71249

NAVAL SHIP DESIGN WORKSHOP

at MIT

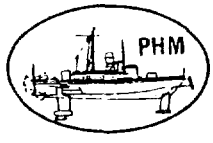
PHM CASE STUDY

Tuesday, 24 July 1979

1300 - 1700

by

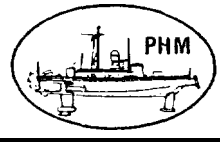
Mr. A. Johnson



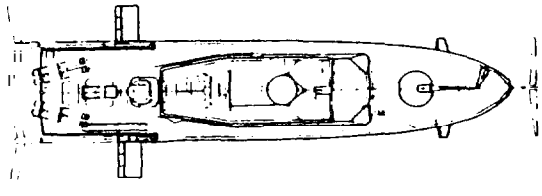
PHM PROGRAM

INTRODUCTION

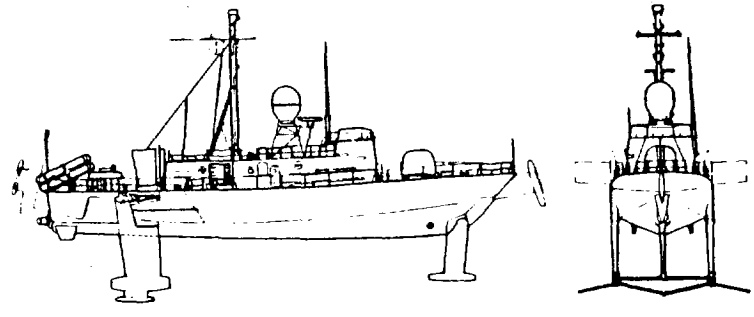
Good afternoon, our next case study is the PHM program. The PHM began as a NATO program which is why its dimensions are listed in meters on the next slide.



OVERALL CONFIGURATION



LENGTH	131.2 FEET	40.005
BEAM	29.5 FEET	8.994
DRAFT		
HULLBORNE (FOILS RETRACTED)	6.2 FEET	1.90
HULLBORNE (FOILS EXTENDED)	23.3 FEET	7.10
FOILBORNE (NOMINAL)	6.6 FEET	2.00
DISPLACEMENT	237 LONG TONS	235 METRIC TONS
SPEED		
HULLBORNE	12 KNOTS	
FOILBORNE	IN EXCESS OF 40 KNOTS	
PROPULSION		
HULLBORNE	2 DIESELS WITH 2 WATERJETS	
FOILBORNE	1 GAS TURBINE WITH WATERJETS	
CREW	21	



The primary mission armament is 8 U.S. HARPOON surface-to-surface missiles in cannister launchers. The secondary battery is a 76 mm gun of origin (AAW & Surface capability). Electrical frequency is 400 Hz with 60 Hz available via static converters. The next slide shows the PHM foil-borne in a sea state.

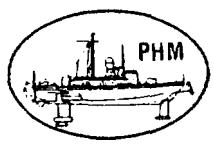


PHOTO
PHM IN A SEA STATE

A letter contract was awarded to Boeing in November 1971 for base-line definition feasibility studies, the ship was launched in 1974, techni-cally evaluated by NAVSEA, then operationally evaluated by an independent Navy agency (COMOPTEVFOR), accepted by-INSURV and delivered to the U.S. Pacific Fleet in 1977. It recently was transferred to the U.S. Atlantic Fleet. Foilborne hours are approximately 1300 at this time.

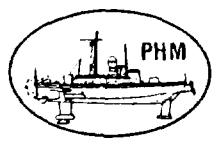
The PHM is a very interesting program; 'is' because there are 5 more under construction. Today's discussion however, will focus on how the design portion of the program was accomplished. I will not discuss or only briefly touch on the other interesting aspects of the PHM program such as:

- The requirements development process
- The sole source decision
- The NATO program
- PHM construction
- The follow-on PHM-3 construction program
- The PHM design particulars and supporting rationale
- Technology transfer

The PHM program was selected as a case study because the design was not performed or managed by NAVSEC; the design was accomplished by the same contractor who constructed the first craft. Although the design and construction phases were handled by separate contracts, the approved (SECNAV) acquisition strategy was to give one contractor full design and construction responsibility.

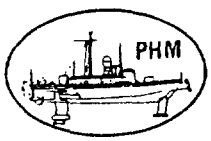
Although in many respects a unique program, some of the PHM experiences and lessons learned have general applicability and are worth considering in connection with more conventional whole ship design farm-outs.

During the following presentation I will cover the following topics:



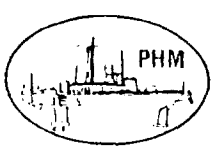
CASE STUDY OUTLINE

- INTRODUCTION
- NAVSEC INVOLVEMENT PRIOR TO BOEING CONTRACT
- DESIGN FARM-OUT DECISION
- RFP APPROACH TO MANAGEMENT OF THE CONTRACTOR
- ACTUAL APPROACH TO MANAGEMENT OF THE CONTRACTOR
- CONCLUSIONS

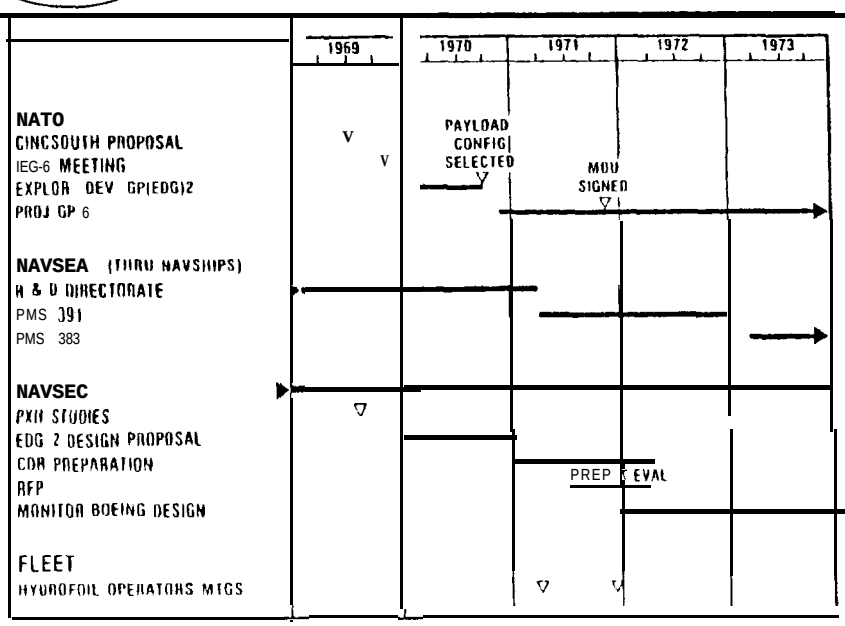


NAVSEC INVOLVEMENT PRIOR TO BOEING CONTRACT

Before getting into a discussion of the design farm-out decision, I want to give you a picture of the program events leading up to the Boeing contract and a perspective on the NAVSEC involvement.



PHM PROGRAM PARTICIPANTS



Earlier today Jim Schuler discussed the events leading up to PHM program insofar as the NATO aspect was concerned. So I will not repeat the story. I will only add that once the NATO Exploratory Development Group 2 concluded that the best platform would be a fully submerged hydrofoil, both Boeing and Grumman began submitting proposals to various NATO countries on their own initiative.

I have not shown OPNAV but they were involved. The resurgence of the Navy's hydrofoil program in the mid-60s created a number of advocates, some well placed in OPNAV. Until March 1971, the NAVSEA (then NAVSHIPS) NATO efforts were coordinated by the R&D Directorate and then transferred to a Ship Acquisition Manager PMS 391 which was a multi-ship SHAPM. When PMS 303 was established, continuity was preserved by transferring not only the PMS 391 Assistant Project Manager and his staff but also PMS 391 himself.

NAVSEC accomplished all design proposals put before the NATO groups by the U.S. Delegation. Until the award of the Boeing contract in November 1971, all design support required by the NATO steering group to explore alternatives, assess implications of requirements variations and develop feasibility studies of National Variants was performed by NAVSEC. The engineering effort was almost totally in-house with some laboratory assistance.

As you can observe, NAVSEC was the only U.S. Navy participant who was involved throughout the program outside of OPNAV. In fact, NAVSEC was the de facto source of program technical continuity.

NAVSEC drafted the COR and coordinated the evaluation of the document though its many drafts. In practice the NAVSEC Design Manager was usually responsible for achieving resolution of conflicting national requirements by proposing and gaining acceptance of not only the essence of the compromise requirements but also the specifices of the language used to specify them in the COR. As directed consequence the NAVSEC personnel were thoroughly familiar with the requirements drivers at any given time during the project.

The 'payoff function' was clear from the very start and boiled down two two elements--commonality and cost for several reasons. Without commonality there would be no NATO program and perhaps no U.S. program although a patrol hydrofoil program had been placed in the budget before the NATO program became firm. Commonality also directly affected the amount

PAY-OFF FUNCTIONS

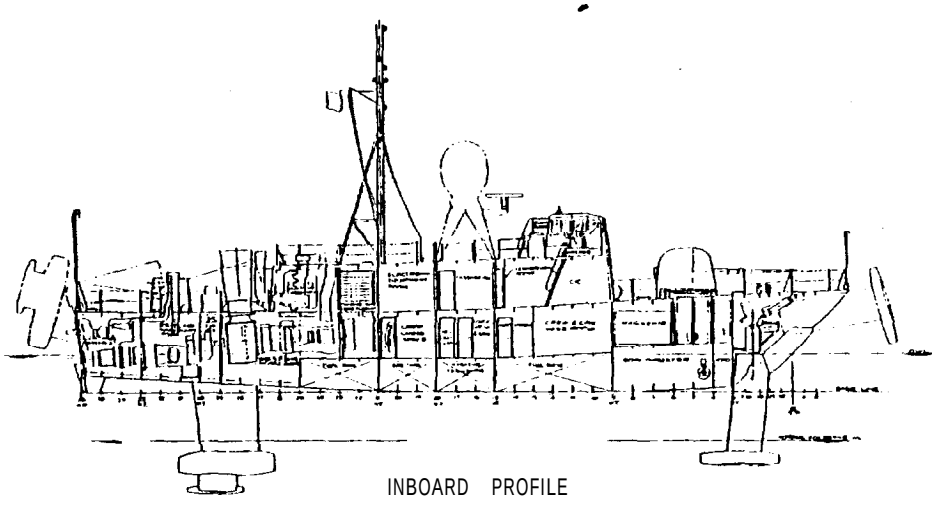
- **COMMONALITY**

- **COST**

of design and production costs shared by the participating Nations as *a* result of the cost-sharing negotiated agreements. Commonality was defined by the NATO Standard Ship concept.

The NATO Standard Ship Design was just that. It was a ship design embodying only those things common between the three National Variants. This was however considerable. The next slide illustrates this point.

NATO STANDARD PHM

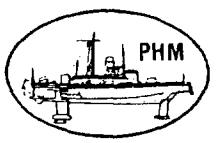


INBOARD PROFILE

The major ship elements not standard were the fire control system, ECM suite, external communications, missiles, combat system command/control and the berthing/messing arrangement. Production unit cost was uppermost in everyones minds. Analysis by the Center for Naval Analysis had quantified a dollar threshold For comparative effectiveness *in* relation to carrier A/C, patrol A/C and the FFG-7 Class to carry out the PHM mission. This threshold did not leave much margin for error.

NAVSEC drafted the technical portions of the RFP. While the SHAPM had the final say the RFP essentially reflected our proposals. I will discuss the RFP in more detail a bit later.

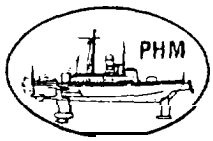
Twice during 1971, NAVSEC gathered all current and previous Navy hydrofoil commanding officers to review the then current PHM baseline design and the COR. At this time in history, the Navy hydrofoil boats, the PCH, AGEH and PGHs had accumulated 2300 hours of foilborne operation which included 6 months of combat operations in Vietnam.



FARM-OUT DECISION

In my opening remark, I noted that the design was accomplished by Boeing, who was also to construct the lead PHM. Unlike the AO-177 case, which you will hear later this week, the decision to have a contractor perform the design was basically made by the SHAPM. SEC concurred in the reasoning leading to this decision.

There were several factors which lead to having the contractor perform the design. They are listed on this slide.

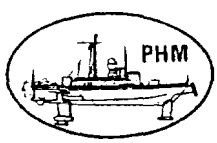


FARM-OUT DECISION FACTORS

- PREVIOUS SHAPM EXPERIENCE
- BOEING IMAGE
- POLITICS AT THE NATIONAL LEVEL
- NAVSEC IMAGE
- NAVSEC SELF-DOUBTS

PREVIOUS SHAPM EXPERIENCE

Some of the SHAPM's civilian personnel had been involved in the Navy's previous hydrofoil acquisition programs. In this slide I have summarized how the Navy had previously gone about designing, contracting for and building hydrofoils.



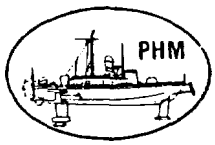
PREVIOUS U.S. HYDROFOIL ACQUISITION STRATEGY

F Y	SHIP	DESIGN AGENT	BUILDER	CONTRACTUAL DOCUMENT
1960	PCH-1 (1201)	BUSHIPS	BOEING	SPECS & DRAWINGS
1962	AGEH-1 (3201)	GRUMMAN	LOCKHEED	SPECS & DRAWINGS
1965	PGH-1 (601)	GRUMMAN	GRUMMAN	CIRCULAR OF REQUIREMENTS (PERFORMANCE)
1965	PGH-2 (601)	BOEING	BOEING	CIRCULAR OF REQUIREMENTS (PERFORMANCE)

Although neither of the PGH and the AGEH experiences were conclusive evidence that these approaches were inherently flawed, they were so perceived when the PGH program, with an acquisition strategy radically different from its predecessors, turned out to be successful..

BOEING IMAGE

The next slide traces the shift in leadership focus within the Navy



HYDROFOIL PROGRAM TECHNICAL LEADERSHIP

LATE 40's THROUGH LATE 50's	ONR
1960 • 1966 (PCH-1 → PGH-1 & 2)	**BUSHIPS/NAVSHIPS**
1966 → PHM INCEPTION	OTNSROC (11)

thru quarter of a century prior to the PHM. Shortly after DTNSRDC took over management of the hydrofoil program, they set up a T&E group, the Hydrofoil Special Trials Unit (HYSTU), located at Bremerton, Washington just across from Puget Sound and Seattle (and with it Boeing). Considering that two of the Navy's four hydrofoils were built by Boeing, that the Boeing PGH was the more visually successful--the Grumman PGH-1 was plagued by right-angle gear problems, and that Boeing was operating under Navy Contract FRESH-1 (a jet engine propelled hydrofoil test sled) and getting publicity from the speed records being set, I cannot help conclude that here was a tendency to regard Boeing as the leader if not the oracle of hydrofoil state-of-the-art. Boeing had also made a good impression on the NATO members particularly Germany.

POLITICS AT THE NATIONAL LEVEL

Politics at the national level exerted some second order effect on the farm-out. As a result of the large Seattle area unemployment stemming from the SST cancellation, Boeing pressured the Executive Branch for jobs.

Thus the political climate probably gave the SHAPM something to ponder when the question of where the design would be performed came up for consideration and gave him one more reason why he should farm the design to Boeing.

However, the political climate was not the principal factor in assigning either the design or the program itself to Boeing. The logical choice for the detail design and construction was Boeing because the PHM foil and propulsion design were similar to the Boeing PGH-1. With the NATO members pushing for a sole source to minimize start-up costs and schedule delay, the existence of political pressure to provide jobs in Seattle was serendipity for a SHAPM who wanted to go sole source to Boeing anyway.

NAVSEC IMAGE

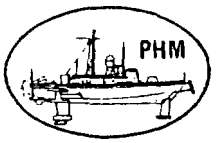
NAVSEC SELF-DOUBTS

It is fair to say that NAVSEC was not perceived as having the same handle on hydrofoil technology as either DTNSRDC, Boeing or Grumman. Nevertheless, NAVSEC considered seriously the idea of doing the design in-house; either completely relying only on the Navy laboratories like DTNSRDC or by putting together a design team including Boeing/Grumman.

The latter idea didn't generate much enthusiasm; being considered as unmanageable unless Boeing or Grumman located their personnel at NAVSEC. This was not likely. The idea of doing the design in-house was finally dropped by NAVSEC after concluding they were weak in the area of foil design and control.

As homework for the future role it would play *in* the PHM program SEC continued the in-house design planning to completion. This effort provided valuable experience in preparing the technical requirements of the RFP and later evaluating the design approach proposed by Boeing.

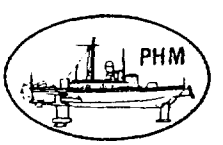
These two areas,perceived (correctly) as weaknesses, were given much greater weight than some NAVSEC strengths which I have listed on the next slide. These however, were quickly seen, once the design began, as areas in which Boeing was weak.



NAVSEC **STRONG SUITES**

- NAVAL OPERATIONAL EXPERIENCE
- KNOWLEDGE OF NAVY DESIGN PRACTICE
- CONVENTIONAL PATROL 80AT DESIGN EXPERIENCE

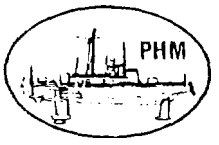
I think the two factors, NAVSEC image and self-doubts, were the principal factors leading to SHAE'M to decide to have Boeing do the design. What was operating was the fatal flawprinciple.



FATAL FLAW PRINCIPLE

- NO FOILS
- NO FLY
- NO PHM

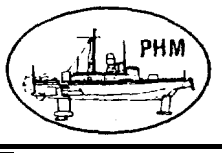
We, NAVSEC (and its successor organization) are in the same boat today with respect to the LCAC program; the LCAC is an Air Cushion Vehicle.



LCAC WEAK AREAS

- NO FAN, NO SKIRT
- NO AIR CUSHION
- NO ACV, NO LCAC

Fortunately for the Navy, such expertise resides at DTNSRDC in the case of ACVs. The question of course is why not at the Navy's design engineering activity.



LESSON

MANAGEMENT MUST BE WILLING TO
INVEST PERSONNEL RESOURCES TO
ACQUIRE **AND** DEVELOP RESIDENT
EXPERTISE IN CRITICAL FACETS
OF EMERGENT TECHNOLOGIES

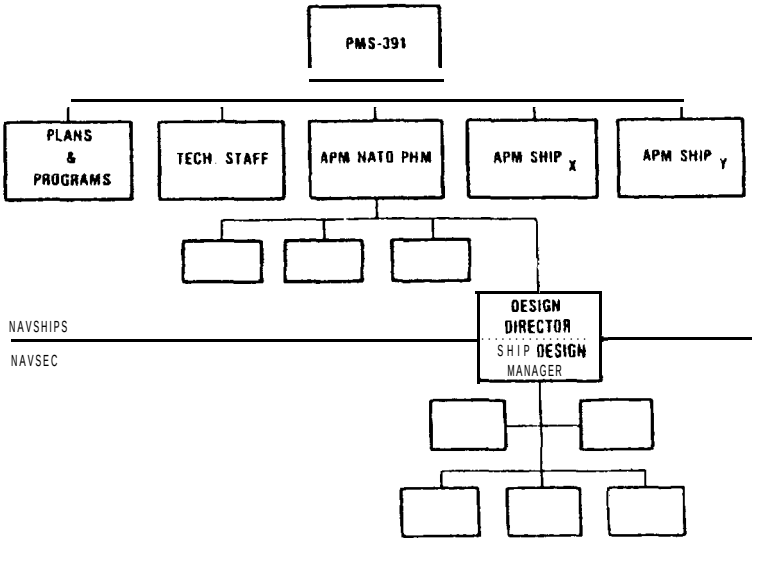
PLANNED APPROACH TO TECHNICAL MANAGEMENT OF CONTRACTOR

There are two aspects of this topic. I will first talk briefly about internal Navy program management and then discuss the planned approach to assuring that the Navy would truly participate in the design process.

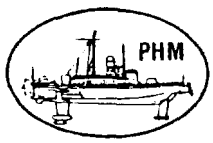
INTERNAL NAVY ORGANIZATION

PMS 391 was a multi-ship SHAPM with the responsibility for patrol, service and mine warfare type ships. Although the SHAPM had a small technical staff, the initial decision was to double hat the NAVSEC Ship Design Manager (SDM) as the PMS 391 PHM Design Director.

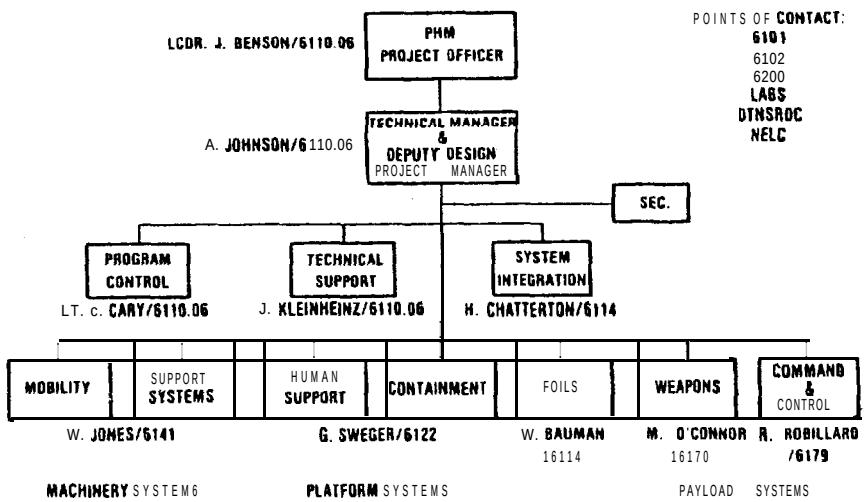
NAVSHIPS - NAVSEC INTERFACE



NAVSEC set up a team as shown on this next slide. The team members listed were assigned full time to the PHM. Points of contact were also established at the two primary support Navy Laboratories.

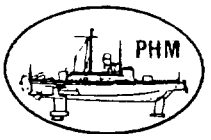


NAVSEC PROJECTTEAM ORGANIZATION



Desks were provided to the team members in both their parent organizations within NAVSEC as well as with the PHM SDM in the NAVSEC Design Division. Their part-time presence in their 'home' organizations preserved their identity and communications links. Sitting together frequently as a team created a visible link and identification with the PHM and enabled an awareness of and sensitivity to the 'environment' surrounding the program. Communication betweer team members (and that's transformable to enhancement of system interfaces) was improved. The ensuring team cohesiveness led to team interactions that were synergistic.Collocation made many things simpler -- you could have a team meeting with everyone sitting at their own desk. Perhaps much of this was possible because none of the team members were 'senior' types ---most were trying to make their mark.

Once the decision was made to have Boeing do the design, interest in the PHM program waned--at all levels. In order to pull 'management' back in, a PHM



PHM EXECUTIVE ADVISORY COMMITTEE

OBJECTIVE

- PROVIDE HIGH LEVEL, MULTI-DISCIPLINE REVIEW OF PROJECT OFFICE HANDLING OF PHM PROGRAM.

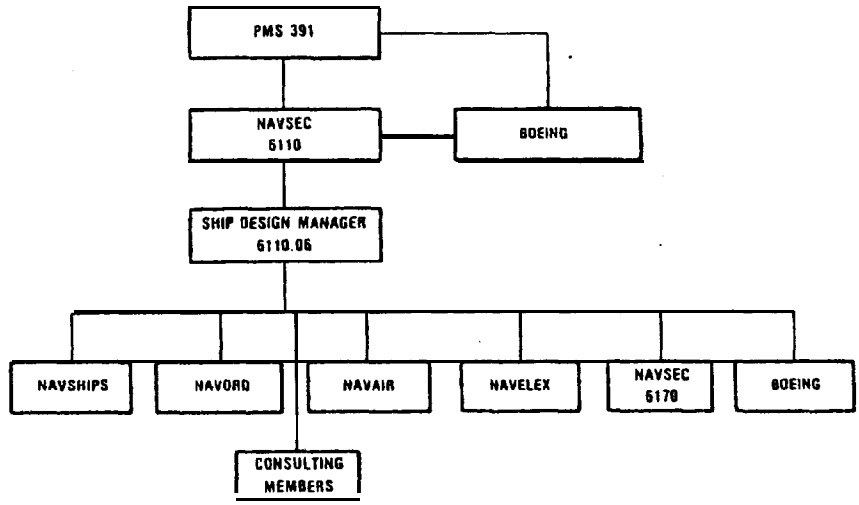
COMMITTEE CONCERNED WITH

- HOW WELL PHM DESIGN MEETS PROGRAM TECHNICAL OBJECTIVES.
- HOW WELL THE QUALITY OF THE FINAL PRODUCT REFLECTS ON NAVSEC.

Executive Advisory Committee was formed. It consisted of all Division/Office Directors and Technical Directors. They were however, invited as individuals. The following slide summarizes the committee's purpose. The group was primarily intended to be involved in problems affecting all of SEC and/or reflecting on SEC's overall image and effectiveness. However, this group would also be useful in resolving impasses between the SDM and the organization when the normal process were not working.

The PHM began before, the merger of SHIPS and ORD into NAVSEA. It was the practice in those days to establish so-called 'Collocation Teams.' Originally they has been physically located side by side but that no longer happened. This extraordinary organization however was given the task of establishing the Navy Material Command guidance for the SHAPM to pass on to the contractor who would actually integrate the Combat System elements. The next slide gives you a view of its members. NAVSEC was designated by NAVMAT directive to head the group.

COMBAT SYSTEM COLLOCATION ORGANIZATION



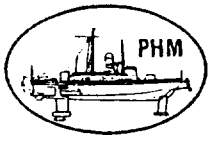
CONTRACT TECHNICAL MANAGEMENT CONCEPT

NAVSECs position was that there should be Navy control exercised over the PHM design development. Neither the SHAPM nor the contractor were likely to agree to request SEC's approval on every detail. The other extreme of no technical participation was considered unthinkable. The selected approach was to allow the contractor freedom for initiative and innovations while retraining contractual leverage to control the Contract when necessary.

MAVSEC proposed the following concept to the SHAPM.

CONTRACT TECHNICAL MANAGEMENT CONCEPT

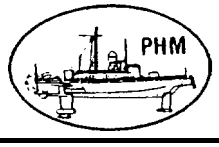
REQUIRE THE CONTRACTOR TO SPELL OUT PLANNING BEFORE HE COMMENCES DESIGN SO THAT NAVY CAN EVALUATE HIS PLANS AND ADVISE HIM OF MAJOR DIFFERENCES OF OPINION BEFORE THE DESIGN STATUS.



CONTRACT TECHNICAL MANAGEMENT CONCEPT

IDENTIFY IN THE RFP THE DECISIONS OVER WHICH THE NAVY WANTS TO EXERCISE FINAL APPROVAL.

REQUEST THE CONTRACTOR TO STRUCTURE THE SCHEDULE SO THE NAVY HAS TIME TO EVALUATE THE DECISION.



CONTRACT TECHNICAL MANAGEMENT CONCEPT

REQUIRE ONLY THAT THE DECISION PAPERS BE SUBMITTED FOR APPROVAL.

ACCEPT THE RESPONSIBILITY FOR ADVISING THE CONTRACTOR OF ASPECTS OF STUDY REPORTS WHICH REQUIRE FURTHER DISCUSSION.

CONTRACT TECHNICAL MANAGEMENT CONCEPT

MAINTAIN A CLOSE **MONITORING** OF THE CONTRACTORS' EFFORT BY FREQUENT MEETINGS COUPLED WITH A REVIEW OF THE STUDIES TO BE SUBMITTED BY THE CONTRACTOR.

PRE-CONTRACT VISIBILITY REQUIREMENTS

TIME-PHASED PRESENTATION OF FLOW AND INTER-DEPENDENCIES OF THE CONTRACTOR'S PLANNED TASKS

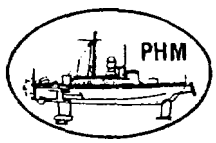
TASK DESCRIPTIONS **FOR** EACH TASK PLANNED **DURING** PHASE D AND I

SUBMISSION DATES FOR DECISION PAPERS, CONFIGURATION REVIEW PAPERS, BASELINE DESIGN REPORTS AND SHIP SPECIFICATIONS

IN REGARD **TO** DECISION PAPERS AND **CONFIGURATION** REVIEW PAPERS

- IDENTIFICATION **OF** DECISION MATRIX
- **IDENTIFICATION** OF SUBSEQUENT TASKS RELATED TO THESE PAPERS

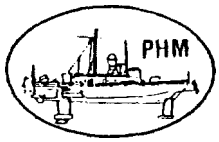
The NATO program envisioned four phases as shown on this next slide.



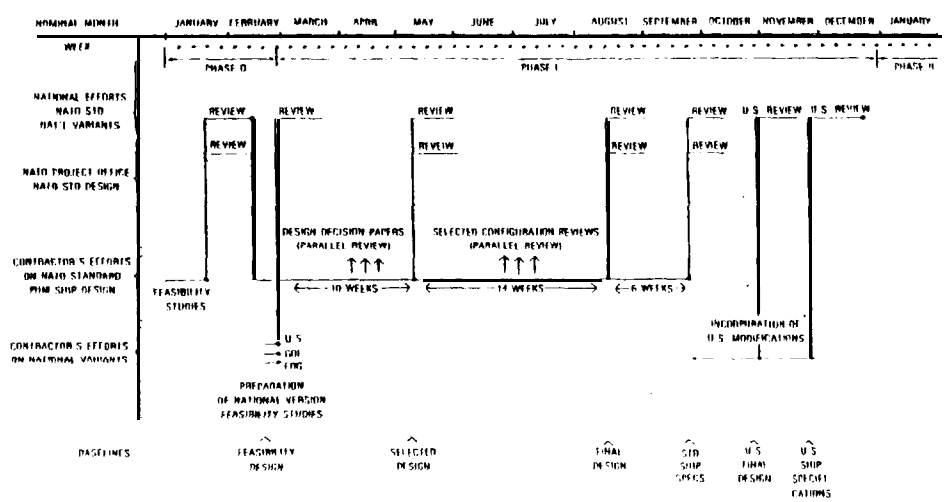
NATO PROGRAM - BOEING

PHASE 0	FEASIBILITY STUDIES LEADING TO SELECTION BY NATO OF NATO STANOARO PHM SHIP DESIGN
PHASE I	CONTRACT DESIGN OF NATO STANDARD PHM AND U.S. NATIONAL VARIANT (12172)
PHASE II	DETAIL DESIGN AND CONST OF TWO U.S. VARIANT PHMS. DELIVERY OF PRODUCTION DATA PACKAGE (3/75 PHM-2)
PHASE III	COMPETITIVE FOLLOW-ON PRODUCTION, FOR ADDITIONAL U.S. VARIANT PHMs. NATO PROGRAM LEAD YARD SERVICES (3/74).

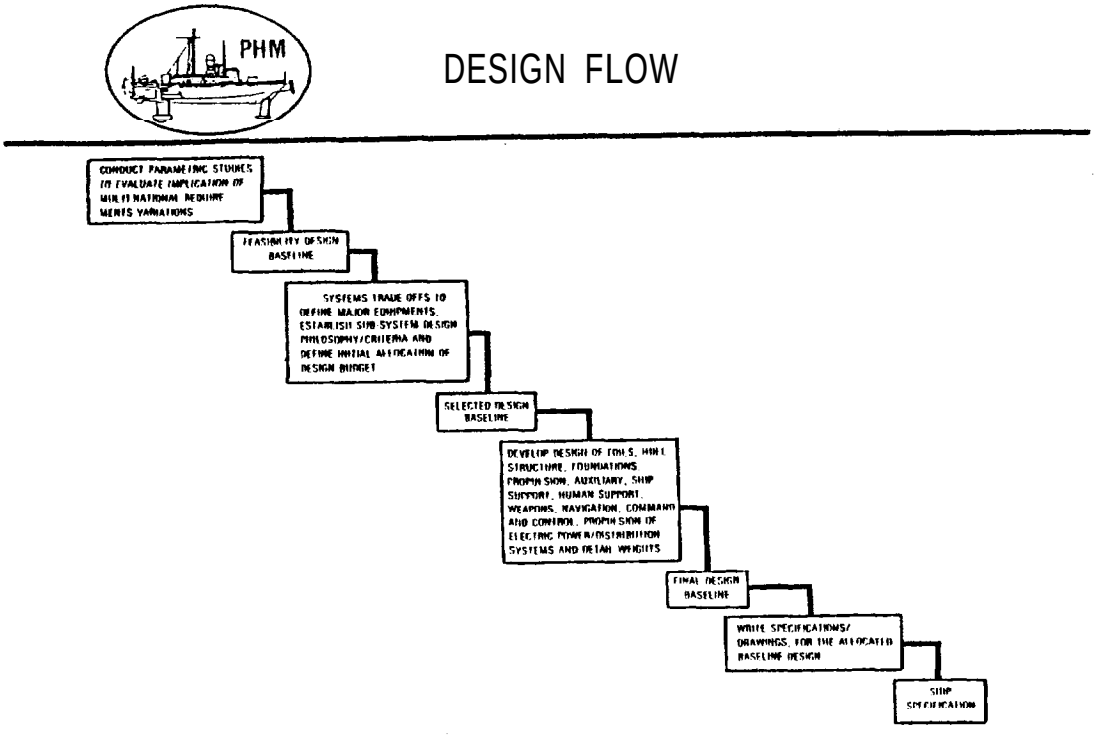
MAVSEC proposed a design process schedule conceptually similar to the NAVSEC norm of feasibility, concept preliminary and contract design. This is described on the following slide.



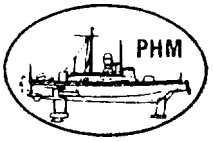
PHM DESIGN SCHEDULE CONCEPT



It was a process punctuated by design baseline reviews and paralled with government monitoring via documentation review, decision points related to selected decision approval controls, and frequent face-to-face contact. The design flow went like this.



The RFP was thus formulated with the following goals in mind. In respect to the last bullet there were two uses for acquiring hydrofoil experience: (a) engineering support of PHM during its operational life; and (b) enable NAVSEC to do future design in-house.

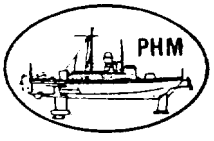


RFP

STRUCTURED WITH FOUR GOALS

- ACHIEVE CONTROL OF DESIGN DECISIONS
- MINIMUM OF INTERFERENCE WITH SCHEDULE OR DESIGN INNOVATION
- EFFECTIVE NATO PARTICIPATION
- ACQUIRE HYDROFOIL DESIGN EXPERTISE WITHIN NAVSEC

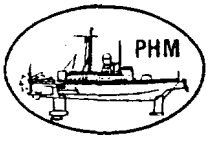
The next slide summarizes the information requested to be in the contractor's proposal.



CONTENTS OF CONTRACTOR'S PROPOSAL

- DESIGN PROCESS FLOW CHART WITH SUPPORTING NARRATIVE
- AGREEMENT/DISAGREEMENT WITH CDR
- EXCEPTIONS TO DELIVERABLES
- MAJOR DOCUMENTATION SUBMITTAL SCHEDULE
- DESIGN AND ENGINEERING MANAGEMENT
- ELEMENTS OF RISK
- ENGINE TESTING/QUALIFICATION REQUIREMENTS
- PHM PROOF AND FATIGUE TEST
- SELECTED TECHNICAL INFORMATION
- PLAN TO ASSURE FUTURE COMPETITIVE PRODUCTION
- OTHER DESIGN PLANS (E.G., HUMAN FACTORS, SAFETY, OA IN DESIGN, ETC.)

The next slide will give you more of an idea of how close SEC wanted to be to the design decision process. It is an amplification of the item on this slide entitled "Selected Technical Information."



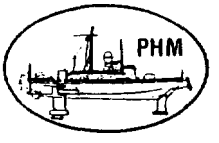
SELECTED TECHNICAL INFORMATION

- FEASIBILITY DESIGN BASELINE OUTLINE
- COMBAT SYSTEM ARRANGEMENT DESIGN CRITERIA
- MISSILE LAUNCHER AND GUN DECK ARRANGEMENT AND FIRING ARC DESIGN CRITERIA
- SHIP MOTION AND CONTROL. ANALVSIS METHODS
- FOIL SYSTEM • MATERIAL SELECTION TRADE-OFF FACTORS AND CRITERIA
- AUTOMATIC CONTROL SYSTEM (ACS)
- FOIL ARRAY STRUCTURAL ANALVSIS CRITERIA
- PROPULSION SYSTEM DESIGN/SELECTION CRITERIA
- ELECTRICAL SYSTEM DESIGN/SELECTION CRITERIA
- AIR CONDITIONING/ELECTRONIC COOLING SYSTEM DESIGN/SELECTION CRITERIA
- UNDERWAV REPLENISHMENT SYSTEM DESIGN/SELECTION CRITERIA
- HABITABILITY CRITERIA/STANDARDS
- STRUCTURAL LOADING CRITERIA
- INTACT AND DAMAGE STABILITY APPROACH
- DESIGN MARGIN PHILOSOPHY

The Decision Papers were seen as key mechanisms for assuring government participation in the decision process and a contractual means of requiring timely disclosure of the design rationale supporting the decision. We were very concerned about discovering major differences at the baseline reviews and having freedom to redirect the design limited by the impact such late direction would have on cost and schedule. The name of the game was clearly to force issues into the open as early as practical.

Boiled down to its essentials, the approach was to maximize pre-start visibility and acquire precise contractual leverage to enable participation in and control of the design; the leverage to be the Decision Papers. It was envisioned that thru constant communication with the contractor coupled with the flow of technical documentation, SEC/Navy would be able to make known to the contractor whether we were in agreement with

his thinking. The objective was to bring Navy and Boeing views into congruance well before any Decision Paper was scheduled. Failing this, then the Decision Paper (about 5 pages in length) would in actuality be his reclama to the Navy view which would have been known to him thru previous communication. There were a total of 22 Decision Papers called out of the RFP.



DESIGN DECISION PAPERS

SHIP SYSTEM
- BALLISTIC PROTECTION
- RELIABILITY/AVAILABILITY ALLOCATIONS
- MINIMUM FOILBORNE SPEED
- ONBOARD REPAIR/MAINTENANCE CAPABILITY
- DESIGN MARGINS
- IR SIGNATURE CHARACTERISTICS/REDUCTION
- RADAR CROSS SECTION/REFLECTIVITY CHARACTERISTICS/REDUCTIONS
- WATERBORNE NOISE SIGNATURE/REDUCTION
- CREW SIZE AND RATING
- NBC PROTECTION

CONTAINMENT
- HULL FORM AND SEAWORTHINESS
- STRUCTURAL MATERIAL SELECTION

FOILS
- FOIL ARRAY MATERIAL SELECTION
- FOIL RETRACTION ALTERNATIVES
- FOILBORNE HEIGHT SENSOR SELECTION
- AUTOMATIC CONTROL SYSTEM DESIGN

MOBILITY AND SHIP SUPPORT
- ELECTRICAL POWER FREQUENCY/VOLTAGE
- POLLUTION ABATEMENT SYSTEM
- PROPULSION SYSTEM (HULL/FOIL) ALTERNATIVES
- ENVIRONMENTAL CONTROL SYSTEM ALTERNATIVES

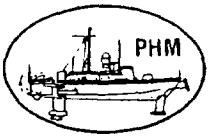
COMMAND & SURVEILLANCE
- EXTERNAL COMMUNICATIONS SUITE SELECTION
- NAVIGATION RADAR SELECTION

These would have been submitted during the period leading up to the Selected Baseline as noted earlier. In retrospect, too many for that timeframe.

The Configuration Review Papers, next slide, were similar in concept, however, these were scheduled to occur during the period leading up to the Final Design Baseline.

INTERFACES

The original agreement with the SHAPM designated SEC as PHM Ship Design Agent, and the NAVSEC SDM as the SHAPM's Design Director. As Design Agent, NAVSEC was to be responsible for assuring that the PHM design meets the COR requirements and that the specifications accurately reflect that design. A working relationship as depicted on the next



CONFIGURATION REVIEW PAPERS

SHIP SYSTEM

- HABITABILITY ARRANGEMEN
- VISUAL SILHOUETTE

FOILS

- TOTAL ACS DESIGN
- FOIL ARRAY AND FOUNDATION STRUCTURAL DESIGN

MOBILITY AND SHIP SUPPORT

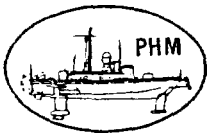
- MACHINERY ROOM AN0 AUXILIARY MACHINERY ROOM ARRANGEMENTS
- EOS ARRANGEMENT
- UNREP/VERTREP ARRANGEMENT

COMMAND & SURVEILLANCE

- ANTENNA ARRANGEMENT
- CIC, PILOT HOUSE ARRANGEMENT AND ELECTRONIC EQUIPMENT
- ROOM ARRANGEMENT

WEAPONS

- WEAPONS ARRANGEMENT

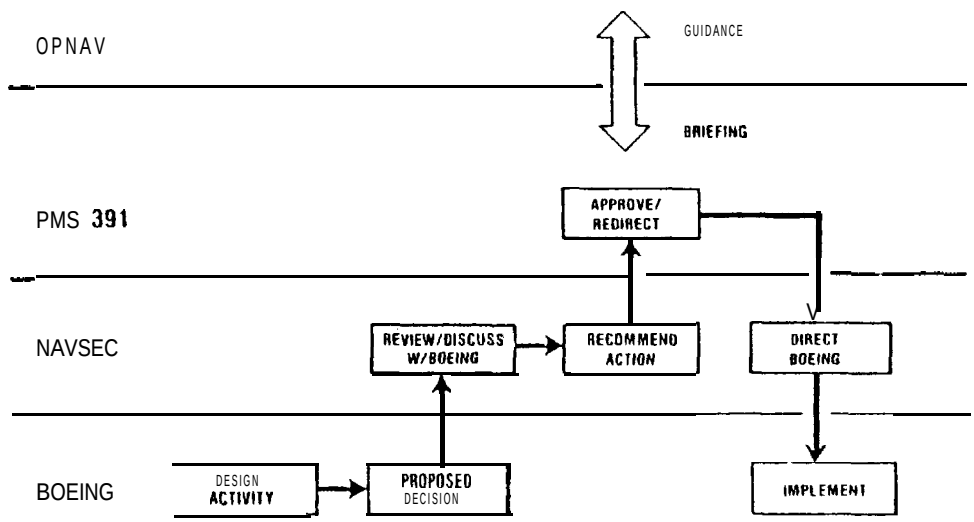


ACTUAL APPROACH TO MANAGEMENT

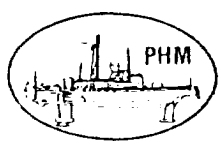
OF THE CONTRACTOR

slide was envisioned. This did not actually work out this way in real life. The subsequent slide shows what actually occurred.

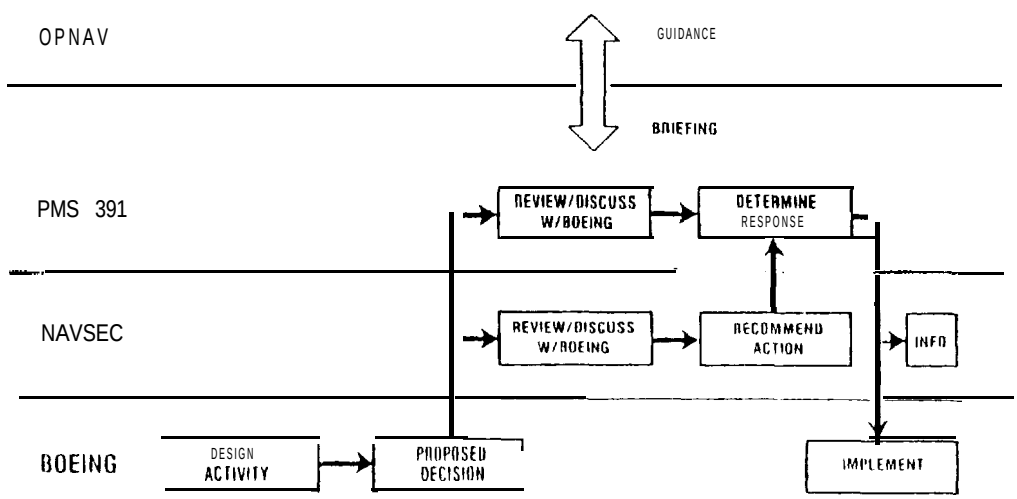
PROPOSED INTERFACE BETWEEN BOEING, SEC & SHIPS



Given the nature of the contract with Boeing and the pressure on the SHAPM to meet performance, cost, and delivery dates it was



ACTUAL INTERFACE BETWEEN BOEING, SEC & SHIPS



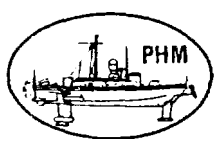
only realistic to expect a more prominent and involved SHAPM presence. However, the SHAPM did not establish a technical staff until the NATO Project Office, PMS 303, was established in 1973.

Relations between NAVSEC and PMS 391 deteriorated as a result of personalities in these organizations. Given to believe that it would have a leading role, NAVSEC not unexpectedly, experienced a cooling of project team enthusiasm when it found itself thrust into a role it perceived as purely advisory, and then one of a non-trusted advisor status. The contract technical management approach selected by the SHAPM also added measurably in that it created a situation wherein NAVSEC was always just behind the power curve even at full effort, so that even where the SHAPM had to make a decision for good reason before NAVSEC could respond, that logical and justifiable action aggravated the situation.

The apparent reason for the poor relationship that developed between NAVSEC and PMS 391/303 during the design and construction phase was the personalities--they did not mesh. There is no denying that. However, the problem was probably rooted in the organizational relationship of SEC and SHIPS in those days. The received roles and responsibilities of these organizations were not mutually shared. The generally held precept is that the SHAPM's prerogatives transcended all. The PHM problems in the respect were similar to other projects' experiences and reflect a universal problem of integrating the functional organization into the Project Manager's mainstream.

CONTRACT MANAGEMENT

The proposal received from the contractor was very much different than had been requested. The following excerpt from a contemporary NAVSEC trip report understates the problem.



NAVSEC **TRIP REPORT**
(MARCH 1972)

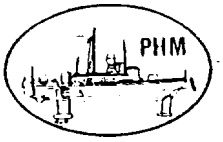
..."THERE HAVE BEEN SEVERAL DISCUSSIONS/CONFERENCES **ON** ITEMIZING A LIST OF CORL ITEMS WHICH BALANCES:

(a) THE CONTRACTOR'S **DESIRE** FOR MINIMUM DOCUMENTATION SO AS TO PROCEED INTO CONSTRUCTION AS SOON AS POSSIBLE

AND

(b) THE NAVY'S DESIRE FOR CONSIDERABLE DOCUMENTATION SO AS TO ENSURE THAT **DESIGN** DECISIONS ARE MADE IN THE BEST INTERESTS OF THE GOVERNMENT AND THAT THE SHIP CAN BE LOGISTICALLY SUPPORTED AND **MODERNIZED** OVER **ITS 15-YEAR** EXPECTED LIFE"

What we received is summarized on the next slide.



BOEING PROPOSAL

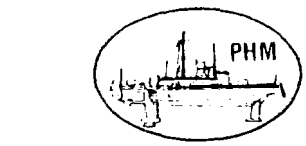
WHAT WE RECEIVED INSTEAD —

- COMPRESSED SCHEDULE
- LESS DOCUMENTATION (REPORTS)

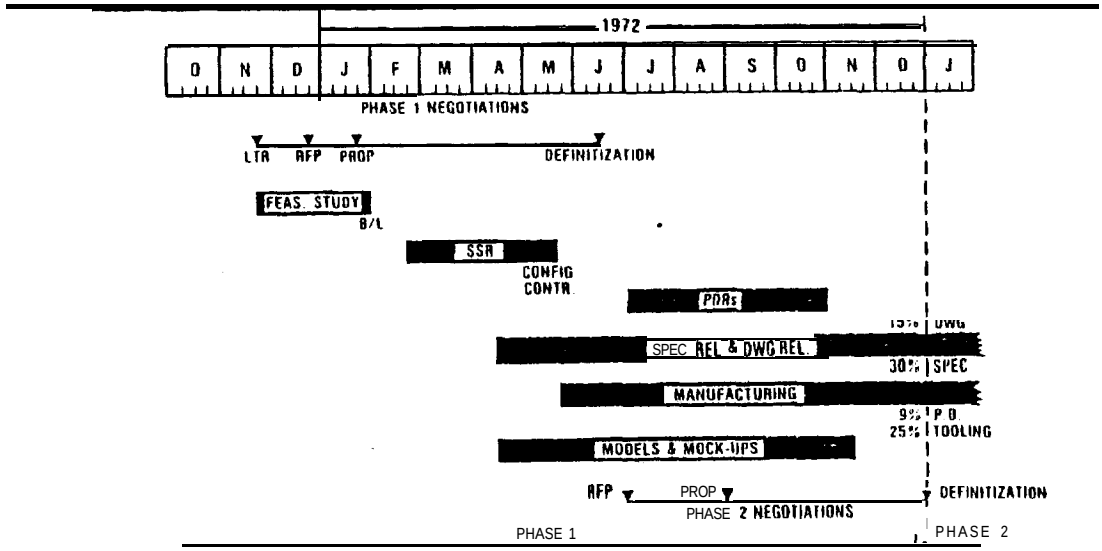
BUT

- ACCESS TO ALL INTERNAL BOEING TECHNICAL DOCUMENTS (500-600)
- DIFFERENT DESIGN CONTROL CONCEPT
  - MONTHLY PROGRAM REVIEWS
  - FOUR DECISION PAPERS
  - 20 PDRs
  - SSR/SSD

Boeing had been taken by surprise at the data requirements, level of decision control and participation specified by the RFP. Initial surprise gave way to grudging acceptance that the RFP requirements were logical. Nevertheless, the intention to maintain control on the Boeing side were evident in the proposal submitted as well in the design process that followed.

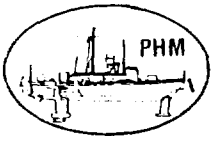


ORIGINAL BOEING SCHEDULE

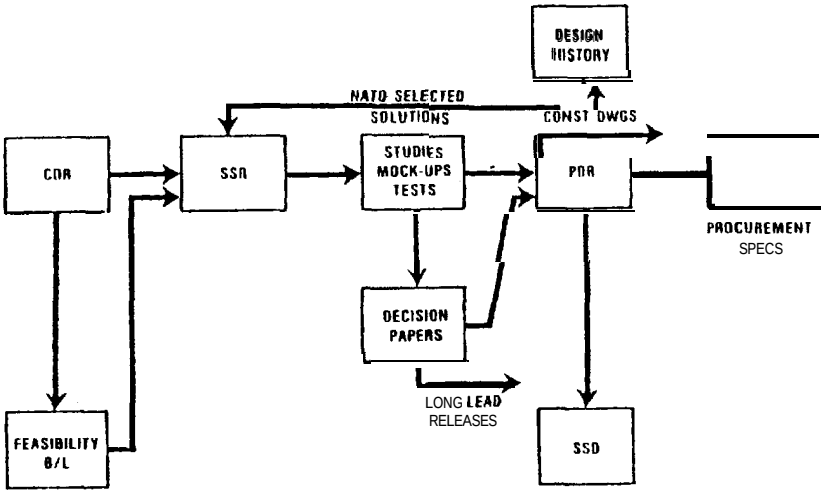


This slide depicts the schedule for the "construct while designing" proposal advanced by Boeing. This schedule is actually a lengthened version of the oroginal proposal, but it is the one that was current when Phase I was initiated. The original proposal had the PDRs completing by August 1972. Events were to extend completion of the PDR into December. Subsequent funding difficulties caused Phase I to extend through March 1973.

The design process proposed by the contractor is depicted on the following slide.

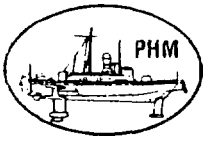


BOEING DESIGN PROCESS



The SSR was to be more definitive than the COR and once approved by the Navy it would come under Configuration *Control* and require a Class I ECP to change. The original plan envisioned that the SSR would be "in-place" as the controlling requirements document before the PDRs began. It didn't happen that way. The SSR was finally accepted by the Navy about the time the PDR phase was being completed. This was one source of problems encountered in conducting the PDRs -- namely requirements unclarity. The COR was a contractual document, but unless the COR and SSR were in agreement, Boeing would consider the requirements not defined and open game even though the COR stated a requirement.

The nature of the PDRs is described on this next chart. The use of PDRs and monthly design reviews is the approach that was apparently characteristic of the Boeing's Air Force Program management approach. There were a total of 20 that would be held. The contractor usually experienced



PRELIMINARY DESIGN REVIEW (PDR)

PURPOSE

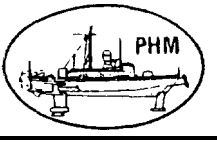
- COMPATIBILITY WITH REQUIREMENTS
- COMPATIBILITY WITH OTHER SYSTEMS/ FACILITIES
- DESIGN INTEGRITY

PROOUCT

- FORMAL IDENTIFICATION OF DOCUMENTS WHICH EST. **INTRASYSTEM** PHYSICAL INTERFACES

RESULT

- RELEASE OF SYSTEM DESIGN TO MANUFACTURING/PROCUREMENT

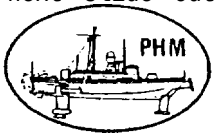


PDR SCHEDULE

1. SHIP SYSTEM I
2. HULL
3. AUXILIARY SYSTEM **PIPING**
4. **HYDRAULICS** SYSTEM
5. FUEL OIL
6. ECS AN0 NBC
7. OUTFIT AND FURNISHINGS
8. FOILS
9. **PROPULSION**
10. ARMAMENT
11. ELECTRIC PLANT
12. SHIP SYSTEM II
13. STEERING SYSTEM II
14. FIRE CONTROL
15. MACHINERY VENTING .
16. FIRE EXTINGUISHER
17. LUBE OIL
18. ANCHOR
19. COMMAND AN0 **SURVEILLANCE**
20. SHIP SVSTEM III

difficulty in providing the data packages as scheduled. Difficulty was experienced on the Navy side with getting its homework done, providing qualified participants and adequately preparing them. Given the key nature of these reviews, more pre-PDR contractor-government design reviews would have yielded invaluable benefits to both parties.

The next slide outlines the relationship between the SSD and the SSR.



REQUIREMENTS AND DESCRIPTION DOCUMENT RELATIONSHIPS

SSR (SHIP SYSTEM REQUIREMENTS)

(INCLUDES CONTRACT REQUIREMENTS ONLY)

TOP LEVEL SYSTEM REQUIREMENTS
- . TOTAL SYSTEM PERFORMANCE ENVIRONMENTS
- . SUBSYSTEM DEFINITION KEY CHARACTERISTICS

VERIFICATION
- TYPE OF VERIFICATION
- TEST CONDITIONS
- . PARAMETERS TO BE USED
- ACCEPTANCE CRITERIA

CHANGED ONLY BY ECP

SSD (SHIP SYSTEM DESCRIPTION)

TOTAL SVSTEM DESCRIPTION
- . INBOARD PROFILES
- . OUTBOARD PROFILES
- ARRANGEMENTS
- OPERATION
- PERFORMANCE

SUBSYSTEM DESCRIPTION
- . SCHEMATICS
- OPERATION
- COMPONENTS
- INSTALLATION
- KEY DETAILS
- PERFORMANCE

- TIE DESIGN SOLUTION TO REQMTS.
- ESTABLISH DESIGN CREDIBILITY
- ORIENTATION DATA FOR CUSTOMER COORDINATION

INTERNAL CONFIGURATION CONTROL UNTIL PHASE II

Note that the SSD never comes under configuration control and is an internal Boeing document. The detail, specifically, in the drawings is to a greater level of detail than the Navy generally reaches even in contract design.

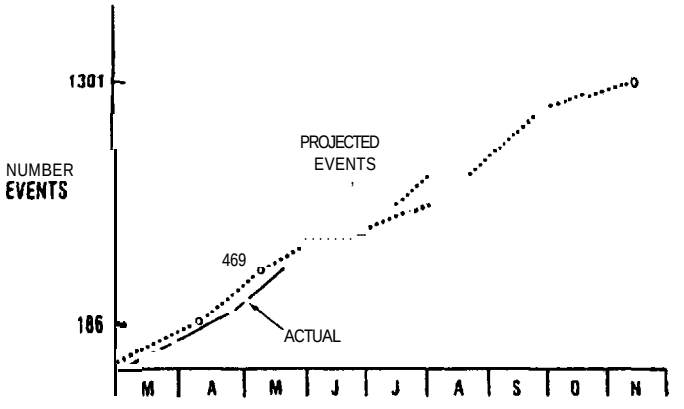
I mentioned earlier that the RFP required the contractor to submit flow charts depicting the flow and inter-dependencies of the various planned design activities. At each monthly progress review, one index of progress was a report on completion of activity shown on the flow charts. This slide

See page 35 for Slide 45

shows the form of the presentation. Slippage was converted to both cost and schedule impact. The large number of events soon burdened the update load to the point where these flow charts were no longer cost effective. A master event chart of considerably less detail would have been useful longer. The exercise of putting these charts together and then tracking status paid dividends in forcing Boeing to think out the design process in a systematic and visible manner "before not when or even after."

The contractor's proposed approach, although modified by the SHAPM to include four Design Decision Papers presented problems for the government in maintaining technical oversight and control of the developing design. The SHAPM, however, was faced with a limited budget and a tight schedule. The contractor statements that a 351 reduction in design costs was possible through deletion of technical data requirements, and a shorter design phase achievable following his approach were features of the Boeing proposal that the SHAPM could not ignore.

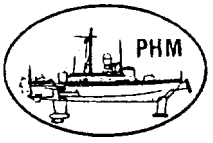
TOTAL PHM ENGINEERING EVENT STATUS SUMMARY — 30 DAY OUTLOOK



TOTAL PHM ENGINEERING EVENT STATUS SUMMARY — 30 DAY OUTLOOK

(CONTINUED)

CHART	NO. EVENTS TOTAL	TOTAL DUE THRU 5/18/72	TOTAL COMPLETE 5/18/72	NO. DELINQUENT	
				NO SCHEDULE IMPACT	SCHEDULE IMPACT
ALL CHARTS	1301	469	448	8	4
1.1	36	10	10	NONE	NONE
1.2	74	27	25	2	NONE
1.3	45	15	15	NONE	NONE
1.4-I-2-3	162	58	58	NONE	NONE
	167	63	63	NONE	NONE
1 561	72	14	12	NONE	2
1.566	57	24	23	1	NONE
1.6	52	22	22	NONE	NONE
1.7	74	25	2 s	HONE	HONE
1 E-I-2-3	215	9 3	8 7	4	1
3 o-1-2	11	13	1.3	NONE	NONE
5.0-I-2-3	276	9 6	95	1	NONE



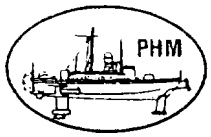
PROBLEM .

- CONTRACT MANAGEMENT APPROACH PROPOSED BY CONTRACTOR AND ACCEPTED BY SHAPM
- IMPLICITLY SHIFTED DESIGN DECISION ANALYSIS BURDEN TO GOVERNMENT
  - IN-HOUSE ALIENATION
  - DECREASED DESIGN CDNTROL
  - REDUCED EXPERIENCE TRANSFER

The government was seemingly always in a catch-up mode with less than adequate awareness of the contractor's reasons or substantiating analysis.

Although the government had really decided during the summer of 1971 to go Sole Source to Boeing, the concept of contract management was only vaguely outlined to Boeing prior to sending them the RF'P. NAVSEC had described their approach in some detail as ear-ly as the summer of 1971. However, apparently for contractual reasons, detailed discussions about matters pertaining to the contract terms, objectives and the degree of decision contract desired by the government were ruled out. Since Boeing was intent on preceeding unregulated, the lack of sounding-out opportunity prior to issuing the RFP ultimately complicated the government's ability to "control" the design.

Once the design began it became clear that there was indeed design experience which Boeing needed.



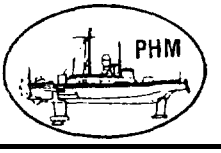
PROBLEM

- **CONTRACTOR'S LACK OF NAVY OPERATIONAL EXPERIENCE AND DESIGN PRACTICE**
- **EXPERIENCE TRANSFER/SHARING IMPEDED BY**
  - SCHEDULE PACE/COMPRESSION
  - "DO IT" THEN "WRITE IT UP" APPROACH OF BOEING
  - DISTANCE BETWEEN SEC AND BOEING
  - BOEING NIH (MOSTLY AT MANAGEMENT LEVEL)
  - "CORPORATE" KNOWLEDGE NOT DOCUMENTED

As this slide indicates, the government faced problems infusing their experience into the program. If the Navy's Corporate design practices and criteria had been available to and discussed with Boeing before the design, the problem would have been lessened.

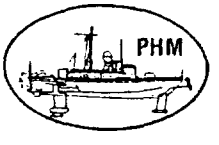
One key to the limited success in staying abreast of the design and participating in the decision process was the constant dialogue between the NAVSEC design team members and their counterparts at Boeing. Phone communications was enhanced by a 24-hour, 7-day-a-week facsimile machine hookup and travel was unrestricted.

The NAVSEC man-day effort amounted to about 3% of the NAVSEC engineering work force at peak levels. It is difficult to find meaningful comparisons in other NAVSEC design efforts. The Saudi Arabian PGG-1 is the closest in size. Both took similar calendar periods of time.



PHM-PGG COMPARISON

	PHM-1	PGG-1 (SAUDI ARABIA)
DISPLACEMENT	231	376 t
LOA	131	190 ft
BEAM	28	27 ft
SPEED	40+ (F/B) 11 (H/B)	30+ KNOTS (GT) 18 KNOTS (DIESEL)
WEAPONS	76mm OTO MELARA HARPOON (8) FCS MK 92 CHAFF LAUNCHERS	76mm OTD MELARA HARPOON (4) 20mm (2) 40mm (1) 81mm MORTOR TDS MK 24 FCS MK 92



PHM-PGG COMPARISON

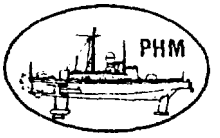
	PHM-1	PGG-1
DESIGN AGENT	BOEING	NAVSEC
NAVSEC MANPOWER EXPENDITURES (PRELIMINARY AND CONTRACT DESIGN		
IN-HOUSE	4,539 MANDAYS	8,707 MANDAYS
OTHER GOV'T ACTIVITIES	856 MANDAYS	3,178 MANDAYS
CONTRACTORS	1.506 MANOAYS	6,299 MANOAYS
NAVSEC PRODUCT	TECHINCAL CONSULTANTS	SPECIFICATIONS AND DRAWINGS

CONCLUSIONS

Even though the PHM design was unique because of existing circumstances, there are some conclusions that can be drawn in respect to in-toto farm-out designs.

- Frequent contract (preferably fact-to-face over the contractor's drawing boards) between NAVSEA systems design leaders and their counterparts in the contractor's organization is critical. However, the number of people on either side must be limited. This creates a greater need for systems competent people for farm-out than perhaps for in-house design.
- Planning is even more important than for in-house design effort and requires considerably more homework to do it well. You need to have been there before to judge the product. Wherever possible, the contractor(s) should be involved/aware of the planning decisions.
- The RFP and the final contract must contain clearly defined mechanisms for timely control of the design through active rather than reactive participation.
- The purpose in farming out the design should be clearly understood by both in-house and contractor. How the internal functional organization's normal peragotives/authorities may be affected by the farm-out decision needs to be addressed well before the design begins. If the design is being farmed out to reduce workload, the approval process should not be structured to then require almost all the people to participate who were supposedly too busy to do the design in the first place. Consideration should be given to assigning accountability to a small interdisciplinary project engineering firm.
- The Achilles heel in the farm-out question usually is the contractor's lack of knowledge with regard to Navy design practice and operational experience. Transferring this only via face-to-face contact is impractical. Such contact is critical but it would be more effective if the Navy's

design practice and criteria were previously available to the contractor. Successful farm-out requires the up front availability of documentation of Corporate practice and experience. Otherwise the problem is playing catch-up throughout the design.



DESIGN AND TECHNOLOGY EXPERIENCE MANUAL

PERTINENT DESIGN AND TECHNOLOGY EXPERIENCE FROM THE AALC AND RELATED PROGRAMS.

- RECOMMENDED DESIGN CRITERIA, PROCEDURES, MARGINS AND SAFETY FACTORS WITH RATIONALE.
- SUMMARIES OF AALC AN0 LCAC DESIGN STUDIES WITH EMPHASIS ON “LESSONS LEARNED”.
- APPLICABLE TECHNOLOGY EXPERIENCE ASSESSMENT.
- ASSESSMENT OF APPLICABLE MILITARY AND COMMERCIAL SPECS.
- SUMMARY OF APPLICABLE DESIGN EXPERIENCE OTHER THAN AALC (BHC. SES, ETC.).