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PAPER COSTS MONEY

An Oral Presentation
to the 1991 Ship Production Symposium
Society of Naval Architects and Marine Engineers

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by

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PAPER COSTS MONEY

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The title of this presentation is "Paper Costs Money." It could also be entitled "Paper Costs Time" or "Paper Causes Inconvenience." We all know, and talk about, the cost of data which are submitted to the government under shipbuilding contracts.

First, I would like to establish some definitions for today's presentation. How many of you know the dreaded acronym "CDRL"? Some people say they are submitting a CDRL." Others say they're submitting "data" or "reports"; purists say "technical documentation."

Today's discussion will focus on the data which were required under recent U.S. Navy shipbuilding contracts. It would be nice to examine vessels being built for several commercial owners, but the field is rather limited. And, naval ships built to either commercial rules or military requirements comprise the preponderance of contemporaneous activities in the industry. Perhaps it is tutorial, but the following terms will be used today for common understanding of Navy data requirements:

CDRL, the Contract Data Requirements List cited as a contract section J exhibit by each Navy contract. The CDRL may be in two or more separate parts, which are listed as exhibits "A," "B," "C," etc. This document invokes all of the data submission requirements on the prime contractor. A CDRL is printed on a DD Form 1423.

ELIN, the Exhibit Line Item Number for each specific data submission requirement of the CDRL.

DID, Data Item Descriptions are invoked by the DD1423, block 4, for each of the ELINs. The requirements of the ELIN may modify the DID or provide amplifying instructions. The DID identifies requirements such as content, format, etc. for a specific report.

Technical documentation, report, or data submission, the data which are submitted to the customer in compliance with a specific DID under a specific ELIN of each exhibit of the CDRL.

SDRL, a Subcontract Data Requirements List invoked by a shipbuilder on a subcontractor. This document goes by a number of different names, based on the custom of the shipbuilder. It serves the shipbuilder as a vehicle to require data be submitted Just as the CDRL serves the Navy.

Now for a-few more terms... which of these do you associate with a CDRL?. "Expensive." "Cost effective." "A waste of time." "Helpful." "Irritant" "Expediter."

It probably takes little imagination to guess which set of terms you picked. Our challenge in the marine industry is to determine how to move towards the other set of words. The money available, to buy ships is diminishing; we must come up with a way to buy more steel for the money available.

One lead ship bid concluded that 20% of the non-recurring cost would be related to data submissions. That was the ship designer/ship builder's cost. It did not consider the added costs of data which were paid for in the material purchased for ship construction. The latter cost becomes buried in the recurring cost lines.

In fact, data costs are incurred...and paid...at several levels of program funding. The shipbuilder sees basic construction cost. A Navy project sees many other cost elements which include data definition, handling, evaluation, and follow-up action.

A typical requirement for a report will result in various costs at a variety of activities for each ELIN:

- Navy prepares the input for requirements to be incorporated in the CDRL which will be included in the 'request for proposal and subsequent contract (typically cost for NAVSEA technical code labor)

'Bidding shipbuilders evaluate the CDRL's requirements, include details in the proposal for the contract (labor charged to Bid & Proposal (B&P) which is then included in general and administrative (G&A) rates)

Shipbuilders identify data to be included in subcontractor estimates; subcontractors evaluate requirements and bid on hardware (labor charged to each subcontractor's B&P which eventually impacts the cost of purchased material)

- Navy evaluates the bids (the more data required, the more complex the evaluation; this influences the labor and time for the evaluation and selection process)

- Winning shipbuilder plans its own data submissions to meet the CDRL; prepares SDRLs for inclusion in purchase orders (POs) to collect needed inputs from subcontractors (non-recurring direct labor, G&A and overhead <O/H>)

- Subcontractors prepare reports required by the SDRL (direct, O/H and G&A labor and other costs such as

capital equipment, reproduction, etc.: these costs are often seen by shipbuilders as recurring material cost>

- Shipbuilder evaluates subcontractor data submissions; correspond to obtain updates and corrections (direct, G&A and O/H labor>

- Shipbuilder prepares technical documentation and other-data submissions required by the CDRL <more-direct, G&A and O/H labor and other costs)

- Navy evaluates shipbuilder data submissions; they: correspond to obtain updates and corrections; this cost- is in direct proportion to the distribution list for each ELIN (labor at various Navy offices and costs for a: number of "highway helper" contracts)

- Shipbuilder responds to the Navy comments, often involving passing those comments back to-the subcontractor (added direct, G&A and O/H-Cost)

- Various Navy offices (and/or "highway helpers") file, retrieve, dispose of, and otherwise handle the various reports; this cost is also in direct proportion to the distribution list for each ELIN (more government program costs)

- Repeat the entire cycle for each recurring report.

Each submission of each report required by each ELIN means a number of people handle the paper. Each person who is involved adds labor cost to the project. While many shipbuilders have the equipment and people to produce technical manuals, prepare microfilm copies of drawings, or take other actions to meet the specific requirements of a DID and DD1423 for the ELIN, many of the subcontractors do not. In either case, the costs appear as capital equipment which is included in the O/H rates, other direct cost <ODC>, and direct or indirect labor.

And even more troublesome, the comment or approval cycle for technical documentation can add an extended period of time to the ship's design and/or construction period. It also adds to the material lead time for new or modified hardware procured for any ship of a class.

Some ELINs state approval is required. If the shipbuilder or subcontractor proceeds prior to receiving approval, it does so at its own risk the comments may cause some significant change resulting in rework of the design or hardware. In some cases, the CDRL gives a specific time period to allow for approval; in others it does not. How long should the shipbuilder wait? And the subcontractor, who has submitted technical documentation via the shipbuilder, must wait even longer. In

the end, both shipbuilders and subcontractors assume the comments will not be extremely disruptive...and proceed.

Next, consider the ELIN which does not require approval. And, 45 days later the Navy's letter arrives with significant comments. What happens then? Should the shipbuilder or subcontractor have proceeded, and was it "at risk"? Waiting for comments which are well within the reviewer's purview slows the product ion cycle, not waiting carries an inherent cost risk. Both options are bad for shipbuilding.

In the final analysis, waiting for comments or approval may depend on the nature of the data item.

What are these data items? A detailed examination of one CDRL, issued under contract N00024-82-C-2121 for MCM-1, revealed an interesting breakdown. But first, some definitions of the categories arbitrarily used for the evaluation (ELIN, title and subtitle provided for each example >:

DELDOC - data submission associated with ship delivery; example: A069, "Electric Accounting Machine Card/Listing, Outfitting Material; Stock Record Cards Afloat <SRCA>, NAVSUP 1114."

DESREVtechnical documentation for review of ship (or hardware component> designs: example: A042, "Report, Reliability and Maintainability Allocations, Assessments, and Analysis; RMAAA, Deratlng Criteria, and Stress Analysis-Report."

HIST - technical documentation with provides a history of the ship's construction; example: A142, "Report, Inclining Experiment (Prellinary [slc] and Final); Inclining Experiment Report."

MAINT - technical documentation which is required for proper maintenance of the ship: example: A099, "Manual, Technical, Preliminary; Preliminary Technical Manual."

MGMT - technical documentation, financial data, schedules and other data submissions which allow the Navy to monitor and manage ship design and construction program; example: A199, "Cost/Schedule Status Report <CSSR>; Cost/Schedule Status Report."

OPNL - technical documentation which is required for proper operation of the ship: example: A101, "Book, Damage Control, All Ships; Damage Control Book."

PROV - technical documentation which is required to provision the ship, both on-board spares and shore-based

logistics: example: A055, "Logistic Support Analysis (LSAR) Data; Logistic Support Analysis Record (LSAR)."

SPCL - requests, reports, and other data submissions which are required on an as-the-need-occurs basis; example: A006, "Proposals, Engineering Change; ECP's and NECP's."

TEST - technical documentation which reports the results-of shipboard or hardware component testing; example: A116, "Report, Ship Trial ; Report of Builder's Trial."

TSTPLN - technical documentation which provides planning and procedures for the conduct of shipboard and hardware testing; example: A179, "Procedures, Test; First Article, (Pre-production) Degaussing Equipment."

TRNG - data and reports associated with the training program for the ship's crew; example: B013, "Instructor/Lesson Guides - Training Courses; MCM Ship Degaussing System."

Some assumptions were used for the analysis to "normalize" the results to be representative of a generic ship contract:

Time span for contract - three years, or 12 quarters, or 36 months

POs requiring technical data - 100 hardware items

Hardware items requiring shock and vibration. qualification - 60 by test or extension

Hardware items requiring high impact (HI) shock & vibration testing - 30 (both grades A and B HI shock>

Approval cycle - reports and technical documentation will each require one comment/resubmission cycle to obtain approval; periodic reports will not require any resubmissions.

Within these categories and following the assumptions, the various ELINs of the CDRL were examined. It was first noted the DD1423 often requires various reports, sometimes with different numbers of copies to differing distribution lists for those reports. Thus, it is necessary to examine the number of items of data, as well as the number of ELINs.

The CDRL for the MCM-1 includes 208 ELINs in Exhibit A (e.g., numbered A001 through A200) plus 23 ELINs in Exhibit B (e.g., numbered B001 through B023>. Of these, 14 ELINs are not used, leaving a total of 217 separate requirements. Some of the ELINs include multiple items, as noted above; thus, there are a total of 278 Exhibit A items and 21 Exhibit B items.

The various data items for MCM-1 were categorized as follows
<Note: four ELINs, due to their multiple items, were categorized in more than one category.):

CATEGORY	ELINs	ITEMS	APPROVAL REQUIRED	% REQUIRE APPROVAL
DELDOC	13	13	1	7.7
DESREV	36	58	26	44.8
HIST	26	37	7	18.9
MAINT		39	14	35.9
MGMT	13	49	13	26.5
OPNL	7	15	12	
PROV	13	12	7	53.8
SPCL	11	11	8	72.7
TEST		19	3	15.8
TRNG	19	21	19	90.5
<u>TSTPLN</u>	<u>24</u>	<u>24</u>	<u>12</u>	
Total	221	299	122	40.8

It might be noted that 41% of the 299 items of data required Navy approval. This has a serious implication for the shipbuilder's schedule.

in order to measure the true cost and schedule impact of the various data items on the shipbuilder and the Navy, it is necessary to determine how many times they are submitted. The Navy's impact is also driven by the number of copies made available (as required by the ELIN's distribution list>. Copies go to a number of different commands and codes within commands. For this analysis, we can use standard explanations based on Appendix 1 to Exhibit A, "General DD Form 1423 Glossary" :

DISTRIBUTION - the number of addressees to receive a copy of each submission of a particular data item: example: ELIN A042 requires 4 which are PMS 303, SEA 05MR, SUPSHIP, and SEA 56Z14.

REGULAR COPIES - the total number of regular copies to be forwarded to all addressees to meet the requirement for each submission of a particular data item; example: ELIN A179 requires 1 copy each be distributed to SEA 56214 and SUPSHIP, and 3 copies be distributed to PMS 303 for a total of 5 regular copies.

REPRODUCIBLE COPIES - the total number of reproducible copies to be forwarded to the designated addressees to meet the requirement for each submission of a particular data item: example: ELIN A142 requires 1 regular copy be distributed to the ship, 2 copies to SUPSHIP, and 3 copies to PMS 303; in addition, SEA 55W2 is to receive 1 reproducible copy.

TOTAL SUBMITS - the total number of submissions required for a particular data item based upon the assumptions described earlier; example: ELIN All6 has a designated frequency of "ONE/R", with a required first submittal 30 days after completion of builder's trial with subsequent submittal "R/ASR"; it is assumed one subsequent submittal will be required, and there is one builder's trial per ship; thus the total number of submissions for this item is 2 per ship.

An analysis of the requirements, by category, of each of the items compared to the distribution requirements, the frequency of submission, and the number of copies required, reveals the following theoretical number of submissions (Note: This is a "theoretical number" of submissions, it does not represent the actual submissions made during the shipbuilding program.):

CATEGORY	DISTRIBUTION	REGULAR COPIES	REPRODUCIBLE COPIES	TOTAL SUBMITTALS
DELDOC	42	59		7 + 63 per ship
DESREV	224	408	23	220 + 3 per ship
HIST	143	237	30	20 + 84 per ship
MAINT	196	251	37	226 + 12 per ship
MGMT	154	297	8	506 + 225 per ship
OPNL	77	114	19	139 + 2 per ship
PROV	29	41	6	59 + 1 per ship
SPCL	42	62	0	not estimated
TEST	68	124	5	179 + 63 per ship
TRNG	39	80	0	42 + 2 per ship
<u>TSTPLN</u>	<u>79</u>	<u>156</u>	<u>1</u>	<u>283 + 25 Per ship</u>
Totals	1,093	1,829	133	1,681 + 480 per ship

It may be interesting to note that a single submission in response to each item would result in 1,093 envelopes in the mail with 1,962 regular and reproducible copies. But, that isn't an accurate picture. It is estimated a total of 1,681 scheduled submissions would be required over the period of contract performance plus another 480 submissions for each ship built. Almost all of those submissions require one or more copies to multiple addressees.

With these data, we can start to draw some conclusions about what drives the costs. Many of the submissions are in what might be considered the oversight categories of design review, management and special categories. The test program includes the test and test planning categories. Integrated logistic support (ILS) comprises the maintenance, provisioning and training categories. The data needed by the ship's crew certainly include much of the ILS plus the delivery documentation, history and operational categories.

The Navy undertook a major revision of the CDRL for the MCM-9 contract (e.g., N00024-88-C-2229), which includes options for

the MCM-10, 11, 12, 13, and 14. One of the stated purposes of the revision was to reduce the requirements for data. The CDRL was reduced to a single exhibit, and includes ELINs A001 through A211, with a total of 279 ELINs. Those requirements are subdivided further into a total of 304 items, and three ELINs are not used.

An analysis of the ELINs of the MCM-9 CDRL for categorization similar to that done for the ELINs of the MCM-1 CDRL produces the following <number in parentheses is the delta between MCM-1 and MCM-9>:

CATEGORY	ELINs	ITEMS	APPROVAL REQUIRED	% REQUIRE APPROVAL
DELD0C	12 (1)	12 (-1)	1 (0)	8.3
DESREV	57 (+21)	62 (+4)	30 (+4)	48.4
HIST	31 (+5)	38 (+1)	7 (0)	18.4
MAINT	41 (+28)	42 (+3)	18 (+4)	42.9
MGMT	50 (+12)	64 (+15)	21 (+8)	32.8
OPNL	14 (+7)	14 (-1)	12 (0)	85.7
PROV	12 (-1)	13 (0)	7 (0)	53.8
SPCL	12 (+1)	12 (+1)	8 (0)	66.6
TEST	21 (+2)	21 (+2)	3 (0)	14.3
TRNG	0 (-21)	0 (-21)	0 (-19)	
<u>TSTPLN</u>	<u>26 (+2)</u>	<u>26 (+2)</u>	<u>13 (+1)</u>	5 0
Total	276 (+55)	304 (+5)	120 (-2)	39.5

While the above table indicates a significant growth in ELINs, the total number of data items grew by only five; and, the number of ELINs requiring approval dropped by two, the percentage dropped about 1%. It can be seen clearly that the growth occurred in the oversight categories, while the training category was eliminated.

Further analysis of the theoretical number of submissions for the MCM-9 contract reveals the following (number in parentheses is the delta between MCM-1 and MCM-9):

CATEGORY	DISTRIBUTION	REGULAR COPIES	REPRODUCIBLE COPIES	TOTAL SUBMITTALS
DELD0C	39 (-3)	56 (-3)	3 (-1)	29 + 63 per ship
DESREV	253 (+29)	464 (+56)	27 (+4)	239 + 6 per ship
HIST	136 (-7)	235 (-2)	31 (+1)	23 + 85 per ship
MAINT	205 (+9)	258 (+8)	42 (+5)	425 +12 per ship
MGMT	187 (+33)	358 (+61)	8 (0)	904 + 223 per ship
OPNL	72 (-5)	117 (+3)	16 (-3)	135 + 2 per ship
PROV	29 (0)	41 (0)	6 (0)	125 + 1 per ship
SPCL	39 (-3)	72 (+10)	1 (+1)	not estimated
TEST	77 (+9)	147 (+23)	6 (+1)	196 + 244 per ship
TRNG	0 (-39)	0 (-80)	0 (0)	0
<u>TSTPLN</u>	<u>86 (+7)</u>	<u>169 (+13)</u>	<u>2 (+1)</u>	<u>285 + 25 Per ship</u>
Totals	1,123 (+26)	1,917 (+89)	142 (+9)	2,361 + 661 per ship

It is again interesting to note that a single submission in response to each item would result in 1,123 envelopes in the mail with 2,059 regular and reproducible copies. Again, that isn't an accurate picture. It is estimated a theoretical total of 2,361 scheduled submissions would be required over the period of contract performance plus another 661 submissions for each of the 6 ships built (including options>, a combined total of 6,327 submissions!

The increase in submissions is disproportionate <i.e., growth of 680 scheduled submissions plus 181 submissions per ship) to the increase in ELINs and items. This is because the submission frequency requirements changed for some ELINs, and the entire body of training data was replaced numerically by management data.

Because MCM-9 is a follow-ship contract, the need for design review, maintenance, operational, provisioning, test, and test planning submissions was probably reduced. However, each hardware change worked to offset that reduction. And, if another shipbuilder which had not previously built a ship of this class wanted to enter the competition, it would be faced with almost the entire set of submissions.

Please do not think by this time the author is picking on the MCM program or its shipbuilders. A similar examination of the CDRL for the T-AO 194 and 196 (e.g., contract N00024-85-C-2131) shows a similar set of requirements in the design review, management and ILS areas. What is missing are many of the test and certification data expected for a warship with its attendant survivability requirements. Other CDRLs for ships such as the CG-47 class follow ships, DDG-51, LHD-2, and similar warship programs include requirements which are quite comparable to the MCM-1 class CDRLs.

How do these requirements relate to the price paid for shipbuilding products? Examination of a 1990-91 bid for a shipyard product produces the following division of price:

- 17.2% One-time costs - design, ILS, and all data
(including those data related to production>
- 73.7% Recurring costs - procurement of material and
 manufacture of the product
- 9.1% Tests & demonstrations - test program, on-board
 crew training, and associated activities.

The line item structure of this particular contract makes it possible to identify the price for the system engineering and design, the drawings and calculations, the ILS analyses and training preparation, and other technical tasks, as well as the program management tasks, all of which are required by the contract. Those prices, which are included in the one-time

cost, can be segregated from the cost of the data submissions per the CDRL. Such submissions account for 24.6% of the price of those contract line items in the "one-time cost" category, and exceed over 4% of the overall price of the bid. Further, the cost of the data included in the procured material prices, combined with the effect of preparing data submissions on G&A and O/H rates (which are applied against all direct costs), would easily raise the data submission impact on the overall contract price to high in the 5-10% range.

It is not possible for this author to examine costs to the government in terms of employee payroll and subcontract help. As is the case with ship designs, a certain level of effort is required to oversee the design and construction of a modern warship or commercial vessel. Design reviews, program progress reports, quality inspections, and witnessing tests are all activities which protect the government's interests. These activities often involve subcontractors as well as the shipbuilders.

It would be interesting if someone with access to the necessary data could prepare a follow-up paper to this one to assess the percentage of the government's programmatic costs which is directly attributable to data definition, receipt, handling, evaluation and follow-up action. It is a safe bet that it is at least as high as the 25% of one-time cost indicated above.

An example at the other end of the spectrum is in order. Conversations with representatives of Astilleros Espanoles SA, the Spanish commercial shipyard, concentrated on data submitted to commercial owners. European commercial shipbuilding requires adherence to governmental regulatory body and classification society regulations and rules, just as occurs in the United States with the U.S. Coast Guard and American Bureau of Shipping.

The ship designer must submit to the owner and the classification society about 40 to 50 plans. These plans are for the approval of the design. They roughly correspond to the U.S. Navy's selected record plans. These same plans are provided to the ship to reflect her as-built condition.

In addition to the plans, equipment arrangements and equipment technical manuals are provided. The manuals, needless to say, do not meet the rather elaborate requirements of today's technical manual contract requirements (TMCRs). Most of the documentation is being delivered in a digital format, with a growing use of laser disks.

It is recognized that a naval warship has ILS, survivability and other requirements which are different from those of a commercial vessel. The designs for warships are typically quite unique, one from the other; and, warships have an

extensive test program to verify proper hardware design and manufacture. In addition, the shipbuilder cannot procure certain outfitting items such as the weapons suite. Thus, there is an increased need for management dialogue between the shipbuilder and the customer. Often times, this increased information flow will involve subcontractors.

Here, then, are seven recommendations for arriving at a logical point somewhere between the extremes of commercial technical documentation requirements and today's "standard" Navy requirements.

First, examine carefully and realistically the results of each data submission. Do reviews really result in design changes? Are data just filed away without action? What happens to each copy on the distribution list, does each addressee need a copy (or copies) of each and every submission of all reports per a particular ELIN? What is the pay-back for the price the government (and we taxpayers) expends on each data item...is it justified economically?

When the CDRL is assembled for the next Navy contract, do not include any ELIN for which there is not adequate justification. This will require a very hard-line approach by the project office; and will, undoubtedly, cause more than a few codes, commands and offices to complain bitterly.

Second, trim the distribution list for each ELIN to the absolute minimum. It costs time and labor to reproduce and distribute multiple copies to multiple addressees. Nonetheless, it probably is cost effective to have the originator make all necessary copies at one time. If this is true, it would also make sense for subcontractors to submit data directly to the Navy.

Third, reduce the frequency of submission of recurring reports to that which is absolutely essential. Make monthly reports quarterly, quarterly reports semi-annual, and so forth. This could cut the total number of submissions in half. Further, much of the cost to prepare management reports is incurred under O/H and G&A accounts, and it would help reduce rates.

The Navy can protect the government's interests by on-site activities. The offices of the supervisors of shipbuilding could have people sit in on the design reviews as the design evolves. This would allow real-time feedback.

The Navy should implement the management principle of "MBWA" for the its oversight of the shipbuilders and their principal subcontractors. "Management by walking around" and seeing what is under test, under construction, and being considered at the design reviews. There would need to be a real effort to eliminate some of the adversary attitudes between the government and prime contractor people, and Washington would

need to develop more trust in the people in the field, but It can be done.

Fourth, make more use of magnetic media and digital formats. Standard computer aided design (CAD) systems today can produce both magnetic media and laser disks for drawings; word processors can produce output in a variety of digital formats. The labor cost savings to provide copies in digital format over paper copy reproduction will more than offset the added cost of materials. An added benefit is the space saving feature of the digital format. Paper copies are needed only for record purposes, only for a selected number of items of technical documentation or financial data, and then to reflect the as-built condition.

Fifth, shipbuilders use a more standardized format to prepare SDRLs. A SDRL would define specific data needed by the shipbuilder, such as a loose parts list. In addition, it would incorporate the exact DD1423 language for applicable ELINs from the CDRL and invoke the same DIDs, only adjusting the number of copies to be submitted to call for the shipbuilder to receive an appropriate number of copies for its own internal use and review. If this were to be done, subcontractors could submit data to the shipbuilder and the Navy concurrently. The approval period for parallel submissions would apply to all of the subcontractors' data, just as to a shipbuilder's data.

Sixth, incorporate a clause in each prime contract that any and all comments must be provided on a data submission not more than 30 calendar days after receipt by the Navy. Approval would be assumed automatically if comments were not received within that time period. Subcontracts would include a similar clause allowing the shipbuilder a total of 15 days for handling the outgoing submission to the Navy and passing the Navy's comments or approval back to the subcontractor.

Seventh, allow only one set of comments on a particular data submission or report. We can all tell horror stories of the technical manual which never does get a "clean" review because each new reader reads with his or her own interpretation of the TMCR, or discovers a previously unknown deficiency.

If this suggestion, along with the parallel submission suggestion above, were to be implemented, subcontractors could incorporate all of the comments at one time, instead of serially, with two resubmittals, as is done now. This would have the effect of saving considerable time as well as cost.

A final observation, the "one set of comments" rule, combined with a "30 day" rule, would enforce discipline on each report's reviewers. If the technical documentation were to be revealed as fatally flawed sometime after the 30 day period allowed for review, or after the subcontractor or shipbuilder

resubmits the report, a simple unilateral change in accordance with the "Changes" clause of the contract could be issued by the contracting officer to provide for yet another submission. If there are any contracting officers in today's audience, I can surmise how you are reacting to this idea!

It is possible, with some real effort on the part of the Navy (as the customer>, shipbuilders and subcontractors, to reduce significantly the cost of technical data and management reports. A goal of 10% of the total program cost (not just basic construction cost) is realistic, and probably achievable. If each of the present Navy ship programs were to have such a reduction, it would be possible to add one more low-mix ship to each year's construction schedule. Is there anyone in the Society today who would not like to see that?

Additional copies of this report can be obtained from the
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