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FACILITY REQUIREMENTS OF THE AIR FORCE AVIONICS LABORATORY

by

Robert K. Wood
Della M. Kennelly
Anthony J. Provenzano

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(Revised)

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LOGISTICS MANAGEMENT INSTITUTE
4701 Sangamore Road
Washington, D. C. 20016

PREFACE

The Air Force Avionics Laboratory facilities are scattered in a dozen locations in Area B, Wright-Patterson Air Force Base, Ohio. The Base Master Plan proposes eventually to consolidate the Avionics Laboratory in the south-eastern corner of the base. The major structure in that area is Building 620 which was designed specifically for the Laboratory. It was intended to be built in three increments, the first two of which have been completed and are occupied. The third increment exists in conceptual design only.

To reassess the requirement for the planned third increment of Building 620, the Commander of the Avionics Laboratory contracted with the Logistics Management Institute (LMI) for a two-phase study of the Laboratory's facility needs and alternatives for satisfying those needs. Phase 1 of the study, which this report covers, assesses the adequacy of the Laboratory's current facilities, analyzes the functional relationships among the Laboratory's organizational activities and identifies facility requirements. Phase 2 of the study, if authorized on the basis of the Phase 1 results, is to be performed largely by an architectural-engineering firm under subcontract to LMI. This effort will develop conceptual designs for facility alternatives and prepare a Military Construction Program project book which will be needed by the Avionics Laboratory to support its submission for construction funds.

The first chapter of this report discusses the Avionics Laboratory's existing facility situation in terms of personnel, space allocation and major facility problems. The second chapter introduces and examines alternatives to address the facility problems and future facility requirements of the Avionics Laboratory. The third chapter elaborates upon the preferred alternative of consolidating Avionics Lab activities to the area of Building 620. The fourth

chapter covers the estimated costs associated with consolidating the Lab's activities, including construction cost and relocation expenses. The fifth chapter covers the tangible and intangible benefits of the consolidation alternative and the sixth chapter presents the study conclusion and recommendation.

LMI appreciates the cooperation, suggestions and time willingly provided by the staff of the Avionics Laboratory. We extend particular thanks to Col. Robert F. Lopina, Commander of the Air Force Avionics Laboratory, Mr. Frank L. Nevius, Chief of the Technical Services Division, Mr. Darwin L. Teilhet, Chief of the Technical Support Branch and Mr. Vincent J. Allenson, Leader of the Facilities Group for their deep interest, strong support and helpful guidance.

SUMMARY

There are three major facility problems at the Air Force Avionics Laboratory:

- the Lab has people scattered in 12 buildings, some of which are separated by more than a mile and a half. The Laboratory Commander has direct access to his immediate staff, but four of the five division chiefs, 16 of the 22 branch chiefs and 60 percent of the Laboratory's personnel are in other buildings;

- only about 60 percent of the space designed for laboratory use in Building 620 is being used as laboratory space;

- it is difficult, time-consuming and very expensive to modify the substandard laboratory space in Building 22 for new research.

Four alternatives for alleviating the facilities problems were examined. The first alternative is to take no action other than the moves now planned. The second alternative is to move the Commander, his immediate staff and the one division office from Building 22 to Building 620. The third alternative is to renovate Building 22 as office space and move branches requiring laboratory space out of Building 22 to Building 620. The fourth alternative is to consolidate as many of the Lab's activities as practicable to the area of Building 620.

Only the consolidation alternative would successfully address the three major facility problems facing the Lab. The consolidation alternative would:

- reduce the number of facilities in which the Lab has personnel from 12 to 8, including a new facility in the area of Building 620. Over 90 percent of the avionics lab personnel would be collocated;

- increase the utilization of laboratory space in Building 620 by 10.7 percent by locating there only branches directly involved in laboratory work; and

- eliminate the substandard laboratory facilities in Building 22 by vacating the building and moving the branches using laboratory space to Building 620.

The other major benefits of consolidation include:

- the release of 108,300 square feet of net useable space while moving into 98,500 square feet of net useable space for a net reduction of 9,800 square feet;

- higher morale from the collocation of all but three branches, better working conditions for many and the ability to become and stay familiar with other branch and division activities;

- more effective management, with the Lab Commander near 90 percent of the staff, all five division chiefs and 21 of 22 branch chiefs. At the present time, the Commander is near only 40 percent of the Lab personnel, only one division chief and 6 branch chiefs;

- increased communication and professional interaction leading to more cooperative and integrated efforts within and between branches and division, increased productivity and increased mission achievement. If the Avionics Lab experienced a modest productivity increase of two percent, that would translate into a $440,000 annual increase in the Lab's capacity to pursue additional missions with no increase in resources, or $4.00 million over a 25 year period at a 10 percent discount rate;

- tangible cost savings estimated at $290,000 per year in 1979 dollars or $2.66 million over a 25 year period, at a discount rate of 10 percent.

The costs of consolidation in 1979 dollars include:

- construction cost of $7.54 million for a new facility of 98,500 net square feet in the area of Building 620;

- moving costs of $241,000;

- staff downtime following relocation of 14.1 man-years at a cost of $423,000.

- operating and maintenance cost of $410,000 per year, a figure that would be no greater and probably less than that for space vacated in a consolidation;

The total incremental cost of consolidation is estimated to be $8.20 million.

The conclusion of the study can be stated concisely: the mission of the Air Force Avionics Laboratory would be enhanced through the consolidation of as many activities as practicable to the area of Building 620.

The study's recommendation is that the Avionics Lab should proceed with the preparation of conceptual designs for the new facility and the Military Construction Program documents to support the Lab's efforts to obtain construction funds.

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A perspective on the existing facility situation of the Air Force Avionics Laboratory (AFAL) is presented in terms of personnel and space allocation at the Lab, followed by a discussion of major facility problems. The data on personnel and space allocation were used in assessing the impacts of alternative means of addressing the Avionics Laboratory's facility problems and future facility requirements.

EXISTING FACILITY REQUIREMENTS

An examination of the Avionics Laboratory's Five Year Plan indicates that future research activity is expected to be approximately the same as it is today. Consequently, the current number of laboratory employees, their distribution among laboratory activities and the space they now use in performing laboratory, office or other functions are important considerations in determining future facility requirements. This is the existing status of the Avionics Laboratory.

Personnel

The Air Force Avionics Laboratory currently employs 921 government personnel. Of these, 61 percent are scientists and engineers; 11 percent are technicians and 28 percent are administrative and support personnel. In addition, 158 contractor personnel are provided facilities from the Laboratory's resources. Table I-1 shows the distribution of these personnel by building and branch.

Space Allocation

The Air Force Avionics Laboratory presently occupies 331,600 square feet of net floor space. This is made up of 155,500 square feet of laboratory

TABLE I-1. NUMBER OF PERSONNEL - AIR FORCE AVIONICS LABORATORY[1]

(as of mid-January 1979)

BUILDING	ORGANIZATION	GOVERNMENT PERSONNEL	ON-SITE CONTRACTORS
620	AA*	11	0
	AAA	27	0
	AAD	31	8
	AAF	33	6
	AAS	24	28
	AAT	16	0
	DH*	7	0
	DHE	45	6
	DHM	35	2
	RWI**	0	0
	WR*	5	0
	WRA	28	27
	WRD	33	0
	WRP**	23	6
	WRW	45	9
	TS*	3	0
	TSL	24	0
	TSR**	2	0
	TSS**	29	12
	620 Total	421	106
22	CO + Staff	9	0
	DO	50	0
	XP	13	0
	RW*	6	0
	RWA	51	0
	RWI**	34	0
	RWM	57	0
	RWP	21	0
	RWT	42	6
	TSR**	43	4
	TSS**	0	5
	22 Total	326	15
22B	DHO	43	7
450	DHR	23	11
	TSR**	0	0
	TSS**	0	8
	450 Total	23	19
23	RWF	45	10
18F	RWF	2	0
622	RWI**	18	0
4B	WRP**	9	1
821	WRP**	14	0
18	TSR**	2	0
653	TSR**	1	0
45	TSR**	17	0
AFAL Total		921	158

[1]See Appendix A for organization chart of the Avionics Lab.

*Division office. **Branch in more than one building.

[1]The majority of the government manpower figures in the table were taken from the records of the Office of Manpower and Personnel of the Air Force Wright Aeronautical Laboratories. They reflect on-board strengths as of 18 January 1979, and, in most cases, are slightly lower than the corresponding manpower authorizations. Estimates of government manpower were also obtained from each division and branch chief and from group leaders in isolated facilities. These estimates provided information on the distribution of personnel by building. For those branches in more than one building, estimates were substituted for official figures in order to reflect the location of the personnel. In each such case, the estimated and official branch totals are very close. On-site contractor manpower estimates were obtained from division and branch chiefs and were verified by comparison with information provided by the Operations Office (DO) of the Avionics Laboratory.

space, 131,050 square feet of office space, and 45,050 square feet allocated to various other functions such as conference rooms, reception areas, computer terminal rooms, reproduction rooms, mail rooms, storage rooms, shops and so forth.

The estimates of net floor space currently occupied by the Avionics Lab are based on data gathered in interviews with branch personnel and from data provided by the Facilities Group of the Technical Services Division. In some cases functions such as computer terminal rooms, reproduction rooms, and branch conference rooms were categorized as office space; in other cases, they were categorized as other space. The distinction between office and other space is not critical since other space is similar in construction to office space. Where the distinction between office space and other space matters, as in the discussion of some specific future facility requirements, we have been explicit.

The distribution of floor space and personnel by building and division is shown in Table I-2, along with the distance in feet from Building 620 to other Avionics Lab buildings. In addition to the divisions, the table shows data for the Commander and his immediate staff and for "AFAL Other." "AFAL Other" is used to show floor space for conference rooms, canteens, and reception areas, which are not associated with any particular division.

As can be seen from Table I-2, most Avionics Lab activities are centered in Building 620 and two buildings that adjoin one another, Buildings 22 and 22B. The newest and largest facility is Building 620, with net floor space of 138,250 square feet of which all but about 36,000 square feet could be used for laboratory space. Under the present alignment 59,600 square feet are set aside for laboratory work and 63,150 square feet

TABLE I-2. PRESENT DISTRIBUTION OF FLOOR SPACE AND PERSONNEL BY BUILDING AND DIVISION

BUILDING	DISTANCE FROM 620 (FT.)	DIVISION	NET FLOOR SPACE (SQ. FT.)				PERSONNEL	
			LAB	OFFICE	OTHER	TOTAL	GOVT	CNTR
620	--	AA	15,050	21,750	--	36,800	142	44
		DH	14,850	11,400	5,000	31,250	87	8
		RW	--	--	250	250	0	0
		WR	18,000	17,700	500	36,200	134	42
		TS	1,450	11,050	5,150	17,650	58	12
		AFAL OTHER	10,250	1,250	4,600	16,100	0	0
		TOTAL 620	59,600	63,150	15,500	138,250	421	106
22	7000	CO & STAFF	--	7,600	350	7,950	72	0
		RW	5,200	31,900	1,150	38,250	211	6
		TS	--	5,450	15,200	20,650	43	9
		AFAL OTHER	--	--	2,300	2,300	0	0
		TOTAL 22	5,200	44,950	19,000	69,150	326	15
22B	7000	DH	9,000	6,200	2,100	17,300	43	7
		AFAL OTHER	--	--	700	700	0	0
		TOTAL 22B	9,000	6,200	2,800	18,000	43	7
450	6400	DH	15,000	2,500	--	17,500	23	11
		TS	--	--	1,400	1,400	0	8
		TOTAL 450	15,000	2,500	1,400	18,900	23	19
23	8000	RW	14,700	3,500	--	18,200	45	10
18F	8000	RW	--	1,200	--	1,200	2	0
622	1800	RW	7,900	4,800	--	12,700	18	0
4B	4400	WR	26,100	1,600	--	27,700	9	1
821	6800	WR	18,000	2,100	--	20,100	14	0
18	8800	TS	--	400	850	1,250	2	0
653	3200	TS	--	--	500	500	1	0
45	5600	TS	--	650	5,000	5,650	17	0
TOTAL LAB			155,500	131,050	45,050	331,600	921	158

for office space. Of this, 10,250 square feet of lab space and 1,250 square feet of office space are being prepared for the Electronic Research Branch (DHR) which plans to move into Building 620 from Building 450. The remaining 23,300 square feet are used to support various other functions. Allocation of floor space by branch in Building 620 is shown in Table I-3.

TABLE I-3. PRESENT DISTRIBUTION OF FLOOR SPACE BY BRANCH IN BUILDING 620

BRANCH	NET FLOOR SPACE (IN SQ. FT.)			
	LAB	OFFICE	"OTHER"	TOTAL
AA*	--	2,150	--	2,150
AAA	--	3,450	--	3,450
AAD	2,850	3,850	--	6,700
AAF	9,000	3,500	--	12,500
AAS	2,200	6,900	--	9,100
AAT	1,000	1,900	--	2,900
DH*	--	1,150	--	1,150
DHE	12,600	5,950	2,950	21,500
DHM	2,250	4,300	2,050	8,600
RWI	--	--	250	250
WR*	--	1,050	--	1,050
WRA	5,500	5,000	500	11,000
WRD	--	4,200	--	4,200
WRP	3,800	2,850	--	6,650
WRW	8,700	4,600	--	13,300
TS*	--	900	--	900
TSL	--	2,000	3,850	5,850
TSR	--	400	350	750
TSS	1,450+	7,750+	950	10,150
ZONE SHOP	10,250+	1,250+	--	11,500
AFAL OTHER	--	--	4,600	4,600
620 TOTAL	59,600	63,150	15,500	138,250

*Division Office

+Space being prepared for the Electronic Research Branch (DHR) presently in Building 450.

In contrast to Building 620, Buildings 22 and 22B are World War II vintage buildings not originally constructed to house laboratory work. Building 22 is a converted aircraft hanger. It has 69,150 square feet of net floor space. Laboratories occupy 5,200 square feet and offices 44,950 square

feet. Various other functions make use of the remaining area. In addition to housing several branches, Building 22 is occupied by the Avionics Laboratory Commander, his staff, and one of the five division offices. Building 22B, located next to Building 22, was constructed as a gun range and later remodeled. It now provides 9,000 square feet of laboratory space, 6,200 square feet of office space, and 2,800 square feet of other space. A detailed listing of the distribution of floor space by branch in Buidings 22 and 22B is provided in Table I-4.

The Avionics Laboratory has floor space and personnel in nine other buildings. Although none has as much space and personnel as either Building 620 or the Buildings 22 and 22B complex, taken together the nine represent a sizable portion of the Lab's resources. The space allocation for these buildings appears in Table I-5.

MAJOR FACILITY PROBLEMS

There are three major facility problems at the Air Force Avionics Laboratory: scattered facilities, underutilization of laboratory space in Building 620 and substandard facilities for laboratory space in Building 22.

Scattered Facilities

The Avionics Laboratory has people in twelve buildings, some of which are separated by more than a mile and a half, as shown in Table I-2. Only one division, Systems Avionics, has all of its personnel in one building. Other divisions have fifteen to fifty percent of their personnel in a different building than the division command. The Laboratory Commander has direct access to his immediate staff, but four of the five division chiefs, 16 of the 22 branch chiefs and sixty percent of the Laboratory's personnel are in other buildings.

TABLE I-4. PRESENT DISTRIBUTION OF FLOOR SPACE BY BRANCH IN BUILDINGS 22 AND 22B

BUILDING	BRANCH	NET FLOOR SPACE (IN SQ. FT.)			
		LAB	OFFICE	"OTHER"	TOTAL
22	CMD STAFF	--	1,650	150	1,800
	DO	--	3,600	200	3,800
	XP	--	2,350	--	2,350
	RW*	--	2,250	--	2,250
	RWA	3,750	7,400	--	11,150
	RWI	--	4,150	--	4,150
	RWM	1,450	10,000	--	11,450
	RWP	--	1,600	--	1,600
	RWT	--	6,500	1,150	7,650
	TSR	--	5,450	15,100	20,550
	TSS	--	--	100	100
	AFAL OTHER	--	--	2,300	2,300
	22 TOTAL	5,200	44,950	19,000	69,150
22B	DHO	9,000	6,200	2,100	17,300
	AFAL OTHER	--	--	700	700
	22B TOTAL	9,000	6,200	2,800	18,000

*Division Office

TABLE I-5. PRESENT DISTRIBUTION OF FLOOR SPACE BY BRANCH FOR OTHER BUILDINGS

BUILDING	BRANCH	NET FLOOR SPACE (IN SQ. FT.)			
		LAB	OFFICE	"OTHER"	TOTAL
450	DHR	15,000	2,500	--	17,500
	TSR	--	--	1,200	1,200
	TSS	--	--	200	200
	450 TOTAL	15,000	2,500	1,400	18,900
23	RWF	14,700	3,500	--	18,200
18F	RWF	--	1,200	--	1,200
622	RWI	7,900	4,800	--	12,700
4B	WRP	26,100	1,600	--	27,700
821	WRP	18,000	2,100	--	20,100
18	TSR	--	400	850	1,250
653	TSR	--	--	500	500
45	TSR	--	650	5,000	5,650
TOTAL OTHER BLDGS.		81,700	16,750	7,750	106,200

A number of studies have shown that distance between individuals can effect organizational communication, which strongly influences the effectiveness of research and development performance. In one study by Thomas J. Allen and Alan R. Fusfeld of Massachusetts Institute of Technology, the authors say,

> There is strong evidence that effective communication is a determinant of effective performance among scientists and engineers in a research and development laboratory. Though some details of cause and effect are unresolved, our studies show very clearly that communication among research groups is influenced strongly by the physical, architectural arrangement of the facilities in which they work; especially we know that communication between individuals is very sensitive to both the horizontal and vertical distances which separate them.[1]

Allen found, for example,

> ...that if you separate two technical people by 60 or 70 feet, you've suppressed the likelihood of technical communication by two-thirds; separate them by another 70 feet and you've essentially eliminated 90 percent of the possibility of technical communication between them.[2]

Underutilization of Laboratory Space

Approximately 40 percent of the space designed for laboratory use in Building 620 is being used as office space: as shown in Table I-3, only about 60,000 square feet is being used as laboratory space out of an estimated 102,000 square feet of space available for laboratories. What aggravates the problem is that the current cost of construction for laboratory space is twice as high as the cost of office space. Based on conversations with architectural-engineering (A&E) firms and the Technical Services Division of the Avionics Laboratory, the current costs of construction are about $110 per square foot and $55 per square foot, respectively.

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[1]Thomas J. Allen and Alan R. Fusfeld, "Design for Communication in the Research and Development Lab," Technology Review, May 1976, page 71.

[2]Edward B. Roberts, "Generating Effective Corporate Innovation," Technology Review, October/November 1977, page 29.

Substandard Facilities for Laboratory Space

It is difficult, time-consuming, and expensive to modify laboratory space in Building 22 for new research. The best example of this problem is the Global Positioning System Evaluator (GPSE) which could have been set up for about 40 percent less cost if it had been done in Building 620. The additional cost was required for the air conditioning, electrical, fire control and water systems.

II. ALTERNATIVES TO ALLEVIATE FACILITY PROBLEMS

We examined four alternatives for addressing the facilities problems and future requirements of the Air Force Avionics Laboratory. The impact of each alternative on the three major facility problems and its cost impact are summarized in Table II-1.

ALTERNATIVE ONE: DO NOTHING

The first alternative is to take no action other than the incremental moves now planned, such as the Electronic Research Branch's (DHR) moving from Building 450 to Building 620 and the Measurements Group's (WRP-2) consolidating to Building 4B.

The major advantage of the first alternative is its cost since it is the least expensive. It would improve the utilization of laboratory space in Building 620 by moving in a branch with considerable laboratory space. On the other hand, the alternative does little to address the problem of scattered facilities - the Avionics Lab moves a branch out of one building but Lab personnel would remain scattered in eleven facilities. Finally, the alternative does not address the problem of substandard laboratory facilities in Building 22. In summary, the moves should take place as planned, but, in themselves, they do not alleviate the Lab's facility problems.

ALTERNATIVE TWO: MOVE COMMAND STAFF TO BUILDING 620

The second alternative is to move the Commander, his immediate staff and the Reconnaissance and Weapon Delivery Division Office (RW) from Building 22 to Building 620. This move would place the command staff closer to division offices, more Avionics Lab personnel and operations. To permit such a move, parts of three branches requiring only office space - the Avionics Systems Engineering Branch (AAA), the ECM Advanced Development Branch (WRD) and the

Technical Support Branch (TSS) other than the Instruments Group - would have to move out of Building 620 to Building 22.

TABLE II-1. SUMMARY OF ALTERNATIVES

ALTERNATIVES	IMPACT ON FACILITY PROBLEMS			COST
	SCATTERED FACILITIES	UNDERUTILIZATION OF LAB SPACE	SUSTAINED LAB FACILITIES	
1. Do Nothing Other Than Currently Planned Moves	Very Little Improvement	Minor Improvement	No Improvement	Low
2. Move Command Staff to Building 620	Problem Aggravated	No Improvement	No Improvement	Lowest
3. Renovate Building 22	Problem Aggravated	Minor Improvement	Problem Eliminated	Medium
4. Consolidate to Area of Building 620	Major Improvement	Modest Improvement	Problem Eliminated	High

Such an alternative does very little for consolidation and nothing to reduce the number of scattered facilities. In fact, it aggravates the problem by separating divisions that now are unified or nearly unified in Building 620, such as the System Avionics Division (AA) and the Electronic Warfare Division (WR). Furthermore, it does not improve the utilization of laboratory space in Building 620, nor does it solve the problem of substandard laboratory facilities in Building 22. Although the second alternative would be inexpensive, involving only relocation costs and minor costs of rearranging office space, it does not address, let alone solve, the major facility problems of the Avionics Lab.

ALTERNATIVE THREE: RENOVATE BUILDING 22

The third alternative is to renovate Building 22 as office space and move branches requiring laboratory space out of Building 22 to Building 620, thereby increasing the utilization of laboratory space in that building and reducing or eliminating the substandard laboratory facilities in Building 22.

The required moves are summarized in Table II-2. The two branches in Building 22 that require laboratory space, the Reference Systems Branch (RWA) and the Radar Branch (RWM), now occupy 5200 square feet of laboratory space and 17,400 square feet of office space, or a total of 22,600 square feet of space (see Table I-4). To provide space in Building 620 for these two branches, the following organizations would move to Building 22 from Building 620: the four division offices presently in Building 620, two branches with only office space (AAA and WRD) and the portion of TSS other than the Instruments Group. These organizations require only office space, in the amount of 14,000 square feet. Unfortunately, to accommodate RWA and RWM in Building 620, a branch which requires both laboratory and office space would have to move from Building 620 to Building 22. The logical candidate

TABLE II-2. ALTERNATIVE THREE: RENOVATE BUILDING 22 AND MOVE LABORATORY FACILITIES TO BUILDING 620

ORGANIZATIONS REMAINING IN BUILDING 22	ORGANIZATIONS MOVING FROM BLDG. 22 TO BLDG. 620	ORGANIZATIONS MOVING FROM BLDG. 620 TO BLDG. 22
CO and STAFF	RWA	AA*
RW*	RWM	AAA
RWI		DH*
RWP		DHM
RWT		WR*
		WRD
		TS*
		TSS**

*Division Office
**Branch in more than one building

would be the Microwave Technology Branch (DHM) which has relatively few laboratory requirements for specialized electrical utilities. DHM currently requires 2250 square feet of laboratory space and 6350 square feet of office and other space. Taken together, the organizations moving from Building 620 to Building 22 would vacate 22,600 square feet.

Based upon discussions with architectural - engineering firms, renovation costs are estimated to be approximately half the cost of new construction on a square foot basis. To renovate the Building 22, with 2250 square feet of laboratory space (for DHM) and 66,900 square feet of office and other space, would cost approximately $2 million, based on a renovation cost of $55 per square foot for laboratory space and $27.50 per square foot for office and other space.

In summary, the third alternative would increase the utilization of laboratory space in Building 620 by about 3000 square feet or 5 percent. Furthermore, it would reduce the amount of laboratory space in Building 22 by moving out two branches requiring about 5200 square feet of laboratory space and moving in one branch requiring laboratory space of 2250 square feet, and it would eliminate the problem of substandard laboratory space by renovating lab space as well as office space. The major disadvantage of the alternative is that it would aggravate rather than solve the first problem - the lack of consolidation - by forcing the separation of divisions that are now unified or nearly unified in Building 620, such as the System Avionics Division (AA) and the Electronic Warfare Division (WR).

ALTERNATIVE FOUR: CONSOLIDATE TO AREA OF BUILDING 620

The last alternative examined would consolidate as many of the Avionics Lab's activities as practicable to the area of Building 620. Although most expensive, this alternative is preferred since it is the only one that successfully addresses each of the Lab's facility problems. The preferred alternative would:

- reduce the number of facilities
- increase the utilization of laboratory space in Building 620
- remove laboratory facilities from Building 22

This alternative is delineated and discussed in the next chapter.

III. PREFERRED ALTERNATIVE - CONSOLIDATE TO AREA OF BUILDING 620

The preferred alternative which we have chosen to elaborate upon would consolidate as many of the Avionics Laboratory's operations as practicable to the area of Building 620. The alternative would involve construction of a new facility made up primarily of office space. The new facility may be an addition to, attached to, or immediately adjacent to Building 620 or some other architectural concept.

In this chapter, the consolidation potential of each Avionics Laboratory element is assessed, a recommended consolidation proposal is presented, and future space requirements by building and division are presented and discussed.

CONSOLIDATION PROPOSALS

In order to identify the facility requirements of a consolidated Avionics Laboratory, we examined the consolidation potential and type of space required by the individual activities of which the Lab is composed. In particular, we determined which organizations could move to office area in a new facility, which could occupy laboratory space in Building 620, which must occupy laboratory space in a new facility, and which could not be moved from their current location. The data we used in making these determinations were gathered during interviews with Lab personnel.

The first issue addressed was the appropriate organizational level within the Lab at which to analyze consolidation potential and building placement. The consolidation alternative assumes that as much of the Avionics Lab as practicable would be accommodated in a new facility consisting primarily

of office space and in Building 620 which has been designed primarily as laboratory space. Collocation of entire divisions would be ideal because of mission commonality but impractical because of the size of divisions and because each has a mix of laboratory and office operations. Interviews convinced us that the branch is the single most important organizational level for location purposes and wherever possible, branch integrity should be preserved. Branch integrity meant that a branch should not be split between its laboratory and office activities even though such a split would increase the utilization of laboratory space in Building 620. We believe it is much more important to keep the entire branch intact, locating those with laboratory and office activities in Building 620 and locating those with only office activities in the new facility.

The second issue was to decide upon criteria for use in determining the consolidation potential and building placement of each branch. The desirability of maximum consolidation suggested that Laboratory operations should be considered likely consolidation candidates unless:

- their essential facility needs cannot be met in either Building 620 or the proposed new facility
- their operations require the use of equipment that cannot be moved without great expense and/or long downtimes

Once consolidation potential was established, building placement criteria were developed. One major objective was to minimize office space in Building 620 without separating branches. This objective could be expressed in terms of the following criteria:

- any branch that requires laboratory facilities should be located, in its entirety, in Building 620
- any branch whose laboratory facility needs cannot be met in Building 620 should be placed in the new facility
- any branch that could perform its mission in non-laboratory space should be placed in the proposed new facility

The final building placement criterion was command proximity: the Laboratory Commander should be as close as possible to his principal Laboratory managers. We believe it is the Commander's prerogative to locate division offices in the new facility with the Lab Commander. Since the new facility would be an addition to, attached to, or immediately adjacent to Building 620, the division chiefs would be near their branch chiefs and division operations.

Two other factors should be considered in placing Lab components within a building. The first is mission commonality which translates into the collocation of branches within the same division where possible. As previously mentioned, mission commonality also suggests that the integrity of the branch should be preserved and where that is not possible, as in the case of some groups in isolated facilities, the group should be kept together.

Similarity of laboratory equipment should also be considered in locating Lab components within a building. We surveyed users of lasers, electro-optics devices and simulators within the Laboratory to determine the value of ready access to other Lab organizations with analogous equipment, and concluded that mission commonality is a more important determinant of location than equipment similarity.

The criteria discussed above, together with information provided by the interviews, were used in deciding whether to move and where to place each branch, staff organization and division headquarters. Table III-1 summarizes the results of this analysis. To provide further rationale for the location of an organization in laboratory space, Table III-1 also indicates the principal experiment or equipment requiring laboratory facilities.

Of the movement candidates, only two organizations with laboratory space requirements could not be accommodated in Building 620. The Electro-Optics

TABLE III-1. SUMMARY OF CONSOLIDATION PROPOSALS

ORGANIZATION	CURRENT BUILDING(S)	PROPOSED BUILDING(S)	PRINCIPAL EQUIPMENT OR EXPERIMENTS**
Staff			
CO & STAFF	22	New Facility	None
DO	22	New Facility	None
XP	22	New Facility	None
System Avionics Division--AA			
AA*	620	New Facility	None
AAA	620	New Facility	None
AAD	620	620	CSEL/PIE
	110 (Area C)	110	Aircraft Support
AAF	620	620	Computer Facility
AAS	620	620	DAIS
AAT	620	620	Cockpit Simulators
Electronic Technology Division--DH			
DH*	620	New Facility	None
DHE	620	620	VLSIC
DHM	620	New Facility	None
DHO	22B	New Facility	Electro-Optics
DHR	450	620	Gallium-Arsenite
Reconnaissance and Weapon Delivery Division--RW			
RW*	22	New Facility	None
RWA	22	620	Ring Laser Gyro/ MEL/SEL

* Division office

** See Appendix C for abbreviations

TABLE III-1. SUMMARY OF CONSOLIDATION PROPOSALS (Continued)

ORGANIZATION	CURRENT BUILDING(S)	PROPOSED BUILDING(S)	PRINCIPAL EQUIPMENT OR EXPERIMENTS**
RWF	23	23	Dynamic Analyzer
	18F	18F	Equipment Storage
RWI	22	New Facility	None
	620 (tower)	620 (tower)	Line-of-Sight Experiments
	622	622	Collimators
	Trebein	Trebein	Long-range Target Site
RWM	22	620	RSPL
RWP	22	New Facility	None
RWT	22	New Facility	None
Electronic Warfare Division--WR			
WR*	620	New Facility	None
WRA	620	620	DEES/EDE
WRD	620	620	None
WRP	620	620	Electro-Optics
	821	821	Radar Reflectivity
	4B	4B	Foreign Exploitation
WRW	620	620	EWAC
Technical Services Division--TS			
TS*	620	New Facility	None
TSL	620	New Facility	None
	280 (Area C)	280	Storage
TSR	620, 22, 45, 653, 18	New Facility+	None
TSS	620	620	PME
		New Facility	None

* Division office

** See Appendix C for abbreviations

+ Self-help graphics shops, consisting of limited special equipment but no TSR personnel, would remain in Buildings 45, 653, and 18.

Technology Branch (DHO) performs work which must be isolated from vibrations, which means a ground floor location with shock isolation pads is needed. Building 620 cannot meet this need since the basement is completely occupied by utilities. The ground floor of the new facility, however, could be designed to accommodate this branch.

The Microwave Technology Branch (DHM) currently occupies Building 620 laboratory space but needs relatively few special facilities. If organizations with heavier laboratory work were moved to Building 620, there would be insufficient space remaining to accommodate DHM. Therefore we concluded that laboratory facilities could best be utilized by moving DHM to specially modified (i.e., 240 volt, 400 cycles per second power) office area in the new facility.

Placement of the remaining branches with laboratory requirements in Building 620 would result in a small amount of unoccupied space. It is suggested that the ECM Advanced Development Branch (WRD), which has no laboratory needs, stay in Building 620. WRD was chosen because it is already in Building 620 and because its area needs most closely match the amount of unoccupied space.

As shown in Table III-1, only three branches (or parts thereof): RWF, RWI and WRP would remain in isolated facilities. Each of these branches merits further discussion.

The Dynamics and Environmental Evaluation Branch (RWF) is principally involved in the testing and evaluation of aircraft sensors and reconnaissance systems. This mission is accomplished through the use of a number of specially designed devices and facilities. The most outstanding of these is the dynamic analyzer, a unique, extremely large aircraft environment simulator. Due to its size, the analyzer requires anchorage to bedrock, powerful

cooling and vacuum units and provisions for the set-up and movement of large equipment frames. All of these requirements are now being met adequately in Building 23, which appears to have few deficiencies. Movement of the RWF branch would necessitate extensive teardown and reconstruction of the dynamic analyzer resulting in significant movement cost and downtime. Also, some of the analyzer's facility requirements, particularly the need for high bay area and bedrock anchorage, would be difficult or impossible to meet in Building 620. Finally, although RWF is a branch of the Avionics Laboratory, more than half of its work is performed for organizations outside of the Lab. Hence, the benefits of consolidation with the rest of the Laboratory are not so great. These facts indicated that the RWF branch could best be accommodated in its current building.

The Electro-Optics and Reconnaissance Branch (RWI) has facilities in four locations: the tower of Building 620, Trebein, Building 622 and Building 22. The tower of Building 620 is used for experiments requiring line-of-sight to a long distance target. Trebein, located eight kilometers from Building 620, serves as the site for such targets and, must be preserved for its experimental capability. No personnel operate full-time from either the 620 tower or Trebein. Building 622 was built primarily to house an 80 foot vertical collimator, which is no longer utilized for its intended purposes but which the Lab would want to keep. Also located in Building 622 are a number of smaller, operational collimators and a few offices. The large collimator cannot be accommodated in Building 620 due to its height. It would be possible to close off the large collimator and move other equipment and all personnel to Building 620. But the amount of available space in Building 622 would be limited, and, as a result, it is doubtful that another occupant could be found. Furthermore, Building 622 is within easy walking distance of

Building 620. The one RWI group in Building 622 should remain. In Building 22, two other RWI groups perform only office tasks and could be moved to the new facility.

Two groups from the Passive ECM Branch (WRP) are located in outlying buildings. The Observables Group (WRP-3) occupies Building 821, a thirty-year-old barn-like structure with 90 foot ceilings. The primary facility in this building is a large anechoic chamber, used to measure the radar reflectivity of a variety of targets. The high ceiling in Building 821 is ideal for this type of work and, due to a shortage of high bay area in Building 620, could not be accommodated there. The size of the chamber, which may need to be increased by as much as 50 percent to accommodate higher frequency radar, makes it infeasible economically to construct this facility as part of the new facility. A third option, movement of the Observables Group to Building 4A, would allow adequate space and ceiling height with the added advantage of consolidating the two outlying WRP groups.

The Measurements Group (WRP-2) performs classified laboratory work, some of which involves the physical teardown of large foreign weapon systems. Building 4B, in which the group is located, is a secure facility with a hangar capable of accommodating the largest systems. Building 620 has no area of sufficient size. An added advantage to Building 4B is the ease of transportation of classified equipment resulting from flightline proximity. The facility needs of both WRP-2 and WRP-3 require that they stay unconsolidated, even though the remainder of the branch is housed in Building 620.

In addition to the three unconsolidated branches, Table III-1 proposes that two buildings in Area C continue to be utilized by the Avionics Laboratory. Part of Building 110 is used by the Systems Development Branch (AAD) as a base of operations for contractors who support Area C aircraft. Movement of

this function to the 620 area would be impractical because it would separate the contractors from the aircraft which they repair. Building 280 is partially occupied by Avionics Laboratory equipment in long-term storage. Equipment from a variety of Lab activities is stored in this building, but no personnel are stationed there. Only the building manager from the Laboratory Material Control Activity Branch (TSL) visits Building 280 regularly. Since few people travel to Building 280 and no suitable storage space is available in the Building 620 area, no movement of equipment from Building 280 is recommended.

FUTURE SPACE REQUIREMENTS

A review of the floor space requirements for all elements of the Avionics Lab was conducted, and estimates of future needs were prepared based on anticipated changes in mission, manning levels, and major pieces of equipment.

The following assumptions underlie the future space requirements. The first assumption is that the number of personnel at the Avionics Laboratory is expected to remain relatively stable. According to the Lab's current Five Year Plan,[1] the number of personnel at the Avionics Laboratory has decreased slightly from 1,113 in 1973 to 960 in 1978.

The second assumption is that the proportion of in-house work for the Avionics Laboratory as a whole will remain relatively stable or increase slightly. The goal of the Avionics Laboratory is to increase modestly the proportion of in-house work.

The third assumption is that a modest five percent reduction in space requirements is possible for those branches moving out of the outdated

[1] AFAL FY80-84 Research and Technology Plan, Part I, Executive Summary, SYS-DLX-(A)-7402, AF Avionics Laboratory, Wright-Patterson AFB, Ohio, October 1978. (For Official Use Only.)

Building 22 into either Building 620 or the new facility due to the flexibility that may be built into newer facilities. The five percent reduction is applied after adjustments for changes in mission, manning and equipment have been considered. We were influenced by the fact that there will be a reduction of about 35 percent in the space requirements of the Electronic Research Branch (DHR) when it consolidates from 17,500 square feet of space in Building 450 to 11,500 square feet of space that was formerly used as a zone shop in Building 620. Also, there would be a reduction of about 25 percent in the space requirements of the Electro-Optics Technology Branch (DHO) if it were to move from Building 22B into the new facility as part of the consolidation.

Although estimates were based on a branch-by-branch review, the changes are presented at the division level. This was done because the Lab assigns space at the division level, and because of the likelihood of changes in mission, size and equipment at the branch and group levels before a consolidation would take place.

Table III-2 presents the future space requirements by building and division after consolidation and the change from the existing situation. The future facility requirements reflect two changes in floor space that the Lab is in the process of carrying out independent of this study. One is DHR's move from Building 450 referred to above. The other is the consolidation of the Measurements Group (WRP-2) of the Passive ECM Branch (WRP) from Building 620 to Building 4B. The Electronic Warfare Division (WR) will keep the vacated space in Building 620, and to provide for the rest of the WRP-2 personnel arriving at Building 4B, 1,000 square feet of open lab space there will be converted to office space.

TABLE III-2. FUTURE FLOOR SPACE REQUIREMENTS BY BUILDING AND DIVISION

BUILDING	DIVISION	NET FLOOR SPACE (SQ. FEET) LAB	OFFICE & OTHER	TOTAL	NET CHANGE (SQ. FEET)
620	AA	17,450	16,650	34,100	(2,700)
	DH	23,550	10,450	34,000	2,750
	RW	5,500	16,800	22,300	22,050
	WR	18,000	18,250	36,250	50
	TS	1,450	6,650	8,100	(9,550)
	AFAL Other	--	3,500	3,500	(12,600)
	Total 620	65,950	72,300	138,250	--
New Facility	Co. & Cmd. Staff	--	8,000	8,000	8,000
	AA	--	5,600	5,600	5,600
	DH	9,000	14,250	23,250	23,250
	RW	--	15,100	15,100	15,100
	WR	--	1,050	1,050	1,050
	TS	--	35,200	35,200	35,200
	AFAL Other	--	10,300	10,300	10,300
	Total New Facility	9,000	89,500	98,500	98,500
22	CO & Cmd. Staff	--	--	--	(7,950)
	RW	--	--	--	(38,250)
	TS	--	--	--	(20,650)
	AFAL Other	--	--	--	(2,300)
	Total 22	--	--	--	(69,150)
22B	DH	--	--	--	(17,300)
	AFAL Other	--	--	--	(700)
	Total 22B	--	--	--	(18,000)
23	RW	14,700	3,500	18,200	--
18F	RW	--	1,200	1,200	--
622	RW	7,900	4,800	12,700	--
4B	WR	25,100	2,600	27,700	--
821	WR	18,000	2,100	20,100	--
450	TS	--	1,400	1,400	(17,500)
18	TS	--	400	400	(850)
653	TS	--	500	500	--
45	TS	--	350	350	(5,300)
	Total Other Bldgs.	65,700	16,850	82,550	(23, 650)
Total Lab		140,650	178,650	319,300	(12,300)

The effect of the consolidation effort would be to place about three-quarters of the Lab's net floor space and 90 percent of the Lab's personnel in the vicinity of Building 620. The net floor space in Building 620 would remain unchanged at 138,250 square feet, although there would be some movement of Lab components into and out of the Building. The new facility would provide 98,500 net square feet of space.

Requirements by Division

The Commander's staff occupies 7,950 square feet of space in Building 22. An additional 450 square feet of space would be provided for a separate classified/unclassified mailroom and a long range planning study facility. Since the staff would be relocated to the new facility, however, a reduction of five percent, or 400 square feet, was imposed, resulting in a net increase of only 50 square feet.

The System Avionics Division (AA) has its entire operation located in Building 620 where it occupies 36,800 square feet of net floor space. Following consolidation, AA would have an area of 34,100 square feet in Building 620, and 5,600 square feet of space in the new facility. The division's total floor space would increase by almost 3,000 square feet: 2,400 square feet of additional laboratory space and 500 square feet of additional office space. The additional space would relieve some cramped laboratory and office space in several branches and would provide laboratory space for major pieces of laboratory equipment expected within the new few years.

The Electronic Technology Division (DH) currently has branches in three buildings: 620, 22B and 450. Its total floor space is 66,050 net square feet. Within the next two years, the Electronic Research Branch (DHR) is scheduled to move out of Buidling 450 into Building 620, and lose 6,000 net

square feet of space. The Electro-Optics Technology Branch (DHO) would move from 17,300 net square feet of space in Building 22B into 13,500 net square feet of space in the new facility, for a net reduction of 3,800 square feet. The Divisions's future space requirements include 1,000 net square feet of additional space, made up of 900 square feet of laboratory space for Very High Speed Integrated Circuit work and for on-site contractors and 100 square feet of office and other space for equipment storage. Taking all of these changes into account, DH would have 8,800 net square feet less space than it now does.

The Reconnaissance and Weapon Delivery Division (RW) has total net floor space of 70,600 square feet. Its branches are located in Buildings 22, 622, 23 and 18F, and it has some space in the tower of Building 620. Following consolidation, the branches housed in Building 22 would occupy space in both Building 620 and the new facility. The group in Building 622 and branch in Buildings 23 and 18F would remain where they are. The Division would require an additional 500 square feet of laboratory space for equipment and an additional 250 square feet of office and other space for an expanded computer terminal room. After reducing space requirements by five percent, however, for branches moving from Building 22, the Division would have an overall net reduction in space requirements of 1,100 square feet.

The Electronic Warfare Division (WR) occupies space in Buildings 620, 821, and 4B. Its total net floor space is 84,000 square feet. Although it has only 36,200 square feet in Building 620, most of its activities are there. Only the Passive ECM Branch (WRP) has groups located in other buildings: the Observables Group (WRP-3) in Building 821 and the Measurements Group (WRP-2) in Building 4B, both of which would remain. The Division would require an additional 1,100 square feet of office and other space in Building 620 to relieve cramped office space, to provide more space for branch conference rooms and for an expanded branch technical information center.

The Technical Division, (TS) which provides support to the other divisions, has 47,100 square feet of net floor space. Most of its functions are carried out in Building 620, but a significant amount of its space is now in Buildings 22, 450, 18, 653 and 45. The Division would require an additional 1,500 square feet to completely house its library from Building 22 and an additional 1,000 square feet for its Tri-Service Industry Information Center. On the other hand, removing the library from Building 45, consolidating other STINFO Branch functions and the five percent reduction in space requirements for TS activities moved from Building 22 would result in a net reduction in the Division's space requirements of 1,150 square feet.

As a division, TS would have space in the same number of buildings, but its major activities would be consolidated to the area of Building 620. One factor preventing further consolidation is the obligation of the STINFO Branch (TSR) to provide library, publications, and graphics support of all the Air Force Wright Aeronautical Laboratories. While many of TSR's functions could be consolidated in the new facility, it would continue to maintain "self-help" graphics shops in Buildings 18, 653 and 45.

Requirements for Common Space

In addition to the areas occupied by the command staff and the divisions, there are other areas that are common to the entire Lab. We grouped these other areas under the category of AFAL Other. Included in this category are conference rooms, food service areas and building reception areas.

Conference Rooms. The Avionics Laboratory has two types of conference rooms, those that belong to individual Lab components and those available on a Lab-wide basis. Division, branch and group conference rooms are taken from the total space alloted to each of these organizations. Since the size and

utilization of these areas are under the control of the activity chief, no investigation of requirements for this type of conference room was conducted. General purpose conference rooms are available for use by all laboratory organizations. Data on these rooms were gathered and analyzed to determine required numbers, capacities and characteristics.

Table III-3 contains data on the location, classification, capacities and usage of the seven general purpose conference rooms currently available to the Laboratory. Usage was determined by obtaining all available data on monthly conference room bookings and translating this information into percentage of working days during which the room was occupied each month. For the purposes of this study, light usage was defined as twenty-five percent and under, medium usage as twenty-six fo fifty percent and heavy usage as over fifty percent. The small conference room in Building 22 South has been converted to a storage area.

TABLE III-3. EXISTING AVIONICS LAB CONFERENCE ROOMS

BUILDING	SPECIFICATION	CLASSIFICATION	CAPACITY	USAGE
22	North	Top Secret	75	Medium
	South	Secret	10	None
	Commander's	Unclassified	20	Light
22B	Ground Floor	Unclassified	25	Light
620	Auditorium	Secret	100	Heavy
	Room 2.8	Secret	40	Heavy
	Room 2.10	Secret	15	Heavy

Four of the conference rooms in Table III-3 are in Buildings 22 and 22B, which would be vacated by the Lab; these conference rooms must be provided for in the area of Building 620 after consolidation. The three conference rooms in Building 620 are heavily utilized already. We recommend that three conference rooms, with a total of 3,400 square feet, be

included in the new facility. One of these should have a top secret classification and a capacity of 100 people in order to replace the North conference room in Building 22. The additional capacity of this room would allow it to be used for large classified meetings which are difficult to schedule into the existing 620 auditorium. Classified gatherings of more than 100 people occur too infrequently to justify the construction of a larger conference room and, therefore, would have to be accommodated in several sessions or in the Base auditorium. An unclassified conference room, capable of accommodating 50 people, would replace the conference room in Building 22B and provide area for large meetings which cannot be held in the Lab component's own conference rooms. The third conference room should be adjacent to the commander's offices and capable of seating 20 people. In addition to these three dedicated conference rooms, we suggest that the cafeteria be capable of converting into an unclassified auditorium (a cafetorium).

The net result of consolidation would be to increase conference room floor space by almost 1,000 square feet. Taken together, the new conference rooms would have roughly 35 percent greater capacity than the ones being replaced.

Food Service Areas. Currently, there is one food service area associated with the Avionics Laboratory. It is a small canteen that seats less than 25 people and occupies about 1,200 square feet of space in Building 620.

Consolidation of the Avionics Laboratory near Building 620 would place 90 percent of the Lab personnel in one area. This concentration of personnel and inadequate food service in the vicinity of Building 620 justifies the inclusion of a cafeteria in the new facility.

At the present time, many Lab personnel drive to on-base cafeterias or off-base restaurants. The inclusion of a cafeteria in the new facility would reduce the amount of time and travel expended during the lunch period (see Chapter V). It would also serve to increase informal communication between Lab personnel, and, as mentioned above, could be used as a large auditorium.

We have used construction industry guidelines to determine the size of the cafeteria, given the size of the organization it serves. For planning purposes, we used an organization of 1,000 people. To that we applied the guideline of 6.7 square feet per person to arrive at an estimate of 6,700 square feet. With a cafeteria that size, the lab would close the canteen in Building 620.

Reception Areas. For the sake of completeness, we include reception areas even though they do not take up much space. Total reception areas for Buildings 22 and 22B are estimated to be 400 square feet. For purposes of this study, the reception area of the new facility is assumed to be 200 square feet. Consolidation would therefore save 200 square feet in reception areas.

Related Moves

Moves by Base organizations other than the Avionics Lab can influence the Lab's consolidation plans. The Air Force Orientation Group may move from Building 4A (a hanger) to another site in the Dayton area. Building 4A would provide suitable laboratory space for the radar reflectivity work of the Observables Group (WRP-3) in Building 821. The Base Civil Engineers would like to raze Building 821 because of its age and its interference with television reception at a nearby Base housing area. Such a move by WRP-3 to Building 4A would result in the collocation of two groups in the Passive ECM Branch.

Another factor of major importance is the availability of potential tenants to move into Buildings 22 and 22B. The Base Civil Engineers reported that a number of organizations could make use of the buildings. The following scenario is representative of what might happen:

- The Avionics Lab would vacate Buildings 22 and 22B and move into Building 620 and the new facility.
- The Aeronautical Systems Division (ASD) would vacate Buildings 167, 125, and 126 and move into Building 22.
- The Air Force Institute of Technology, which needs room to expand, would move into Buildings 167, 125 and 126.
- The Flight Dynamics Lab and ASD contractors would vacate Buildings 63 and 173 respectively and move into Building 22B. Then the base could raze Buildings 63 and 173, which are old structures.

IV. COSTS OF CONSOLIDATION

Consolidation of the Avionics Lab's operations to the area of Building 620 would involve construction of a new facility. The following costs were estimated: construction cost of a new facility, operating and maintenance costs and relocation expenses associated with consolidating the Avionics Lab.

CONSTRUCTION COSTS

Construction costs are based upon the amount and type of floor space required. The new facility would house a total of 123,000 square feet of laboratory, office, and support space, a cafeteria, and utility space. The estimated construction cost for the new facility is about $7.5 million in 1979 dollars. Estimated at the mid-point of construction in 1982, the cost of construction is about $9.5 million, assuming eight percent annual inflation in construction costs.

Table IV-1 shows the amount of square feet by type of space, cost per square foot, cost attributable to each type of space, and total estimated construction cost for the new facility.

TABLE IV-1. ESTIMATED CONSTRUCTION COST OF NEW FACILITY
(in 1979 Dollars)

TYPE OF SPACE	SPACE (SQ. FT.)	COST PER SQ. FT. ($)	COST ($ MILLIONS)
Laboratory (net)	9,000	$110	$0.99
Office & Other (net)	82,800	$ 55	$4.55
Cafeteria (net)	6,700	$ 85	$0.57
Building Facility	24,500	$ 55	$1.35
Parking Lot	63,000	$ 1.33	$0.08
TOTAL - NEW FACILITY			$7.54

Estimates of laboratory, office and other space are based on the requirements of the organizations that could be located in the new facility, as discussed in Chapter III and as shown in Table III-2. The size of the cafeteria was derived using architectural and engineering (A&E) guidelines that were applied to the size of the organization to be served. The final category is building facility space, which is the difference between net and gross floor space. Its major elements are hallways, stairways, elevators, and areas housing utilities and other environmental support equipment. Facility space was assumed to be equal to 25 percent of net floor space. This is based on the ratio of gross to net floor space per person as detailed in an Air Force Regulation ASDR 87-1, which allows a maximum of 162 square feet per person for gross floor area and 130 square feet per person for net floor area.

The size of the parking lot was based on a need for 200 additional parking spaces. The number of additional parking spaces was in turn determined by taking the net addition of 400 people to the Building 620 area and applying the Air Force allowance of one space for every two employees. We then used the construction industry guideline of 315 square feet per space, which takes into account roadways as well as parking spaces.

The dollar per square foot cost factors used in estimating construction costs for laboratory, office and other space, and building facilities space were supplied by the A&E firms we contacted and confirmed by personnel in the Avionics Lab's Facilities Group. The dollar per square foot cost factors for the cafeteria and parking lot were provided by LMI's facilities construction consultant based upon discussions with local A&E firms.

RELOCATION COSTS

Moving Cost

The moving cost of consolidating the Avionics Laboratory into Building 620 and the new facility is based on the amount of space and the type of equipment that would be moved. Cost data for moving office and laboratory equipment were obtained from the Air Force Flight Dynamics Laboratory, which consolidated in 1975 and has equipment similar to that of the Avionics Laboratory. Moving cost data were also obtained from Draper Laboratory, which consolidated its operations from 15 buildings to one in 1977.

The cost data associated with moving office equipment was based on a relocation of Flight Dynamics Laboratory office space in 1975, which was conducted by Laboratory personnel. The cost of moving, which includes personnel pay incurred during the move, was $26,500. Escalating that figure by eight percent annually, the cost in 1979 dollars would be about $33,400. The amount of floor space involved in the move was 120,000 square feet; the resulting cost factor in 1979 dollars would be about $0.30 per square foot. By applying that factor to the 107,100 square feet of office space to be moved from Buildings 22, 22B and 620, we have estimated the cost of relocating office space to be $32,000.

The moving of office space at Draper Lab was done by commercial movers at a cost of about $0.50 per square foot in 1979 dollars. We based our estimate of moving office space on Flight Dynamics Lab experience, because Avionics Lab personnel in the Technical Services Division thought that the Lab would move its own office space, as did the Flight Dynamics Lab.

The laboratory equipment used by the Flight Dynamics Laboratory is reportedly similar in size and complexity to that of the Avionics Laboratory. In 1974, the Flight Dynamics Laboratory contracted with a commercial mover to

relocate 50,000 square feet of laboratory space for $388,000. In terms of 1979 dollars, that would be about $527,000 or about $10.50 per square foot. The comparable cost factor from Draper Lab's relocation of laboratory space is about one third the cost per square foot. We believe that the Flight Dynamics Laboratory experience is more relevant. Therefore, the estimated cost of moving Avionics Lab equipment from 16,500 square feet of laboratory space is $173,000.

In addition, the Avionics Laboratory would have to move six granite blocks currently used by the Electro-Optics Technology Branch in Building 22B. A cost estimate provided by an on-base contractor who would be a candidate to perform the work, was $6,000 per block for a total cost of $36,000.

The estimated cost for the entire move is approximately $241,000.

Staff Downtime Following Relocation

When the physical move in consolidating the Avionics Lab takes place, the work of the Lab would be disrupted. Because of the temporary loss of productive time, we have included staff downtime as a cost. Estimates of downtime are based on the assumption that all office and most laboratory equipment could be moved and set up in one work day. This does not mean that the entire Avionics Lab could be relocated in one day; rather individual components could be. We have also estimated that, in addition to the day of the move, another day would be lost as the affected staff settles into the new work environment. We have therefore allotted two days of downtime for each employee in a Laboratory component being moved.

There are three exceptions in which the relocation of a branch would disrupt work for an extended period of time. In the case of the Reference Systems Branch (RWA), the disruption would last two months and affect seven people resulting in 14 man-months of downtime. Eight people in the Radar

Branch (RWM) would take one month each in setting up its equipment, for a loss of eight man-months. About 16 people in the Electro-Optics Technology Branch (DHO) would be on downtime for six months each, resulting in eight man-years of downtime due to interruption of their work. The other people in these branches would have downtime of two days each.

Total downtime for all organizations being relocated is estimated to be 14.1 man-years based upon 230 work days per year. That level of downtime represents about one and a half percent of the Avionics Lab's annual personnel effort. At the average scientist and engineer salary, the cost of downtime would be $423,000.

OPERATING AND MAINTENANCE COSTS

Operating and maintenance (O&M) costs for the new building facility should be about the same, on a dollar per square foot basis, as the O&M costs for Building 620. Based on data provided by the Lab's Facilities Group, operating costs for Building 620 in 1978 were $816,000 or $3.04 per square foot based upon 268,000 square feet of gross floor space. During the same year, maintenance costs for Building 620 averaged $13,600 or $0.05 per square foot. Escalating these cost factors to 1979 dollars at an eight percent inflation rate yields $3.29 per square foot and $0.055 per square foot for operating and maintenance costs respectively. Maintenance costs are particularly difficult to estimate due to the wide year-to-year variation caused by the one-time nature of many maintenance projects.

Applying the cost factors to a new facility of about 123,000 square feet of gross floor space yields an estimated operating cost of $404,000 and maintenance cost of $6,700 for a total annual O&M cost of $410,000 in 1979 dollars.

Since there is generally no utility metering of individual buildings at the Base, it is often extremely difficult to estimate operating and maintenance costs of an individual building. We believe strongly, however, that the O&M costs of the new facility would be less than the O&M costs of the space vacated by the Lab.

SUMMARY COSTS OF CONSOLIDATION

The costs of consolidation are summarized in Table IV-2. The initial costs total $8.20 million in 1979 dollars while annual costs are $410,000. We believe that the operating and maintenance costs of the new facility would be no greater and probably less than the O&M costs of the space vacated by the Avionics Lab. Therefore the O&M costs shown in Table IV-2 are not additional or incremental costs to the Lab. As a result, the total incremental cost of consolidation is only the total intial cost: $8.20 million in 1979 dollars.

TABLE IV-2. SUMMARY OF CONSOLIDATION COSTS
(1979 Dollars)

COST CATEGORY	INITIAL	ANNUAL
Construction Cost	$7,540,000	
Relocation Costs		
Moving Cost	241,000	
Downtime Cost	423,000	
Operating & Maint.Cost		$410,000
TOTAL	$8,204,000	$410,000

V. BENEFITS OF CONSOLIDATION

The major benefits of consolidation are intangible benefits that are difficult to quantify and express in monetary terms. In addition, there are tangible benefits in the form of cost savings which, although substantial, are not expected alone to justify a new facility.

INTANGIBLE BENEFITS

There are a large number of benefits of consolidation that contribute to at least one of four broad categories of intangible benefits:

- improved efficiency
- higher morale
- more effective management
- increased mission achievement

Improved Efficiency

Consolidation would allow more efficient use of both personnel and facilities. Over 90 percent of the Avionics Laboratory personnel would be together in the area of Building 620 and the new facility - unaffected by inclement weather or the inconvenience of communication from isolated facilities. More productive time would result from reduced travel between buildings and reduced travel at lunch time. Research productivity would be enhanced by the concentration of staff and the increased opportunity for communication through greatly reduced separation distances and the increased incidence of meeting in common areas such as hallways and cafeteria.

The Avionics Laboratory would no longer have its personnel in five buildings: 22, 22B, 18, 45 and 450 (from which a move is already planned).

The Lab would vacate Buildings 22 and 22B and greatly reduce its space requirements in Buildings 18 and 45 leaving only small self-help graphics shops. Independent of the moves already planned, the Avionics Lab would release about 108,300 square feet of net usable space for other organizations at the Base. The figure includes 3,000 square feet and 12,000 square feet in Buildings 22 and 22B respectively that are not now being used by any organization at the Base. At the same time, the Lab would be moving into a new facility with 98,500 square feet of net usable space, a reduction of 9,800 square feet, while gaining a cafeteria and other space additions.

Consolidation would increase the utilization of laboratory space in Building 620 by 6,350 feet or 10.7 percent. Only branches directly involved in laboratory work would use the space, with the exception of the ECM Advanced Development Branch (WRD) which would remain in Building 620 since no other branch requiring laboratory space could be accommodated there. With greater utilization of laboratory space in Building 620, further time and cost savings in converting laboratory facilities for new experiments or projects would result due to the flexibility of the building's modular construction.

The report publication process for all Air Force Wright Aeronautical Laboratories would be streamlined by the consolidation of the Scientific and Technical Information Branch (TSR). Utilization of the Laboratory's technical library would be increased by bringing it closer to more people in the Avionics Lab. Electronic supply stocks would be further consolidated since they would no longer be needed in Buildings 22, 22B and 450.

Higher Morale

Higher morale would result from the consolidation of the Lab. No group would be separated after the consolidation and, in all but three cases, it would be possible to collocate entire branches. The Electro-Optics and

Reconnaissance Branch (RWI) would have groups in both Building 622 and the new facility. The Passive ECM Branch (WRP) would have groups in Buildings 821 (or 4A), 4B and 620. The Technical Support Branch (TSS) would be separated to a much lesser extent with its Instruments Group in Building 620 and the rest of the Branch in the new facility.

Personnel currently occupying antiquated or substandard facilities would have much better working conditions. With 90 percent of the Lab staff together there would be improved communication and professional interaction, making it possible to become and stay familiar with other branch and division activities. Increased interaction would enhance the feeling of Lab unity and pride. Higher morale would assist the Avionics Lab in recruiting, motivating and retaining the high quality staff that is the Lab's main strength.

More Effective Management

More effective management would result from easier access to more Avionics Lab personnel and operations and the ensuing increased communications. The Lab Commander would be near 90 percent of the staff, all five division chiefs and 21 of 22 branch chiefs. At the present time the Commander is near only 40 percent of the Lab's personnel and only one division chief and six branch chiefs. With increased communication and professional interaction, more cooperative and integrated efforts within and between branches and divisions would develop and grow. With increased cooperative and integrated efforts within the Lab, more effective management would be one result. Finally, security would be easier to manage with fewer Lab buildings. For example, there would be less movement of classified information and material between buildings.

Increased Mission Achievement

All of the factors discussed above would contribute toward the goal of increased mission achievement. Improving the experimental conditions of laboratory activities currently occupying unsuitable facilities would improve the rate, consistency and quality of their output. For example, the Electronic Research Branch (DHR), now housed in environmentally uncontrolled area in Building 450, expects to increase the reliability and improve the end product of the gallium-arsenite crystal growth process by moving to high quality laboratory conditions in Building 620. Consolidation of facilities and personnel would increase communication and professional exchange among the staff, increasing the potential for more cooperative and integrated activities within the Lab and for more effective performance.[1] While we know of no easy way to quantify more effective performance in terms of increased productivity, we believe increased productivity would result from consolidation. If the Avionics Lab experienced a modest productivity increase of two percent, that would translate into a $440,000 annual increase in the Laboratory's capacity to pursue additional missions with no increase in resources ($4.00 million over a 25 year period at a 10 percent discount rate).

TANGIBLE BENEFITS

Tangible benefits in the form of cost savings can be identified in five areas:

- travel
- computers
- reproduction
- graphics
- custodial services

[1]Thomas J. Allen and Alan R. Fusfeld, "Design for Communications in the Research and Development Lab," Technology Review, May 1976, pp. 65-71.

In each case, conservative estimates have been made in developing the expected cost savings.

Reduced Travel Time and Cost

Travel between Building 620 and Buildings 22 and 22B would be eliminated by the consolidation. The number of current trips between them is estimated to be at a level of 780 trips per month, based upon a survey conducted by the Facilities Group of the Avionics Lab for this study. Assuming that an extra ten minutes of travel time is required for each round trip between those Buildings compared to the same trip after consolidation, approximately 0.85 man years of travel time could be saved annually. This translates into a $25,500 annual savings, based upon the average salary of the Lab's scientists and engineers. Another $4,000 in savings results from eliminating the automative cost associated with the trips, based on 2.6 miles round trip and 17 cents per mile.

Trips by members of the Lab staff to an on-base cafeteria or an off-base restaurant for lunch would be reduced by a cafeteria in the new facility for those Lab personnel in the area of Building 620 after the consolidation. A survey of those personnel was conducted by the Operations Office of the Lab for this study. The survey indicated that, at the present time, 4060 person trips per month are made to an on-base cafeteria and 3640 person trips per month are made to an off-base restaurant. If we assume that

- consolidation would elminate all of the trips to an on-base cafeteria and 80 percent of the trips to an off-base restaurant with the addition of a cafeteria in the new facility
- eight minutes could be saved by the elimination of each trip to an on-base cafeteria, and
- 20 minutes could be saved by the elminiation of each trip to an off-base restaurant

approximately 9.85 man years of travel time could be saved annually. Based on the average salary for all Lab personnel, the time saving translates into a cost savings of $236,000.

Reduced Computer Costs

The Avionics Laboratory currently has two remote job entry systems tied to the Aeronautical Systems Division computer center in Building 676. One system is an outdated CDC 731 machine in Building 620 limited to card entry, while the other is a new CDC 1700 system with card, tape and disk entry capability in Building 22. After consolidation the 1700 system would be moved to Building 620 and serve the bulk of the Lab's personnel. The 731 machine would be returned to the vendor, for a monthly rental savings of $1,000, or $12,000 annually.

Reduced Reproduction Costs

Consolidation would permit a reduction in the number of reproduction machines currently in use. The Administrative Group (DOA) would turn back to the Base five Dennison reproduction machines. The savings that would result from no longer maintaining these machines would total $2,500 annually.

Reduced Graphics Costs

The Scientific and Technical Information (STINFO) Branch (TSR) maintains graphics shops in five buildings to support elements of the Air Force Wright Aeronautical Laboratories, including the Avionics Lab. Consolidation of the STINFO Branch would allow it to remove five large Ozalid graphics production machines. Each machine currently incurs annual maintenance costs of $600. By removing them from service, the Avionics Lab would save $3,000 annually. In addition, by removing the machines from service, the Lab would avoid a one-time expense of $30,000 for building modifications required if the machines were to meet new environmental standards.

Reduced Custodial Service Costs

Custodial costs would be reduced by replacing relatively difficult to clean space in Buildings 22 and 22B with a modern facility in the area of Building 620. Building 620 requires six custodians for its 268,000 square feet gross. At that rate, the new facility would require three custodians for its 123,000 square feet gross. Since four custodians are required for Buildings 22 and 22B, a savings of one contractor custodian would be realized at an annual cost savings of $7,000.

Total Cost Savings

The cost savings are summarized in Table V-1. The total annual savings expected from these five sources are $290,000. Over the 25 year life of the new facility, this would amount to a savings of $2.66 million in 1979 dollars, assuming a discount rate of ten percent and including the one-time $30,000 savings in reduced graphics costs.

TABLE V-1 TANGIBLE BENEFITS OF CONSOLIDATION IN THE FORM OF COST SAVINGS
(1979 Dollars)

TYPE COST SAVINGS	ANNUAL SAVINGS
Reduced Travel Time and Cost	
Between Bldg. 620 and Bldgs. 22 and 22B	$ 29,500
To On-Base Cafeteria and Off-Base Restaurant	236,000
Reduced Computer Costs	12,000
Reduced Reproduction Costs	2,500
Reduced Graphics Costs	3,000
Reduced Custodial Service Costs	7,000
TOTAL COST SAVINGS	$ 290,000

VI. CONCLUSION AND RECOMMENDATION

CONCLUSION

The conclusion of this study can be stated concisely: the mission of the Air Force Avionics Laboratory would be enhanced through the consolidation of as many activities as practicable to the area of Building 620.

Only the consolidation alternative would successfuly address the three major facility problems facing the Lab. The consolidation alternative would:

- reduce the number of facilities in which the Lab has personnel from 12 to 8, including a new facility in the area of Building 620;
- increase the utilization of laboratory space in Building 620 by 10.7 percent by locating there only branches directly involved in laboratory work; and
- eliminate the substandard laboratory facilities in Building 22 by vacating the Building and moving the branches using laboratory space to Building 620.

The other major benefits of consolidation include:

- the collocation of over 90 percent of the Avionics Lab personnel;
- the release of 108,300 square feet of net useable space while moving into 98,500 square feet of net useable space for a net reduction of 9,800 square feet;
- higher morale from the collocation of all but three branches, better working conditions for many and the ability to become and stay familiar with other branch and division activities;
- more effective management with the Lab Commander near 90 percent of the staff, all five division chiefs and 21 of 22 branch chiefs. At the present time, the Commander is near only 40 percent of the Lab personnel, only one division chief and 6 branch chiefs;
- increased communication and professional interaction leading to more cooperative and integrated efforts within and between branches and divisions, increased productivity and increased mission achievement. If the Avionics Lab experienced a modest productivity increase of two percent, that would translate into a $440,000 annual increase in the Lab's capacity to pursue additional missions with no increase in resources, or $4.00 million over a 25 year period at a 10 percent discount rate;

- tangible cost savings estimated at $290,000 per year in 1979 dollars or $2.66 million over a 25 year period, at a discount rate of 10 percent.

The costs of consolidation in 1979 dollars include:

- construction cost of $7.54 million for a new facility of 98,500 net square feet in the area of Building 620;
- moving costs of $241,000;
- staff downtime following relocation of 14.1 man-years at a cost of $423,000;
- operating and maintenance cost of $410,000 per year, a figure that would be no greater and probably less than that for space vacated in a consolidation.

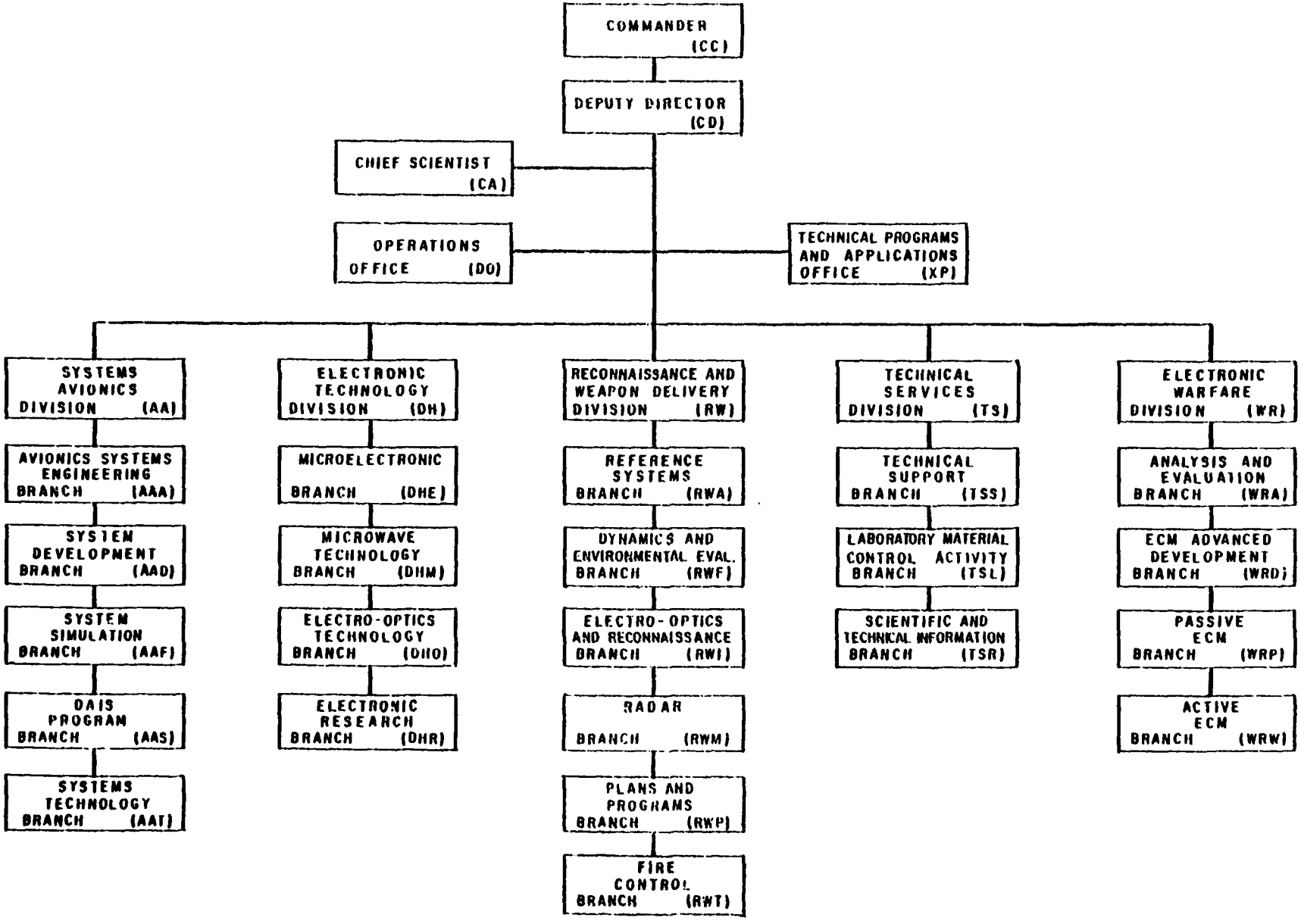
The total incremental cost of consolidation is estimated to be $8.20 million.

RECOMMENDATION

The recommendation of this study is that the Avionics Lab should proceed with the preparation of conceptual designs for the new facility and the Military Construction Program documents needed to support the Lab's efforts to obtain construction funds.

APPENDIX A

ORGANIZATION CHART OF AIR FORCE AVIONICS LABORATORY



APPENDIX B

PERSONS CONTACTED

Adelsberger, Ltc. R. Wayne	Deans Office, Air Force Institute of Technology
Allenson, Vincent J.	Leader, Facilities Group (TSS-1), Technical Support Branch, Technical Services Division, Air Force Avionics Laboratory (AFAL)
Almassy, Maj. Robert J.	Acting Chief, Electronic Research Branch (DHR), Electronic Technology Division, AFAL
Ardrey, Robert G.	Chief, Laboratory Materiel Control Activity Branch (TSL), Technical Services Division, AFAL
Austin, Claude R.	Facilities Engineering Group (AAF-1), System Simulation Branch, Systems Avionics Division, AFAL
Bahret, William F.	Chief, Passive ECM Branch (WRP), Electronic Warfare Division, AFAL
Barbadora, Albert V.	Leader, Management Information Systems Group (DOM), Operations Office, AFAL
Beeson, Maj. Wayne R.	Assistant Chief, System Development Branch (AAD) System Avionics Division, AFAL
Brim, Terrance A.	Chief, DAIS Program Branch (AAS), System Avionics Division, AFAL
Cummings, Larry E.	Measurements Group (WRP-2), Passive ECM Branch, Electronic Warfare Division, AFAL
Cunningham, G. Kenneth	Management Information Systems Group (DOM), Operations Office, AFAL
Deal, Robert E.	Deputy Chief, Reconnaissance and Weapon Delivery Division (RW), AFAL
Dixon, J.	Directorate of R-D Civil Engineering, Aeronautical Systems Division
Driscoll, David	Comptroller, Draper Laboratory, Cambridge, Massachusetts
Edwards, William J.	Chief, Electronic Technology Division (DH), AFAL
Eppers, William C.	Deputy Director (CD), AFAL

Falter, James W.	Chief, Technical Programs and Applications Office (XP), AFAL
Gauder, Charles C.	Chief, System Development Branch (AAD), System Avionics Division, AFAL
Geltmacher, Harold E.	Leader, Electro-optics Sensor S&E Group (RWI-3), Electro-optics & Reconnaissance Branch, Reconnaissance and Weapon Delivery Division, AFAL
Goss, Ltc. Charles R.	Electronic Technology Division (DH), AFAL
Haley, James C.	Chief, Dynamics and Environmental Evaluation Branch (RWF), Reconnaissance and Weapon Delivery Division, AFAL
Haubert, Sadie L.	Leader, Administration Group (DOA), Operations Office, AFAL
Helgeson, Eugene W.	Chief, ECM Advanced Development Branch (WRD), Electronic Warfare Division, AFAL
Hill, James L.	Facilities Manager, Facilities Group (TSS-1), Technical Support Branch, Technical Services Division, AFAL
Hoskins, Pearl	Leader, Facility Engineering Group (AAF-1), System Simulation Branch, System Avionics Division, AFAL
Jacobs, Col. Joseph H.	Chief, Electronic Warfare Division (WR), AFAL
Johnson, James G.	Chief, Scientific and Technical Information Branch (TSR), Technical Services Division, AFAL
Jones, Ltc. Eugene E.	Chief, Avionics Systems Engineering Branch (AAA), System Avionics Division, AFAL
Kellog, Raymond	Electronics Engineer, Operations Office (DO), Air Force Wright Aeronautical Laboratories
Kennedy, Pat O.	Industrial Engineer, Facilities Group (TSS-1), Technical Support Branch, Technical Services Division, AFAL
Lanich, William Jr.	E-O Sensor S&E Group (RWI-3), E-O & Reconnaissance Branch, Reconnaissance and Weapon Delivery Division, AFAL
Lopina, Col. Robert F.	Commander, AFAL

Mahone, Robert T.	Facilities Chief, Electro-optical Sensor S&E Group (RWI-3), Electro-optical and Reconnaissance Branch, Reconnaissance and Weapon Delivery Division, AFAL
McKenzie, Ltc. Jerry L.	Chief, Operations Office (DO), AFAL
Mullins, Dennis	Industrial Engineer Technician, Facilities Group (TSS-1), Technical Support Branch, Technical Services Division, AFAL
Murray, Daniel C.	Leader, Measurements Group (WRP-2), Passive ECM Branch, Electronic Warfare Division, AFAL
Nevius, Frank L.	Chief, Technical Services Division (TS), AFAL
Paulson, Ronald F.	Acting Chief, Electro-optics Technology Branch (DHO), Electronic Technology Division, AFAL
Raroha, Maj. George H.	Deputy Chief, Reference Systems Branch (RWA), AFAL
Rees, Donald S.	Chief, Microwave Technology Branch (DHM), AFAL
Reeves, Richard M.	Chief, Radar Branch (RWM), Reconnaissance and Weapon Delivery Division, AFAL
Remski, Richard L.	Leader, Microwave Device Group (DHM-1), Microwave Technology Branch, Electronic Technology Division, AFAL
Ringo, Ronald L.	Chief, Reference Systems Branch (RWA), Reconnaissance and Weapon Delivery Division, AFAL
Roberds, Col. Richard M.	Chief, Reconnaissance and Weapon Delivery Division (RW), AFAL
Scarpino, Frank A.	Chief, Systems Technology Branch (AAT), System Avionics Division, AFAL
Schwing, R.	FGD Branch, Flight Dynamics Laboratory
Seaton, Paul B.	Chief, Analysis and Evaluation Branch (WRA), Electronic Warfare Division, AFAL
Siferd, Ltc. Raymond E.	Chief, System Avionics Division (AA), AFAL
Simons, Robert A.	Leader, Observables Group (WRP-3), Passive ECM Branch, Electronic Warfare Division, AFAL
Sink, Roger D.	Chief, Plans and Programs Branch (RWP), Reconnaissance and Weapon Delivery Division, AFAL

Skalski, James F.	Leader, Integrated Circuit Design Group (DHE-4), Microelectronic Branch, Electronic Technology Division, AFAL
Spector, Marvin	Chief, Fire Control Branch (RWT), Reconnaissance and Weapon Delivery Division, AFAL
Stewart, J.	Chief, TSP Branch, Flight Dynamics Laboratory
Strottner, Maj. Phillip	Deputy Chief, Technical Services Division (TS), AFAL
Tehan, John E.	Chief, Active ECM Branch (WRW), Electronic Warfare Division, AFAL
Teilhet, Darwin L.	Chief, Technical Support Branch (TSS), Technical Services Division, AFAL
Tilmans, Ltc. Henry M.	Asst. for R&D Management, Electronic Technology Division (DH), AFAL
Totten, James E.	Leader, Effectiveness Evaluation Group (WRA-2), Analysis and Evaluation Branch, Electronic Warfare Division, AFAL
Urban, Gale D.	Chief, Electro-optics and Reconnaissance Branch (RWI), Reconnaissance and Weapon Delivery Division, AFAL
Vance, Helene	Administrative Officer, Office of the Assistant for Manpower and Personnel, Air Force Wright Aeronautical Laboratories
Vlachos, George	Draper Laboratory, Cambridge, Massachusetts
Wagner, Stanley E.	Chief, Microelectronic Branch (DHE), Electronic Technology Division, AFAL
Weber, Harold E.	Leader, Microwave Systems Technology Group (DHM-3), Microwave Technology Branch, Electronic Technology Division, AFAL
Weber, Maj. John G.	Chief, System Simulation Branch (AAF), System Avionics Division, AFAL

APPENDIX C

LIST OF ABBREVIATIONS

CSEL	-Communication System Evaluation Laboratory
DAIS	-Digital Avionics Information System
DEES	-Dynamic Electromagnetic Environment Simulator
EDE	-Electronic Defense Evaluator
EWAC	-Electronic Warfare Anechoic Chamber
MEL	-Mobile Evaluation Laboratory
PIE	-Processed Imagery Evaluation
PME	-Precision Measurement Equipment
RSPL	-Radar Signal Processing Laboratory
SEL	-Software Evaluation Laboratory
VLSIC	-Very Large Scale Integrated Circuits

APPENDIX D

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