN - PRODUCTION ENGINEERING SUPPORT - QUALITY CONTROL - TECHNICAL DOCUMENTATION	- MODIFICATIONS - MID-LIFE UPDATES	
PROGRAM MANAGEMENT		- PROPOSAL MANAGEMENT - PLANNING - NEGOTIATIONS - COST CONTROL - MARKETING SUPPORT	- COST/SCHEDULE CONTROL - SUB-CONTRACTOR CONTROL - DELIVERABLES - REPORTS & REVIEWS - CONFIGURATION CONTROL		
QUALITY ASSURANCE		- PROCEDURES - AUDITS - PREQUALIFICATIONS - QA PLAN	- VENDOR SURVEILLANCE - DESIGN REVIEWS - ACCEPTANCE TESTING		
INTEGRATED LOGISTICS SUPPORT		- CONCEPT DEVELOPMENT - SUPPORTABILITY - RELIABILITY/ MAINTAINABILITY - PROVISIONING PLANS - MAINTENANCE CONCEPT	- SPARES - DOCUMENTATION - TECHNICAL PUBLICATIONS	- R&M DATA - MATERIAL CONTROL	- INVENTORY LIQUIDATION
TRAINING		- PLANNING/CONCEPT DEVELOPMENT	- OPERATOR/MAINTENANCE TRAINING	- IN-SERVICE TRAINING	
MAINTENANCE		- PLANNING/CONCEPT DEVELOPMENT	- IN-PROCESS MAINTENANCE - STORAGE - MATERIAL CONTROL	- WARRANTY SERVICE - CONTRACT MAINTENANCE - DATA	
TECHNICAL SERVICES			- INSTALLATION - INTEGRATION - DET TO VERE - TEST & TRIALS	- CONFIGURATION CONTROL - DOCUMENTATION UPDATES - SYSTEM SUPPORT - MODIFICATION IMPLEMENTATION	- SCRAP PLAN

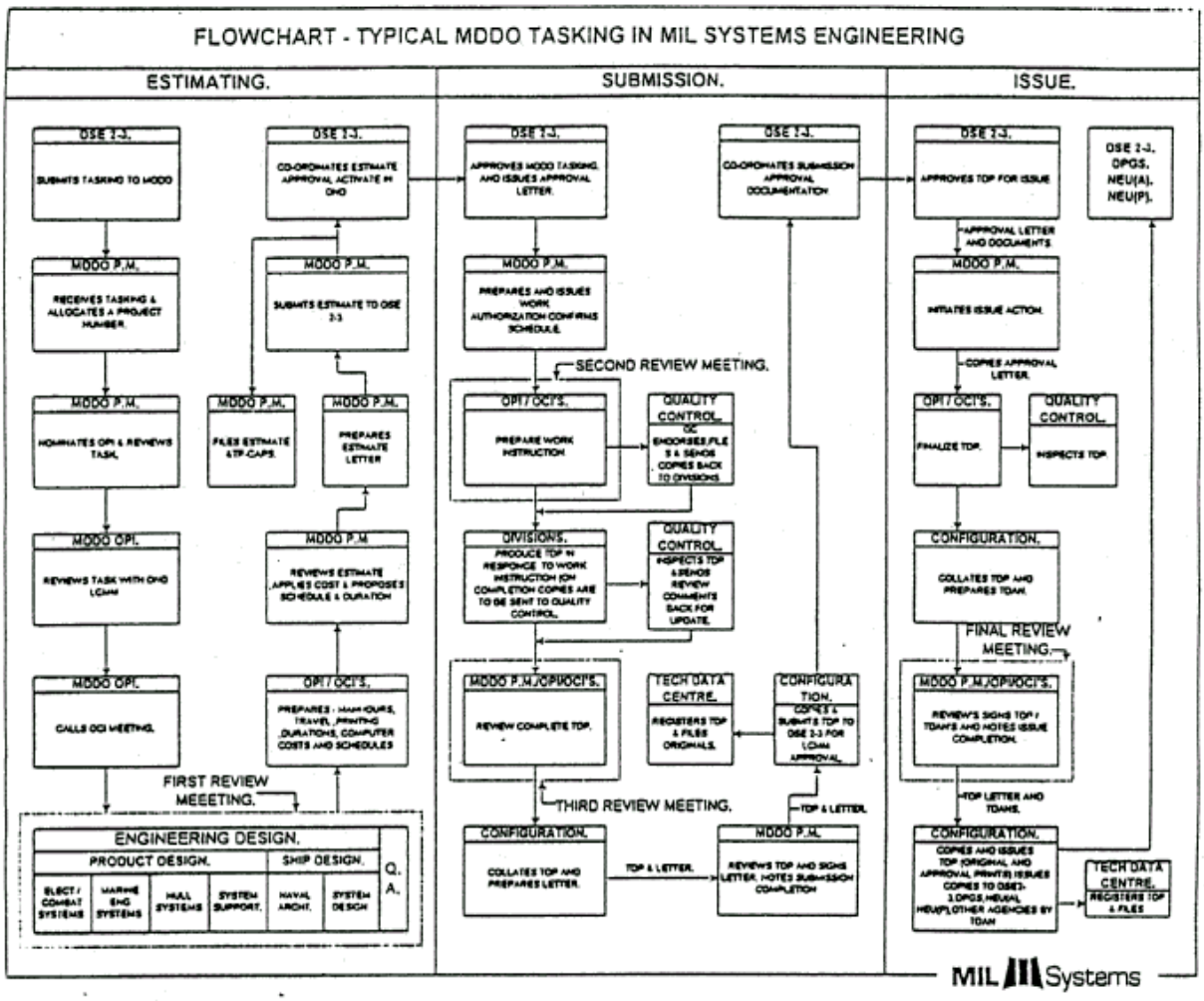
THE GOVERNMENT PROCUREMENT PROCESS

MIL Systems

During the life of the MDDO contract MIL Systems has from time-to-time found it beneficial to identify process in order to provide for continuity and efficiency for DND. The following samples are included herein to illustrate the very detailed nature of process and documentation control required for a modern, high density warship. The preceding identifies typical activities from Program development to ship decommissioning, while the subsequent charts cover MDDO Taskings, Survey activities, In Service data managemnt and generic Control of Change.

This position of organizing and thus managing the taskings under the NCDO/MDDO contracts, and of presenting that process to the Navy, occurred from time to time and in many instances became standard Navy practise. For example, the first phase of a new project requires Engineering that has four facets to it, viz. Program Development, Response, Implementation and In-Service applications. Similarly, the elements for Program Management, Quality Assurance, ILS, Training, Maintenance and Technical Support were also identified. The in-house process at MIL Systems was also definitized

and is shown in the next chart, showing the Navy the process followed and the steps whereat the Navy could monitor the Company's progress, if they so desired. The same process was followed in each of MIL Systems' Divisions, viz. MSEI Halifax, MSEI Esquimalt and in the Main Office in Ottawa.



The text that follows is part of the original chart but has been separated to provide better readability of the diagram, which was prepared to facilitate the rotation of uniformed personnel through the various DND Sections associated with the MDDO contract activities.

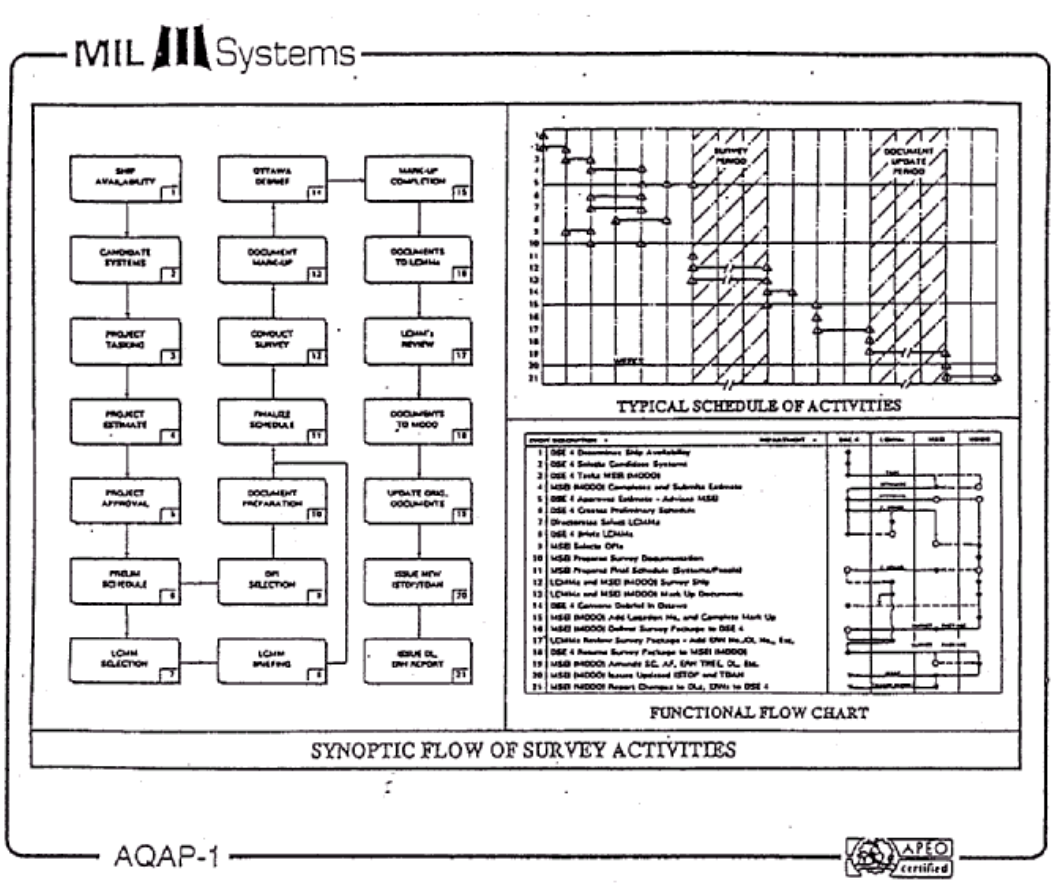
This chart was prepared for DGMEM to describe the activity required by MIL Systems to comply with the requirements of the MDDO contract occasioned by the rotation of DND's uniformed personnel. Particularly, the interface with DND's "MDDO Contract Officer" was to be highlightted.

The chart was widely dispersed throughout DND HQ, NEU (Atlantic) and NEU (Pacific)

Similarly, the road map for Ship Survey activity was also definitized, as follows:

Ship surveys are an essential part of In Service ship management to ensure that the detailed condition of a ship is verified prior to any ship alteration design.

Life Cycle Maintenance Management relies heavily on this function and it was prudent to ensure that all LCMM's knew what their role was in ship surveys, and had an understanding of the required sequence of events and a generic schedule.

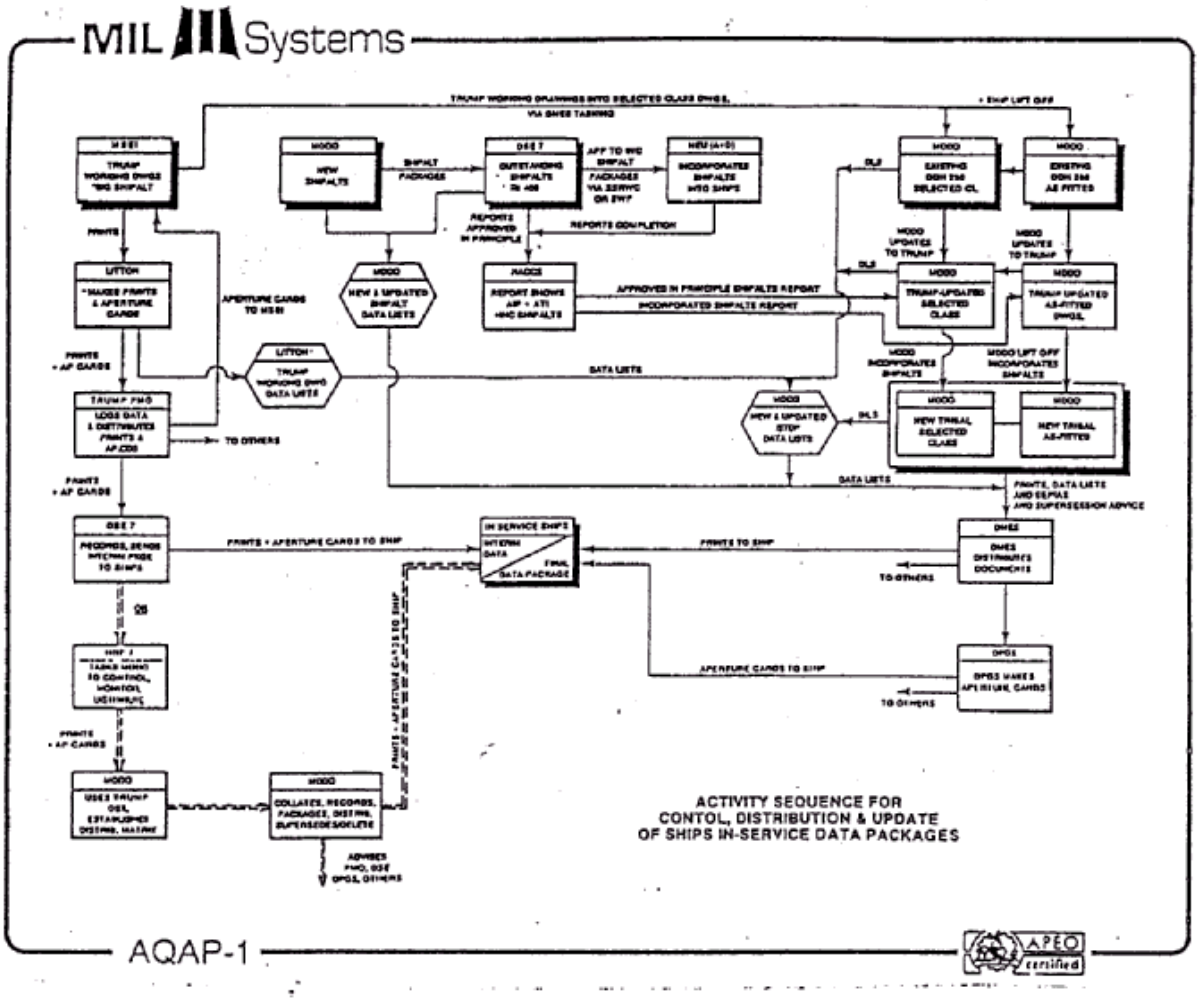


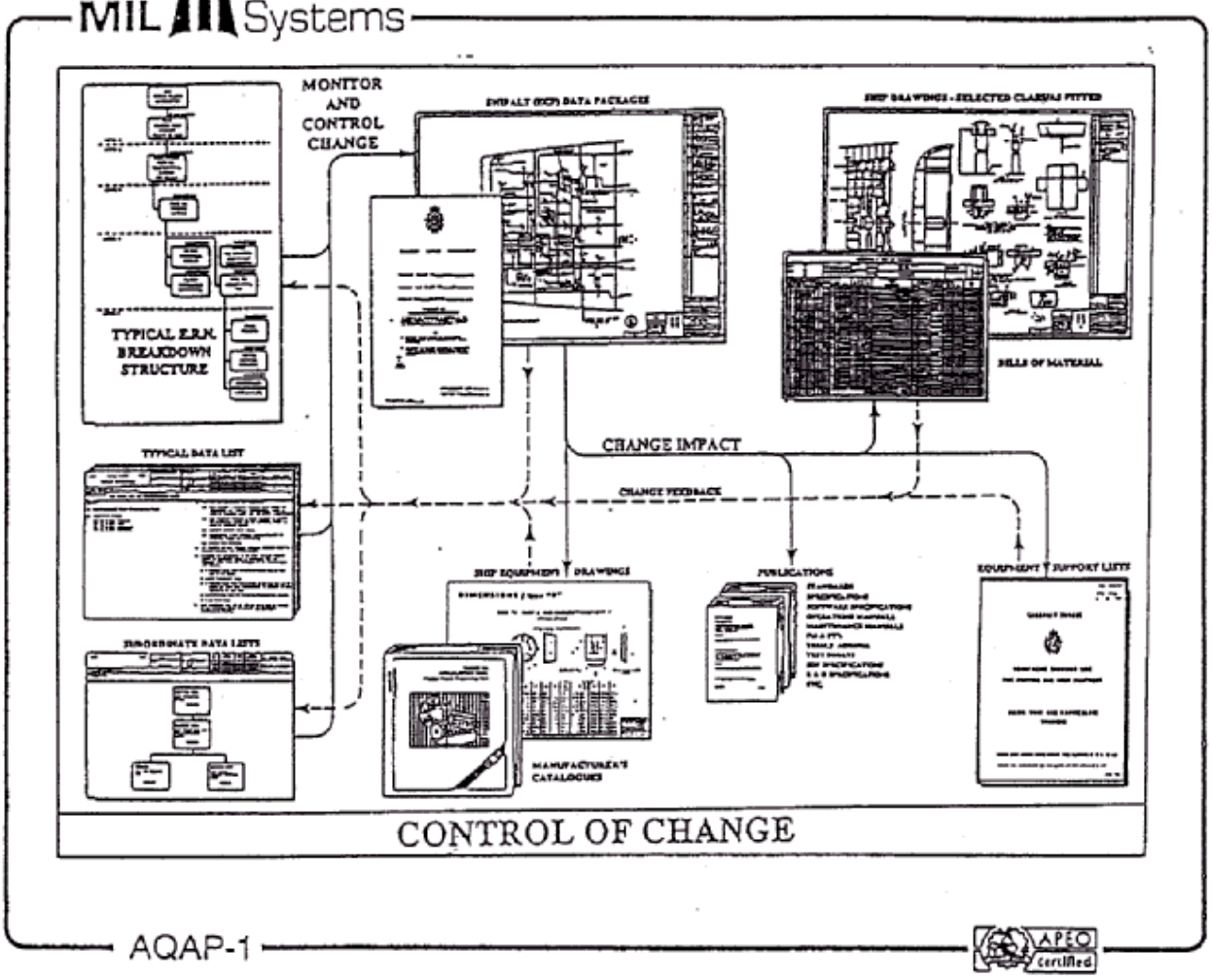
Also, a new ISTDP process was required, resulting in:

When DND was contemplating a new "In Service TDP" there was uncertainty of the approach to be used. MIL Systems developed the above approach to ensure that all TRUMP changes were captured, that all outstanding ShipAlts/ECP's would be recognized and that ship configuration untouched by TRUMP would be preserved.

It demonstrated that an interim "ISTDP" for on-board use could be expedited.

This was ultimately the basis for the current major ISTDP projects in MDDO and has been demonstrated in our recent work on HMCS Iroquois.


MIL Systems
ACTIVITY SEQUENCE FOR
CONTOL, DISTRIBUTION & UPDATE
OF SHIPS IN-SERVICE DATA PACKAGES
AQAP-1



This chart was prepared to assist DSE 4 in a series of seminars on

"Configuration Control & Change Control".

It illustrates the links and the documents that are both affected by changes and which generate feedback.

This illustration has been widely displayed in DND HQ.

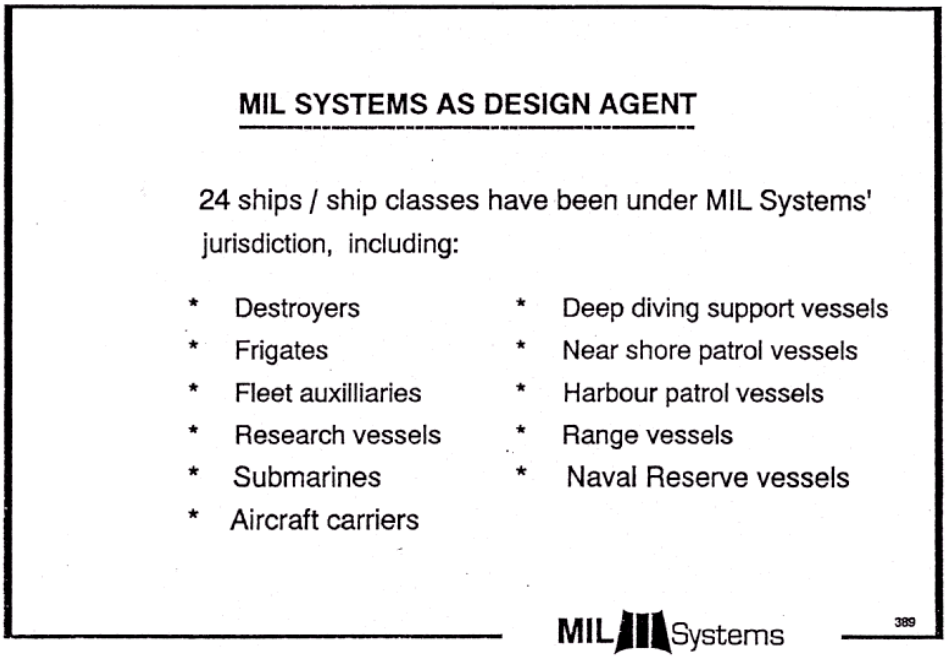
MIL SYSTEMS AS DESIGN AGENT

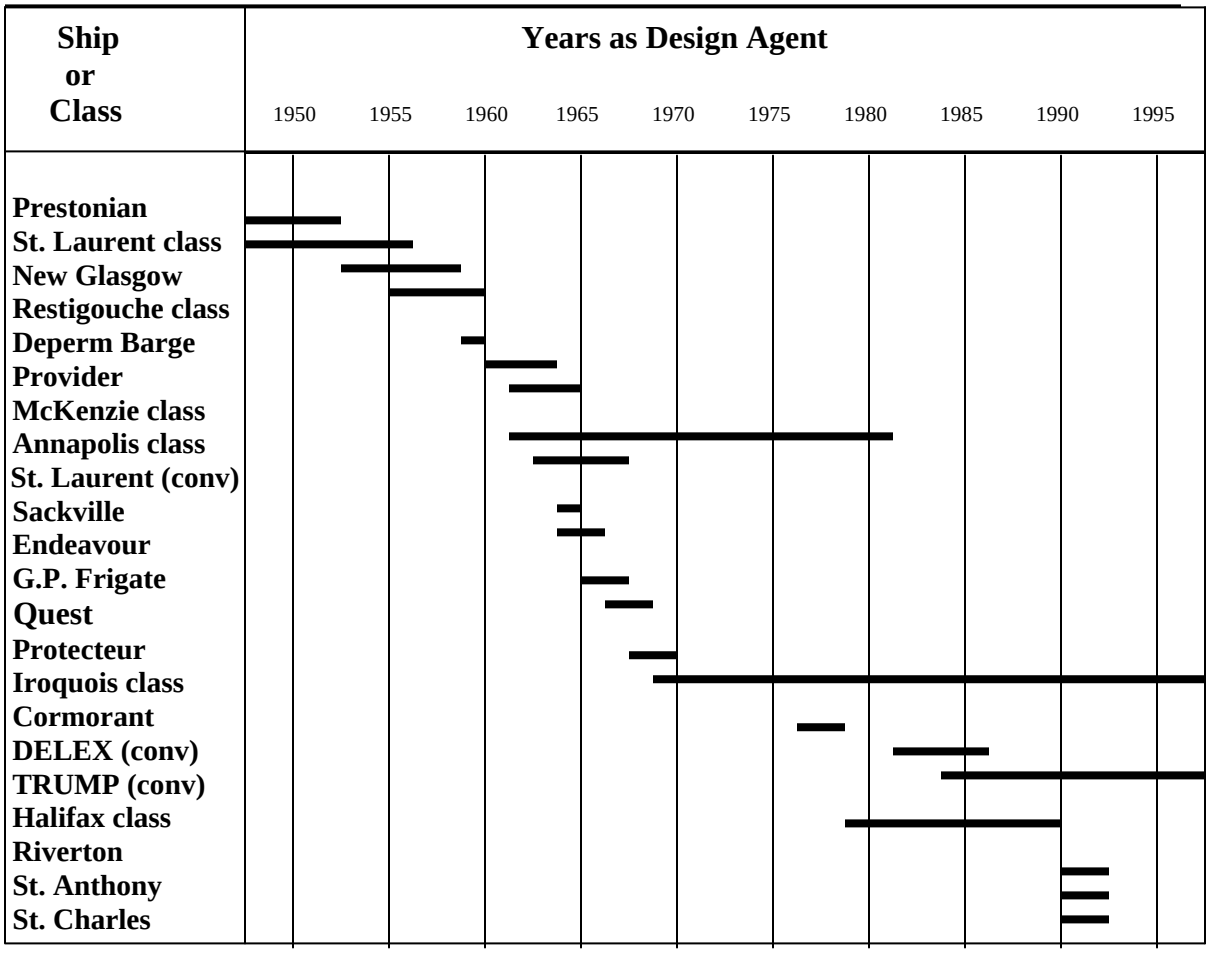
MIL SYSTEMS AS " DESIGN AGENT "

The following two tables show the extent of MIL Systems' experience as Design Agent, i.e. for all Navy ships since 1949 to the present.

MIL Systems was the concept designer and some 70% of the detail design for the Canadian Patrol Frigate (CPF) under contract to Saint John Shipbuilding. Upon completion of that contract the Design Agent role reverted to SJSL as the Prime Contractor for CPF; the concept design experience however, remains with MIL Systems.

MIL Systems designed an MCDV prior to the RFP being issued in order for our Proposal effort to be concentrated on the data requirements. In the event our design satisfied the Design Requirements, but we lost the contract based on price. MIL Systems has bid for the In Service Support Contract (ISSC) for the MCDV, the contract award for which is expected in September, 1995.





TimeLine of MIL Systems as Design Agent

The preceding two charts summarize an absolute wealth of experience of MIL Systems as Design Agent of the Navy's ships from 1949 to 1995, the date of submission of this Proposal. It covered every ship the Navy had as well as every conceivable type of service those ships required throughout their in-service lives. The third chart, which follows, provides the specific services rendered by ship/ship class. The two pictures are of the "biggest" ship and the "smallest" ship, **Bonaventure & St. Charles**, respectively.

Bonaventure, 1968

SAINT CHARLES *11/1986, van Ginderen Collection*

and the “longest” period as Design Agent, The Iroquois Class , sometimes referred to as the DDH 280 Class which were later upgraded to the TRUMP configuration.

SERVICES TO THE CROWN

The next chart presented titled **SERVICES TO THE CROWN** shows the general scope of services performed by the core of people drawn together by Canadian Vickers, resulting in the current corporate entity MIL Systems Engineering. The following three charts go into more detail defining the major areas of service that were rendered to the Navy over the years, specifically in the capacity of Design Agent.

They included the manufacture of scale models of both equipment and finished ships, the latter normally to 1/80 scale. Scale models of the Halifax Class were, in fact, delivered to the Navy under contract for in-house training purposes. Similarly, when MIL Systems wanted to present a new ship concept to the Navy for consideration, the scale model ship was a powerful marketing tool, both the Multi-role (**SMART**) ship (shown below) and the MCDV ship were examples of this approach. Scale models were also made of commercial ship projects, of note being the High Speed Sounding Vessel for the Canadian Coast Guard, the vessel being a catamaran hull configuration (dealt with later).

1/80th scale model of **S**trategic **M**ulti-role **A**id & **R**eplenishment **T**ransport (**SMART**)

SERVICES TO THE CROWN

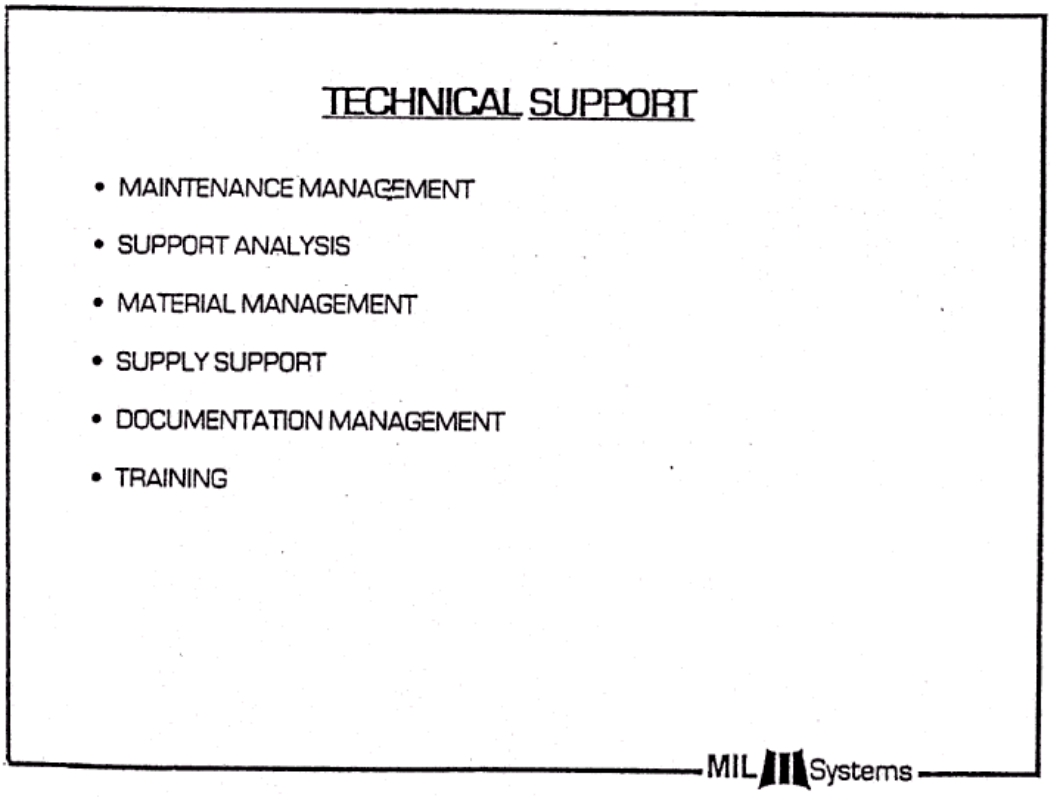
- FEASIBILITY STUDIES, TRADE-OFFS & DETAIL DEFINITION STUDIES
- CONTRACT DEFINITION, INCLUDING SPECIFICATIONS & DRAWINGS
- DETAIL DESIGNS, WORKING DRAWINGS & RELATED SUPPORT DOCUMENTATION
- AS MADE" & "SELECTED CLASS" DRAWINGS
- FABRICATE MODELS AND MOCK-UPS - MODEL TESTING
- BILLS OF MATERIAL, PROCUREMENT SPECIFICATIONS & PROCUREMENT
- STANDARDS & SPECIFICATIONS FOR EQUIPMENT & SHIPBUILDING MATERIAL
- AVAILABILITY OF EQUIPMENT & SHIPBUILDING MATERIAL
- SUPPORT TO HMC DOCKYARDS AND PROVISION OF LCMM SERVICES

MIL Systems

PROGRAM SUPPORT

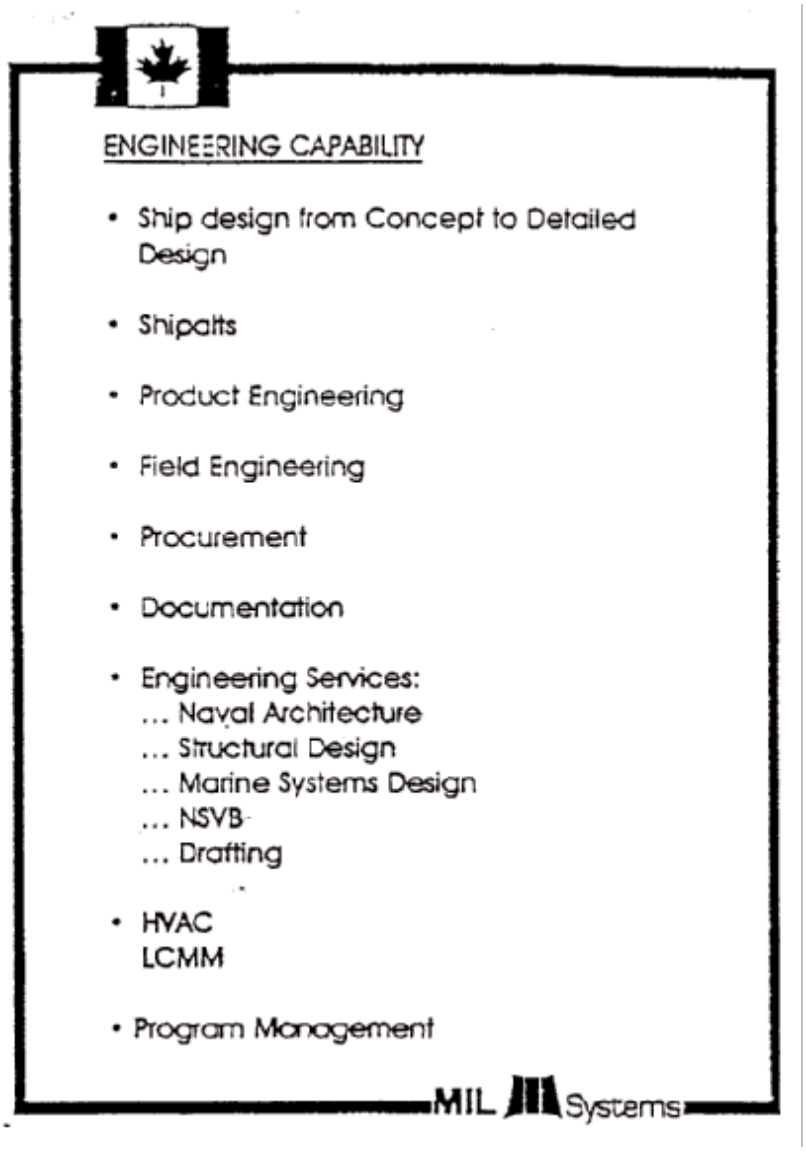
- WORK PLANNING, SCHEDULING & MONITORING (MIL STD 881)
- COST / SCHEDULE CONTROL (DoDI 7000.2)
- CONTRACT / SUBCONTRACT MANAGEMENT
- CONFIGURATION MANAGEMENT (MIL STD 480 / 483)
- RISK ANALYSIS & MANAGEMENT
- DATA MANAGEMENT
- PROCUREMENT & EQUIPMENT QUALIFICATION
- QUALITY ASSURANCE (AQAP 1 / ISO 9001)
- REGIONAL & INDUSTRIAL BENEFITS

MIL Systems

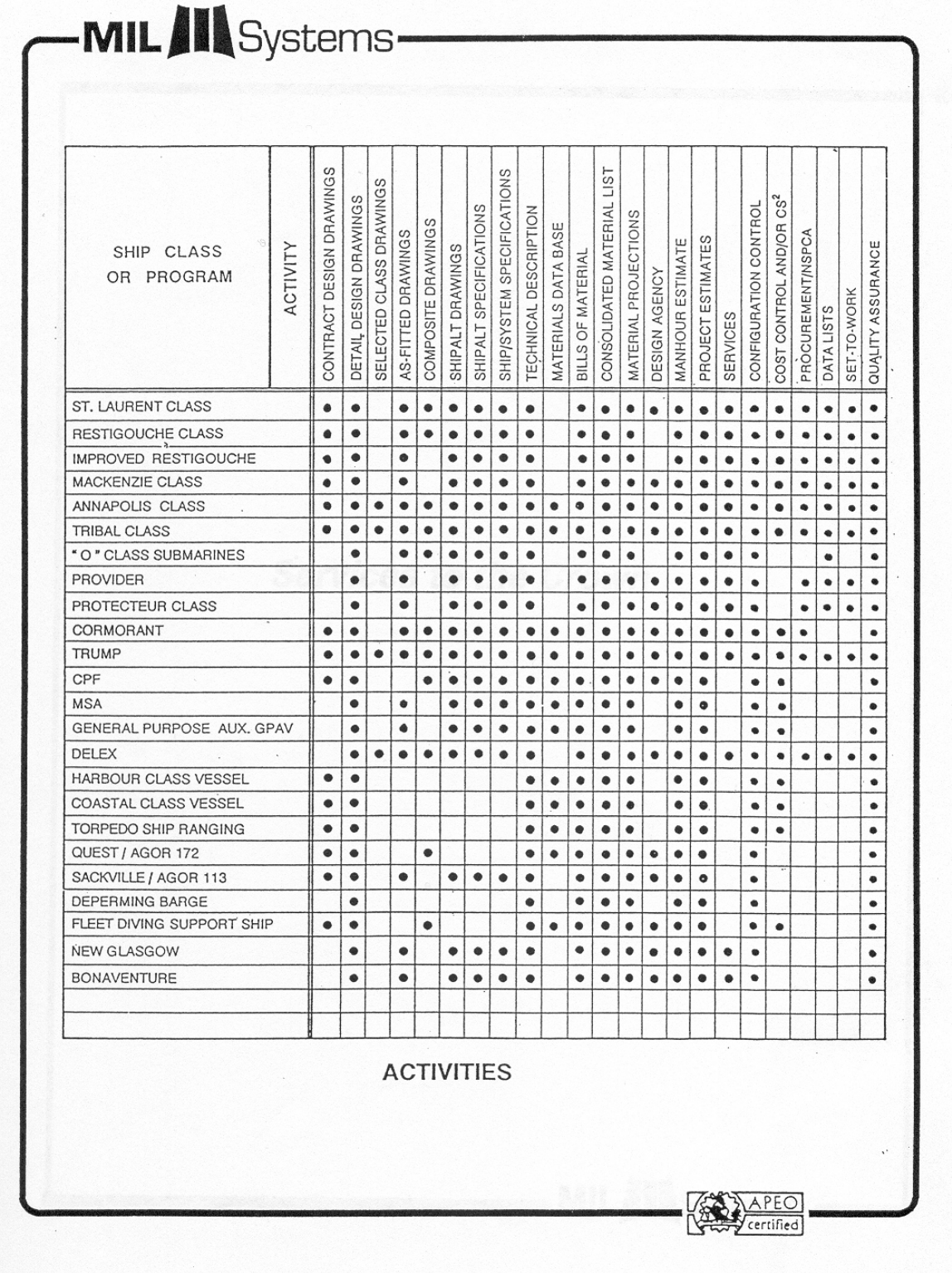


Clearly, a myriad of words would be needed to describe in detail these Services To The Crown, but suffice it to state that each and every item was dealt with more than once in minute detail for most of the ships in the role as Design Agent, and for many others ships not covered by the Design Agent mantle.

Typically, the list of activities recorded in the Engineering Capability chart was provided for all new ship designs and major ship conversion projects.



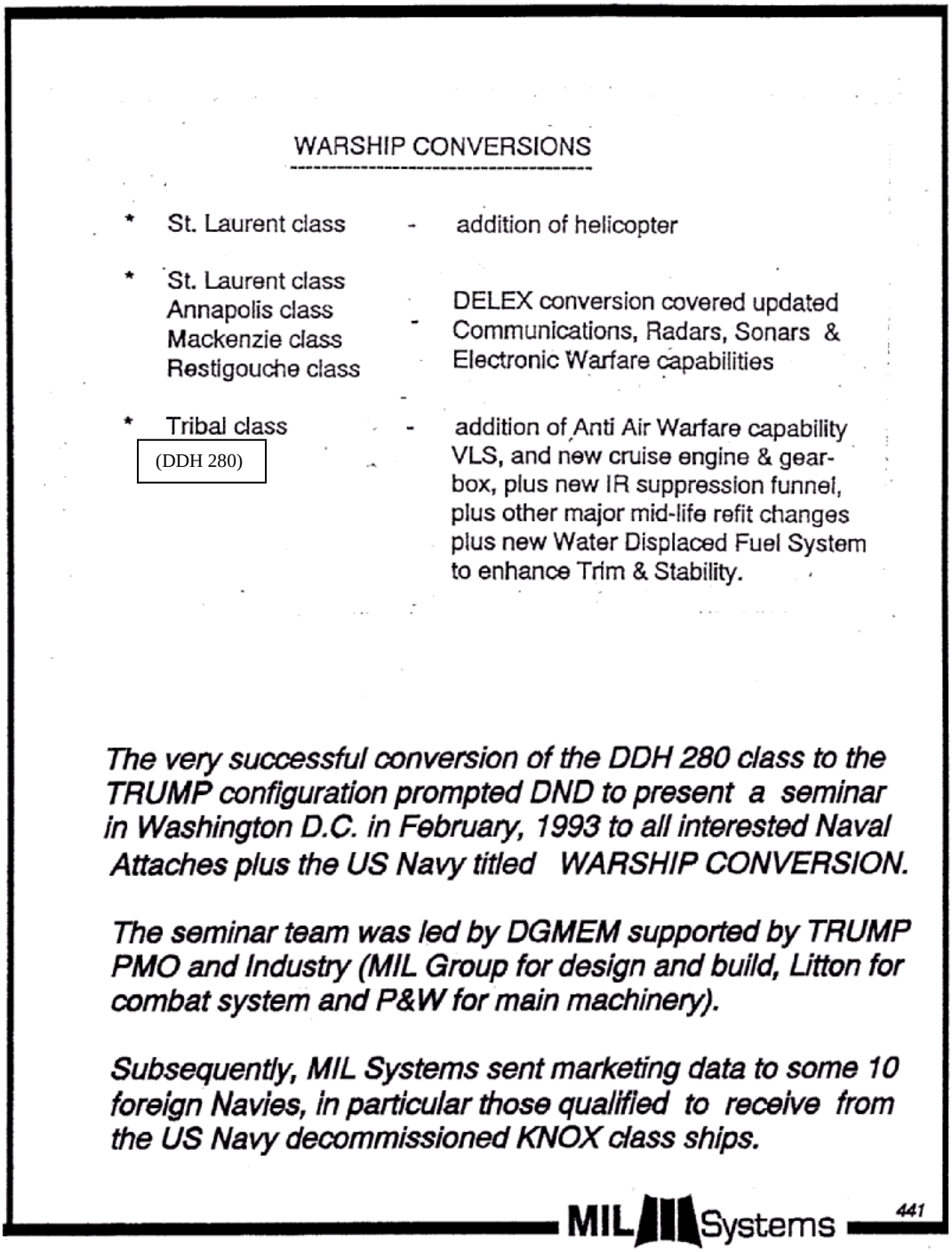
During these 46 years, a number of major conversions of warships to improve their effectiveness to the Fleet were designed under the NCDO/MDDO contract format. The following chart lists the ship classes involved and the generality of their conversions.


MIL Systems
SHIP CLASS OR PROGRAM
ACTIVITY
CONTRACT DESIGN DRAWINGS
DETAIL DESIGN DRAWINGS
SELECTED CLASS DRAWINGS
AS-FITTED DRAWINGS
COMPOSITE DRAWINGS
SHIPALT DRAWINGS
SHIPALT SPECIFICATIONS
SHIP/SYSTEM SPECIFICATIONS
TECHNICAL DESCRIPTION
MATERIALS DATA BASE
BILLS OF MATERIAL
CONSOLIDATED MATERIAL LIST
MATERIAL PROJECTIONS
DESIGN AGENCY
MANHOUR ESTIMATE
PROJECT ESTIMATES
SERVICES
CONFIGURATION CONTROL
COST CONTROL AND/OR CS²
PROCUREMENT/NSPCA
DATA LISTS
SET-TO-WORK
QUALITY ASSURANCE
ST. LAURENT CLASS
RESTIGOUCHE CLASS
IMPROVED RESTIGOUCHE
MACKENZIE CLASS
ANNAPOLIS CLASS
TRIBAL CLASS
" O " CLASS SUBMARINES
PROVIDER
PROTECTEUR CLASS
CORMORANT
TRUMP
CPF
MSA
GENERAL PURPOSE AUX. GPAV
DELEX
HARBOUR CLASS VESSEL
COASTAL CLASS VESSEL
TORPEDO SHIP RANGING
QUEST / AGOR 172
SACKVILLE / AGOR 113
DEPERMING BARGE
FLEET DIVING SUPPORT SHIP
NEW GLASGOW
BONAVENTURE
ACTIVITIES
APEO certified

Probably the most significant conversion was the introduction of on-board helicopters, which dramatically expanded the effective range of the ship in its anti-submarine role, both for hunting and for attacking. The **Sikorsky CH-124A Sea King** helicopter was the vehicle of choice and provided outstanding service well past its initially intended life span. It was to have been replaced by the EH 101 in the 1991-1992 timeframe but fell victim to political football in that it was contracted for by the Brian Mulroney Conservative Federal Government but immediately cancelled by the succeeding Jean Chretien Liberal Federal Government in 1993, the consequence of which was that at the time of writing, 2003, the Sea King was still in service and its replacement was not yet selected. To maintain the Sea King in service the Navy had to spend considerably more maintenance man-hours/flying hour to keep the Sea King fit for flight than had ever been envisaged, and of course at great penalty to both the Navy's fiscal budget and its skilled manpower base.

The Sikorsky CH-124A Sea King

WARSHIP CONVERSIONS



WARSHIP CONVERSIONS

* St. Laurent class	-	addition of helicopter
* St. Laurent class Annapolis class Mackenzie class Restigouche class	-	DELEX conversion covered updated Communications, Radars, Sonars & Electronic Warfare capabilities
* Tribal class (DDH 280)	-	addition of Anti Air Warfare capability VLS, and new cruise engine & gear-box, plus new IR suppression funnel, plus other major mid-life refit changes plus new Water Displaced Fuel System to enhance Trim & Stability.

The very successful conversion of the DDH 280 class to the TRUMP configuration prompted DND to present a seminar in Washington D.C. in February, 1993 to all interested Naval Attaches plus the US Navy titled WARSHIP CONVERSION.

The seminar team was led by DGMEM supported by TRUMP PMO and Industry (MIL Group for design and build, Litton for combat system and P&W for main machinery).

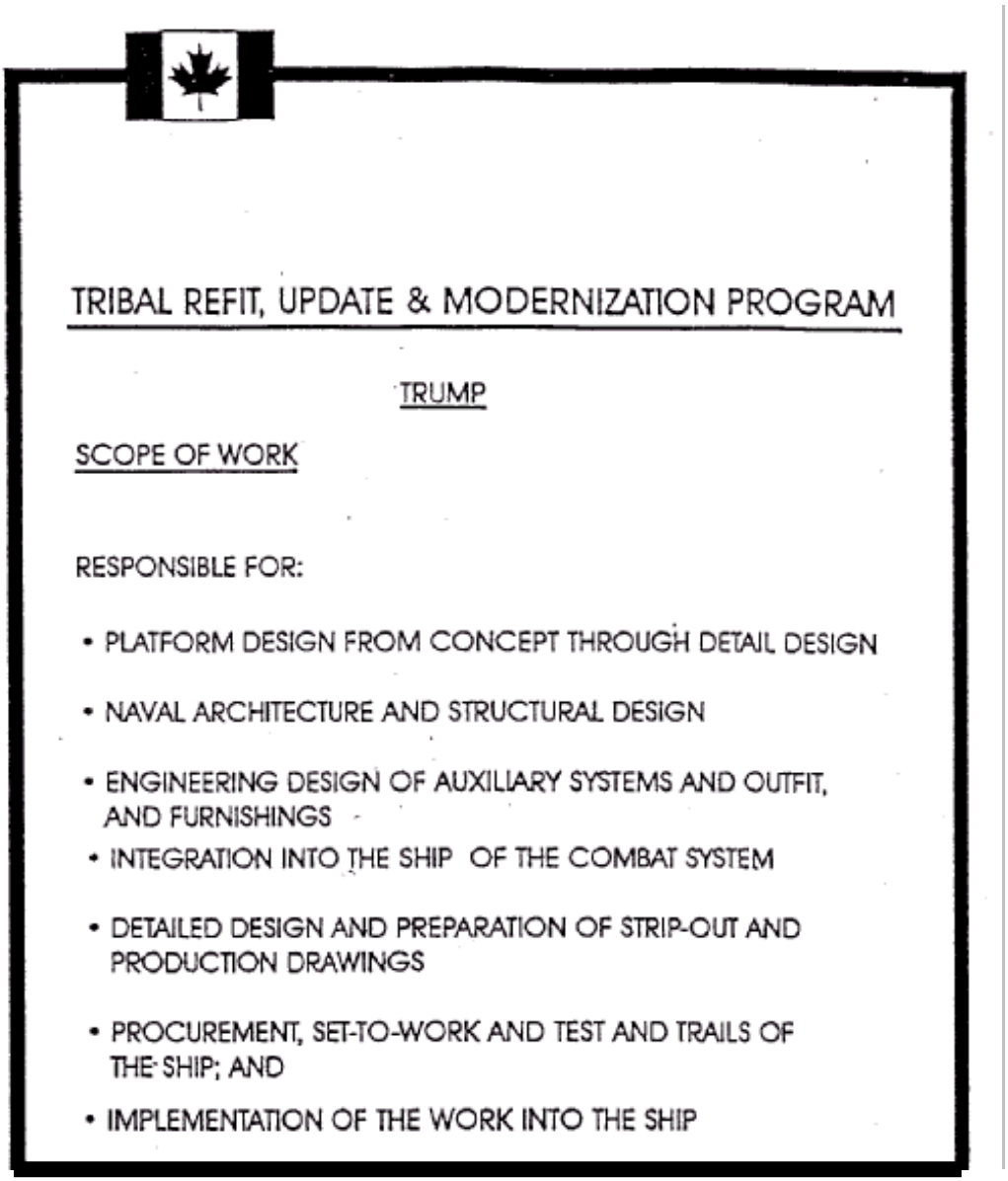
Subsequently, MIL Systems sent marketing data to some 10 foreign Navies, in particular those qualified to receive from the US Navy decommissioned KNOX class ships.

MIL Systems 441

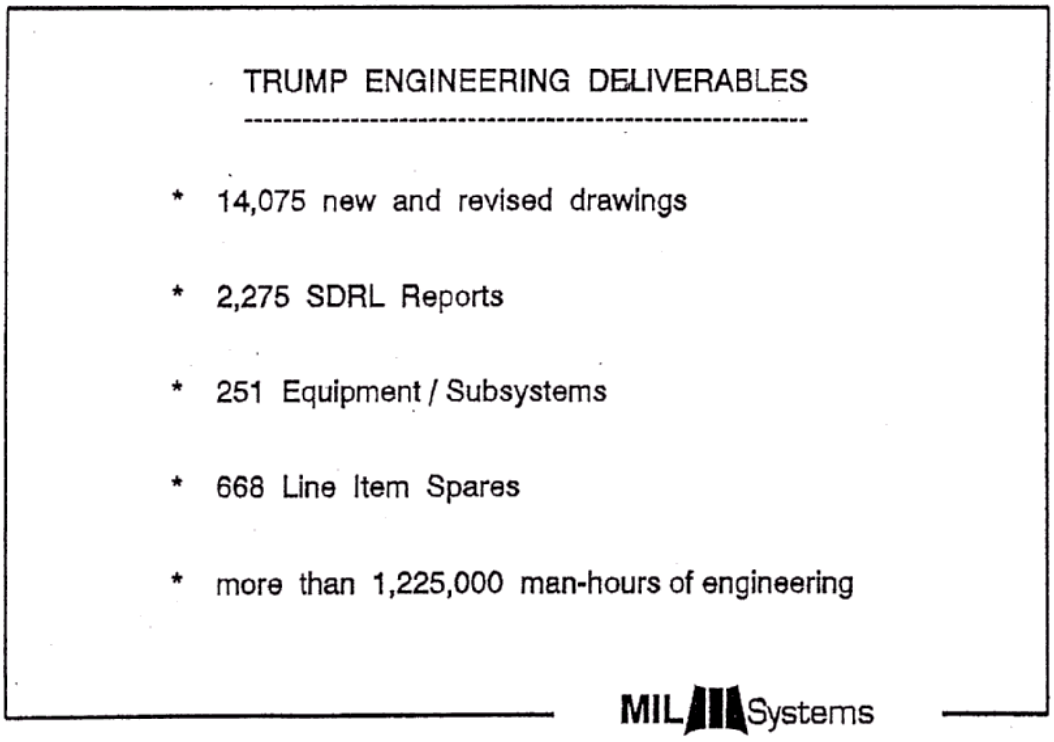
By far the most exhaustive conversion was that of the DDH 280's, known colloquially as **TRUMP (T**ribal **R**efit **U**pdate **& M**odernization **P**rogram**).**

DDH 280 pre-TRUMP

The conversion required a mammoth amount of engineering data. The original contract was held by Litton Canada in that it was the supplier of the major conversion requirement, viz. the Vertical Launch System. MIL Systems had the task of engineering this system, and all the other upgrades that the Navy required, into the DDH 280's.



The ships had to be stripped of a lot of obsolete equipment and bulkheads and other main structures had to be removed and relocated. The engineering task is summarized in the following chart:



Some details of the conversion requirements and their solutions follow:

* LONGITUDINAL STRENGTH

PRE - TRUMP - low factors of safety in the hull girder to resist wave-induced shear forces and bending moments

TRUMP FIX
- redistribution of load items to reduce load variation along the length of the ship
- addition of longitudinal girders on 1 deck and along the bottom plating
- replacement of side shell plating aft in way ot the flight deck

RESULT - 20% increase in structural factors of safety

MIL Systems

* TRIM AND STABILITY

PRE - TRUMP
- marginal intact & damaged stability characteristics
- problem with bow trim in normal operational conditions

TRUMP FIX
- introduced a WDFS to maintain weight low in ship
- moved deadweight aft to correct trim problem, e.g. fuel, water, stores etc.
- improved subdivision within ship to reduce extent of flooding when damaged
- implemented weight control program during conversion to ensure both wieght & VCG growth stayed within defined boundaries

RESULT
- 50% improvement in the stability charateristics
- correction of the bow trim problem

MIL Systems

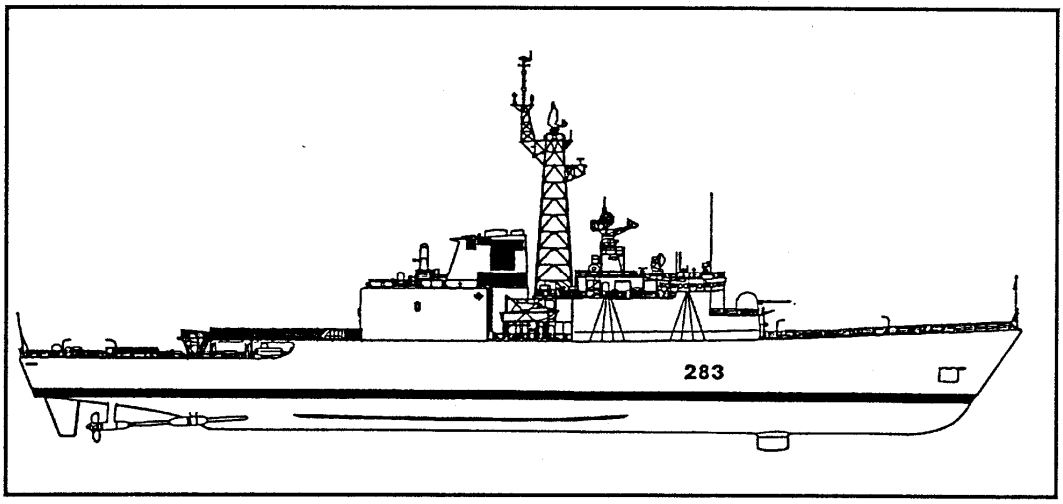
Details of the WDFS mentioned in the Trim and Stability solution, which contributed greatly to the impressive new stability of the DDH 280's, are:

WATER DISPLACED FUEL SYSTEMS

The System Solution to the Mid Life Crisis

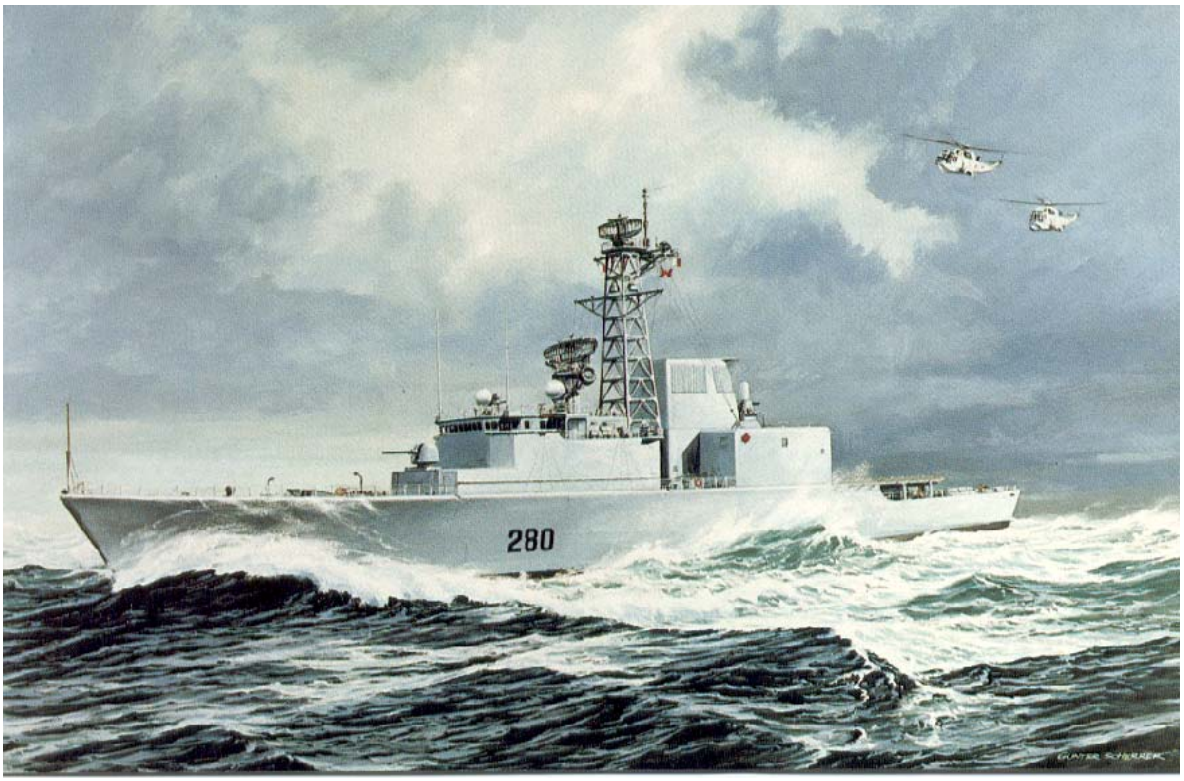
The conversion of an existing naval vessel to meet current standards and accommodate payload equipment and systems associated with a new role is frequently compromised by its inability to achieve acceptable intact and damage stability margins. The incorporation of an engineered Water Displaced Fuel System can provide the total solution to a full range of stability deficiencies experienced by older naval vessels.

MIL Systems has the full range of expertise and capability required to; undertake feasibility assessment, and engineering design, prepare engineering change proposals, procure and qualify equipment and components, and quality set-to-work and prepare in-service documentation required to install, operate and maintain a Water Displaced Fuel System.



MIL Systems team of Naval Architects, Marine Systems Engineers, Production and Material Specialists has engineered such a system for the Canadian Navy's DDH 280 Class. The implementation of this system permitted the conversion of this class of 4 Anti-Submarine Warfare Destroyers to a new role as Area Air Warfare and Task Group Command Ships.

In the course of this undertaking the **MIL Systems** team; demonstrated the feasibility of achieving acceptable fuel quality for gas turbine engines, met stringent pollution control requirements, integrated all features and factors to represent a system solution thus providing the new DDH 280 Class with a new lease of life.



DDH 280 post TRUMP

SPECIALISED ENGINEERING STUDIES

MIL Systems has been tasked over the years with specialized engineering covering a very broad range of naval and other DND subjects. They include market surveys of technology innovations as well as operational analysis subjects.

They have also included some very advanced studies as well as more routine needs such as establishing Standards for a number of management needs.

Some such studies are listed below:

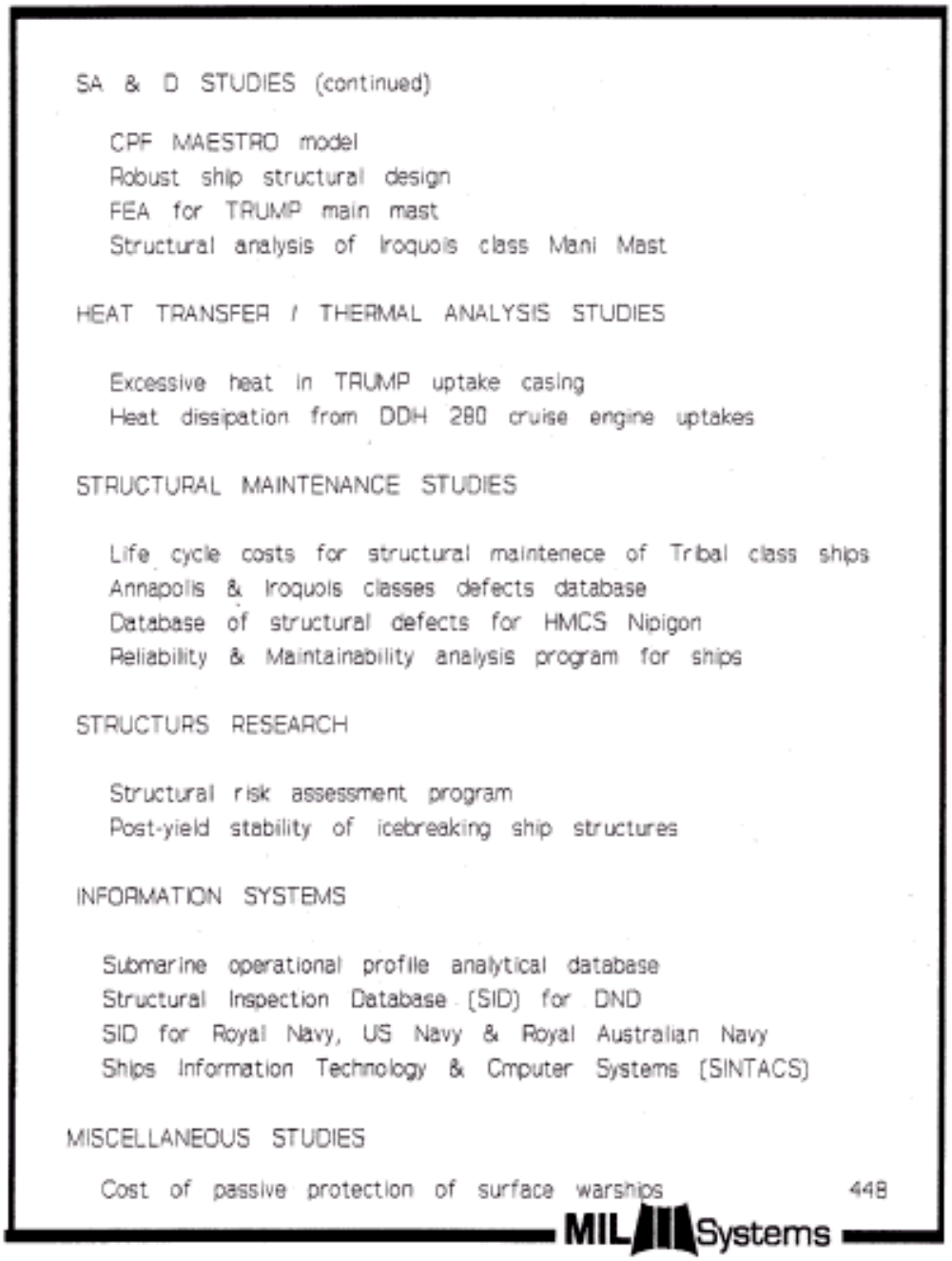
STANDARDS & GUIDELINES

- Helicopter deck plate design procedure
- Standard for Finite Element Analysis (FEA)
- New Structural Design Standard
- CF ship Structural Integrity program
- Use of Classification Society Rules for CF ships
- Fibre reinforced plastics Guidance Document

STRUCTURAL ANALYSIS & DESIGN

- FEA for Mk.16 CIWS on HMCS Provider
- FEA analysis of lower deck structural vibration on CCG ship Henry Larsen
- AN/SQS 510 sonars for Portuguese Navy

MIL Systems



These progressively more complex studies over the years helped MIL Systems Engineering to hone its engineering skills in both the traditional format and in the growing computer software generation format, the SIDS technology being one example of the latter in the early 1990's.

Excerpts from some of the advertising brochures in the Specialized Engineering area follow, and are self explanatory.

MIL Systems

ENGINEERING ANALYSIS SERVICES

The Engineering Technology Division of MIL Systems Engineering Inc. offers a wide range of advanced engineering analysis services. These services are provided by a team of highly qualified and experienced engineers and computer professionals. This experience has been built up over several years and has been refined in a demanding design environment where high quality and timeliness are critical.

Areas of Specialization

- Finite element analysis
- Non-linear analysis
- Dynamic, shock and vibration analysis
- Fatigue and fracture analysis
- Structural and mechanical design
- Environmental loading
- Standards development
- Risk and probabilistic analysis

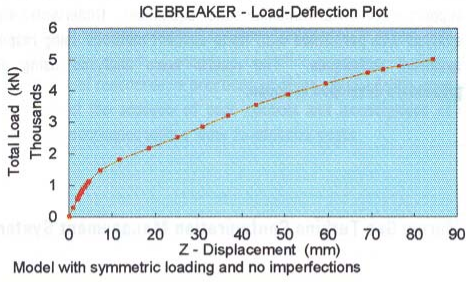
Services Offered

- Engineering analysis
- Conceptual, preliminary and detailed design
- Experiment design
- Feasibility and cost studies
- Software development, training and maintenance
- Project management

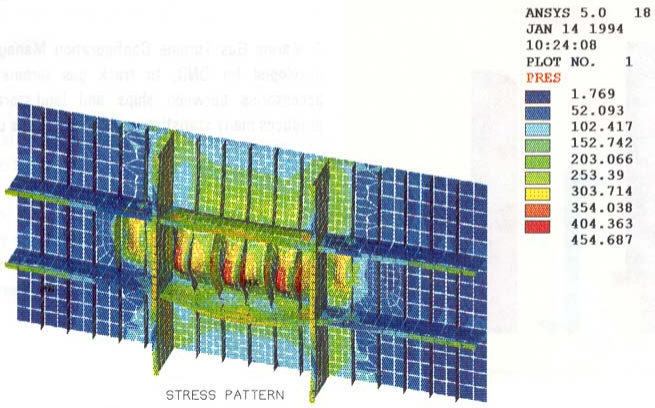
Typical Projects

Post-Yield Behaviour of Icebreaker Structure

The Transportation Development Centre has contracted MIL Systems to investigate the feasibility of using finite element analysis for predicting the instability of stiffeners in the post-yield range in typical icebreaker structure. Results from an experimental program by Carleton University, under the direction of MIL, are being compared with finite element analyses conducted in our Engineering Computing Laboratory.



Model with symmetric loading and no imperfections



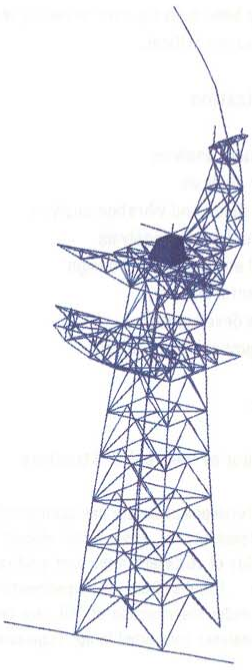
STRESS PATTERN
NONLINEAR ANALYSIS OF ICEBREAKER GRILLAGE

MIL Systems

TYPICAL PROJECTS

Design Check of Mast Structure

Littons Systems Canada Limited contracted to perform the ship integration of new navigation radars on the mast of the Canadian Navy Iroquois Class destroyers. The integration process required the design of new support structure and analysis of the reconfigured mast using finite element techniques. Loads designed for were combined wind and ship motions, underwater shock, and nuclear air blast. The mast vibration characteristics were investigated as was the possibility of local member vortex-induced vibration.

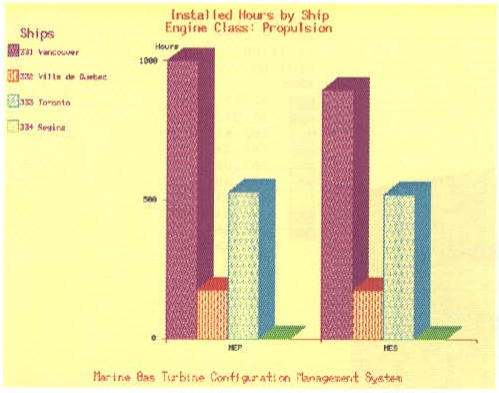


Mast Dynamic Response

Shock Analysis of Sonar Installation

The Portuguese Navy, through the Canadian Navy, contracted MIL Systems to determine the structural adequacy of their frigate to support a new fit of Canadian sonar equipment. Underwater shock analysis was performed with finite element methods using response spectrum techniques. The results were analyzed using post-processors developed in-house.

Marine Gas Turbine Configuration Management System



Marine Gas Turbine Configuration Management System

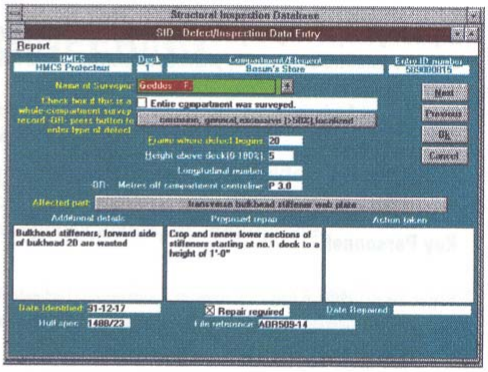
A Marine Gas Turbine Configuration Management System was developed for DND, to track gas turbine engines and their accessories between ships and land-storage. The system produces many statistics, graphs and charts under user control.

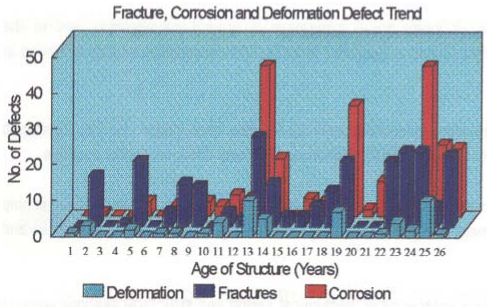
MIL Systems

TYPICAL PROJECTS

Development of Structural Inspection Database System

MIL Systems developed the Structural Inspection Database (SID) software system. SID allows data entry and reporting on structural inspections and defects for ships, facilitates the management of surveys and repairs, and aids in research and development initiatives. The software was written for Microsoft Windows and hence sports a graphical user interface (GUI). There are three sites using the software in Canada, and trials are underway in the UK.





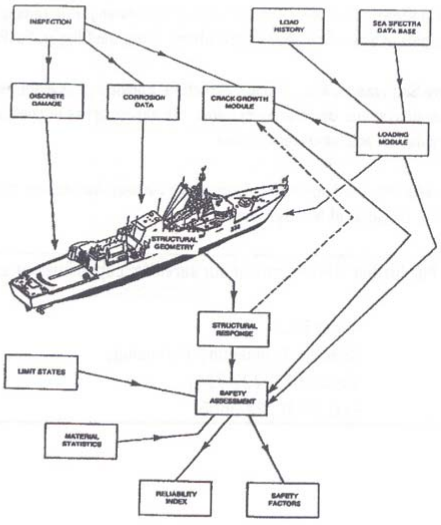
Cost Analysis Studies

Several cost analysis studies have been undertaken in areas such as the implementation of signature reduction measures on ships, and repair and maintenance practices on ships. In the latter case this required the analysis of past records and investigation of alternative strategies with a view to minimize costs.

Risk Analysis Studies

A number of projects have required the application of probabilistic techniques. Examples include:

- A pilot system was developed to predict the residual strength of damaged ship structures. Reliability techniques were used in which the load and strength are expressed in probabilistic terms.
- An analysis was performed on the statistics of damage sustained by vessels in pollution incidents. The analysis was used to establish the risk that particular compartments would be breached in collisions, groundings etc.



MIL Systems

MARINE ENGINEERING

The Marine Engineering Department of **MIL** Systems Engineering Inc. provides the full range of "traditional" marine engineering services (mechanical and electrical), fully cognizant of classification societies, military, and government regulations and specifications, as appropriate.

In addition to these traditional services we are able to provide designs and specifications for advanced propulsion systems and specialized auxiliary systems.

SERVICES OFFERED

- Propulsion system trade-off studies (new vessels and re-engining existing vessels)
- Propulsion systems (mechanical & electric drives) design and specification
- Auxiliary systems design and specification
- Specialized auxiliary systems including:
  - Water displaced fuel systems
  - Liquid level management systems
  - Fire detection, suppression and control systems
- Electrical and Electronic systems design and specification
- Electrical power plant analysis and fault current analysis
- Degaussing systems design and specification
- Cathodic protection design and specification
- Atmosphere independent propulsion (AIP) systems
- Life cycle costing
- Machinery and systems condition assessment

MIL Systems

RECENT PROJECTS

Re-Engining Studies

The re-engining of a vessel is usually undertaken to achieve overall life cycle cost savings for the remaining life of the vessel. Re-engining may also be necessary where prime movers have become unreliable and/or unsupportable. A re-engining trade-off study is essential to determine if indeed a change in prime movers will result in life cycle cost savings. Such a study includes:

Strip-out costs for the existing prime movers and affected auxiliary systems; and, for both a number of new candidate prime movers (including modern control and monitoring systems) and the existing plant,

- Performance expectations (including potential maximum vessel speed)
- weight and space considerations
- range
- capital costs for new material and equipment
- installation costs
- the determination of (remaining) lifetime fuel, oil, maintenance and manning costs based on a customer provided operational profile
- the overall savings achievable over the remaining life of the vessel using the above calculated costs
- noise and vibration evaluation
- reliability and availability assessment (where data is available)
- expected reduction in exhaust emissions.

MIL Systems has conducted numerous such studies including:

Canadian Patrol Frigate (CPF) Mid-Life Re-Engining Study

This study evaluated 10 alternative propulsion systems for the re-engining of the CPF, including the use of ICR gas turbines, simple cycle gas turbines, and diesel engines. The evaluation included all of the criteria noted above. This study, like many others, made wide use of MIL's in-house generated databases and life cycle costing software, developed over a number of years.

Propulsion and Electrical Plant Selection for New Vessels

From high level concept studies to detailed specifications and drawings MIL Systems has considerable experience in the area of propulsion and electrical plant design, selection and evaluation. Most recent projects include:

Catamaran Sounding Vessel (Canadian Coast Guard) - Contract Design

Evaluation, selection and specification of the entire propulsion and electrical plants.

30 m Cutter (Canadian Navy) - Concept Design

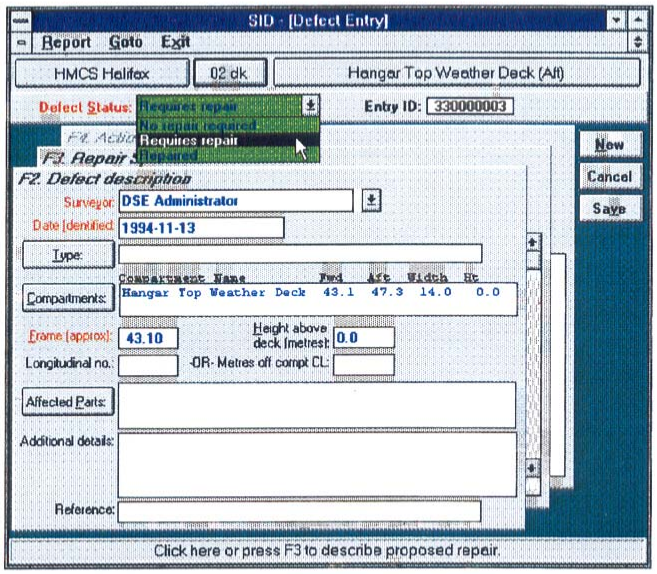
The evaluation of a number of diesel engines for both propulsion and electrical plants.

SWATH Frigate (Canadian Navy) - Concept Design

Trade-off study between electric propulsion and a number of mechanical propulsion systems.

MIL Systems

STRUCTURAL INSPECTION DATABASE (SID)



SID DEFECT ENTRY SCREEN

The Structural Inspection Database (**SID**) is a PC-based application which manages data on structural surveys, defects and repairs on ships. **SID** can assist in the assessment of structural integrity, in the management of survey and repair strategy,and in various R & D initiatives.

SID is in use at three Canadian Department of National Defence sites, and is undergoing trials at the U.K. Ministry of Defence and at the Carderock Division of the U.S. Naval Surface Warfare Center.

MIL Systems

STRUCTURAL MAINTENANCE STUDIES

In the current climate of financial restraint, structural maintenance costs of ships are coming under increased scrutiny. In addition there is pressure to keep ships in service beyond their design life. The objectives of reducing structural maintenance costs and extending the life of structures are best achieved within a systematic integrated approach to the design, construction, operation and maintenance of ship structures, as embodied in structural integrity plans. There are several elements that are key to such initiatives.

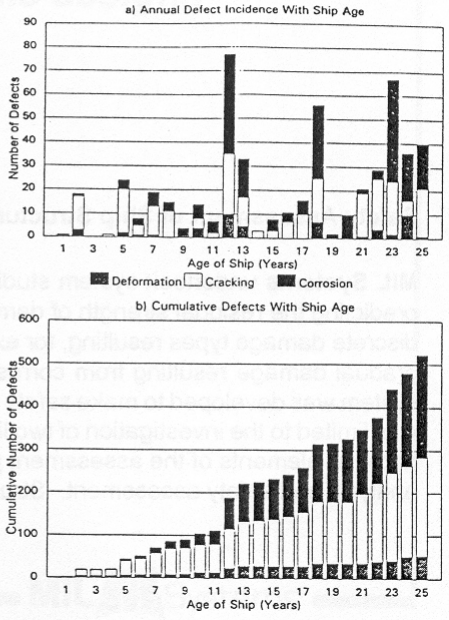
These include:

- Analysis of historical damage data
- Analysis of current costs
- Development of models for predicting corrosion and fatigue
- Systems for tracking defect and repair data
- Safety assessment of ship structure
- Cost benefit analysis

Typical studies undertaken in this area by **MIL Systems** include:

Analysis of Defect, Repairs & Cost Data

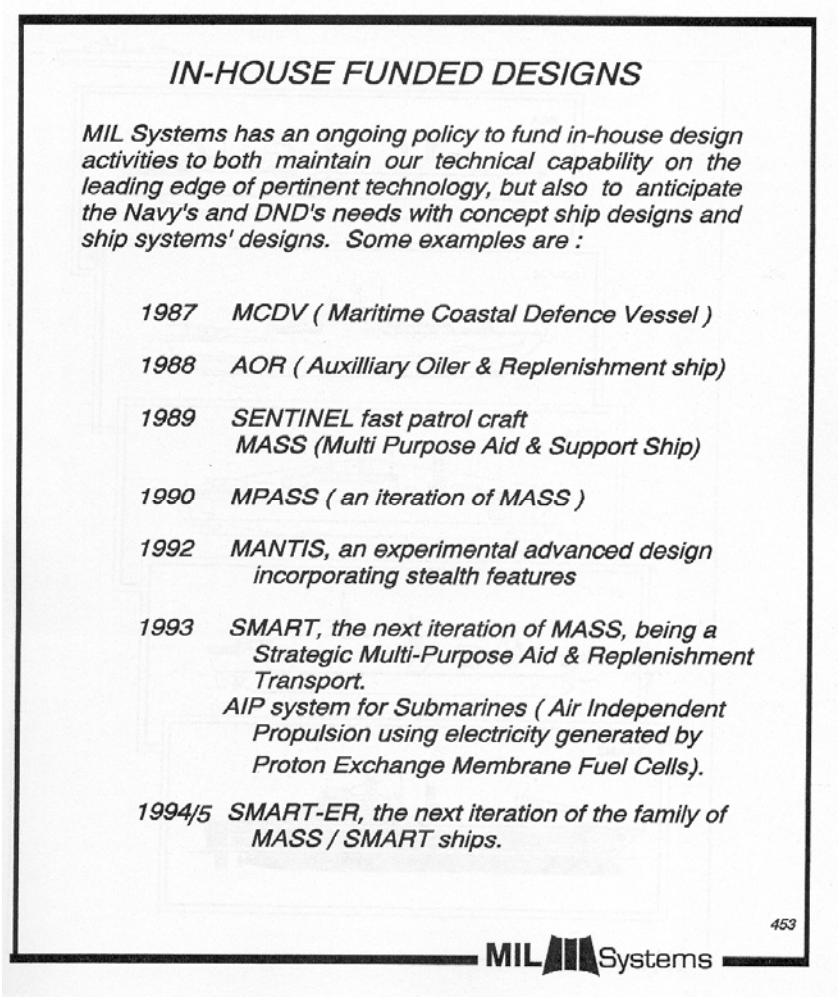
MIL Systems has conducted several studies on the life-cycle trends and cost of structural repairs of ships. In support of these studies structural maintenance histories of several ships were assembled into computer databases for analysis. The maintenance records were organised according to defect type (e.g. cracks, corrosion, deformation, fabrication,) type of structure, location, magnitude and cost of repair. The data was analysed to establish trends as functions of various ship attributes. The results of these analyses led to the development of defect incidence and repair cost prediction models. These models can be used to estimate total life-cycle costs for these ships, and to evaluate potential cost savings for alternative maintenance strategies.



IN-HOUSE FUNDED

SHIP & SHIP SYSTEMS' DESIGNS

The annual budget of MIL Systems Engineering included in its Marketing section funding for in-house designs that the Company believed the Navy might be interested in. Some of the major projects are listed in the following chart. The Navy did implement an MCDV project and showed intense interest in MASS which (a) superceded the AOR replacement, and (b) later through innovations more closely suited to the Navy's thinking became named SMART. The Navy was known to be thinking of the ability to extend the submerge duration of their diesel electric submarines and a Proposal was made based on the extension from 48 hrs. to 14 days by the use of hydrogen/oxygen driven Fuel Cells. Further discussion of Proposals to the Navy in the form of Discussion Papers, rather than fully detailed technical Proposals are given in Section 1 hereto.



MIL Systems

THE SMART SHIP

PROVIDING FLEXIBILITY TO GOVERNMENT FLEETS

The **Strategic Multi-role Aid and Replenishment Transport** ship is designed to cost effectively handle the wide ranging support activities required of government fleets. From oil pollution clean up to strategic sealift and disaster relief, the SMART Ship provides the capability and flexibility for fast and effective worldwide deployment.

PRINCIPAL PARTICULARS

Length (overall)	178 m	Shaft Power	17500 KW
Length (waterline)	156 m	Complement:	
Beam	28 m	Officers	8
Depth (to Main deck)	21 m	Petty Officers	20
Draft	8 m	Crew	53
Displacement (Deep)	18800 tonnes	Unallocated	60
Speed	21 knots	Deadweight	9000 tonnes
Endurance at 15 knots	11000 n. miles	Cargo Fuel	6500 tonnes
Machinery	2 Medium speed diesels/single shaft	Vehicle Capacity (internal)	2444 lane metres
		Container Capacity (external)	200 TEU

MIL Systems

ONE VESSEL – MULTIPLE CAPABILITY

Missions:

Naval Task Force Replenishment

Strategic Sealift

Environmental Emergency Response

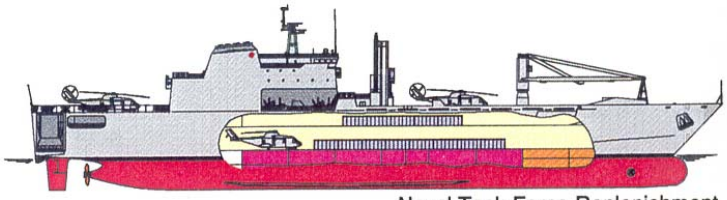
Sovereignty Enforcement

Peacekeeping

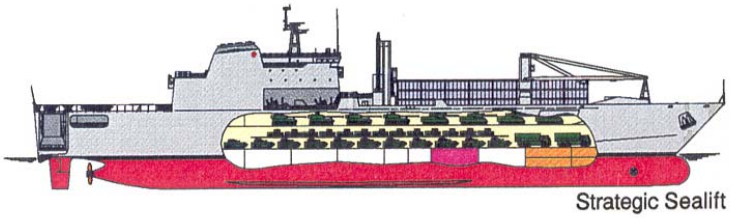
Helicopter Support

Search and Rescue

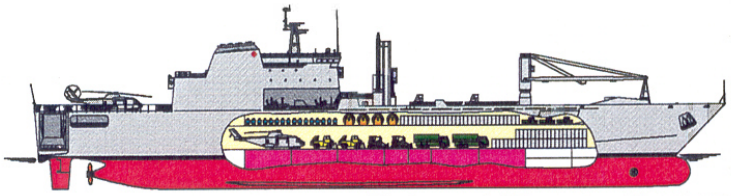
Cargo Transportation



Naval Task Force Replenishment



Strategic Sealift



Environmental Emergency Response

VESSEL ATTRIBUTES

- Carries sufficient fuel, JP5 and stores together with appropriate replenishment equipment to be able to restore and refuel a small naval task force.
- Transports a complete range of wheeled and tracked vehicles and helicopters: containerized, palletized and other cargo including ammunition.
- Tankage to store the clean-up products of oil spills and the ability to fit containerized oil/water separators to maximize this capacity.
- Can carry and maintain 4 medium sized helicopters which can be deployed from two flight decks.
- Provision for extensive hotel facilities for up to 600 mission specific support personnel.
- Comprehensive Command and Communication facilities.
- Unloads cargo using two side ramps and a heavy lift crane permitting transfer to barges or primitive shore facilities.
- Minimal manning.
- Operates from the sub-arctic to the Persian Gulf.
- Design and construction to Classification Society requirements.

MIL Systems

MASS – A MULTI-ROLE AID AND SUPPORT SHIP FOR PROVIDING FLEXIBILITY TO GOVERNMENT FLEETS

This multi-purpose Roll-On Roll-Off Lift-On Lift-Off (RO-LO) cargo vessel is designed to handle the wide ranging support activities required of all government fleets. From oil pollution clean up to cargo transportation and disaster relief, the MASS provides the capability and flexibility for fast and effective response.

PRINCIPAL PARTICULARS

Length overall, L_{OA}	138.8 m	Machinery	4 Medium speed diesels
Length on the waterline, L_{WL}	126.0 m	Power, P_s	14000 KW at 220 rpm
Beam moulded, B	20.0 m	Propellers	2 Controllable Pitch
Depth to No 1 deck, D	14.0 m	Complement:	
Draft mean, T	6.0 m	Officers	23
Deep displacement, Δ_t	9500 tonnes	Petty Officers	5
Trial Speed, V	21.0 knots	Crew	32
Endurance at 17 knots	6000 n. miles	Spare/Passengers	50

■ THE MIL *MANTIS*

• Description

The MIL *mantis* is a hybrid advanced marine vehicle borrowing technology from the SWATH, the hydrofoil and the wave piercing catamaran. The majority of the vessels weight is supported by a fully submerged cylindrical hull which is attached to the above water superstructure by slender aerofoil shaped struts. Vessel stability is achieved by a combination of a very low centre of gravity and catamaran type outrigger hulls. The vessels transverse and longitudinal stability is enhanced as forward speed increases by small hydrofoils attached to the hull cylinder.

• Particulars

Length	: 82m	Beam	: 12.5m
Draft	: 11m	Displacement	: 2015 Tonnes
Speed	: 38 Knots	Power	: 21,000 KW

• Stability

Due to it's very low centre of gravity and unique configuration the *mantis* has exceptional stability with a theoretical positive GZ up to 180° of roll. Damaged stability is also ensured with the above water superstructure able to support the vessel should the hull cylinder become completely flooded.

• Seakeeping

Powering and seakeeping are the primary advantages of the *mantis* over a conventional monohull. With a very small waterplane area, wave piercing outriggers and the main hull 4 meters above the static waterline the *mantis* is able to pass through wave systems equivalent to sea state 6 conditions without significant roll, pitching or speed loss.

• Structure

The submerged hull cylinder and lower struts of the *mantis* are built of steel in a configuration similar to submarine construction. The superstructure is built of light weight, high strength, aluminum incorporating aircraft type fabrication technology.

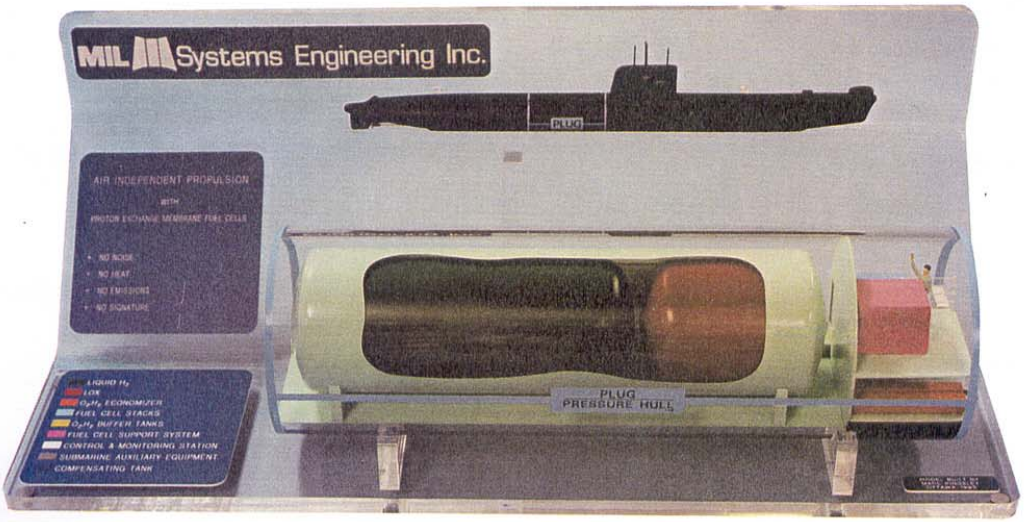
• Stealth

The *mantis* is designed to have minimal heat, radar, acoustic and magnetic signatures. The superstructure is designed using concepts similar to the F-117 stealth fighter, it's gas turbine electric propulsion system ensures minimal underwater noise and it's shrouded air cooled gas turbine exhaust and extensive hull insulation reduces heat signatures.

MIL Systems

SUBMARINE
AIR INDEPENDENT PROPULSION SYSTEM

The **submarine Air Independent Propulsion (AIP) power system** has been designed to dramatically extend the deep submerged time of diesel-electric submarines by 14 days minimum. The advance of Proton Exchange Membrane (PEM) fuel cells is such that long-life, rugged, predictable performance is now available at economic production prices.

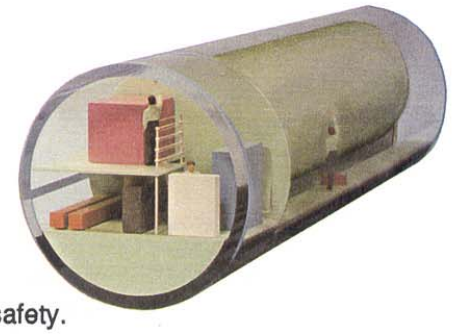


PRINCIPAL PARTICULARS:

In the specific case of an "O" boat class design:

Overall Length Extension (plug length):	18.9m
Effect on Boat Speed:	- 1 knot maximum at top speed
Effect on Boat Trim:	improved balance
Increase in Boat Weight:	427 tonnes

Note: No degradation to boat stealth signature or safety.



MIL Systems

FUEL CELL SYSTEM

Patented closed loop control system (CLCS) with 2 parallel series of 10 x 60-cell stacks producing 440 VDC (nominal) at 682 amperes, fully automatic operation from start-up, operational monitoring to shut-down (normal or emergency). Cell active area 780 cm^2 with LHV efficiency of 0.58.

AIP DATA:

Voltage	440	VDC
Power	300	kW
Energy	100	MWh
Operating Temp.	70	°C

REACTANTS:

LOX (-183°C)	45,000	kg
LH_2 (-253°C)	5,700	kg
Autonomy	70	days

REFUELING:

6 hours.

ADDITIONAL WEIGHT:

Structure	135	
Through-boat System	8	
AIP System	13	
Reactant Storage	164	
Total Lightship	320	tonnes
Reactants for 14 days	51	
Deepload Weight	371	tonnes

LOCATION:

All inside pressure hull