

SHIP PRODUCTION COMMITTEE  
FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

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# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **Proceedings of the REAPS Technical Symposium**

### **Paper No. 24: Implementing IHI Technology at Avondale**

U.S. DEPARTMENT OF THE NAVY  
CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

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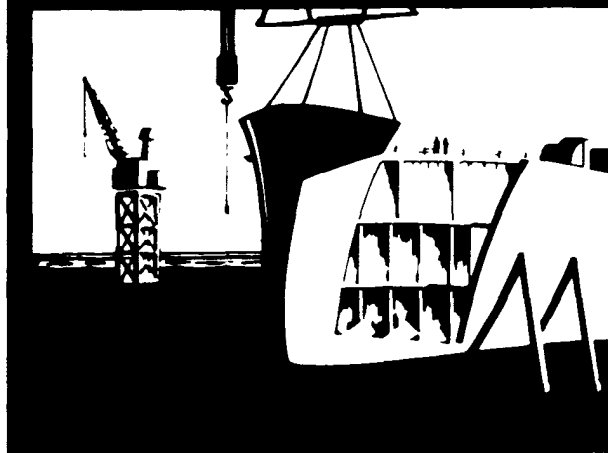
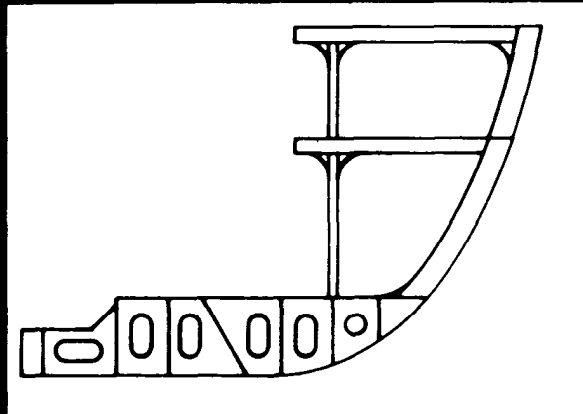
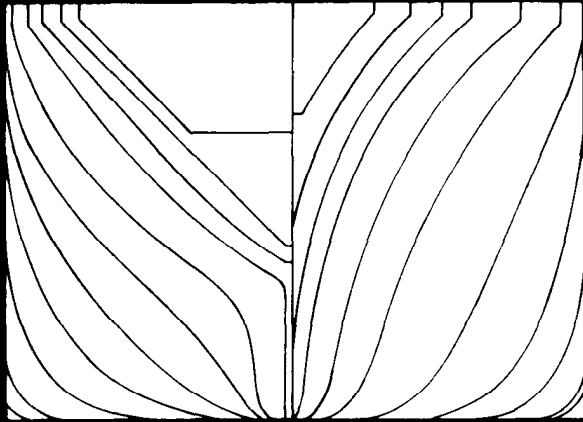
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FOR  
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AND  
PRODUCTIVITY  
IN  
HIPBUILDING

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## **IMPLEMENTING IHI TECHNOLOGY AT AVONDALE**

**Charles J. Starkenburg  
Vice President, Planning and Scheduling  
Avondale Shipyards Inc  
New Orleans, Louisiana**

**Mr. Starkenburg is in charge of all planning and scheduling for prebid and postcontract ship construction. He is also responsible for all preoutfitting and hull planning, and for implementation of all IHI technology transfer.**

### **ABSTRACT**

**This is a presentation of basic advantages, successes, and problems experienced with the introduction of IHI technology into an American shipyard. Fundamental and historical patterns that must change in order for this technology to be completely successful are discussed.**

## IMPLEMENTING IHI TECHNOLOGY AT AVONDALE

IN MAY, 1979, A FIRM DECISION WAS MADE BY MANAGEMENT AT AVONDALE SHIPYARDS TO ENGAGE THE SERVICES OF IHI MARINE TECHNOLOGY, INC. FOR A COMPREHENSIVE SURVEY OF OUR ENGINEERING AND PRODUCTION METHODS.

THE SURVEY COMMENCED ON AUGUST 29, 1979 AND COMPLETED ON OCTOBER 2. THE SURVEY WAS CONDUCTED BY SEVEN (7) MEMBERS FROM IHI.

A PRELIMINARY REPORT WAS GIVEN TO SHIPYARD MANAGEMENT ON OCTOBER 1, AND ON THE BASIS OF THE PRELIMINARY FINDINGS, IT WAS DECIDED THAT FURTHER TECHNOLOGY EXCHANGE WOULD BE BENEFICIAL IN ORDER TO:

- (1) IMPROVE CONTRACT DELIVERY TIME,
- (2) SHORTEN HULL CONSTRUCTION PERIODS,
- (3) REDUCE ENGINEERING AND LABOR COSTS.

A PROPOSAL FOR SERVICES FROM IHI MARINE TECHNOLOGY, INC. WAS THEN REQUESTED. THE PROPOSAL WAS SENT TO AVONDALE IN NOVEMBER 1979 AND CONSISTED OF THE FOLLOWING:

- (1) ASSISTANCE IN ACCURACY CONTROL FOR A PERIOD OF THREE (3) MONTHS USING ONE (1) ENGINEER,
- (2) ASSISTANCE IN PRODUCTION HULL PLANNING AND PRODUCTION OUTFITTING PLANNING FOR A PERIOD OF SIX (6) MONTHS WITH TWO (2) ENGINEERS.
- (3) ASSISTANCE ON COMPUTER APPLICATION FOR A PERIOD OF TWELVE (12) MONTHS WITH ONE (1) ENGINEER.

IT WAS DETERMINED THAT THE STUDY AND EXCHANGE EFFORT WOULD BE DEVOTED TO A MAXIMUM OF TWO (2) CONTRACTS:

(1) A THREE (3) VESSEL CONTRACT FOR CONTAINER SHIPS.

(2) A SINGLE VESSEL CONTRACT FOR A HOPPER DREDGE.

SOME PROBLEMS WE FOUND, FOR EXAMPLE, WERE VERY BASIC BUT ARE, OF COURSE, HISTORICALLY WELL KNOWN TO AMERICAN SHIPBUILDING. AS AN EXAMPLE, THE LENGTH OF DESIGN TIME! COMPARED TO TOTAL CONTRACT TIME, DESIGN TIME IS EXCESSIVE.

WHEN THIS IS RELATED TO IHI DESIGN VERSUS CONTRACT TIME, IT BECOMES EVIDENT THAT THE DIFFERENCES REPRESENT A SERIOUS CHALLENGE TO AMERICAN SHIPBUILDERS.

EACH AMERICAN SHIP OR VESSEL IS MORE OR LESS A CUSTOM BUILT ENTITY. DESIGN CHANGES OCCUR VERY FREQUENTLY AFTER CONTRACT DUE TO REQUIREMENTS FROM OWNERS AND REGULATORY BODIES. ANOTHER BASIC PROBLEM IS RESOLUTION OF VENDOR INFORMATION AND EVALUATION OF TECHNICAL DATA ON GUIDANCE AND CONTRACT DRAWINGS FROM SHIP OWNERS, CONSULTANTS AND NAVAL ARCHITECTS. IT OFTEN IS UNCLEAR AND REQUIRES MUCH IN MAIL TIME TO CLARIFY.

THE IHI RECOMMENDED PROCEDURES DEVELOPED FOR AVONDALE SHIPYARDS WORK TOWARD A FINAL DESIGN DURATION OF EIGHT (8) MONTHS FOR FUTURE SHIPS. THIS REQUIRES MUCH MORE UP FRONT EFFORT PRIOR TO CONTRACT SIGNING. IT ALSO MEANS A TIGHTER, MORE EXPENSIVE AND LENGTHIER COOPERATIVE EFFORT BETWEEN PRODUCTION PLANNING, MARKETING AND SHIP OWNERS PRIOR TO BIDDING OR NEGOTIATING THE CONTRACT.

IN ADDITION TO THE EARLIER ON EFFORT, MANY STRUCTURAL CONNECTIONS AND BRACKETS ARE NOW PLANNED TO BE MADE STANDARD AND PRE-APPROVED BY CLASSIFICATION SOCIETIES, SO THAT THEIR USE WILL ELIMINATE THE LENGTHY TIME APPROVAL NECESSARY IN THEIR INCORPORATION ON FUTURE CONTRACTS.

PROBLEMS ALSO DIFFICULT TO RESOLVE ARE PROCURED ITEMS; SUCH AS **MACHINERY**, MISC. EQUIPMENT AND CRITICAL MATERIALS.

IT ACCOMPLISHES LITTLE TO SHORTEN DESIGN AND HULL CONSTRUCTION TIME IF EQUIPMENT AND MATERIAL DELIVERIES ARE LATE OR UNDEPENDABLE.

TO CUT OPENINGS IN THE COMPLETED HULL FOR LATE EQUIPMENT INSTALLATION, WHEN USING THE IHI TECHNOLOGY, ONLY MEANS THE JOB IS COMPLETELY OUT OF PHASE.

AN EFFORT IN PROGRESS TO ALLEVIATE THIS PROBLEM IS THE ADOPTION OF A MATERIAL AND MANUFACTURING STANDARDS CATALOG AND HAVING THESE STANDARDS APPROVED BEFORE OR AT CONTRACT SIGNING BY OWNER AND CLASSIFICATION SOCIETIES.

IT IS ESSENTIAL IN DEVELOPING MACHINERY AND EQUIPMENT STANDARDS TO ALSO MAKE VENDORS STANDARDS PROFITABLE TO THE VENDOR BY PROVIDING A LIMIT TO THE VARIETY OF TYPES, SIZES AND MATERIALS USED. THE TIME FRAME FOR PROCUREMENT CAN THUS BE SHORTENED. STANDARDS DO NOT REQUIRE EXTENSIVE COMMUNICATIONS WITH VENDORS AND OWNERS TO FINALIZE A SPECIFICATION. ONE GOOD REASON FOR RECOMMENDING THE USE OF STANDARDS IS A PASS ON BENEFIT SHARED BY THE SHIPOWNER AND A FASTER DELIVERY TIME FOR HIS VESSEL.

SPECIFIC EFFORTS UNDER WAY, NOW, AT AVONDALE, ARE AS FOLLOWS:

- (1) WE INTEND TO CONSISTENTLY PURCHASE SIMILAR EQUIPMENT FROM THE SAME VENDOR INsofar AS POSSIBLE AND THEREBY HOPE TO GAIN THEIR CONFIDENCE IN US AS A FUTURE CUSTOMER AND AN INCREASED INTEREST ON THE PART OF THE VENDOR'S MANAGEMENT.
- (2) WE ARE DEFINING THE VENDOR REQUIREMENT FOR EQUIPMENT IN THE ADVANCED PROGRAMS GROUP NOW IN SUFFICIENT PRE-BID DETAIL TO ALLOW THE PURCHASING DEPARTMENT TO PLACE ORDERS IMMEDIATELY UPON RECEIPT OF A CONTRACT.

THE STUDY OF DRAWINGS REVEALED PROBLEMS THAT MANY SHIPYARDS HAVE HAD OVER THE YEARS.

WORKING DRAWINGS HAVE HISTORICALLY BEEN OF A LARGE SIZE AND FILLED WITH A MULTITUDE OF INFORMATION TO SATISFY EVERYONE. THIS HAS LED TO A COMPLEX AND SOMETIMES HARD TO DECIPHER DOCUMENT THAT BECOMES VERY DIRTY AND TORN DURING CONSTRUCTION USE.

UNDER RECOMMENDATIONS BY IHI, TODAY THIS SITUATION IS CHANGING. QUOTING WORDS FROM MR. OGAWA OF IHI (quote) "AFTER DIGITAL COMPUTER SYSTEMS ARE INTRODUCED IN THIS FIELD, THE WORKING DRAWINGS WILL BE CHANGED TO BE DRAWN LESS GEOMETRICALLY AND MORE NUMERICALLY. COMPUTER PROGRAMS ACCEPT ONLY NUMERICAL DATA, AND SINCE HULL STRUCTURES, MACHINERY, PIPES AND OTHER ITEMS ARE INDICATED BY NUMERICAL SIZES, THE NECESSITY FOR GEOMETRICAL ACCURACY IS COMPARATIVELY REDUCED.

MORE MANHOURS ARE REQUIRED TO PRODUCE GEOMETRICALLY ACCURATE DRAWINGS, BECAUSE ON GEOMETRICAL DRAWINGS ALL AREAS MUST BE ACCURATE, WHILE ON NUMERICAL DRAWINGS ONLY MAJOR POINTS MUST BE ACCURATE." (unquote)

WORKING DRAWINGS IN THE NEAR TERM WILL BE OF A CONVENIENT SIZE AT AVONDALE SINCE THEY WILL BE FOR SHIPYARD USE ONLY. THEY WILL BE ISSUED ON A "NEED TO KNOW" BASIS SIZED ACCORDING TO PACKAGE, UNIT SUB ZONE OR ZONE. BASICALLY, ONE WORKING DRAWING WILL CORRESPOND TO ONE GROUP OF JOBS CALLED (A PALLET). IT WILL INCLUDE ALL MATERIALS -HANDLED AT ONE WORKING STAGE, IN ONE ZONE AND AT ONE TIME.

DRAWINGS WILL BE SIMPLIFIED, USING WHAT IS TERMED SYMBOLIC LOGIC. SYMBOLIC LOGIC IS USED TO REPLACE AND CLEAR THE DRAWING OF MISCELLANEOUS DETAILS. THESE DETAILS HAVING BEEN ESTABLISHED AS STANDARDS THROUGHOUT THE ENTIRE SHIPYARD, AND REPLACED BY SYMBOLS.

BY EARLY NEXT YEAR, AVONDALE WILL HAVE IN THE FIELD ALL DRAWINGS FOR THE HULL PRE-FAB, SUB-ASSEMBLY, ASSEMBLY AND ERECTION OF THE A.P.L. CONTAINER SHIP CONTRACT. THIS GROUP OF DRAWINGS WILL BE CALLED THE UNIT CONTROL MANUAL:

THESE DRAWINGS WILL BE BY PROCESS STAGE OF CONSTRUCTION AND NO DRAWING WILL MEASURE OVER 8½" x 17", YET IT WILL HAVE ALL THE INFORMATION NECESSARY FOR CONSTRUCTION. THE SAME IS BEING DEVELOPED FOR PIPING, PACKAGE UNITS, ZONE AND SUB-ZONE ON-BOARD OUTFITTING.

ONE OF THE FIRST STUDIES TO BE RECOMMENDED AND IMPLEMENTED WAS ACCURACY CONTROL.

TO THIS END, A QUALIFIED AVONDALE ENGINEER WAS PLACED IN CHARGE OF AN ACCURACY CONTROL GROUP. IN MARCH 1980, WITH THIS GROUP AND WITH IHI ENGINEERS, A PILOT PROGRAM WAS RUN ON A NUMBER OF UNITS SELECTED FROM A SINGLE SHIP IN CONSTRUCTION. GROUND RULES WERE ESTABLISHED AND TAUGHT TO VARIOUS FRONT LINE SUPERVISORS.

SEVERAL COMPLETED ASSEMBLIES WERE DIMENSIONED BY IHI METHODS AND THE INACCURACIES WERE LOCATED AND CORRECTED. SINCE APRIL 1980, MOST EFFORTS HAVE GONE INTO THE PRE-FABRICATION AND PANEL LINE SHOP. ACCURACY CONTROL SHEETS WERE SET UP AS A STANDARD FEEDBACK AND INFORMATION FORM. PIECES WERE CHECKED ON A PERCENTAGE BASIS, THAT IS; IF 20 OUT OF 20 PIECES WERE FOUND TO BE INACCURATE, THEN 100% OF THESE PIECES WERE CHECKED UNTIL THE PERCENTAGES DROPPED. IF THE INACCURACIES DROPPED OR OCCURRED ONLY 1 OUT OF 20 PIECES, THEN ONLY 5% OF THESE WERE INSPECTED.

THIS GROUP NOW OPERATES ON A CONTINUOUS BASIS IN THE SHOP WITH MINIMUM SUPERVISION FROM IHI.

SINCE INITIATING ACCURACY CONTROL IN THE PRE-FABRICATION AND PLATE SHOP, THE ACCURACY HAS IMPROVED DRAMATICALLY, AND THE GROUP IS NOW READY TO EXPAND INTO OTHER AREAS OF FABRICATION AND ASSEMBLY AS PROCESS LANES ARE DEVELOPED.

PHYSICAL SHIP CONSTRUCTION STARTS WITH THE STEEL PRE-FABRICATION, SUB-ASSEMBLIES, UNIT ASSEMBLY AND ERECTION OF THE HULL. GROSS HULL CONSTRUCTION IS ROUGHLY BROKEN DOWN INTO THE FOLLOWING PERCENTAGES.

IN THIS REGARD, AVONDALE AND IHI ARE NOW COMPLETING A STUDY AIMED AT RE-ORGANIZING THE VARIOUS YARD PLATENS AND STEEL WORK CENTERS INTO MANUFACTURING PROCESS LANES CAPABLE OF ASSEMBLING 8000 TONS OF STEEL PER MONTH. PROCESS LANE PARAMETERS FOR TONNAGE FLOW IS BEING CALCULATED BY AREA AS SHOWN IN THESE LAYOUTS: FIRST, BY SHARE CATEGORIES;<sup>④</sup> SECOND;<sup>⑤</sup> BY THE WEIGHTED PERCENTAGE OF EACH CATEGORY BY SHAPE PROJECTED ON A DESIRED THROUGH PUT OF 8000 TONS PER MONTH; THIRD,<sup>⑥</sup> BY A RELATIONSHIP BETWEEN THE TOTAL UNIT WEIGHT ASSEMBLED AND THE AREA FOR EACH BAY USING FOR COMPARISON A THROUGH PUT OF 7,000 TONS A MONTH EXPERIENCED AT IHI. PRODUCTION AREA FLOW RATES AT IHI ARE TWICE AMERICAN RATES. TARING INTO ACCOUNT GREATER WORKER EXPERIENCE AND THE FACT THAT MORE AREAS IN JAPAN ARE UNDER ROOF,<sup>⑦</sup> THE FOLLOWING CALCULATION IS PROJECTED FOR AVONDALE. A TONNAGE FLOW OF 8,000 TONS PER MONTH FOR OUR YARD IS ESTIMATED TO NEED AN AREA BREAKDOWN AS SHOWN, WITH THE FIGURES IN PARENTHESSES SHOWING IHI'S RATIO. USING THIS BREAKDOWN AS A GUIDE, THE EXISTING AVONDALE PLATENS SEEM MORE THAN ADEQUATE FOR THE INCREASE IN TONNAGE FLOW. THIS MEANS, OF COURSE, LITTLE OR NO CAPITAL INVESTMENT REQUIRED FOR ADDITIONAL AREA. SOME CAPITAL WOULD BE REQUIRED, OF COURSE, FOR CONVEYORS OR OTHER DESIRED MECHANICAL AIDS FOUND TO BE NECESSARY. THIS WILL VARY SOMEWHAT WITH THE TYPE OF VESSEL AND TYPE OF CONSTRUCTION USED.

THE STUDY IS SCHEDULED TO COMPLETE BY MIDDLE OCTOBER AND IS CONSIDERED TO BE A MOST IMPORTANT AND VITAL STEP TO NOT ONLY REDUCE HULL COSTS BUT IN ESTABLISHING DESIGNATED AREAS AND LANES FOR CONTROL OF MATERIAL AND DETERMINING PRE-OUTFITTING STAGES. THE IMPLEMENTATION OF THIS STUDY IS EXPECTED TO DEVELOP OVER A PERIOD OF 8 TO 12 MONTHS.

PIPING INSTALLATIONS IN SHIPBUILDING REPRESENT A VERY EXPENSIVE EFFORT IN MATERIAL AND LABOR. PIPING IS THE SECOND MOST COSTLY ITEM IN SHIP CONSTRUCTION AT AVONDALE.

AS A MATTER OF PRACTICE, UP UNTIL RECENTLY, THE ENGINEERING DEPARTMENT AT OUR YARD HAD LIMITED ITS PIPING DETAIL SKETCHES OF PIPE PISCES TO ONLY THOSE SIZES OF PIPE 2" AND ABOVE. THIS MADE THE PRODUCTION PIPE DEPARTMENT RESPONSIBLE FOR FIELD RUNNING PIPING UNDER 2", GENERATING A TENDENCY TO CREATE INTERFERENCE PROBLEMS. MUCH DECISION MAKING BY FRONT LINE SUPERVISORS AND MIDDLE MANAGEMENT FOREMEN ALSO RESULTS IN COSTLY MARKING, CUTTING, BENDING AND FABRICATION ON THE JOB SITE INSTEAD OF CONVENIENTLY IN THE SHOP.

ON RESEARCHING VARIOUS TYPES OF VESSELS, IT WAS FOUND THAT PIPE PIECES BELOW 2" IN SIZE REPRESENT APPROXIMATELY 50% OF THE TOTAL AMOUNT OF PIPE PIECES IN A VESSEL. AN 1,800 UNIT CONTAINER SHIP, FOR EXAMPLE, BUILT AT IHI HAS A TOTAL OF 13,047 FABRICATED PIPE PIECES, APPROXIMATELY 6,950 OF WHICH ARE UNDER 2".

AS YOU CAN SEE, THE AMOUNT OF PIPE PIECES BELOW 2" CAN BE A CONSIDERABLE NUMBER. ON THIS BASIS, IT HAS BEEN DECIDED TO ENGINEER AND FABRICATE MOST PIPE PIECES DOWN TO AND INCLUDING ½" SIZES. THESE PIPE PIECES DRAWN BY "CADAM" WILL APPEAR NOT ONLY AS SKETCHES, BUT SKETCHES THAT INCLUDE MATERIAL SPECIFICATIONS, JOB ORDER, PALLET NUMBERS, PLANNING ROUTINES, ROUTING AND COATING

OR FINAL TREATMENT SPECIFICATIONS. THE PERTINENT INFORMATION WILL BE TRANSLATED TO THE SHOP MANAGEMENT CODES AND STORED IN THE COPIES SHOP MANAGEMENT SYSTEM FOR SEMI-AUTOMATED PIPE SHOP MANUFACTURING. PIPING, AS A RESULT OF IHI ZONE OUTFITTING TECHNIQUES, IS NO LONGER FABRICATED IN OUR YARD BY ENTIRE SYSTEMS BUT BY PALLET, PRE-OUTFIT UNIT AND ZONE SCHEDULES.

THIS WILL REDUCE CONSIDERABLY THE AMOUNT OF FABRICATED PIPE PIECES THAT GENERALLY TAKE UP INACTIVE STORAGE SPACE. IT ALSO LENDS ITSELF TO A MUCH MORE EFFICIENT SHOP MANAGEMENT SYSTEM WITH PIPE PIECES BEING PALLETIZED FOR DESIGNATED FINAL TREATMENT OF PRE-OUTFIT AND ZONE LOCATION.

MUCH HAS BEEN ACCOMPLISHED AT THIS POINT IN THE MANUFACTURING OF PACKAGE UNITS AND ON UNIT OUTFITTING AT AVONDALE. ON THE A.P.L. CONTAINER SHIPS, FOR INSTANCE, A TOTAL OF FORTY-ONE (41) MACHINERY PACKAGE UNITS HAVE BEEN DEVELOPED. THIS DOES NOT INCLUDE THOSE ENTIRE UNITS THAT ARE VIRTUALLY PACKAGES IN THEMSELVES.

THE DRAWINGS PRODUCED BY ENGINEERING IN THE DESIGN OF THESE PACKAGE COMPONENTS ARE A COMPOSITE OF THE COMBINED IDEAS OF ENGINEERING, PRODUCTION PLANNING AND THE PRODUCTION FIELD. THUS THEY REPRESENT A CONSENSUS OF THE MOST DESIRABLE CONSTRUCTION METHODS.

WEEKLY MEETINGS TAKE PLACE ON EACH JOB WITH EACH DEPARTMENT REPRESENTED BY A WORKING MEMBER. DRAWINGS ARE DISCUSSED EARLY IN THEIR DEVELOPMENT AND, IF SEEN NECESSARY, ARE CHANGED TO THE OPTIMUM CONSTRUCTION METHODS. PIPING IS REROUTED IF REQUIRED. PRODUCTION IDEAS ARE INCORPORATED INTO WORKING DRAWINGS 'WHENEVER POSSIBLE.

THESE MEETING ALSO SERVE AS THE FEEDBACK FORUM FROM THE FIELD FOR DRAWING CORRECTIONS AND MODIFICATIONS.

PRE-OUTFITTING ON UNIT AND ON BOARD IS PROBABLY THE MOST RECOGNIZED TECHNIQUE AT THIS PARTICULAR TIME IN OUR YARD. THE REASON FOR THIS IS THAT IT IS THE MOST VISIBLE AND MOST EASILY UNDERSTOOD BY THE WORK FORCE.

THE BENEFITS AND ADVANTAGES OF UNIT AND ZONE OUTFITTING ARE MOST APPARENT TO THE EMPLOYEE AND FRONT LINE SUPERVISOR PERFORMING THE WORK. THE FACT THAT HE IS ABLE TO PRE-OUTFIT IN FRESH AIR AND GOOD LIGHTING, THOSE ITEMS HE PREVIOUSLY HAD TO DO IN CLOSED TANKS AND POOR VISIBILITY, SHOW HIM INSTANT PRACTICAL ADVANTAGES FOR ADOPTING THE SYSTEM.

THE IMPROVED SAFETY CONDITIONS AND LESS OF A COMPETITIVE STRUGGLE FOR FACILITIES SHOW HIM PERSONAL ADVANTAGES FOR ITS ADOPTION.

AS IN ALL MANUFACTURING, SOME PARAMETERS MUST BE USED TO GAGE THE EFFECTIVENESS OF THE METHODOLOGY BEING USED.

IN THE CASE OF PRE-OUTFIT PLANNING AND ZONE OUTFITTING, THERE ARE SEVERAL MEANS TO EVALUATE PERFORMANCE. ONE IS TONNAGE OF PRE-OUTFIT ITEMS INSTALLED PRIOR TO REEL LAYING, . ERECTION AND LAUNCH. THIS METHOD IS POPULAR AT IHI.

THE METHOD TENTATIVELY BEING CONSIDERED BY AVONDALE IS TOTAL MANHOURS OF OUTFITTING PRIOR TO REEL AND TOTAL MANHOURS PRIOR TO LAUNCH VERSUS TOTAL MANHOURS OF OUTFITTING AFTER LAUNCH TO DELIVERY. THIS WILL COMPARE TO A PAST PERFORMANCE BASE TAKEN FROM APPROXIMATELY **TWENTY (20)** VESSELS. THE MEASURED PERFORMANCE WILL BE ARRIVED AT AS A PERCENTAGE GROWTH OF OUTFITTING BEING ACCOMPLISHED PRIOR TO KEEL AND LAUNCH. THIS APPROACH OF GAGING PERFORMANCE PROGRESS WILL BE USED UNTIL A MORE SOPHISTICATED METHOD CAN BE ESTABLISHED FROM HISTORICAL DATA ON A WEIGHT BASIS.

IN ALL OF THIS, IT IS MOST IMPORTANT TO SERIOUSLY CONSIDER SCHEDULING. SCHEDULING IS THE DISCIPLINE THAT STITCHES EACH OPERATION TOGETHER IN ITS PROPER ORDER. EACH DEPARTMENT, FROM ADVANCED PROGRAMS, THRU ENGINEERING, DOWN TO PRODUCTION, HAS SCHEDULE RESPONSIBILITY. THESE RESPONSIBILITIES FOLLOW PRECISE TIME PATTERNS OF WHAT IS TO BE ACCOMPLISHED WITHIN DESIGNATED TIMEFRAME. ⑨

SHOWN HERE IS AN EXAMPLE OF TIME SCHEDULING AT AVONDALE BY DEPARTMENT AS IT RELATES TO HULL PROGRESS FROM MARKETING THRU DESIGN AND ENGINEERING TO MOLD LOFT. RESPONSIBILITIES OF THIS CHART ARE ONLY BRIEFLY DEFINED BECAUSE OF CHART SIZE.

CERTAIN INFORMATION, AS YOU CAN SEE, MUST BE DEVELOPED AND CONSOLIDATED FOR ISSUING IN TIME FOR THE PRE-PLANNED MEETING DATES INDICATED BY "CONTRACT", "K", "B" AND SO FORTH. ⑩

FROM THIS IS DEVELOPED A "TREE STRUCTURE OF SCHEDULES" THAT INCLUDE FABRICATION, OUTFITTING AND TESTING. THIS IN TURN BREAKS DOWN ALL WORK EFFORT INTO DETAIL SCHEDULES FOR EXECUTION. PARTICIPATION EFFORT IN MAKING THESE SCHEDULES ORIGINATES ALL THE WAY FROM FRONT LINE FOREMEN AND MECHANICS TO MIDDLE AND UPPER MANAGEMENT.

IT IS EXTREMELY IMPORTANT THAT SCHEDULES BE:

- (A) REALISTIC - THAT IS TO SAY SAFELY WITHIN THE FACILITY AND PERSONNEL MAXIMUM LOADING, CAPABILITY.
- (B) RECOGNIZED - THIS MEANS THEY ARE OFFICIAL DOCUMENTS OF TOP MANAGEMENT AND CAN ONLY BE CHANGED BY TOP AUTHORITY.
- (C) RESOLUTE - THIS INDICATES THEY ARE REGARDED BY ALL EMPLOYEES AS STEADY AND DETERMINED WORK GUIDES.

AS OF SEPTEMBER 15, 1980, THERE ARE MANY MAJOR EFFORTS BEING

STUDIED AND CONSIDERED FOR IMPLEMENTING AT AVONDALE SHIPYARDS.

TIME CONSTRAINTS PREVENT ME FROM FURTHER DETAILING OF OUR TOTAL EFFORT IN THOSE AREAS NOW BEING STUDIED, RECOMMENDED OR CONSIDERED FOR IMPLEMENTING. THE THIRTY-ONE (31) MONTH MILESTONE DEVELOPED BY AVONDALE DOES NOT PRETEND TO COMPLETE IN 2½ YEARS WHAT TOOK APPROXIMATELY 18 YEARS TO ACCOMPLISH AT IHI. IT IS ONLY AN INITIAL INCREMENTAL TIME MEASUREMENT ALONG THE WAY.

CHANGES SHOULD COME SLOWLY, AND PARTICULARLY WITH CHANGES IN ORGANIZATION STRUCTURES. THIS IS TRUE WITH ANY DEPARTURE FROM TRADITIONAL METHODS.

SHIPBUILDING, USING THIS PARTICULAR PHILOSOPHY, NEEDS COOPERATIVE ACCEPTANCE BY MANAGEMENT, THE WORK FORCE AND SUPERVISORS FOR ITS SUCCESSFUL EVOLUTION. THIS SEEMS LESS A PROBLEM IN JAPAN WITH JAPANESE WORKERS SINCE THEIR SOCIAL AND TRADITIONAL CUSTOMS HAVE ALWAYS DIRECTED THEM TO THIS OBJECTIVE.

WITH THE AMERICAN WORKER, WE HAVE A MUCH DIFFERENT SITUATION. HIS SOCIAL AND TRADITIONAL CUSTOMS ARE NOT THE SAME. HIS EDUCATION VALUES ARE INDEPENDENTLY ARRIVED AT. HIS COOPERATION, HOWEVER, CAN STILL BE OBTAINED BY INVOLVING HIM AT THE WORKER LEVEL, TO EXPOSING HIM TO THE WORKER PROBLEMS AND TO GIVING HIM A GREATER VOICE IN THEIR SOLUTIONS.

SOLUTIONS THAT PASS UP TO MANAGEMENT AND EVENTUALLY BECOME MANAGEMENT POLICIES IN RECOGNITION OF THE EMPLOYEES EFFORTS.

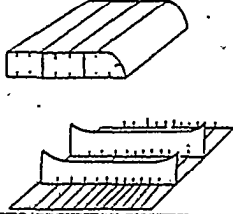

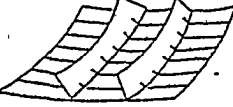

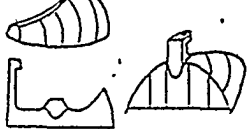
THIS SYSTEM AND, TECHNOLOGY, I AM CONVINCED, WILL INCREASE PRODUCTIVITY; BUT, ONLY IF WE DO IT!

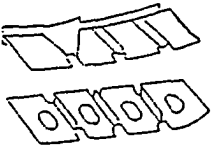
**COMPARISON: DESIGN VS. CONTRACT TIME**

AVERAGE ASI		AVERAGE IHI	
<b>CONTAINER SHIP</b>			
CONTRACT TIME	34 MOS.	CONTRACT TIME	14 MOS.
DESIGN DURATION	20.5 MOS.	DESIGN DURATION	6 MOS.
<b>PRODUCT CARRIER</b>			
CONTRACT TIME	36 MOS.	CONTRACT TIME	14 MOS.
DESIGN DURATION	20 MOS.	DESIGN DURATION	6 MOS.

**HULL CONSTRUCTION BREAKDOWN**

MOLD LOFT & CUTTING	10%
SUB ASSEMBLY & ASSEMBLY	50%
ERECTION	40%

CATEGORY	UNIT NAME	SHAPE	BAY
FLAT PANEL UNIT	MIDPART: DOUBLE BOTTOM SIDE SHELL LONG. BHD.		(20)
SEMI FLAT PANEL UNIT	AFT & FORE PART: DECK, FLAT, T. BHD.		(18)
CURVED UNIT	AFT & FORE PART: SIDE SHELL		(16) (17)
3 DIM. UNIT	AFT & FORE PART: INNERBOTTOM		(17)
AFT & FORE END UNIT	BOW CONST. STERN CONST. CANT. CONST.		BUILD. WAY

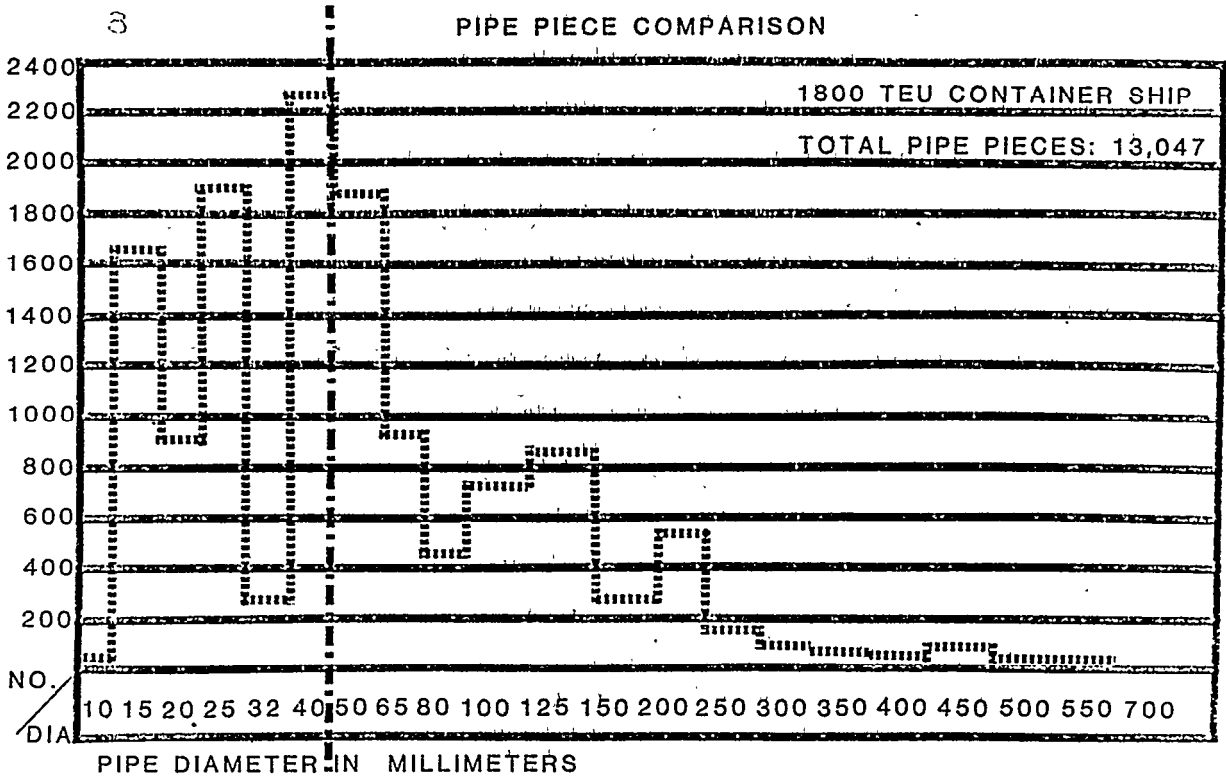
CATEGORY	SUB UNITS	BAY
ORDINARY SUB 	FLOOR & GIRD OF INNERBOTTOM WEB FR. & GIRD OF SIDE SHELL WEB FR. & GIRD OF DECK WEB FR. & GIRD OF L. BHD. ETC.	(14)
OTHERS	BUILT UP LONG.	(15)
	BILGE KEEL RUDDER HAWSE PIPE MAST SEA CHEST BULWARK ETC.	(19)

CATEGORY	%	ASS. WT./MONTH (TONS)
FLAT PANEL UNIT	52.8%	4,224
SEMI FLAT PANEL UNIT	8.2%	656
CURVED UNIT	14.8%	1,184
3 DIM. UNIT	8.5%	680
A & F END UNIT	9.6%	768
OTHERS	6.0%	480

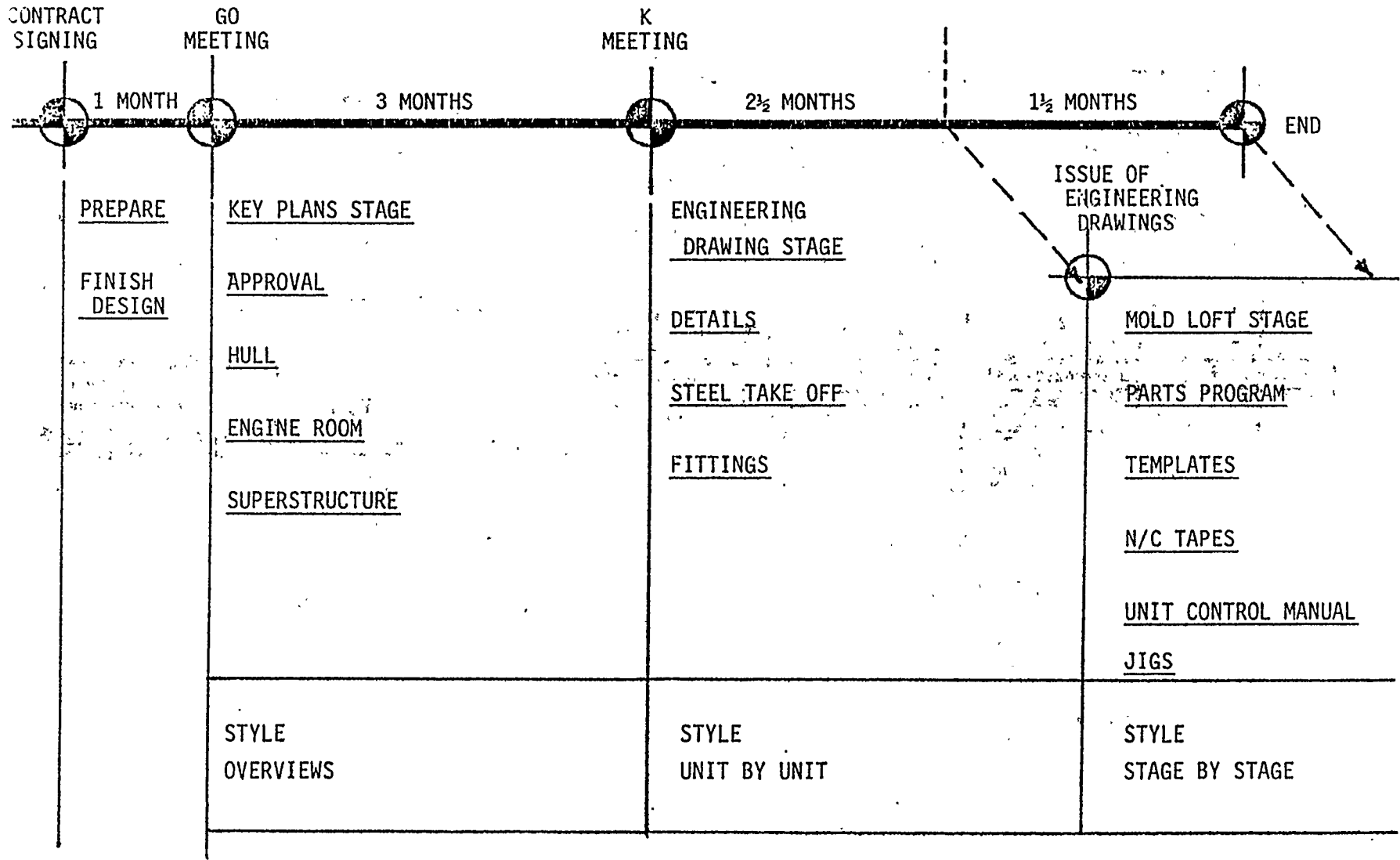
ASS. WT. = 8,000 TONS/MONTH

CATEGORY	UNIT NAME		ASS. WT. TON/MONTH	AREA M <sup>2</sup>	PRODUCTIVITY OF AREA TON/MONTH M <sup>2</sup>
PANEL UNIT	MID PART: D. BOTTOM S. SHELL T. BHD. U.DK.	3K 4K 4W 3W 2W 1A	4,060	7,700	0.53
SEMI PANEL UNIT	A & F PART: DECK, FLAT, T. BHD.	2A	1,314	3,200	0.41
3 DIM. UNIT	A & F PART: D. BOTTOM	3A	450	1,000	0.45
CURVED UNIT	A & F PART: CURVED S. SHELL	1W	1,176	2,700	0.44
ASS. TOTAL			7,000	14,600	0.48

CATEGORY	ASSWT TON	PRODUCTIVITY OF AREA T/M.M <sup>2</sup>	REQD. AREA M <sup>2</sup>	BAY	EXISTING AREA M <sup>2</sup>
FLAT PANEL UNIT	4,224	0.26(0.53)	16,246	⑳ & PANEL	16,800
SEMI FLAT PANEL UNIT	656	0.20(0.41)	3,280	⑱	4,000
3 DIM. UNIT	680	0.23(0.45)	2,960	⑰ ⑯	4,750
A & F PART: DOUBLE BOTTOM					
CURVED UNIT	1,184	0.22(0.44)	5,380		4,350
A & F END UNIT	768			UP & LOW BUILD. WAY	
OTHERS	480			⑲	3,100



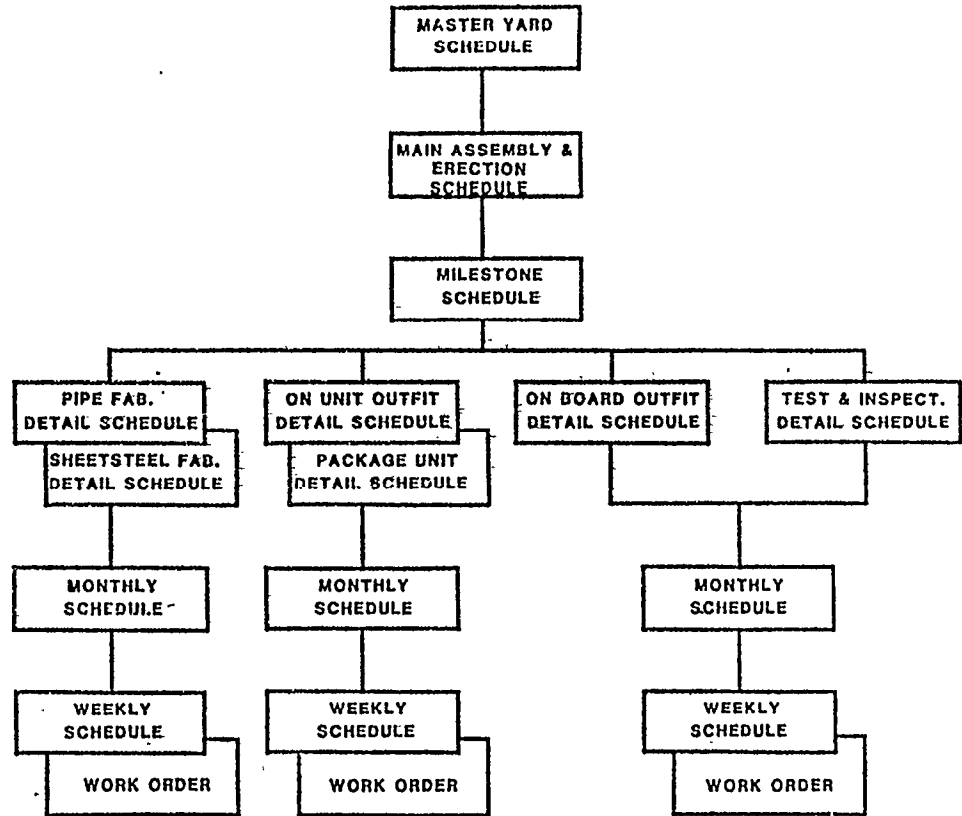
HULL ENGINEERING SCHEDULE  
AT AVONDALE SHIPYARDS, INC.



553

### TREE-STRUCTURE OF SCHEDULES

SCHEDULE MEETINGS	
☆ CHAIRMEN & MEMBERS	DESCRIPTION
☆ PROD. PLANNING V.P. PROD. ENG. V.P. & MGR. PROD. V.P. & MGR. PERSONNEL CONCERNED	DECISION OF MILESTONE CHECKING OF PROGRESS HOLD ONCE A MONTH
☆ CHIEF OUTFIT PLANNER PROD. ENG. MGR. PROD. MGR. PERSONNEL CONCERNED	DITTO
☆ PROD. ENG. MGR. PROD. MGR. CRAFT SUPTS. FOREMEN PERSONNEL CONCERNED	DITTO
☆ PROD. ENG. PLANNERS CRAFT SUPTS. FOREMEN PERSONNEL CONCERNED	CHECKING OF PROGRESS AGAINST SCHEDULES



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