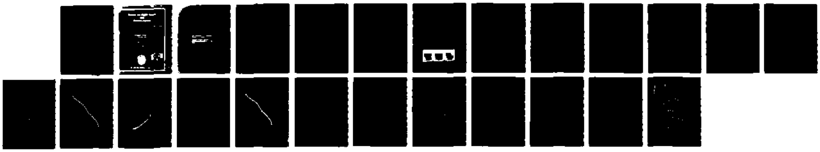
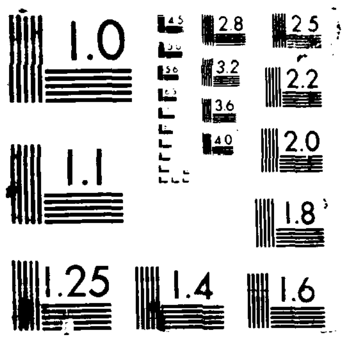
AD-A195 937 COMMON MODULES: A SUCCESS STORY(U) CENTER FOR NIGHT VISION AND ELECTRO-OPTICS FORT BELVOIR VA W B MORROW JUN 88 AMSEL-NV-TR-0068 1/1

UNCLASSIFIED F/G 17/5.1 NL




1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

Center for Night Vision and Electro-Optics

AMSEL-NV-TR-0068

COMMON MODULES
A Success Story

by

Walter B. Morrow, Jr.

June 1988

FORT BELVOIR, VIRGINIA 22060-5677

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	3. DISTRIBUTION/AVAILABILITY OF REPORT Distribution unlimited; approved for public release.
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AMSEL-NV-TR-0068	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Center for Night Vision and Electro-Optics (CNVEO) 6b. OFFICE SYMBOL *(If applicable)* AMSEL-RD-NV-TS	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS *(City, State, and ZIP Code)* Technical Support Division Fort Belvoir, VA 22060-5677	7b. ADDRESS *(City, State, and ZIP Code)*
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
Command Modules — A Success Story (U)

12. PERSONAL AUTHOR(S)
Walter B. Morrow, Jr.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Final	FROM 1971 TO 1986	June 1988	22

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
Thermal Imaging System (TIS); Multi-Purpose Infrared System(MIRS); detector/dewar; Common Module Detector Program

19. ABSTRCT *(Continue on reverse if necessary and identify by block number)*

During the late 1960s and early 1970s, the US military found *far-infrared* or *thermal imaging* systems very useful as night vision devices because of ready application as troop-carried, combat vehicle-mounted, and aircraft-mounted systems. The rapid proliferation of applications posed a serious financial problem, yet clearly solved critical needs. The development and acquisition process for each system's development, purchase, and maintenance was both lengthy and expensive. Therefore, an investigative committee was formed in 1971 within the Center for Night Vision and Electro-Optics to analyze the problems and develop the design concept for Common Modules.

This report focuses on the detector modules and develops cost benefits accrued to date and expected to accrue in the Army's future as a result of common module development and implementation.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT [x] UNCLASSIFIED/UNLIMITED [x] SAME AS REPORT [ ] DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Walter B. Morrow, Jr.	22b. TELEPHONE *(Include Area Code)* 703-664-5694 22c. Office Symbol AMSEL-RD-NV-TS

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

PREFACE

During the late 1960s, *far-infrared* or *thermal imaging systems* were successfully used as Night Vision Devices. Their unlimited uses provided ready application as troop-carried, combat vehicle-mounted and aircraft-mounted systems. Rapid proliferation of such systems solved critical tactical needs, but also posed serious financial problems. The normal development acquisition process with each application's custom-developed, maintained system was lengthy and prohibitively expensive. The Army's Center for Night Vision and Electro-Optics (CNVEO) [formerly the Night Vision Laboratory], began an investigation to determine if the Army's need for thermal systems could be met and simultaneously reduce the expected costs of unique systems development. A working committee was formed in 1971 to analyze the problem and develop the design concept for Common Modules consisting of a core set of modules, mixed and matched to a wide variety of objective optics, eyepieces, TV cameras, and other specialized modules. This report focuses specifically on the detector module and develops the Army's present and projected cost benefits resulting from common module development and implementation. The detector module was chose because, as a major cost driver among the modules, its wide application was well known.

TABLE OF CONTENTS

Figures

Tables

SECTION I. BACKGROUND

To determine if the Army's need for thermal systems could be met with a limited number of common applications, and thus significantly reduce the expected costs of stand-alone or unique system development, CNVEO formed an investigative committee in 1971. The committee determined that the necessary Thermal Imaging System (TIS) possess the following characteristics:

- Lightweight
- Operate in military environments
- Provide differing fields of view
- Take full advantage of the existing state-of-the-art infrared (IR) systems
- Fully tailorable to meet the peculiar requirements of each system application.

The committee proposed a solution using the Multi-Purpose Infrared System (MIRS) which operated in the 8 to 14 micrometer wavelength band of the far-infrared and was then the lightest weight system available. Modification of the MIRS would fully modularize it, and change and standardize the technique by which the central IR sensor element is scanned in order to form the imagery. The common module concept would develop a core set of common modules which could be mixed and matched and married to a wide variety of objective optics modules, eyepieces, TV cameras, and other specialized modules.

The basic modules were the scanner, detector/dewar, IR imager, visual collimator, cryogenic cooler, preamplifier, postamplifier, auxiliary electronics, bias regulator, scan/interlace electronics, and light emitting diode (LED) array. Also included was a set of alternate modules which were smaller versions of the imager, collimator, and detector/dewar to create systems meeting the unique configuration and performance requirements of each application.

This report focuses on the detector modules shown in Figure 1, and develops cost benefits accrued to date and expected to accrue in the Army's future as a result of common module development and implementation. The detector module was chosen because it is historically a major cost driver among the modules; it has a reasonably visible—although complex—history; and has known wide application.

DT-594/UA (180) DT-617/UA (120) DT-591/UA (60)

Figure 1. Detector Modules

The detector, using Mercury Cadmium Telluride (HgCdTe or HCT) as the core sensor material, was characterized by a very difficult manufacturing process involving solid-state crystal growth through a zone refining process last many months. Yields were understandably low and costs understandably high. HCT was chosen as the sensor material on the strength of its intrinsic performance properties, but it remained a most difficult material to effectively produce. The necessity to operate in the 77 to 80°K range produced its own set of problems in interfacing with various cryogenic refrigeration devices.

However, the technical problems were identified, analyzed, and resolved. Today, common module detectors are produced in three basic formats: 60 elements, 120 elements, and 180 elements. Two minor variations on the 60- and 120-element detectors exist and are manufactured by the five companies shown in Table 1. They are used in eleven Army systems, eight Navy systems, and at least one Air Force system as indicated in Table 2. Implementation in five additional Army systems is planned. (**Note:** Only the Army applications are considered in this report.) As of the end of 1985, approximately 28,000 detectors were manufactured or under contract solely for Army applications. An additional 51,000 units are expected to be delivered to Army units by 1992. If Navy and Air Force detector units were included, the total would increase by about 10,000 units.

Table 1. Common Module Detector Producers

COMMON MODULE DETECTOR PRODUCERS					
DETECTOR	TI	SBRC	HONEYWELL	NERC	AEG
DT 591 (60EL)	X	X	X		
DT 591A (60EL)	X	X	X		
DT 594 (180EL)	X	X	X		X
DT 617 (120EL)	X	X	X	X	X
DT 617A (120EL)				X	

Table 2. Systems Using Common Module Detectors

SYSTEMS USING COMMON MODULE DETECTORS		DETECTOR (60) DT-591, DT-591A	DETECTOR (180) DT-594	DETECTOR (120) DT-617, DT-617A
AN/TAS-4, 4A, 4B (TOW)	ARMY	X		
AN/TAS-5 (DRAGON)	ARMY	X		
AN/TAS-6, -6A (NODLR)	ARMY	X		
C-NIGHT (COBRA)	ARMY			X
BSA (BFVS)	ARMY	X		
AN/VSG-2 (TTS, M-60)	ARMY			X
TIS (M-1)	ARMY			X
TADS (AAH)	ARMY		X	
PNVS (AAH)	ARMY		X	
CHAPPAREL	ARMY		X	
AHIP (ASH)	ARMY			X
OR-89 (S-3)	NAVY *			X
AN/AAR-42 (A-7)	NAVY *		X	
AN/AAS-36 (P-3)	NAVY *			X
AN/AAS-37 (OV-10)	NAVY *			X
AN/AAS-38 (A-1B)	NAVY *			X
AN/AAS-33 (A-6)	NAVY *			
AN/KAS-1 (CWDD)	NAVY *	X		
SEA FIRE	NAVY *			
AN/AAQ-9	AIR FORCE *			X

ONLY ARMY APPLICATIONS WILL BE CONSIDERED IN THIS ANALYSIS

SECTION II. APPROACH

The analysis in this report was developed from the 49 contracts described in Table 3. Nonrecurring costs for this report are defined as including research and development (R&D) costs (as exhibited by various development-type contracts); manufacturing, materials, and technology (MM&T) contract costs; and facilitization contract costs. Some costs are missing because they are lost in system development contracts for which no breakout by module appears to exist. Recurring costs are developed from production procurements when available, but rely primarily on spares procurements and qualification contracts. Beyond this, a fairly simple, predominately graphic approach was taken. All cost data was normalized to FY86 constant base year dollars using DOD deflator guidelines provided by Office of the Director of the Army Budget, Office of the Comptroller of the Army. System schedules (Table 4) have been provided by the US Army Communications-Electronics Command (CECOM), the various Project Management Offices, and other cognizant program and planning offices. Although operations and support maintenance costs have not been considered in the detector analysis at this time, they are briefly considered with regard to the common modules collectively.

Table 3. Basic Data Sources Detector History

BASIC DATA SOURCES DETECTOR HISTORY	
49 CONTRACTS	1972 - 1985
32	— R&D — MM&T — FACILITIZATION — QUALIFICATION
17	— SPARES
CONTRACTORS	— TEXAS INSTRUMENTS — HONEYWELL EOD — SANTA BARBARA RESEARCH CENTER — HUGHES AIRCRAFT COMPANY — NEW ENGLAND RESEARCH CENTER — OPTOELECTRONICS INCORPORATED — SPECTRONICS — AEG TELEFUNKEN

Table 4. Cumulative Detector Schedules

CUMULATIVE DETECTOR SCHEDULES BY SYSTEM APPLICATION (INCLUDES SPARES)														
FY	TAS-4	TAS-6	TAS-5	TADS/ PNVS	TTS M-60	TIS M-1	COBRA CNITE	AHIP	M-1 CITV	M-1 DTV	BFVS	FISTV	CHAP	TOTAL
76					630									630
77				53	(630)									683
78	2	2		(53)	634									691
79	188	8	13	103	712	101								1,125
80	1186	69	331	(103)	1077	440								3,206
81	2179	264	1669	392	1914	1069					100			7,527
82	3240	421	2826	880	3059	1824					800			13,050
83	4453	589	3336	890	4296	2769					1500			17,833
84	5809	678	4477	1007	5576	3729		16			2200			23,492
85	6636	785	4872	1570	6901	4709		60			3000			28,333
86	7210	838	5224	1854	8141	5649		116			3800	200		33,032
87	9472	1089	6899	2134	10192	6589	120	176		720	5706	461	2	42,960
88	11306	1293	8257	2302	12246	8436	360	270	720	1440	6691	760	226	54,307
89	13683	1557	10017	2566	13578	10519	880	582	1440	2160	8406	1175	375	66,888
90	14904	1693	10922	2578	14910	12471	993	910	2160	2819	9811	1343	637	76,151
91	15123	1717	11084	(2578)	15700	13425	(993)	1129	(2160)	(2819)	10497	1437	693	79,355
92	(15123)	(1717)	(11084)	(2578)	(15700)	13455	(993)	(1129)	(2160)	(2819)	(10497)	(1437)	(693)	79,385
RATE	1080/YR	123/YR	853/YR	184/YR	983/YR	961/YR	248/YR	141/YR	720/YR	704/YR	954/YR	240/YR	139/YR	8,200/YR*

CUMULATIVE SCHEDULE
( ) = 0 FOR THE YEAR

*4 PRODUCERS ARE ASSUMED TO BE PRODUCING AT A RATE OF 2050 PER YEAR

SECTION III. ANALYSIS OF CURRENT COMMON MODULE BASELINE

The unit cost data shown in Table 5 was used to develop the unit cost curve of Figure 2. This was done by normalizing all costs to FY86 constant dollars, then taking the weighted average cost of the units procured (Table 4) for each year, and finally, weighing the data using the values in the Cumulative Quantity Built columns. The "qualifications" units were essentially treated as "first unit costs," as they represented a first effort by the manufacturer. These values were applied in 1975 for comparison purposes.

The cumulative investment curve of Figure 2 was developed by simply accumulating the costs for R&D, MM&T, and facilitization contracts. The steep slopes exhibited in the 1976 and 1980-1982 data represent major infusions of MM&T and facilitization money into the industry. The complete curves in Figure 2 form a basic set from which the remaining analysis was developed.

Figure 3 represents the cumulative recurring costs as estimated for the 79,385 detector units shown in the total column of Table 4. This curve was computed using the unit cost curve of Figure 2 such that:

$$\sum_{i=1}^{16} U_i Q_i = \text{Cumulative Recurring Cost:}$$

where it is indexed over the years 1977-1992, and Q_i is the actual quantity procured in the year i. Practically, Q_i is the cumulative quantity in the year i minus the cumulative quantity in the year i-1.

The combination of the nonrecurring investment curve of Figure 2 with the recurring cost curve of Figure 3 results in the total program cost for common module detectors as shown by the common module curve of Figure 4. The calculated data was smoothed by application of a three-point rolling average in order to clarify the trend exhibited by the data. This curve was the baseline cost for the analysis.

Table 5. Detector Unit Cost Data

DETECTOR TYPE					CUMULATIVE QTY BUILT		
YEAR	60 EL	120 EL	180 EL	UNKNOWN	60	120	180
1974				@ 41,928			
1975			2 @ 47,498**				
1976						630	
1977	1 @ 45,139		53 @ 31,127 2 @ 47,655**			630	53
1978					4	634	53
1979			50 @ 25,000		209	813	103
1980		110 @ 21,591			1586	1519	103
1981	220 @ 6,600	100 @ 21,500 125 @ 19,500 96 @ 12,636* 2 @ 49,742	288 @ 15,000		4152	2983	392
1982	5000 @ 3,300	400 @ 15,000	2 @ 63,033**		7287	4883	880
1983					9878	7065	890
198[illegible]	556 @ 3,649	91 @ 10,950 113 @ 10,538 127 @ 14,900	127 @ 14,500		13164	9321	1007
1985	1742 @ 3,374 700 @ 4,279 500 @ 5,300	400 @ 7,985 150 @ 11,300 680 @ 8,249	446 @ [9,000] 224 @ 6,990		15293	11470	1570

* 180 EL DOWNGRADED TO 120

[ ] DETECTOR COOLER ASS'Y @ 11,456

** QUALIFICATION UNITS

SOURCE OF DATA: REFERENCED CONTRACTS

FROM TABLE 4

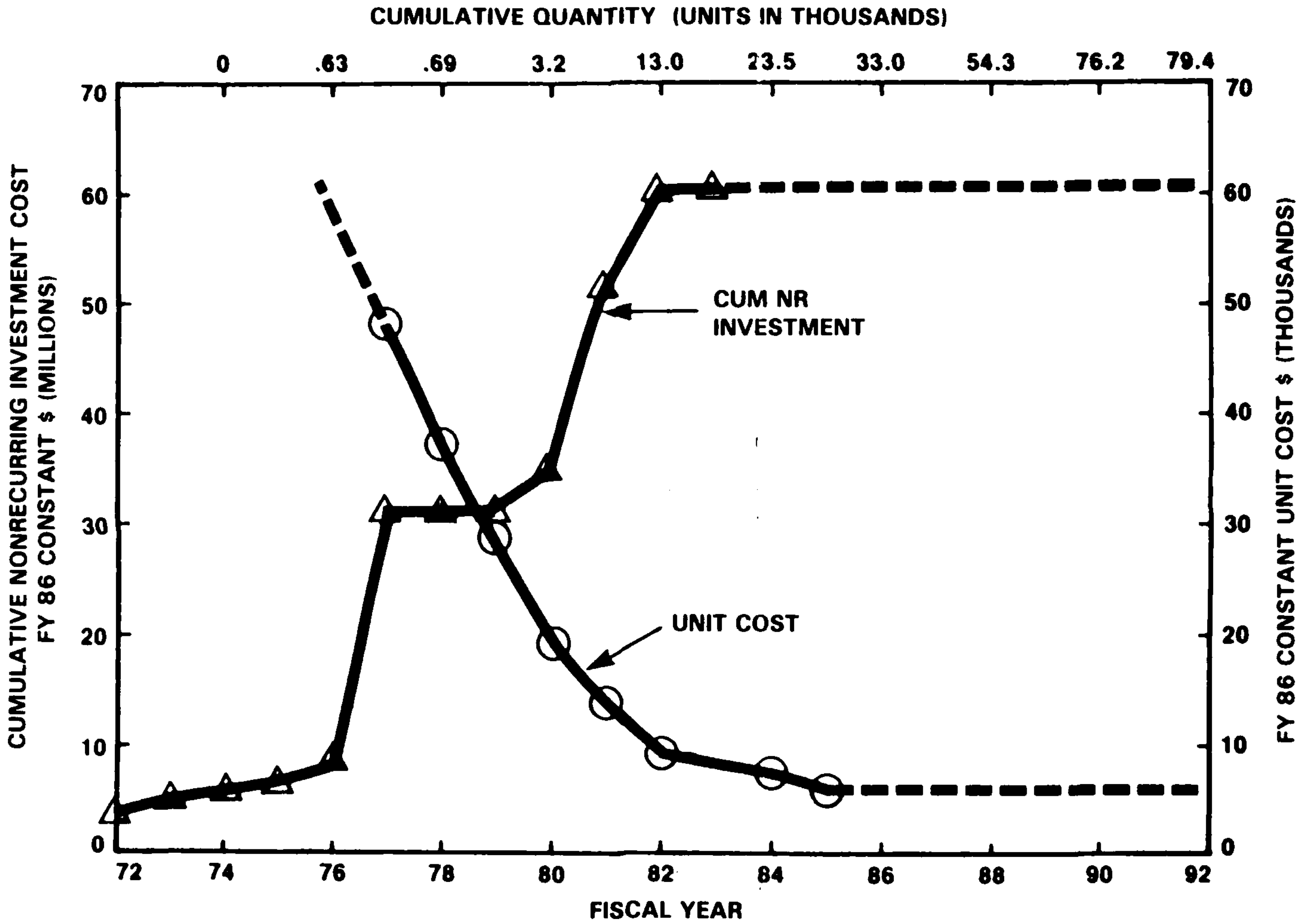


Figure 2. Cumulative Nonrecurring Investment Cost, Unit Cost (Historical)

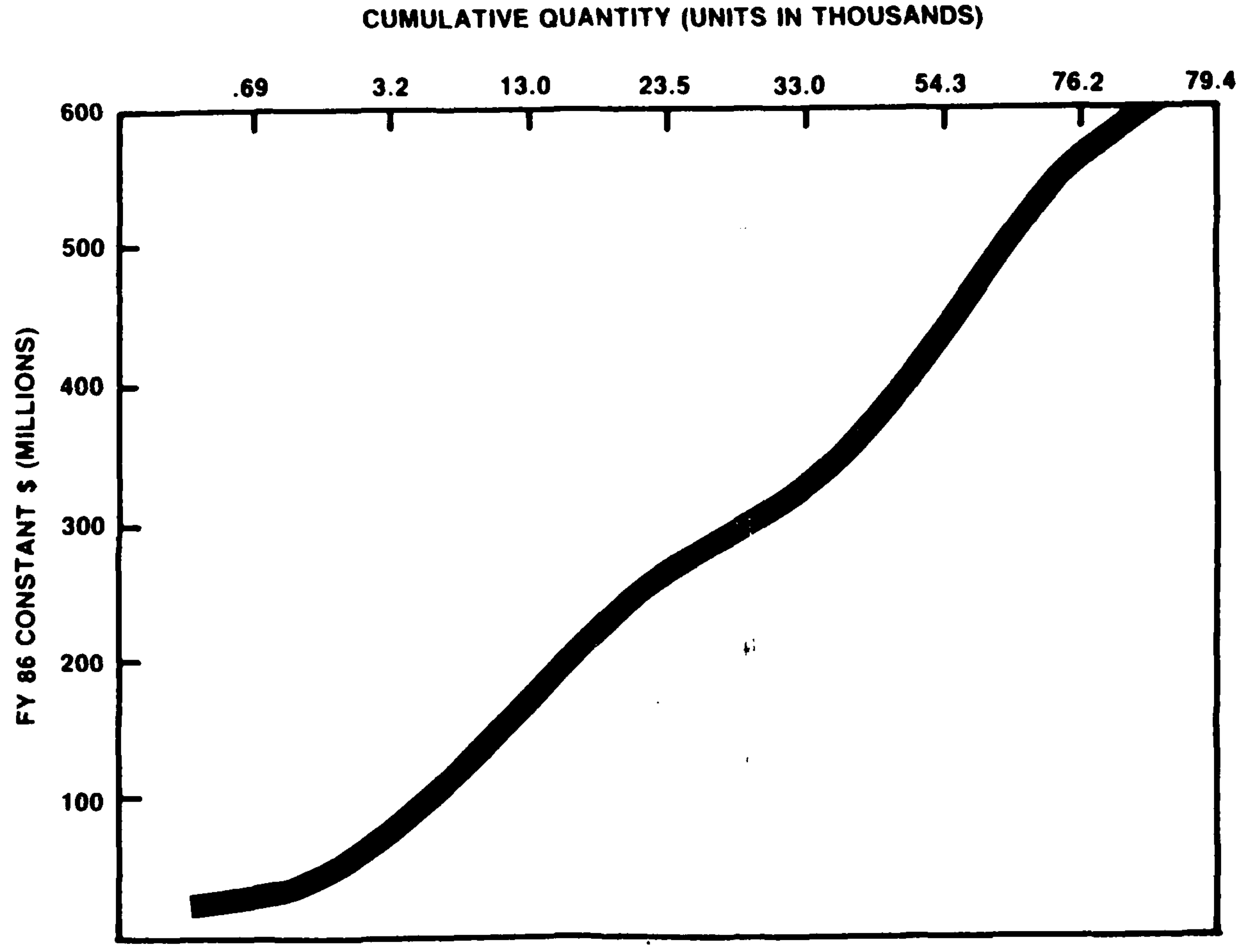


Figure 3. Estimated Cumulative Recurring Cost

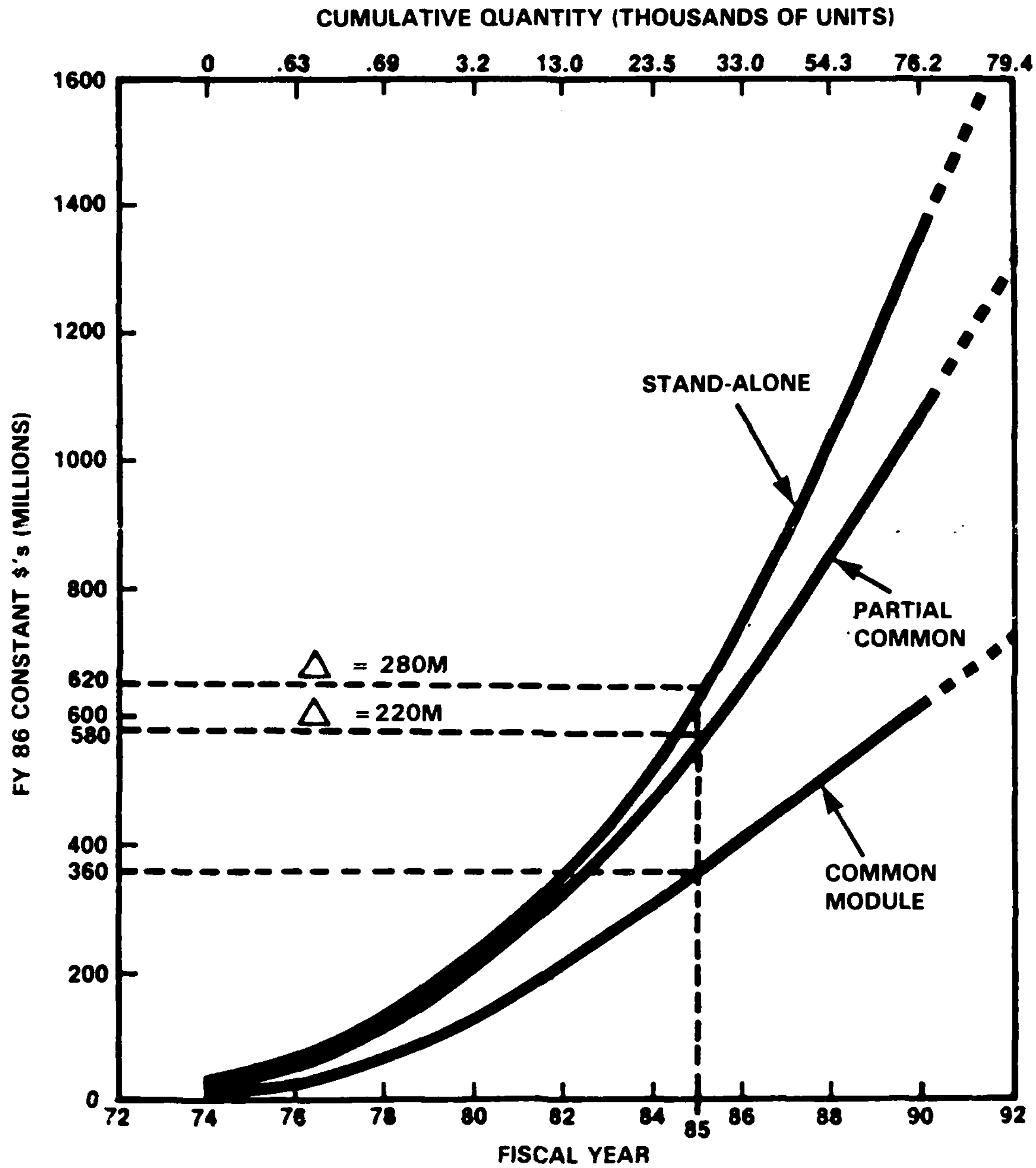


Figure 4. Stand-Alone vs. Common Module Detector Cumulative Program Cost

SECTION IV. THE NON-COMMON ALTERNATIVE

It is virtually impossible to know what would have happened had the Army never had a Common Module Detector Program. We cannot know if our answer is "right" or "wrong"; however, we can make some hypotheses and then consider the consequences. We might assume, for instance, that all technology problems associated with HCT would have remained, and their solutions would have been achieved only with an effort equivalent to that applied in the Common Module Detector Program.

The Common Module Detector Program provided a central focus across an industry, with a consequent synergism not evident in "go-it-alone" programs. With the Army's Project Management System, which tends to make program managers look inward to their own programs, it is not clear that solutions across the industry would be as readily shared or achieved. The large production base promoted by common modules might also be lacking. Therefore, it is not unreasonable to assume that each system covered in this analysis might have been developed as a stand-alone system. The analysis proceeds on this basis without regard to any affordability issues.

For the remaining analysis, the cumulative recurring cost for each system application (for example, AN/TAS-4, AHIP, CITV) can be scaled from Figure 3. This is illustrated using Figure 5 and the M-60 Thermal Tank Sight (TTS), for an example. As a stand-alone system, a cumulative quantity of 15,700 is required (Table 4). The curve as shown in Figure 5 is bounded at 15,700. The ending year is set equivalent to 15,700 as 1991, and the beginning year as 1976. The nonrecurring cost is scaled simply by using a relative rate factor. From Table 4, the rate row gives the average annual production rate for each system. For TTS, the rate is 983 units per year. The total rate is 8,200 per year, but assuming four equal producers, none will produce more than an annual average of 2,050. Next, using the total nonrecurring cost for the Common Module Program and adjusting for production rates, we calculated the following for TTS:

$$60.5 \text{ X } \frac{983}{2{,}050} = \$29 \text{ million in nonrecurring (NR) cost}$$

The total recurring (R) cost (Figure 5) is $215 million; therefore,

$$\begin{aligned} R &= \$\ 215M \\ \underline{NR} &= \underline{\quad 29M} \\ \text{Total} &= \$244M \end{aligned}$$

The NR is spread in direct proportion to the Common Module Detector Program in accordance with the relation:

$$NR\ (NC)i = \frac{NR\ (NC)TOT}{NR\ (C)_{TOT}} \text{ X } NR\ (C)i$$

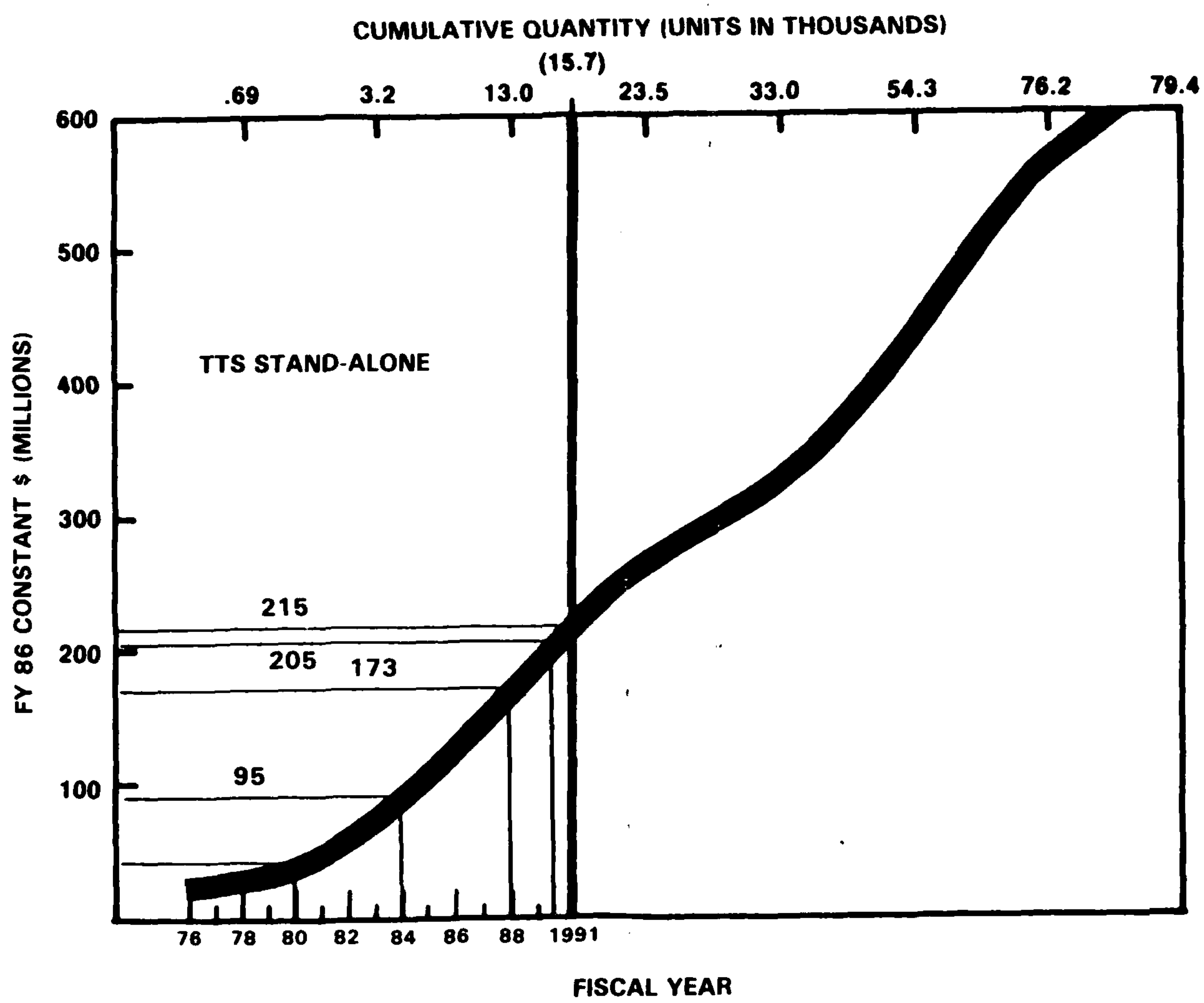


Figure 5. Estimated Cumulative Recurring Cost

This whole process is repeated and summed by year for each stand-alone system, resulting in the stand-alone curve of Figure 4. The non-recurring cost spread result is shown in Table 6.

This process results in an estimated savings to the Army of $280 million by the end of 1985 in the detector program alone, and a projected savings or cost avoidance of $902 million by 1992.

On the premise that complete stand-alone development represents a worst-case scenario, it was alternatively assumed that with a limited number of producers in the field, internal commonality peculiar to each might develop as a normal process in the prudent conduct of business. In this case, the analysis is repeated as in the stand-alone case, except commonality is assumed for certain groups of systems.

This approach is admittedly based on who is building which systems now. Thus, the following systems were grouped and schedules combined for commonality:

Group 1. AN/TAS-4, AN/TAS-5, AN/TAS-6

Group 2. M-1 TIS, CITV, COBRA CNITE

Group 3. BFVS, FISTV, DTV

The remaining systems—TTS (M-60), CHAPPAREL, and TAD/PNVS—were assumed to remain stand-alone. This analysis produces the partial common curve of Figure 4. Compared to this case, the Common Module Detector Program would still indicate a savings of $220 million by the end of 1985, and $535 million by 1992. These results are shown in Figure 6 and summarized in Table 7.

Table 6. Nonrecurring Cost Spread Function

FY	TAS-4	TAS-6	TAS-5	TADS PNVS	TTS	TIS	COBRA CNITE	AHIP	DTV	BFVS	FISTV	ITV	CHAP	CITV	PART COMMON				FY
															TAS-4 TAS-5 TAS-6	TIS CITV CNITE	BFV FISTU DTV		
72	2.4	0.4			2.2										4.6			4.6	72
73	2.9	0.4	2.0		2.3	2.2									5.5	2.7		5.8	73
74	3.2	0.4	2.3		2.8	2.7									5.7	3.3		5.9	74
75	3.7	0.43	2.4		3.4	2.8				2.2					6.8	3.4	3.0	7.0	75
76	4.5	0.5	2.9		4.2	3.4				2.6					8.4	4.0	3.7	8.8	76
77	16.6	2.0	3.7	0.4	15.2	4.2				2.8					30.7	5.0	4.6	31.6	77
78	16.6	2.0	13.4	0.6	15.2	15.2				4.0					30.7		5.6	31.6	78
79	16.7	2.0	13.4	0.7	15.4	15.2		0.4		14.8					30.8	20.3	20.7	31.7	79
80	18.0	2.1	13.4	2.6	16.6	15.4		0.5		16.0					33.5		22.6	34.4	80
81	27.3	3.2	14.6	2.8	25.1	16.6	0.6	0.6		29.2					50.1	34.9	33.9	51.6	81
82	31.7	3.7	22.0	4.2	25.2	25.1	0.8	2.2		28.0		1.2			58.7	35.0	39.5	60.3	82
83	31.8	3.7	25.5	4.4	29.3	25.2	1.1	2.3	2.0	28.2	0.5	2.6	0.4	2.0	58.9		39.6	60.5	83
84			26.6	4.9		29.3	3.8	3.5	2.4		1.0	7.0	0.4	3.0					84
85							4.2	4.2	2.9		3.7	7.6	0.6	11.1					85
86							6.2		16.8		4.0	11.5	2.2	12.1					86
87							7.3		17.8		6.1	13.4	3.5	18.2					
88									20.7		7.1		4.2	21.2					88
89																			89
90																			90
91																			91
92																			92
TOTAL	31.8	3.7	25.6	4.9	29.3	29.3	7.3	4.2	20.7	28.2	7.1	13.4	4.2	21.2	58.9	35.0	39.6	60.5	

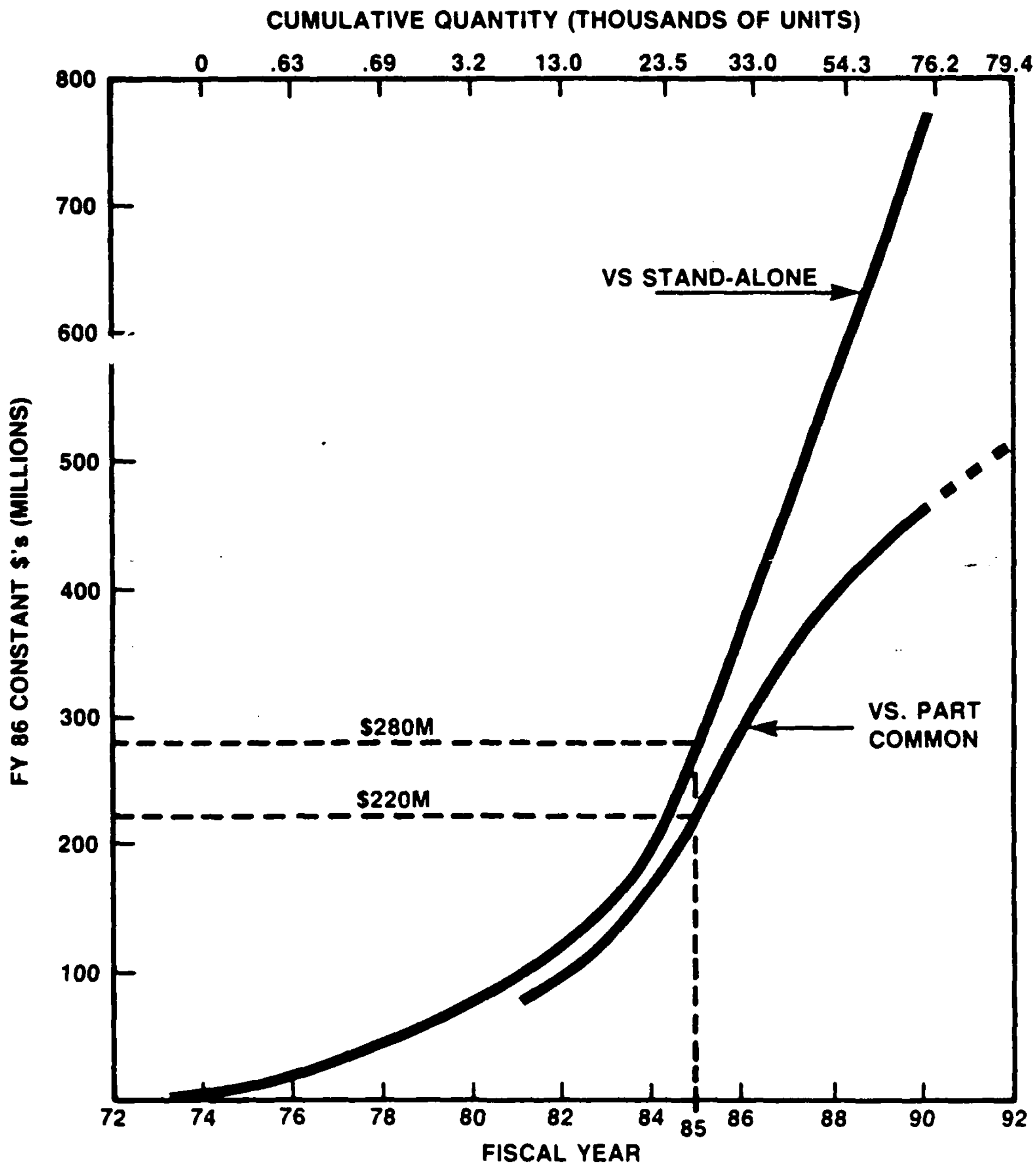


Figure 6. Cumulative Program Savings Estimate

Table 7. Results Data Summary

FY 86 CONSTANT DOLLARS [DETECTOR PROGRAM]					
CASE	NONREC. INVESTMENT ($ MILLIONS)	AVG. PROG. UNIT COST ($ THOUS)	AVG. UNIT RECUR. COST ($ THOUS)	1992 ESTIMATED TOTAL COST ($ MILLIONS)	COST DIFFERENTIAL OR SAVINGS ($ MILLIONS)
COMMON MOD	60.5	8.5	7.7	VS 675	-0-
PARTIAL COMMON MOD	133.5	15.2	13.3	1210	+535
STAND-ALONE	230.9	19.9	17.3	1577	+902

SECTION V. CONCLUSIONS

By 1985, the Common Module Detector Program produced an estimated cost savings of $220 to $280 million. While a detailed analysis requires completion, one might suggest that as of 1985, the total Common Module Detector Program has shown a recurring and nonrecurring investment of approximately $757 million in FY86 constant dollars. Of this amount, the detector is $\frac{355.7}{757.0} = 0.47$ or 47%.

If, in considering the balance of the Common Module Detector Program, the remaining 17 modules should conservatively produce only 25% to 50% of the savings estimated for the detectors alone, this total savings at the end of 1985 would aggregate between $275 million and $420 million and, by 1992, it would be between $669 million and $1,353 million.

From an affordability viewpoint, the detector results simply mean that, because of the Common Module Detector Program, the Army has been able to buy at least 10,000 more detectors through 1985 than the same budget would have afforded without a comprehensive program. Similarly, by 1992, the Army will have bought and deployed at least 46,000 more units than otherwise could have been afforded (Table 8). Similar results of affordability may be attributed to the Common Module Program as a whole.

The legacy of Common Modules continues refining existing modules by reducing weight and cost, and improving life and performance. A typical example of this expectation is the Integrated Detector/Dewar Cooler Assembly (IDCA) which promises exceptional life cycle cost savings.

Table 8. Conclusions

TOTAL COMMON MODULE PROGRAM ESTIMATED SAVINGS FY 86 CONST $ (MILLIONS)

	PESSIMISTIC	OPTIMISTIC	ADDITIONAL DETECTORS AFFORDED
CUMULATIVE SAVINGS THROUGH 1985	275	420	10,000+
CUMULATIVE SAVINGS THROUGH 1992	669	1353	46,000+

DISTRIBUTION FOR REPORT NO. AMSEL-NV-TR-0068

Director
10 ATTN: AMSEL-RD-NV-TS
1 ATTN: AMSEL-RD-NV-D
Ft. Belvoir, VA 22060-5677

1 Commander
US Army Laboratory Command
ATTN: AMSEL-C
2800 Powder Mill Road
Adelphi, MD 20783-1145

1 Commander
US Army Communications Electronics Command
ATTN: AMSEL-RD-D
Fort Monmouth, NJ 07703-5000

1 Director
US Army Materiel Systems Analysis Activity
ATTN: AMXSY
Aberdeen Proving Ground, MD 21005

1 Program Manager
Advanced Attack Helicopter
US Army Aviation Systems Command
Bldg. 105
4300 Goodfellow Boulevard
St. Louis, MO 63120-1798

1 Project Manager
Hellfire/Ground Laser Designators
US Army Missile Command
Redstone Arsenal, AL 35898-5000

1 Project Manager
Target Acquisition Designation System/ Pilot Night Vision System (TADS/PNVS)
US Army Aviation Systems Command
Bldg. 105
4300 Goodfellow Boulevard
St. Louis, MO 63120-1798

1 Project Manager, Stinger
U.S. Army Missile Command
Redstone Arsenal, AL 35898-5000

1 Project Manager
Night Vision Devices
US Army Center for Night Vision and Electro-Optics
Fort Belvoir, VA 22060-5677

2 Defense Technical Information Center
ATTN: DTIC-FDA
Cameron Station, Bldg 5
Alexandria, VA 22314-6145

1 Director
TRADOC Systems and Analysis Center
ATTN: ATOR
White Sands Missile Range, NM 88002-5502

2 Commander
Belvoir RD&E Center
ATTN: STRBE-BT, Tech Library
Fort Belvoir, VA 22060-5606

1 Project Manager
Abrams Tank System
US Army Tank-Automotive Command
Warren, MI 48397-5000

1 Project Manager
M60 Tanks
US Army Tank-Automotive Command
Warren, MI 48397-5000

1 Program Executive Officer
Close Combat Missiles
ATTN: AMCPEO-CM
US Army Missile Command
Redstone Arsenal, AL 35898-8040

1 Project Manager
Bradley Fighting Vehicle Systems
US Army Tank-Automotive Command
Warren, MI 48397-5000

1 Project Manager, Cobra
US Army Aviation Systems Command
4300 Goodfellow Boulevard
St. Louis, MO 63120-1798

1 Project Manager
US Helicopter Improvement Program
US Army Aviation Systems Command
4300 Goodfellow Boulevard
St. Louis, MO 63120-1798

1 Program Executive Officer
Intelligence and Electronic Warfare
ATTN: AMCPEO-IEW
Vint Hill Farms Station, Bldg. 209
Warrenton, VA 22186-5115

END
DATE
FILMED
9-88
DTIC