ESTABLISHING THE TRAINING COST FOR A COMPLEX WEAPONS SYSTEM: AN EXAMPLE USING THE P-3 FRS

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This paper describes an approach of establishing the training cost for a complex weapons system. The Navy P-3 Training Program in VP-30 and VP-31 was used as a model in establishing the cost parameters. In this program over 5,691 training objectives were developed stretching over seven crew positions and a multitude of training tracks. This paper will show how costs were developed for each crew position describing the costs for learning center, for weapon system trainer, for cockpit procedure trainer, for position trainer and for the aircraft itself.

INTRODUCTION

Problem and Overview

This paper describes, using the example of the Navy's ASW Patrol Fleet Replacement Squadron (FRS), Patrol Squadron 31 (VP-31), a model for estimating the training costs for a complex weapons system. It is not a definitive list of all costs nor does it attempt to account for all costs in the Patrol FRS. It does, however, account for the major cost contributors and give a framework for gathering and estimating them.

The manager for a complex weapons system training organization currently makes major decisions affecting syllabus changes without, in many cases, realizing the impact of these decisions on the total training system cost. A training squadron often has cognizance of but a limited part of the total syllabus costs, usually aircraft direct operating costs. The costs for the instructor salaries, training devices, Instructional Systems Development (ISD) efforts, and student time are not visible, and thus are often discounted.

Consideration by the training manager should be given to the costs in making changes to the syllabus as well as their instructional implications. The Defense Science Board placed considerable emphasis on the need to make cost benefit analysis when making training management decisions (1).

Background

Previous studies have been found that bring a methodology to bear on the problem in part, but none have application for the operational user. Doughty, Stern, and Thompson (2) have developed a guideline for cost analysis in a typical U.S. Navy "A" School but their study did not adequately reflect the ISD acquisition costs, or the costs relevant to more exotic hands-on media such as flight simulators and aircraft flight hours. They also do not cover multiple training tracks and the interaction of media versus training tracks resulting from multicrewed systems. Orlansky and String (3, 4) give a rather complete generalized model for estimating training costs. However, they do not apply their model in a complete manner to a specific Navy training application. Allbee and Semple (5) have developed an extensive cost model using various U.S. Air Force examples which do not apply to Navy fleet training due to the differing data source bases between Air Force and Navy data files. The Allbee and Semple cost model does render valuable insights for the development of cost models. However, the model is too detailed for use by fleet training squadrons, in that it takes into account some variables that are not useful at the FRS. An example of this is the factoring into the model the costs of such items as the Air Staff and Higher Headquarters.

Existing studies approaching the data for fleet level use are either outdated or incomplete. Browning, Ryan, Scott, and Smode (6) were not tasked to look at any media except the 2F87F simulator, and did not make comparisons in other than the pilot training track. The cost data in the study were also based on July 1976 dollars. Braby, Henry, and Morris (7) indicate some guidelines for costing media alternatives that are helpful in isolating costs of conventional media. Goclowski, King, Ronco, and Arkren (9) have described a model identifying system ownership costs (SOC). Their SOC model is a good reference in attempting to establish a generality for identifying cost drivers in a complex training system.

The present study is not a new approach to the data in the aggregate but represents a refinement of existing models for the user in the fleet readiness squadron.

DEVELOPMENT OF THE MODEL FOR ESTIMATING P-3 TRAINING COSTS

This section describes a model for estimating the training costs for the VP Fleet Replacement Squadrons (FRS), VP-30 and 31. It includes certain simplfying assumptions that will be discussed below. However, it is important to note that the major cost drivers have been identified and are shown as variables. This model follows the construct of Orlansky and String (3, 4) in that it does not display sensitivity to the timing of costs or to budget implications of program alternatives. It serves as a general structure for estimating training costs.

Student Load

The determination of student quotas for this model was reported by Thode (10). The quotas are displayed for a one-year period by position for one FRS, and for both FRSs. Also shown are data for 15 years. 15 years is required for later calculations for estimating the revision costs of the ISD material and the life-cycle costs of certain media.

TABLE 1

NOMINAL STUDENT LOAD

	1 YEAR		15 YEARS
POSITION	One FRS	Both FRS	
Pilot	180	360	5,400
NFO	120	240	3,600
FE	140	280	4,200
SS 1/2	120	240	3,600
SS 3	60	120	1,800
COMM	40	80	1,200
ORD	120	240	3,600
	Total all years		23,400

A simplifying assumption has been made as it pertains to student load. Student attrition has not been accounted for. It is estimated that attrition is of minimal significance for the VP cost model. If, however, attrition is of program significance it can be accommodated by adding to the student load an additional student quota that represents the impact of each loss on the total load. For a more complete discussion of attrition see Orlansky and String (3).

Description of Demand Created by Current Syllabus

The Master Course Syllabus (MCS) (8) describes each hour of instruction for all media and crew positions. Crew positions are described by type of aircraft (P-3B or P-3C) as well as by job title. The MCS is summarized in Table 2. The number of instructional objectives for each crew position is taken from CO VP-31 LTR (11). The media shown include learning center activities, the numerical designations of training devices and simulators, and the P-3 itself.

TABLE 2

SUMMARY OF MASTER COURSE SYLLABUS

CREW POSITION	# OBJECTIVES		SYLLABUS HOURS BY MEDIA					
	Total	LC	2C45/69	2F87F	14B44	2F87T	P-3	
Pilot								
1st Tour	1000	248	22	28	3	32	95	(B-20)
2nd Tour[a]		239	9	30	--	32	50	(B-15)

*B = B Stage Hours

TABLE 2 (Continued)

CREW POSITION	# OBJECTIVES	SYLLABUS HOURS BY MEDIA				
		LC	2C45/69	2F87F	Static/A/C	P-3
FE[b]	413	265	8	36	11	104 (B-40)
		LC	P-3 LAB	2F69	2F87T	P-3
NFO B[a]	843	252	21	69	---	70
C[a]	869	386	27	--	74	54
		LC	14B44	2F69	2F87T	A/C LAB	P-3
SS 1/2 B	575	236	57	32	--	20	36
C	605	229	54	--	32	35	30
		LC	14B40	2F69	2F87T	15Z1	15E16	A/C LAB	P-3
SS 3 B	298	98	--	32	--	9	11	26	70
C	366	154	36	--	32	--	--	25	70
		LC	Static/A/C	A/C LAB	P-3				
ORD B	199	44	33	18	24				
C	209	40	31	15	24				
COMM B	345	130	17	51	30				

TOTAL -- Hours of Developed Instruction by Media

Number of Learning Objectives		5,691
Learning Center Hours of Instruction		2,321
Syllabus Hours Assigned to	2C45/69	79
	2F87F	94
	2F87T	205
	2F69(T)	133
	14B44	114
	P-3	657
	P-3 (Lab)	228
	P-3 (Static)	92
	14B40	36
	15Z1	9
	15E16	11

Notes:
a = Tactical Team Training An Additional 54 hours
b = NAMTRADET an Additional 160 hours
c = Pilot 1st and 2nd tour objections are not differentiated

Table 3 shows the instructor-to-student ratio required by various generic hands-on media. This ratio will be used later in the cost estimating section. The cost for the learning center is described along with the assumptions in the cost estimating section.

The instructor/student ratio is only part of the resource factor for a P-3 sortie. A similar concern is the number of crew positions that benefit from any flight training hour. An analysis of the MCS suggests the following allocation of flight hours per position.

Position	Proportion of Flight Hours
MCS Phase B	
Pilot	.5
FE	.5
MCS Phase C & D	
All	.14

TABLE 3

INSTRUCTOR/STUDENT RATIO FOR HANDS-ON MEDIA

Position	OFT/PT	WST	P-3
1. Pilot	.5	.5	1
2. NFO	1	1	1
3. FE	.5	.5	.5
4. SS 1/2	.25	.5	.5
5. SS 3	.5	1	.5
6. COMM	--	--	.5
7. ORD	--	.3	.5

REF: Welch (12)

(For example: The ratio of a syllabus flight hour for a pilot student to an instructor flight hour is 1 to 1).

For Phase B flight hours during familiarization the MCS shows that one pilot and one FE are trained. Therefore, each should share in the demand for that flight hour, and the proportion for each is one-half (.5). In C and D stages, however, all crew members are receiving training of some type, and it is assumed that the flight hour costs are spread across all positions. This data will then be used in the establishment of costs for flight hours.

Estimating Training Costs

The example shown below is a method of establishing training costs. Certain simplifying assumptions have been made, and they will be discussed. The cost "driver" will be discussed in the five sections. Section 1 provides the costs of instructional systems development. Section 2 shows the learning center costs. The training device costs are given in Section 3. Section 4 shows the P-3 aircraft costs, and Section 5 provides the instructor costs.

The costs shown below are an approximation of the "level of effort" for each cost category. They show the approximate cost "drivers" in the VP FRS. It was deemed impractical to attempt to ascertain the small cost differences among some P-3 model types, e.g., one P-3C was considered, not all the variations of P-3C, Update I, Update II and so forth. Also, all pilot costs assumed the P-3C, not P-3B or update syllabi.

Other simplifying assumptions are as follows:

1. Due to the lack of data, costs were not identified for VP-30 and 31 instructor training. The high turnover of pilot instructors might make this a cost category that should be developed in the future.

2. As was explained in an earlier section, student attrition was assumed to be zero. If there is in fact a significant student attrition in some tracks, the time where attrition occurs and the percentage of course completion needs to factored into the student costs.

3. Administrative overhead, flights aborted due to equipment malfunctions, out of maintenance check flights, and instructor NATOPS/instrument check flights have not been included as student flight hours.

4. Except as noted, costs have not been established for some student categories such as 2nd tour NFO, 2nd tour FE, NARF test pilots, or other rare categories.

5. The total overhead of indirect administration has been eliminated for simplicity although it could be added if desired. The

overall proportional costs between media, however, would probably remain unchanged. Some of the administrative overhead factors that were not addressed are Squadron, Wing, COMNAVAIRPAC, and FASOTRAGRUPAC, administration and headquarters costs. Allbee and Semple (5) gives an example of USAF training cost and does include costs of some of the higher headquarters.

6. P-3 aircraft costs were developed as shown from the NALCOMIS (Commander Naval Air Systems Command) report (13), but depreciation was not added to the calculation. Depreciation is deemed to be not relevant in consideration of the cost of the P-3. Obsolescence due to its mission capability probably occurs prior to its max airframe life. However, if aircraft depreciation is desired, Orlansky (3) shows programmed flying hours to be 429 per year, aircraft acquisition $8,280,000 and service life 15 years. This yields a straight line depreciation of $552,000 per year or $1287 per aircraft hour.

7. Costs for military construction have not been included in the model except for the modification to the learning center. The Moffett learning center costs were included for they were a major cost in the establishment of the revised P-3 curriculum. It was also assumed that the learning center costs at NAS Moffett Field were representative of the costs at NAS Jacksonville, FLA.

8. Costs were assumed to be in constant dollars. It is obvious that they are rapidly changing in the current environment. However, for the purposes of this model relative costs across media are important, not absolute costs. For the same reason costs were not discounted for future years in accordance with DODI 7041.3.(14)

9. Allowance has not been made for any major changes in the future to the P-3 aircraft. If perchance, a P-3D or P-3C Update IV is developed the ISD update costs for new equipment or a new aircraft (e.g., P-4A) would require a new cost estimation. The addition of a new aircraft, new equipment, or major software changes to the existing aircraft requires a reevaluation of the costs. The current aircraft mix except where noted for Table 6 represents the base line for this report.

10. All data shown in the report except ISD costs (Table 8) are for NAS Moffett Field, California, only and costs for NAS Jacksonville, Florida, are probably about the same. It is, therefore, assumed that there are not significant differences between training sites.

Instructional System Development Costs

The ISD cost will be discussed in two general areas: first, the initial ISD cost; and second, the costs required to maintain curriculum currency. These two cost areas will then be displayed in a table showing the ISD costs per student.

Initial Costs

The initial contractor cost for the P-3 activities was determined from the contract. The VP ISD team personnel costs, table 4, were developed based on Welch (12) for the staffing and man-years, and by using Koehler (15, 16) for billet costs. The research psychologist/educational specialist man-years and billet costs are from Thode (10).

The category of other media costs shown in table 5 accounts for audio-visual services performed by the U.S. Navy, and for reproduction costs of the A/V productions (10). CO VP-31 LTR (11) is the reference for all other data in table 5.

Maintenance Costs

A training program for a fleet aircraft is not an unchanging, static syllabus of instruction. Walker (17) evaluated an ISD activity for training crew members to fly a U.S. Navy fleet aircraft (S-3A) with a similar mission to the P-3. The results of this study showed that over a two-year period 22 percent of the media required change either due to content, learning strategy or media related issues. Table 6 assumes that a significant effort is involved in maintenance of the curriculum, an effort which decreases over time. For it is assumed that during years 1-5 the current ISD staff shown on table 6 will be required to revise/update the instruction. The staffing plan for the initial years after introduction of the ISD syllabus was based, in part, on recommendations developed by Walker (17). (NPRDC developed the staffing recommendations (18).) For years 6-10 the requirement for the maintenance of P-3B instruction has been deleted from the revision staff, and for years 11-15 only minor revisions of instruction for crew members of the P-3C are assumed.

TABLE 4

VP ISD TEAM PERSONNEL COSTS

RANK/RATE	DESIGNATION/ RATING	MY	COST
O-4	1320	8	$ 270,072
O-3	1310	16	1,205,552
O-3	1320 (P-3B)	17	496,366
O-3	1320 (P-3C)	16	467,168
E-7	AW	4	107,060
E-6	AW SS/3B	6	138,828
E-6	AW SS/3C	6	138,828
E-6	AW SS 1/2	17	393,346
E-6	AO	8	223,024
E-7	AD	3	95,370
E-6	AD	10	280,340
E-5	AT	4	94,488
E-5	DM	4	63,276
E-3	DM	6	71,100
Civilian	GS 11/12	13	700,000
			$4,544,818

NPRDC

GS-12 Research Psychologists $50,000 10 Man-years $500,000

NOTE: Personnel based on personal communication with Thode (10) and LCDR Welch (12).

TABLE 5

ISD DEVELOPMENT COSTS SUMMARY

Courseware Contract	$2,947,626
VP ISD Team Personnel Costs	4,544,818
Other Media Costs	503,792
	$7,996,236
TOTAL # of Training Objectives in VP Curriculum	5,691
TOTAL # of Hours of Instruction in VP Curriculum All Tracks	5,463

$$\frac{\text{Development Cost}}{\text{Instructional Hours}} = \text{Cost Per Hour for Development}$$

$$\frac{\$7,986,236}{5463} = \$1,464$$

TABLE 6
ISD UPDATE COSTS

VP 31/FASO ISD UPDATE PERSONNEL YEAR 1-5

#	Rank/Rate	Designator	Title	VP-31	FASO	Billet Cost
Administrative-Support Staff						
1	LCDR	1320	ISD Team Director	x		$ 33,759
1	LCDR	1310	Asst Team Director	x		69,559
1	LT	1310	Syllabus Director	x		75,347
1	LT	1320	Syllabus Director	x		29,198
			SUB TOTAL			$207,863
SUBJECT MATTER EXPERT						
1	LT	1310	B Pilot	x		$ 75,347
1	LT	1310	C Pilot	x		75,347
2	LT	1320	B NFO	x		58,596
1	LT	1320	B NFO		x	29,198
2	LT	1320	C NFO	x		58,596
1	LT	1320	C NFO		x	29,198
3	AW-1		SS 1/2	x		69,414
2	AW-1		SS 1/2		x	46,276
1	AWC		SS 3	x		26,765
1	AW-1		SS 3	x		23,138
1	AW-1		SS 3		x	23,138
1	AOC		C ORD	x		34,342
1/2	AO-1		B ORD	x		13,939
1	ADCS		FE	x		33,933
1	AD-1		FE	x		28,034
1	AR-1		B Comm	x		30,689
			SME SUB TOTAL			$655,950

Civilian Staff

1	GS-11 Educational Specialist	$24,200
1	Civilian Editor	14,600
		$38,800
	Total Military costs	$863,813
	Cost Adjusted by .58 Factor (see text)	-362,801
	Adjusted Cost	501,012
	Civilian Staff Cost	38,800
	Yearly Cost (years 1-5)	$539,812

#	Rank/Rate	Designator	Title	VP-31	FASO	Billet Cost
Administrative-Support Staff						
1	LCDR	1320	ISD Team Director	x		$ 33,759
1	LCDR	1310	Asst Team Director	x		69,559
1	LT	1320	Syllabus Director	x		29,198
			ADMINISTRATIVE SUB TOTAL			$132,516

TABLE 6 (Continued)

VP-31/FASO ISD UPDATE PERSONNEL YEAR 6-10

Subject Matter Experts

1	LT	1310	C Pilot	x		$ 75,347
2	LT	1320	C NFO	x		58,596
1	LT	1320	C NFO		x	29,198
3	AW-1		S3 1/2	x		69,414
2	AW-1		S3 1/2		x	46,276
1	AWC		SS 3	x		26,765
1	AW-1		SS 3	x		23,138
1	AW-1		22 3		x	23,138
1	AOC		C ORD	x		34,342
1	ADC3		FE	x		33,933
1	AD-1		FE	x		28,034
			SME SUB TOTAL			$448,181

Civilian Staff

1	GS-11 Educational Specialist	$24,200
1	Civilian Editor	14,600
		$29,800
	Total Military Costs	$580,697
	Cost Adjusted @ by .58 Factor (see text)	-243,893
	Adjusted Cost	336,804
	Civilian Staff Cost	38,800
	Yearly Cost (years 6-10)	$375,604

#	Rank/Rate	Designator	Title	VP-31	FASO	Billet Cost
Administrative Support Staff						
1	LCDR	1320	ISD Team Leader	x		$ 33,759
1	LT	1310	Syllabus Director	x		75,347
			ADMINISTRATIVE SUB TOTAL			$109,106
Subject Matter Experts						
1	LT	1310	C Pilot	x		$ 75,347
1	LT	1320	C NFO	x		29,198
1	LT	1320	C NFO		x	29,198
1	AW-1		SS 1/2	x		23,138
1	AW-1		SS 1/2		x	23,138
1	AWC		SS 3	x		26,765
1	AW-1		SS 3		x	23,138
1	AOC		C ORD	x		34,342
1	AD-1		FE	x		28,034
			SME SUB TOTAL			$292,298

Civilian Staff

1	GS-11 Educational Specialist/ Editor	$24,200
	Total Military Costs	401,404
	Cost Adjusted @ by .58 Factor (see text)	168,590
	Adjusted Cost	$232,814
	Civilian Staff	38,800
	Yearly Cost (years 11-15)	$276,614

TABLE 6 (Continued)

VP-31/FASO ISD UPDATE PERSONNEL YEAR 11-15

TOTAL ISD UPDATE COSTS

Year	Per Year	Total
1-5	$539,812	$2,699,060
6-10	375,604	1,818,020
11-15	276,614	1,383,070
		$5,960,150

Table 6 thus portrays the cost for the VP-31/FASOTRAGRUPAC ISD Update based on the current staffing, and on future projections. The staffing is shown in three categories, administrative support, subject matter experts, and civilian. A pair of columns show if the staff position is at VP-31 or FASOTRAGRUPAC. The billet costs are from Koehler (15, 16).

The military billet costs as they affect this model have been reduced by .58. NPRDC (18) has calculated that each military member of the ISD staff will be devoting 150 days per year to revision/update duties. Since there are 260 working days in a year this, then, works out to approximately a ratio of .58 to one man-year. Military duties, leave, TAD, flying, and other duties account for the remaining days.

ISD Cost Summary

The total ISD costs, then, can be developed by adding the total costs of the development and the costs of the maintenance requirements. The ISD cost per instructional hour or per learning objective is found by dividing the number of hours or objectives into the total ISD cost as shown in table 7.

The cost per student for ISD is then found by:

1. Determining the percentage a specific track is of the total training (in this case by percentage of training objectives represented by each training track). The number of objectives per track is found in table 2.
2. Determining the total number of students in each track over the 15 years of estimated life from table 1.
3. Dividing cost per track by the total number of students in the track.

TABLE 7

TOTAL ISD COSTS

Development	$ 7,966,236
Update	5,560,150
TOTAL	$13,556,386

ISD Cost / Instructional Hour	=	Total ISD Cost Per Hour	Total ISD Cost / Objective	=	Total ISD Cost Per Obj.
$13,556,386 / 5463	=	$2,481	$13,556,386 / 5691	=	$2,382

These data showing cost per student are shown for each track in table 8. For simplicity no differentiation was made between P-3B, P-3C, Update I, II, etc. The ISD costs for each aircraft type overlap a great deal and their relative cost differences would not greatly change the overall relationship among media.

Learning Center Costs

FASOTRAGRUPAC maintains a learning center at VP-31 and both VP-31 and FASOTRAGRUPAC provide instructors to support the instruction. The costs for the learning center (LC) have been allocated in the following manner. Although this calculation is shown for one site the costs for both sites is assumed to be the same.

Milcon and Equipment. The learning center has 198 carrels. For this model it is assumed that the LC and its associated equipment will have a 10 year useful life. The initial milcon and equipment costs were about $600,000. The investment costs then of the LC are $60,000 per year. For further discussion about milcon costs see Allbee and Semple (5).

LC Support Costs. The LC support costs for FY 79 are reported below and were supplied by FASOTRAGRUPAC (19). FASOTRAGRUPAC reports military costs by using NAVCOMPNOTE 7041, the composite standard military rate table. This table only accounts for pay and allowances, not the overhead which is represented in the Koehler (15, 16). The latter appear to be a more accurate reflection of the actual costs. An example is that they include the cost for pilot training for the billet cost of a pilot, NFO training for NFO, etc. If NAVCOMPNOTE 7041 is used for a Lieutenant it shows a yearly cost to be $24,611; Koehler (15) shows a pilot to cost $75,347 and a NFO to cost $29,198 per year. Billet costs for civilians rate are under development and should be used in future models (20). The FASOTRAGRUPAC (19) figure for overhead for civilians is too low at 10%. A sample check with Koehler (20) shows that to be an underestimate of about 10-20 percent.

TABLE 8

ISD COST PER CREW POSITION

Position	% of Training Objectives	% of Cost	Total Students	Cost Per Student ($)
Pilot	26	$ 3,524,660	5400	653
NFO	23	3,117,969	3600	866
FE	11	1,491,202	4200	355
SS 1/2	16	2,169,022	3600	603
SS 3	10	1,355,639	1800	753
COMM	9	1,220,075	1200	1017
ORD	5	677,219	3600	188
TOTAL COST		$13,556,386		

The cost categories are: graphics personnel, duplication personnel and supplies, and LC staff. The graphics and duplication personnel are required to update and reproduce the AV and printed instructional materials. The FASOTRAGRUPAC budget for learning center applicable supplies is added at this point to LC costs. The LC staff consists of those civilian and military personnel who issue materials and maintain the learning center. Table 9 shows the cost of the LC not including the instructors.

TABLE 9

LEARNING CENTER SUPPORT COSTS PER YEAR

Graphics Personnel at FASO Moffett

GRADE/RATE	NUMBER	PER YEAR	OVERHEAD	TOTAL
GS-9	1	18739	10%	$ 20,612
GS-7	4	15317	10%	67,394
GS-5	2	12368	10%	27,209
GS-4	1	11054	10%	12,159
			TOTAL	$127,376

Duplication Personnel at FASO Moffett

LI 2	3	15567	INC	$ 46,701
SN (LI)	2	11848	INC	23,676
			TOTAL	$ 70,397

LC Supplies				$ 60,000
Learning Center Staff				
Civilian				
GS-5	1	12368	10%	$ 13,604
GS-3	1	9846	10%	10,830
GS-2	2	8902	10%	19,584
GS-4	1	11054	10%	12,159
Military				
YN 2	1	15347	INC	15,347
AZ 3	1	14971	INC	14,971
AA (AZ)	3	13878	INC	41,634
			TOTAL	$128,131

Total Noninstructor Learning Center Costs Per Year

MILCON and Equipment Per Year	$ 60,000
Graphics Personnel	127,376
Duplication Personnel	70,397
Supplies	60,000
LC Staff	128,131
TOTAL	$326,024

$$\frac{\text{Total LC noninstructor cost}}{\text{Total Number of Students}} = \text{Total noninstructor cost per student}$$

$$\frac{\$326024}{780} = \$418$$

Instructor Costs

The learning center instructor personnel costs are shown in table 10. Since both FASO and VP-31 at differing times provide instructors to the LC depending on student progress in the MCS, it was assumed that a full time instructor man-year equivalent was required in the LC for each track. The assumed instructor rank/rate is also shown. Koehler (15, 16) again are the billet cost references.

Learning Center Cost Summary

Table 11 shows the total cost of the LC for each crew position accounting for both noninstructor (NI) and instructor costs per student.

TABLE 10

LEARNING CENTER INSTRUCTOR PERSONNEL COSTS

Crew Position	Instructor Rank/Rate	Instructor Cost Per Year	Students Per Year	Cost Per Student
Pilot	LT	$75,347	180	$419
NFO	LT	29,189	120	243
FE	E-6	28,034	140	200
SS 1/2	E-6	23,138	120	193
SS 3	E-5	18,662	60	311
Comm	E-5	23,622	120	197
ORD	E-5	18,602	40	465
		Total	780	

TABLE 11

TOTAL LEARNING CENTER COSTS PER STUDENT
AVERAGED OVER ALL STUDENTS, ALL TRACKS

Crew Position	Noninstructor	Instructor Cost	Total
Pilot	$418	$419	$837
NFO	418	243	661
FE	418	200	618
SS 1/2	418	193	611
SS 3	418	311	729
Radio	418	197	615
ORD	418	465	883

NOTE:

Costs per hour can be found by dividing the total LC cost by the number of hours in the MCS, i.e., for pilot LC hours total 248; cost $837, therefore cost is $3.38 per hour.

Training Device Costs

Training device costs have two major components, acquisition costs and operating costs. Allbee and Semple (5) discuss in their model an elaborate means for estimating these costs in an Air Force setting. Orlansky and String (3) take a somewhat simpler view of arriving at the same costs. Browning, et. al., (6) estimates the cost for only the training devices required for pilot training. This model, then, is an elaboration of the Orlansky and String model.

Training Device Acquisition Costs. Table 12 shows the training device acquisition costs. The unit prices were obtained from the Chief of Naval Education and Training (CNET), directory of Naval Training Devices (21). The unit price was amortized over 15 years to calculate the price per year. Fifteen years of service life for a device is assumed. It should be noted, however, that the unit price reflected in the CNET report is probably low in that it does not reflect costs from trainer engineering changes and costs from changes or modifications to the P-3. The operating hours were reported by FASOTRAGRUPAC to the NALCOMIS reporting system. The yearly operating hours authorized were then divided into the acquisition cost per year in order to calculate the acquisition cost per hour.

TABLE 12

TRAINING DEVICE ACQUISITION COSTS
AT NAS MOFFETT FIELD, CA

Trainer	Unit Price	Price Per Year If Amortized 15 Years	FASO Operating Hours	Acquisition Cost Per Hour Per Year
2F87 (F)*	$4,278,760	$285,250	8756	$65.16
2F87 (T)*	4,646,882	309,792	8023	77.22
14B40	2,081,970	138,798	1512	91.80
14B44	2,764,113	184,274	2526	72.95
2C45A	1,232,740	82,183	1423	57.75
2F69E	4,270,000	284,667	3139	90.69

*Two devices at Moffett.

NOTE: Certain obsolete devices were deleted from this table due to insufficient data being available, e.g., 15 Z 1.

TABLE 13

FASOTRAGRUPAC REPORTED OPERATING COSTS

Trainers	FY79 Costs	Authorized Operating Hours	Operating Costs Per Hour
2F87 (F)	$326,083	8,756	$ 37
2F87 (T)	277,608	8,023	35
14B40	89,607	1,512	60
14B44	98,323	2,526	39
2C45A	57,078	1,423	40
2F69E	321,311	3,139	102

Operating Costs

Table 13 depicts the FASOTRAGRUPAC FY 1979 reported operating costs per device (19).

Training Device Cost Summary

Table 14 shows a summary of the annual operating and acquisition costs per device per year from tables 12 and 13.

Although the annual cost per device represents a significant cost in this model, the cost per student hour must be considered. An assumption is made that there is no slack variable, that is, when a student seat is available for assignment it will be filled. If this assumption is used, then the cost per seat in the model can be found by adding the acquisition cost per hour (table 12) and operating cost per hour (table 13) to obtain this total cost per hour per seat. Then, the number of seats per device are divided into the cost per hour to obtain cost per student hour per seat (table 15). If a seat is available for scheduling but not used, it creates a negative cost to the model, adding to the real cost. The actual student usage might only be 80 percent of the authorized operating hours. If this is so, it raises the true cost of a student hour. In order to make this model as workable as possible, the simplifying assumption is made to ignore this factor.

TABLE 14

TOTAL TRAINING DEVICE OPERATING AND ACQUISITION COST PER YEAR PER DEVICE

# Trainer	Yearly Amortized Acquisition Cost	FY 79 Operation & Maintenance Cost	Yearly Costs
(2)2F87 (F)	$570,500	$326,083	$896,583
(2)2F87 (T)	619,584	277,608	897,192
(1)14B40	138,798	89,607	228,405
(1)14B44	184,274	98,323	282,597
(1)2C45A	82,183	57,018	139,261
(1)2F69E	284,667	321,311	605,978

TABLE 15

TRAINING DEVICE
COST PER STUDENT SEAT HOUR

Trainer	Acquisition Cost Per Hour	Operating Cost Per Hour	Total Cost Per Hour	Total Number Student Seats	Cost Per Student Hour
2F87F	$65	$ 37	$102	3	$34
2F87T	77	35	112	5	22
14B40	92	60	152	3	51
14B44	73	39	112	6	19
2C45A	58	40	98	3	33
2F69E	81	102	200	8	25

Instructor cost for each instructional medium, table 16, was obtained by using the billet costs from Koehler (15) for enlisted billet costs and Koehler (16) for the officer billet costs. The rate/rank of the instructors are shown in the assumptions. The proportional cost of each instructor to each medium was taken from table 3. The following assumptions were used in the development of table 16.

1. Pilot instructor is an O-3
2. NFO instructor is an O-3
3. FE instructor is an E-6 AD
4. SS 1/2 instructor is an E-6 AW
5. SS 3 instructor is an E-5 AW
6. COMM instructor is an E-5 AT
7. ORD instructor is an E-5 AO
8. 2,000 hours per instructor man year

Aircraft Flight/Lab Costs

The cost per hour for the P-3C aircraft was determined from the NALCOMIS report (13). First, the total annual flying hours for the P-3C aircraft for 1979 was determined to be 104,863. Then the total aircraft support cost, less petroleum oil and lubricants (POL) and training support was obtained. This cost is $155,257,000. Annual flight hours were divided into aircraft support costs, resulting in a figure for cost per hour without POL, which equates to the cost of a lab aircraft, of $1,480 per hour. The COMNAVAIRPAC (22) reported cost per flight hour for POL is $951. The cost per flight hour is therefore $2431. As indicated before in the assumptions, aircraft depreciation has not been factored into the costs.

TABLE 16

INSTRUCTOR COST PER HOUR FOR INSTRUCTIONAL MEDIA (in $)

	OFT/PT	WST/Aircraft Lab	P-3 Flight
1. Pilot	18	18	37
2. NFO	15	15	15
3. FE	7	7	7
4. SS 1/2	3	6	6
5. SS 3	5	9	5
6. COMM	--	--	6
7. ORD	--	3	5

As described earlier, the pilot and flight engineer accrue half of the aircraft cost per hour during Phase B of the MCS, since they are the only two crew student positions who log flight hours during that Phase. During Phases C and D, seven crew student positions are filled. For each flight hour, the cost is distributed across all crew positions.

RESULTS

Cost Summaries for P-3 Training Curriculum

Table 17 displays the cost per hour for each instructional medium for each crew position. The cost for each training device hour was obtained by adding the training device cost per student hour (found in table 15) to the VP-31 instructor cost per hour, for training devices, aircraft lab and aircraft hours (from Table 16).

Table 18 shows the total cost for each crew position. The ISD costs were obtained from table 8 and the learning center (LC) costs from table 11.

The cost for each medium was calculated by multiplying the costs per hour (table 17) by the number of hours each student utilized a media displayed in the master course syllabus (table 2).

Billet costs were determined by that proportion their scheduled MCS training time is of a man-year. An average student rank/rate was used. For example, a first tour pilot is probably a ENS, he takes 100 working days to complete the syllabus. This is about 42 percent of a man-year. Koehler was referenced for annual billet costs (15, 16).

The costs to train a typical P-3 crew have been summarized from Table 18 and are displayed as Table 19.

TABLE 17

COST PER HOUR PER MEDIUM PER CREW POSITION
(in $)

	2C-45/ 2F69	2F87F	14B44	2F87T	P-3 MCS Phase B	P-3 Phase C,D
Pilot						
1st Tour (B or C)	51	52	37	40	1252	384
2nd Tour (B or C)	51	52	--	40	1252	384

	2C-45/ 2F69	2F87F	2F87T	Static A/C	P-3	
FE (B or C)	40	41	29	UNK*	1222	354

	A/C LAB	2F69	2F87T	P-3
NFO B (1st Tour)	755	40	--	362
C (1st Tour)	755	--	37	362

	14B44	2F69	2F87T	A/C LAB	P-3
SS 1/2 B	22	31	--	746	353
C	22	--	28	746	353

	14B40	2F69	2F87T	A/C LAB	P-3
SS 3 B	--	34	--	749	353
C	56	--	31	749	353

	A/C LAB	P-3
ORD B	496	352
C	496	352

	A/C LAB	P-3
COM, B	745	352

NOTE:
* Static A/C are assumed to have no cost since they do not have power and can be any A/C not in use on the flight line.

TABLE 18

COST PER CREW POSITION
(in $)

CREW POSITION							
Pilot	ISD	LC	2C45/ 2F69	2F87F	14B44	2F87T	P-3
1st Tour (ENS)	653	837	1122	1456	111	1280	51980
2nd Tour (LCDR)	653	837	459	1560	NA	1280	32254

	Billet Costs	TOTAL
	14,389	$71,828
	29,215	$66,257

TABLE 18 (Continued)

COST PER CREW POSITION
(in $)

FE	ISD	LC	2C45/ 2F69	2F87F	P-3
(AD-3)	355	618	320	1476	71536

Billet Costs	TOTAL
6,511	$80,816

	ISD	LC	A/C LAB	2F69	2F87	P-3
NFO B (ENS)	866	661	15855	2760	--	25340
C (ENS)	866	661	20385	--	2738	19548

Billet Costs	TOTAL
11,375	$56,857
11,375	$54,573

	ISD	LC	14B44	2F69	2F87T	A/C LAB
SS 1/2 B (AW-3)	603	611	1254	952	--	14920
C (AW-3)	603	611	1188	--	896	26110

P-3	Billet Costs	TOTAL
12708	6411	$37,499
10590	6411	$46,409

	ISD	LC	14B40	2F69	2F87T
SS 3 B (AW-3)	753	729	--	1088	--
C (AW-3)	753	729	2016	--	992

15Z1/15E16	A/C LAB	P-3	Billet Costs	TOTAL
2016 *	19474	24710	4856	53626
--	18725	24710	4856	52781

* (Device 15Z1 is obsolescent, costs are not identified in COG-20 index, device 14B40 costs were therefore assumed.)

	ISD	LC	A/C LAB	P-3	Billet Costs	TOTAL
ORD B (AO-3)	188	883	18848	8448	2063	30430
C (AO-3)	188	883	14800	8448	2063	26382

(A/C LAB for B assumes 2 students per class, C four students per class.)

	ISD	LC	A/C LAB	P-3	Billet Costs	TOTAL
COM B (AT-3)	1017	615	37995	10560	8238	58425

(A/C LAB assumes two students.)

TABLE 19

FRS TRAINING COSTS FOR A P-3C CREW

Pilot	2nd Tour	$ 66,257
	1st Tour	71,828
Flight Engineer		80,816
Naval Flight Officer	2 @ 54,573	109,146
Sensor Stations, 1 & 2	2 @ 46,409	92,818
Sensor Station, 3		52,781
Ordinance Man		26,382
	Total	$500,028

DISCUSSION

A summary of the percentages that the various components, ISD, learning center, training devices, aircraft, and student billet costs represent along with their approximate costs are depicted below. Table 19, which arrays the data, has been compiled from approximate costs to train a P-3C crew, about $500,000. Table 18 arrays the cost for each component by crew position.

Component	$ Cost	Percentage of Cost
ISD	5,540	1.1
LC	6,448	1.2
Training Devices	21,716	4.3
P-3C Total	375,719	75
(Lab Only)	(126,515)	(25)
(Flight)	(249,204)	(50)
Billet Cost	92,606	18.5
Approx.	$500,000	

The cost for ISD-related activities when considered in the total costs to train a P-3C crew is, when viewed in the total P-3 program, minor. Even though their possible impact on overall costs are significant. This is, in part, a reflection of spreading the ISD costs across the probable life cycle of the weapons system. The learning center costs are also minor when viewed in the total crew training costs, about 1.2 percent. Training devices also only represent 4.3 percent of the total training costs, this was a surprising finding in view of their initial acquisition costs. The P-3 aircraft costs as related to the crew training costs are the major contributors. The total P-3 costs represent 75 percent of the cost to train a P-3C crew. The flight-hour costs represent 50 percent of the total crew costs and the use of the P-3 aircraft as a lab represents 25 percent.

A model specifically tailored for collection of data in order to support decision making in fleet replacement squadrons seems to be warranted, in that the data to support such a model is existing and can be used, if correctly applied, for decision making. It should also be noted that this report only covers the cost side of a possible cost benefit model. The benefit assumptions also should be considered in a total system model.

The costs for the P-3 when used as an aircraft lab are extremely high and contribute about 25 percent of the cost to train a crew. The cost impact of A/C lab is significant in the NFO, SS 1/2, SS-3, ORD, and CON B crew positions. A cost analysis appears to be warranted in order to support decisions regarding the acquisition of supplemental training devices. (For example, if the P-3 Lab were to be used by the P-3C NFO for harpoon missile training due to a paucity of realism in the training device, application of a cost model might support acquisition of a requisite device.)

The fine tuning of the training support requirements for a major weapons system is a complex process. The costs involved are not clear to Navy planners since they cross budgetary lines of control. A model such as this can assist the planners in a fleet training location to help estimate the relative impact on the total training cost that are reflected by component cost changes.

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