THE IMPACT OF MANPOWER, PERSONNEL, AND TRAINING (MPT) ON LIFE CYCLE COST

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ABSTRACT

Life cycle cost is probably the most important determinant of new aeronautical systems acquisitions. Operating and support (O&S) costs are 40% to 60% of life cycle cost (LCC). Manpower, personnel, and training average 65% to 70% of O&S costs. The Air Force has recognized the significance of the "people cost" of a weapon system and has established a number of regulations and organizations to address the issue. One of the responsibilities of the Directorate of Acquisition Logistics, DCS, Development Planning (ASD/XRL) is to ensure that Air Force planners understand the impact MPT costs will have on future aeronautical systems. This paper outlines all of the different elements of MPT costs that are considered during the O&S portion of a LCC estimate.

INTRODUCTION

Historically, the Air Force, like many other agencies, both DoD and corporate, has fallen into the ill-fated practice of focusing the cost analysis of a particular system on the acquisition cost (research, development, test and evaluation (RDT&E), and production) of a weapon system. The emphasis was (and still is to a great degree) on "how much" is it going to cost to procure this system. The cost of operating, maintaining, and supporting the aircraft was practically forgotten. In the earlier days of aviation, this practice was tolerated since O&S was still not a relatively large chunk of LCC. However, in the late 1960s and early 1970s, as aircraft and aircraft systems became more complex, O&S cost began to grow as a percentage of LCC at a significant rate.

Today, LCC consists of acquisition, O&S, and disposal costs. Since historical emphasis has been on acquisition costs, the experience base is relatively extensive. The O&S cost estimating field, however, is still relatively new and the knowledge and experience base is still relatively small in comparison. Indicative of this fact is the "gray area" that exists between the cost analysis responsibility of the comptroller and that of logistics. Traditionally, the comptroller has been responsible for all cost estimates. O&S cost, however, takes logistics factors into consideration. Therefore, there has been some debate over whether the logistician or the comptroller should be responsible for this new area of cost analysis. In many cases, the logistics officer with little or no expertise in cost analysis inherits the responsibility. O&S costs include the cost of MPT, material, and facilities that are incurred while operating, supporting, and maintaining a weapon system. The largest and probably most challenging portion of O&S costs is the MPT portion. This is the area that this paper will focus its discussion.

MANPOWER, PERSONNEL, AND TRAINING

The estimation of MPT cost is not a trivial task. Before a detailed discussion is started, it may be helpful to define MPT.
What exactly does the Air Force mean by the terms manpower, personnel, and training? Manpower is the quantitative number of people required to operate, maintain, and support a weapon system. Personnel are the qualitative aspects of manpower requirements: aptitude, skill, grade levels, force management, and the career field structure, necessary to recruit, train, and maintain a capable force to operate, maintain, and support all systems in the inventory. Training refers to all the processes and equipment used to prepare personnel to operate, maintain, and support a system.

At the very basic level, the intent of O&S cost estimating is to take into consideration the number of people required to operate, maintain, and support a unit (such as a squadron of 25 aircraft) of a particular weapon system, the number of people authorized by higher headquarters for the unit and the number of persons actually possessed by the unit. In theory these quantities should be equal. In actuality, however, they can be and often are very different. The challenge of O&S cost estimation is the attempt to quantify a number of indirect costs. This includes the acquisition cost of people including the initial travel costs and the cost of basic training, undergraduate pilot training, technical school, etc. Other indirect costs include base operations and maintenance costs which include the cost of medical services, base exchange and commissary services, and security police.

To illustrate the impact of these indirect costs, consider a hypothetical situation involving the purchase of a new car which will be called the "Jupiter." Not only is the car itself purchased, but also a driver and a mechanic. The driver must be sent to a basic driving school to learn basic driving skills and then to a specialized driving school that teaches driving techniques unique to the Jupiter. Similarly, the mechanic has to be sent to a primary technical school to learn basic mechanical skills and then to a specialized mechanical school to learn skills particular to the Jupiter. In addition, both persons must be paid a salary that includes paid vacations, living facilities, meals and medical insurance. All of these costs are incurred over a twenty year period which is the average operational life of a Jupiter. This illustration provides an appreciation for how expensive MPT to operate, support, and maintain today's systems can be. What follows is a detailed discussion on the structure of the MPT portion of a O&S cost estimate.

UNIT MISSION PERSONNEL

This is the cost of pay and allowances of those people directly assigned to support the unit's mission. The most commonly accepted structure for organizing this group of personnel is as follows:

- Aircrew
- Maintenance
  - Organizational
  - Intermediate
  - Ordnance
  - Other Maintenance
- Other Unit Personnel
  - Unit Staff
  - Security
  - Remaining Unit Personnel

The object is to determine the number of people (manpower) in each of these elements. Usually the estimate is made in terms of officers, enlisted, and civilians. More detailed analysis, however, can go as far as to separate the personnel by Air Force specialty codes (AFSCs) and rank. Once the number of people are determined, costs are calculated by simply multiplying them by standard pay and allowance factors. One of the most accurate and comprehensive sources of all Air Force standard cost factors is Air Force regulation (AFR) 173-13, Standard Air Force...
Cost and Planning Factors. This regulation contains inputs from the various Major Commands (MAJCOMS) as much as possible and is updated annually by the Air Force Cost Center. It contains composite factors for officers, enlisted, and civilian personnel, that reflect a proportional distribution of rank in the force.

The aircrew element is the total number of crews required to operate the aircraft in the unit. This number has to be sufficient to ensure combat readiness and meet administrative requirements such as leave, sickness, and TDY. This number is usually determined by the appropriate MAJCOM and reported as a "crew ratio." For example, an aircraft that has a crew capacity of two and a crew ratio of 2.0 maintains a total of four crews for each aircraft in the unit.

Maintenance personnel are the largest group of people in the majority of aircraft squadrons. They are responsible for inspecting, servicing, and repairing the aircraft, aircraft equipment, support equipment, ordnance, and training devices. Determining the appropriate maintenance manpower and personnel is somewhat more difficult than determining aircrew. It is highly dependent on reliability (how often it breaks), maintainability (how long it takes to fix), utilization rate (how often it is used), deployment concepts (who, where, how many), and maintenance concept (what is fixed where and by whom).

One method of determining maintenance manpower and personnel is to use the actual or estimated maintenance man-hours per flying hour (MMH/FH) of a system. This is the number of maintenance man-hours at the base level spent servicing, inspecting, and repairing the aircraft and its components on and off the aircraft for each base at which the aircraft is flown. Once the MMH/FH is known, this information is used in conjunction with annual flying hours per aircraft and the number of man-hours a person is expected to work to determine the maintenance manpower required.

One concern with this method of estimating is that it is based on peacetime data. The basis of MMH/FH rates are maintenance data information systems. The current systems basically contain peacetime information. This results from the fact that although the military purchases equipment to fight wars, the overwhelming majority of the time they operate during peace. As a result, the maintenance data information systems primarily reflect peacetime conditions. A potential remedy for this situation would be to adjust the peacetime data to reflect wartime conditions using cost estimating relationships. These costs estimating relationships could be obtained by gathering data from a wartime situation (Operation Desert Storm, for example). Another method would be to adjust unit manpower documents of current systems to reflect the manpower of estimated systems. A more systematic method is to use a computer model to simulate aircraft maintenance activities at a base and determine the appropriate amount of manpower and personnel needed to accomplish the task. The Logistics Composite Model (LCOM), which is used by the Directorate of Manpower, Personnel, and Training (ASD/ALH) and various Air Force MAJCOMS uses this logic. It is used to determine the approximate amount of MPT that will be required to support future systems.

Other unit personnel costs include the sum of unit staff, security, and remaining unit personnel elements. Unit staff personnel are those individuals who perform the administrative functions of the unit. These include flying supervision, operations control, planning, scheduling, flight safety, and unit administration. Security
personnel include those who are responsible for the security of the weapon system. People responsible for base security and traffic control are not included here. When the mission of the system includes the use of nuclear weapons, allowances are made for additional personnel. Remaining unit personnel include all remaining personnel that have not been accounted for by the other unit personnel elements. Often these are special personnel for squadrons with unique missions such as photo developers for a reconnaissance squadron.

INSTALLATION SUPPORT PERSONNEL

This category accounts for the base support personnel required to support an aircraft squadron. It consists of elements for base operating support (BOS), real property maintenance (RPM), and medical support. Base support personnel are normally required even if there are no aircraft at the base. In this instance, the margin of support personnel required directly as a result of the aircraft squadron is quantified.

Base operating support personnel are responsible for the operation of the installation and the tenant organizations stationed there. The tasks and functions involved include but are not limited to communications, supply, services, and transportation. Real property maintenance personnel are responsible for the maintenance and operation of the installation facilities and related maintenance and engineering services. In other words, these are the people who are responsible for the physical upkeep of the squadron. Medical personnel are the peacetime contingent necessary to care for the unit mission personnel and their dependents.

ACQUISITION AND TRAINING

This cost category contains the recurring cost to initially acquire and train personnel prior to their assignment to an operational base. Acquisition cost includes basic training and recurring military training. Costs for officers and enlisted are calculated separately by multiplying the manpower by standard acquisition cost factors and turnover rates. The acquisition cost factor for officers is the sum of the cost to recruit and a weighted average of the cost to graduate from the Air Force Academy, Reserve Officer's Training Corps (ROTC), school Officer Training School (OTS). For enlisted, it is the cost to recruit and to complete basic training. As with the other standard cost factors, AFR 173-13 is probably the most comprehensive and reliable source of information.

Training costs are attributed to the cost to provide job specialty training. Like acquisition costs, it is calculated by multiplying the manpower by a standard training cost factor and a turnover rate. However, this computation done at a more detailed level since officers and enlisted are subdivided into more categories. Officers are distinguished as pilots, navigators, and non-aircrew, and enlisted as aircrew and non-aircrew.

INDIRECT PERSONNEL AND SUPPORT

This cost category consists of three elements: 1) Miscellaneous Operations and Maintenance, 2) Medical Operations and Maintenance (O&M) Non-Pay, 3) and Permanent Change of Station (PCS). Miscellaneous operations and maintenance are costs that the government pays for each military and civilian employee that are not associated with regular pay. This includes such things as TDY travel, utilities, and office supplies. Medical O&M non-pay include the non-wage costs for items such as medical supplies or services such as CHAMPUS (DoD funding of civilian care) for each military person. Permanent change of station costs include the expense of moving
military personnel in the Unit Mission and Installation Support Personnel categories.

SUMMARY

The basic structure for the estimation of manpower, personnel, and training costs is as follows:

**Unit Mission Personnel**
- Aircrew
  - Military
  - Maintenance
    - Military
    - Civilian
  - Other Unit Personnel
    - Military
    - Civilian

**Installation Support Personnel**
- Base Operating Support
  - Military
  - Civilian
- Real Property Maintenance
  - Military
  - Civilian
- Medical
  - Military
  - Civilian

**Indirect Personnel Support**
- Miscellaneous Operations and Maintenance
  - Medical O&M Non-Pay
  - Permanent Change of Station

**Personnel Acquisition and Training**
- Acquisition
- Individual Training

At the conclusion of this paper, an example of a MPT cost estimate for a F-16C fighter aircraft is provided. The Cost Oriented Resource Estimating (CORE) model was used with AFR 173-13 as the data source. A synopsis of the algorithms, inputs, and outputs are also provided. Following are a series of four charts (Figs 1-4). Figure 1 is a plot of the F-16C example. Figures 2-4 are MPT cost plots for other aircraft currently in the Air Force inventory.

CONCLUSION

This paper has described the basic structure of MPT cost determination in O&S cost analysis. It is not the norm, however. No two cost estimates are ever the same. Usually there are unique assumptions, deviations in methodology, or changes in algorithms. This the reason they are referred to as estimates. Since the field of O&S cost analysis is relatively new, the structure and methodology for the determination of MPT costs varies. There has been a significant amount of literature which has tried to improve and standardize this area of cost analysis. Much more effort must be devoted to this area since MPT is such a significant portion of O&S costs. As our weapon systems continue to increase in complexity, O&S costs will also increase accordingly.

NOTES

1Manpower Personnel, and Training
Aeronautical Systems Division (ASD) Systems Engineering Notebook, ASD/ENET, Wright Patterson AFB OH.

REFERENCES


### Manpower and Personnel Acquisition

| Officers: no. of officers x acq. cost x turnover rate |
| Enlisted: no. of enlisted x acq. cost x turnover rate |

### MIL/Civ Pay

- Military: no. officers/enlisted x pay rate
- Civilian: no. of civilians x pay rate

### Training

**Aircrrew:**
- Pilot: PAA X crew no. x crew ratio x trng cost x turnover rate
- Non-Pilot: PAA X crew no. x crew ratio x trng cost x turnover rate

**Enlisted:**
- PAA X crew no. x crew ratio x trng cost x turnover rate

### Support/Other

**Cost Factors**
- PAA: 24 aircraft
- Crew Ratio: 1.25
- Annual Unit Ops: 336 flying hours
- Officer Pay: $62,178
- Enlisted Pay: $27,780
- Officer Turnover: .073
- Non-Rated Officer Turnover: .072
- Pilot Turnover: .061
- Non-Pilot Crew Turnover: .053
- Enlisted Turnover: .107

### Unit Mission Personnel

**Aircrrew**
- Officers: 32
- Enlisted: 0

**Maintenance**
- Officers: 11
- Enlisted: 541
- Civilian: 0

**Security**
- Officers: 0
- Enlisted: 13

**Other Unit Personnel**
- Unit Staff: 0
- Officers: 0
- Enlisted: 7

### Installation Support Personnel

**Base Operating Support**
- Officers: 1
- Enlisted: 52
- Civilian: 18

**Real Property Maintenance**
- Officers: 3
- Enlisted: 3
- Civilian: 1

**Medical**
- Officers: 1
- Enlisted: 5
- Civilian: 1

### Indirect Personnel Support

**Miscellaneous O&M**
- Installation Support Non-Pay: $7450
- Medical O&M Non-Pay:
  - Officers: $367
  - Enlisted: $367
- Permanent Change of Station:
  - Officers: $6213
  - Enlisted: $3644

**Acquisition and Training**
- Acquisition:
  - Officer: $77,740
  - Enlisted: $3104
- Training:
  - Officer, Non-Rated: $15,793
  - Enlisted, Non-Rated: $8904

### Output

**ANNUAL MPT COST (# in millions)**
- UNIT PERSONNEL PAY: $20.4
- PERSONNEL SUPPORT: $11.0
- PERSONNEL ACQUISITION AND TRAINING: $0.2

**TOTAL:** $31.6

(See figure 1)