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Enhancing the Assessment of the Costs and Benefits of International Pilot Training (IPT) Within the U.S. Air Force

Is It Worth It?

McKay McLaren
Enhancing the Assessment of the Costs and Benefits of International Pilot Training (IPT) Within the U.S. Air Force

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McKay McLaren

This document was submitted as a dissertation in December 2014 in partial fulfillment of the requirements of the doctoral degree in public policy analysis at the Pardee RAND Graduate School. The faculty committee that supervised and approved the dissertation consisted of Bart Bennett (Chair), Fred Timson, and William A. Williams.
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Preface

This dissertation provides a unique perspective on valuing the total monetary cost and the operational monetary and nonmonetary benefits of international pilot training (IPT) that have not been explored previously. We investigate the costs of IPT that result from the sale of defense equipment through the U.S. government Foreign Military Sales (FMS) program. Costs are not fully reimbursed due to 1) special discount rates for North Atlantic Treaty Organization (NATO) nations and many other allies and 2) rates below actual costs. There are costs to the service above and beyond even the full reimbursement rate or formal course price for international training. We use the case study of F-16 international training at the Tucson Air National Guard to derive the direct cost incurred through discounting, as well as an estimate of the cost above and beyond the full FMS price.

We provide a unique approach to assess operational benefits of IPT not previously considered. We quantify the operational savings to the U.S. Air Force (USAF) realized by USAF-trained international partners in coalitions with U.S. forces. We focus on the primary components of the operational costs borne by our allies during the Libya conflict in 2011, explicitly including deployment-oriented flying costs, tanker costs, personnel travel costs, equipment delivery costs, and costs for ordnance expended. We then provide an overall assessment of the monetary costs and savings of IPT.

Finally, we provide an example of the nonmonetary benefits of FMS to the USAF by analyzing the impact of FMS-provided capability on allied interoperability. We measure changes in interoperability of allied nations from the conflicts in Kosovo (1999) to Libya (2011). We outline FMS activity from 1999 to 2011 for the allied nations and use historical analysis and structured interviews with military leaders to assess the impact FMS has had on allied interoperability.

This research shows that within the historical operational aspects considered in this dissertation, the benefits of FMS-directed IPT to the USAF are shown to outweigh the monetary costs. There are other monetary and nonmonetary benefits of FMS and IPT along with some additional IPT costs and reciprocal benefits not covered in this dissertation. Additional costs accrue in the administration and execution of IPT. Benefits include the impact on the U.S. defense industrial base, bilateral defense relationships, regional stability, U.S. force structure impacts, spare parts procurements, and the extended impact on the USAF training enterprise. When considering these factors, one may find additional value of FMS and IPT to support the findings of this research.

This research is sponsored by the Director of Policy, International Affairs, Office of the Under Secretary of the Air Force (SAF/IAP). Part of the work was conducted within the Manpower, Personnel, and Training Program of RAND Project AIR FORCE as part of a fiscal
year 2013 study, *Foreign Military Sales and Air Force Training Capacity*. The target audience for this research is SAF/IA, AETC/IA, AFSAT, Air Force leadership, and anyone interested in FMS, training, and international coalition building. This research is for FMS policymakers, not operational planners or programmers.

The views expressed in this dissertation are those of the author and do not reflect the official policy or position of the USAF, Department of Defense, or the U.S. government.

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The author invites comments on the information presented in this report and welcome modification, as well as additional ideas for consideration, as part of our current research effort. Comments should be directed to McKay McLaren as follows:

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Summary

The cost to the U.S. Air Force (USAF) for providing international pilot training (IPT) is offset by the benefits from having capable international partners operate alongside U.S. forces. This thesis is broken into two parts. The first is the comparison of monetary costs and benefits. We demonstrate that the monetary benefits gained from a country’s participation in operations with the U.S. outweigh the monetary costs for their IPT. The second part of the analysis provides insight into one nonmonetary operational benefit of IPT, interoperability. Through Foreign Military Sales (FMS) and subsequent training (such as IPT), greater interoperability is achieved from using similar equipment and having common training. This nonmonetary analysis strengthens the results from the monetary comparison, demonstrating that indeed the value of IPT gained in operations outweighs the monetary costs of providing the training.

The United States sells billions of dollars of equipment, weapons, and aircraft to their allies each year. A portion of these funds provides personnel training. The FMS of aircraft are of particular interest to the USAF, as the service is responsible for training nearly all of the aircrew and maintainers for these aircraft. Although our foreign partners reimburse a large percentage of the direct cost, the USAF bears a portion of the total cost. In addition, there are arguably other costs above and beyond the full FMS reimbursement rate for a number of reasons. In order to provide a thorough cost analysis, we examine the known FMS-directed IPT costs from offering discounted pricing to allies as well as explore the additional costs above and beyond the full course price of IPT.

We calculate the costs associated with IPT by using F-16 training as a case study. From 2006 to 2013, the USAF absorbed $133 million, or an average of $17 million a year from offering discounts to partners for F-16 pilot training. In addition, over the same time period the USAF absorbed $84 million, or an average of $10.5 million a year in costs not captured with the full reimbursement rate. Therefore, the total average retrospective cost per pilot amounts to

---

1 For example, the tuition rate for NATO pilots to attend the Air National Guard International Basic Course for F-16C/D only covers 93 percent of the FMS full tuition rate. NATO gets a discounted reimbursement rate of roughly 94 percent for other courses, such as the T-6, T-38, IFF, and C-17 (162nd FW/HQ/FMB, “AFSAT Tuition Rates and Appropriations Summary 2012,” AF613, January 2013). There are other costs, such as base infrastructure, maintenance, administrative, and opportunity costs that are not included in the tuition and that would increase the percentage of cost borne by the USAF. As the price reflects the cost of training, then the balance of the training cost rests with the service to provide.

2 All costs computed or cited in this document are in fiscal year 2013 dollars unless otherwise stated.
$588,000. This is the average nonreimbursed cost the USAF bears for training each international F-16 pilot.³

Costs per pilot can be offset by considering operational benefits. One benefit of FMS and consequently IPT is the savings to the USAF from allied FMS aircraft participation in operations.⁴ The forces that join in operations substitute for forces and capabilities that the United States would have otherwise had to commit. We examine Operation Odyssey Dawn (OOD) and the subsequent Operation Unified Protector (OUP) as case studies.⁵ In particular, we assess the operational savings from having Belgian, Norwegian, and Danish F-16s participate in Libya during these operations in 2011. We estimate that at least 12 additional USAF F-16s would have been needed to replace the 18 foreign F-16s used in the operation. The number of U.S. aircraft is adjusted for the differences in aircraft and aircrews between forces, as well as differences in their operation tempo. The operational savings total approximately $16 million for OOD, followed by additional savings in OUP totaling $170 million. The savings include two-way travel costs, ordnance expended, added personnel costs, and additional flying costs.

Combining the operational savings from OOD and OUP with the cost to train pilots from Belgium, Denmark, and Norway provides a case study of the efficiency of USAF training and value of IPT for NATO nations. We examine the net savings from OOD and OUP under various assumptions on the number of pilots needed during those operations from the participant countries. We found that if allies join in short duration coalition operations such as OOD the resultant saving to the USAF can offset the cost to train dozens of their pilots, while larger campaigns such as OUP can offset the cost to train a few hundred pilots. These findings may be applied to other NATO nations that participate at essentially the same level in coalition operations.

The savings and value of IPT are increased when considering other nonmonetary benefits. Capturing the full value of FMS-directed IPT can be challenging due to various benefits that are difficult to estimate within a monetary calculation alone. Interoperability is one such

³ There are also more minor costs, such as administrative and opportunity costs, that are difficult to estimate and are not captured in this work. These costs would only increase the cost per pilot the USAF bears.

⁴ We realize that our allies could buy other aircraft not requiring USAF training and use them in a future operation, as the French and the British have. The USAF would save only the amount associated with replacing these forces with U.S. forces. There are other operational advantages associated with the USAF sourced FMS training and equipment. By providing FMS training, the USAF does provide a stronger foundation on which to base future conflict operational and force-planning processes. In other words, training is considered an enabler for working more closely with our allies on future well-coordinated joint concept of operations with our military forces. FMS aircraft, then, potentially have additional advantages for U.S. industry stability, such as reduced unit cost for USAF variants, greater interoperability, and other issues. This methodology for quantifying monetary benefits of IPT narrowly quantifies the costs avoided through allied and coalition participation in a conflict that would otherwise require the USAF to expend additional resources.

⁵ OOD is a particularly good example of a short, U.S.-led operation to accomplish specific goals. It is representative of a type of contingency that may well recur in the future.
nonmonetary benefit that adds value to IPT. Improving operational interoperability helps both nations as it enables them to perform more difficult missions while improving operational effectiveness from working together. In order to more fully capture the benefits of interoperability, we expand the impact from IPT alone, to all FMS (of which IPT is a result). While the link from FMS to enhanced interoperability is difficult to establish, we use a combination of quantitative and qualitative reasoning to argue that such a link does exist and has made a difference in past operations. We argue that if FMS leads to functional gains in warfighting, and those gains are indicative of improvements in interoperability (as opposed to other constraints or facilitators), then FMS enables interoperability and, hence, provides an additional, nonmonetary operational benefit.

We use Operation Allied Force (OAF) over Kosovo in 1999 and OOD and OUP over Libya in 2011 as the comparative points of analysis. The first objective is to link FMS sold during the interim period with improvements in warfighting capabilities between Kosovo and Libya. Through expert opinion, we selected four major FMS items (precision munitions, advanced targeting pods, tactical data links, and aircraft) that were sold between operations as depicted in Table S.1. We show that the sale of aircraft also leads to increases in international military education and training (IPT falls under the broader IMET) and international military exercises. We use historical analysis and interviews with military leaders to show that the FMS of those items and their effects led to improvements in the following warfighting capabilities: precision strike; dynamic targeting; joint data networks; targeting (in general); and training and tactics, techniques, and procedures (TTPs).

Having established the link between FMS and warfighting gains, we then connect warfighting gains to enhanced tactical interoperability between Kosovo and Libya. We use historical analysis to compare interoperability between Kosovo and Libya at the tactical, operational, and strategic levels of war. The literature indicates that the five warfighting capabilities are in fact interoperability improvements at the tactical level of war. We link each FMS item sold with the interoperability improvement and show that without the purchase of the item, the resulting level of interoperability and mission capability would not have been possible during operations in Libya. This qualitative analysis is supported by structured interviews with NATO military representatives from countries that participated in both Kosovo and Libya.6 Participants causally linked the purchase of FMS equipment with interoperability and enhanced mission capability gains from Kosovo to Libya. We further justify this conclusion using quantitative analysis showing improvements in the areas of precision strike and dynamic targeting between Kosovo and Libya. We argue that allied increases in these two difficult warfighting areas are indicative of fighting alongside U.S. Forces, and thus interoperability, rather than just supporting operations. We conclude that FMS enabled improvements in

6 These countries include: the United Kingdom, France, Belgium, Denmark, Norway, Spain, Italy, and Canada.
warfighting, resulting in increased tactical interoperability. Interoperability is therefore one additional benefit of FMS and consequently IPT that should be considered in FMS decisionmaking and when valuing IPT.

### Table S.1. Impact of FMS on Interoperability

<table>
<thead>
<tr>
<th>U.S. FMS Equipment, Training, and Effects</th>
<th>Countries Involved with FMS</th>
<th>Warfighting Capabilities / Tactical IO Improvements from Kosovo to Libya</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precision munitions:</strong> Joint Direct Attack Munition (JDAM)</td>
<td>BE, ES, IT, NO, DK, CA</td>
<td>X</td>
</tr>
<tr>
<td><strong>Advanced targeting pods (ATPs):</strong> Sniper and Litening</td>
<td>BE, ES, IT, NO, DK, CA</td>
<td>X</td>
</tr>
<tr>
<td><strong>Tactical data link:</strong> Link 16</td>
<td>BE, FR, ES, IT, NO, DK, CA</td>
<td>X</td>
</tr>
<tr>
<td><strong>Aircraft</strong></td>
<td>BE, ES, IT, NO, DK, CA</td>
<td></td>
</tr>
<tr>
<td><strong>Air exercises</strong></td>
<td>UK, FR, BE, ES, IT, NO, DK, CA</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Air exercises and international military education and training (IMET) results from the sale of FMS aircraft. 
NOTE: BE = Belgium; FR=France; ES=Spain; IT=Italy; NO=Norway; DK=Denmark; CA=Canada.


The USAF should consider IPT a valuable investment for future operations. While our primary conclusion is that operational savings should be included in estimates of the value of
FMS and IPT, we also note that this calculus could be extended to other key decisions. Policymakers should consider the monetary and nonmonetary benefits of FMS when prioritizing, budgeting, and allocating IPT resources. For example, a variety of objectives are currently used to prioritize the allocation of scarce IPT student slots including the desire to build or maintain strategic partnerships. Our research suggests that the likelihood of allied participation in future operations and the potential savings from this participation should be included as an additional discriminator. This research suggests that the USAF can more effectively build partnership capacity by giving higher priority to countries that are likely to 1) participate in and provide greater U.S. support for coalition operations and 2) increase interoperability through sustained FMS programs. A greater understanding of the overall cost-effectiveness of FMS will aid policymakers in such areas as the need to rethink the prices charged or the U.S. resources supplied to IPT, therefore shaping future FMS policy.
Acknowledgments

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAR</td>
<td>air-to-air refueling</td>
</tr>
<tr>
<td>AECA</td>
<td>Arms Export Control Act</td>
</tr>
<tr>
<td>AETC</td>
<td>Air Education and Training Command</td>
</tr>
<tr>
<td>AFB</td>
<td>Air Force Base</td>
</tr>
<tr>
<td>AFSAT</td>
<td>Air Force Security Assistance Training</td>
</tr>
<tr>
<td>AFTOC</td>
<td>Air Force Total Ownership Cost</td>
</tr>
<tr>
<td>ANG</td>
<td>Air National Guard</td>
</tr>
<tr>
<td>AOC</td>
<td>Air Operations Center</td>
</tr>
<tr>
<td>ATO</td>
<td>air tasking order</td>
</tr>
<tr>
<td>ATP</td>
<td>advanced targeting pod</td>
</tr>
<tr>
<td>AWACS</td>
<td>Airborne Warning and Control System</td>
</tr>
<tr>
<td>BOS</td>
<td>base operating support</td>
</tr>
<tr>
<td>C2</td>
<td>command, control</td>
</tr>
<tr>
<td>C4</td>
<td>command, control, communications, computers</td>
</tr>
<tr>
<td>CAP</td>
<td>Combat Air Patrol</td>
</tr>
<tr>
<td>CONUS</td>
<td>continental United States</td>
</tr>
<tr>
<td>CTA</td>
<td>Country Team Assessment</td>
</tr>
<tr>
<td>DAMIR</td>
<td>Defense Acquisition Management, Information Retrieval</td>
</tr>
<tr>
<td>DISAM</td>
<td>Defense Institute of Security Assistance Management</td>
</tr>
<tr>
<td>DoD</td>
<td>U.S. Department of Defense</td>
</tr>
<tr>
<td>DoS</td>
<td>U.S. Department of State</td>
</tr>
<tr>
<td>DSAMS</td>
<td>Defense Security Assistant Management System</td>
</tr>
<tr>
<td>DSCA</td>
<td>Defense Security Cooperation Agency</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>---------</td>
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<tr>
<td>OOD</td>
<td>Operation Odyssey Dawn</td>
</tr>
<tr>
<td>O&amp;S</td>
<td>Operations and support</td>
</tr>
<tr>
<td>OPTEMPO</td>
<td>Operational tempo</td>
</tr>
<tr>
<td>OUP</td>
<td>Operation Unified Protector</td>
</tr>
<tr>
<td>P&amp;A</td>
<td>price and availability</td>
</tr>
<tr>
<td>PAA</td>
<td>primary authorized aircraft</td>
</tr>
<tr>
<td>PAF</td>
<td>Project AIR FORCE</td>
</tr>
<tr>
<td>PGM</td>
<td>precision-guided munition</td>
</tr>
<tr>
<td>REMIS</td>
<td>Reliability and Maintainability Information System</td>
</tr>
<tr>
<td>SAMM</td>
<td>Security Assistance Management Manual</td>
</tr>
<tr>
<td>SAF</td>
<td>Secretary of the Air Force</td>
</tr>
<tr>
<td>SAF/IA</td>
<td>Office of the Deputy Under Secretary of the Air Force for International Affairs</td>
</tr>
<tr>
<td>SAR</td>
<td>Selected Acquisition Report</td>
</tr>
<tr>
<td>SCAR</td>
<td>Strike Control and Reconnaissance</td>
</tr>
<tr>
<td>SCO</td>
<td>Security Cooperation Office</td>
</tr>
<tr>
<td>STANAGS</td>
<td>standardization agreements</td>
</tr>
<tr>
<td>TACP</td>
<td>tactical air control party</td>
</tr>
<tr>
<td>TCT</td>
<td>Time Critical Target</td>
</tr>
<tr>
<td>TDY</td>
<td>temporary duty</td>
</tr>
<tr>
<td>T-MASL</td>
<td>Training-Military Articles and Services List</td>
</tr>
<tr>
<td>TTP</td>
<td>Tactics, techniques, and procedures</td>
</tr>
<tr>
<td>UAE</td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>UAV</td>
<td>Unmanned aerial vehicle</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>USAF</td>
<td>U.S. Air Force</td>
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<tr>
<td>USTRANSCOM</td>
<td>U.S. Transportation Command</td>
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</tbody>
</table>
1. Introduction

Objective and Policy Significance

The Foreign Military Sales (FMS) program is the U.S. government's method for selling defense equipment, services, and training to our allies. Many sales result in obligations to the services to train personnel from partner nations. For example, the U.S. Air Force (USAF) trains partner nation pilots to fly the platforms purchased through FMS. However, the training costs from this international pilot training (IPT) are rarely fully recovered from our partners, as the vast majority of countries receive a discounted course price for training. The extra costs associated with IPT are borne by the USAF, causing many to question whether IPT is truly cost-effective. To make matters worse, there are other uncalculated costs, above and beyond the course price, that are recognized by the IPT community but unaccounted for in the full FMS course price offered by the services. And, other administrative and opportunity costs from the scheduling and general vicissitudes of IPT also call into question the value of providing this service.

Furthermore, U.S. FMS are on the rise, reaching $65 billion in new sales for fiscal year (FY) 2012. With an increase in sales, the demand for IPT has also increased. Increasing demands for IPT creates shortages in the finite USAF training capacity, causing further doubts as to the value of IPT. Although international training in general only accounts for 6 percent of the total training capacity, decisionmakers in the USAF are already faced with prioritizing which countries receive the training. This situation creates additional friction and inefficiencies in the training enterprise when foreign student course entry dates slip for a variety of reasons.

Despite these concerns, the thesis for this dissertation is that the costs of IPT are offset by the value received when U.S. forces are working with these partner nations in military operations. The purpose of this research is to expand on the body of research and methodologies that assess

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7 See Chapter Three for further details.
10 AETC AFSAT/FM, DoD, USAF, personal communication, October 30, 2013
11 Skip Williams et al., Valued Partners: Quantifying the Value of Foreign Military Training to the USAF, Santa Monica, Calif.: RAND Corporation, RR-756, forthcoming, October 2014.
12 Other FMS benefits not discussed in this dissertation only strengthen this thesis. The author realizes that future operations are difficult to predict with certainty. This work looks at recent military operations as a way to understand the dynamics associated with working with partners and isolate costs and costs avoided by U.S. forces.
the costs and benefits of FMS-directed IPT to the USAF, thus giving policymakers a clearer picture of the overall value of IPT and the priority that decisionmakers should place on training international pilots. The unique methodologies in this dissertation may be used by the combatant commands and the services in their respective decisionmaking roles to assess allies on a country-by-country basis, to make recommendations for prioritizing future IPT for coalition partners, and in valuing future FMS and IPT for the USAF.

In order to substantiate the thesis that FMS-directed IPT is indeed worth the cost incurred to the USAF, this dissertation addresses the following main research questions:

- What are the quantifiable total monetary costs to the USAF for IPT?
- What are some of the operational benefits that the USAF receives from IPT that are not traditionally considered?
  - How did allied participation with FMS-supplied F-16s reduce USAF involvement and costs in recent operations?
  - How do FMS agreements and their timely, efficient execution affect allied air interoperability with U.S. forces?

We will show that, on balance the cost of IPT is outweighed by the monetary benefit the USAF receives from allied participation in operations. In addition to the monetary advantage, the nonmonetary benefit of FMS as realized in interoperability adds to the overall value the USAF receives.

**Monetary Cost to Train International Pilots**

The cost of offering discounts to international partners is well-known to the USAF. Due to the nature of U.S. alliances, few countries fully reimburse the USAF for IPT. The discount provided to NATO allies must be understood within the context of cost-sharing, cost-avoidance, or reciprocal agreements between the United States and NATO. Discounts to non-NATO countries are more of a subsidy because they may not be able to afford the training otherwise. At the very least, discounts allow the nation’s training funds to go further. Additionally, discounts can be offered at the time of sale as offsets or incentives to purchase the defense equipment and associated training. From 2006 to 2013, the USAF absorbed $133 million in cost from

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13 The most significant support offered to the United States comes in the form of the Host-Nation Support of overseas bases. Through direct or indirect payments (e.g., reduced rent, tax write-offs, construction assistance), many nations hosting overseas U.S. bases provide monetary support and share in the costs of U.S. military presence. Understanding the true cost-sharing is difficult, as many costs and benefits occur within explicit NATO requirements, such as the Security Investment Program Contributions while others occur outside the framework. (Michael Lostumbo et al., *Overseas Basing of U.S. Military Forces: An Assessment of Relative Costs and Strategic Benefits*, Santa Monica, Calif.: RAND Corporation, RR-201-NDRI, 2013.)

discounted course pricing from F-16 IPT alone. This is enough money to train approximately 50 pilots. This research will analyze these known costs involved with IPT, as well as explore the costs above and beyond the full reimbursement price. Once a truer monetary cost has been calculated, we then analyze the operational savings and weigh the benefits against the monetary cost.

**Monetary Savings in Operations**

This dissertation develops a unique methodology for deriving the monetary benefit from partner participation in coalition operations. These quantifiable savings realized by the USAF are due to allied aircraft and aircrews substituting for U.S. forces that would otherwise need to be deployed and employed to achieve operational or mission objectives. Calculating the operational costs avoided by the USAF through coalition operational activity adds a unique dimension in evaluating the benefits of FMS that has not been included in past analyses. Quantifying the amount of cost avoided by the USAF from partner participation in international coalitions is one way of assessing the monetary benefits of FMS international training. We perform an analysis of the cost to train an adequate number of pilots for operations in order to facilitate a fair comparison between the overall monetary costs and benefits of IPT for those nations that participate in operations.

With a clearer understanding of the monetary costs and benefits of IPT, the USAF will better-understand the consequences for the FMS course pricing and training priority offered to countries. We weigh some of the monetary benefits of FMS against the cost to train international pilots in the United States. This will improve policymaker understanding of the overall cost-effectiveness of FMS for countries likely to participate with U.S. forces in coalition operations, the need to rethink the price charged or the U.S. resources supplied, and therefore shape future FMS policy. The methodology in this research can capture the monetary IPT value for any country that participates in any operation, thus providing policymakers a method for assessing IPT in the future. However, there are many nonmonetary benefits of FMS (and consequently IPT) which potentially increase its worth to the USAF. We expand our research by qualitatively assessing one nonmonetary benefit of FMS: interoperability.

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15 See Chapter Three for full calculations.

16 There are many reasons why the United States would want to include operational partners within a military response. This dissertation focuses on the costs incurred in FMS training balanced with the ability to avoid the costs of development when a partner accepts some level of mission responsibility. In this sense, activity performed by a partner would not have to be performed by a corresponding United States element.

17 This analysis is not comprehensive in that it seeks only to identify and compare costs relying on similar partner capability. The analysis was limited to just F-16s in this case, a general purpose fighter employed by both the U.S. and a range of foreign partners. The analysis also demonstrated a method that could be expanded to include more partners and additional metrics for measuring productivity as national sensitivities will allow.
The Value of Interoperability

Many of the benefits of FMS are complex, subjective in nature, and can be hard to quantify. Some of the reported benefits of FMS found in the literature center on FMS and increasing interoperability between U.S. forces and allies, fortifying bilateral defense relationships and enhancing regional stability, and supporting the industrial military base.18 These geopolitical and military benefits may not have a direct financial value or this value may not be visible until years later. Nevertheless, they have potentially unique and desirable nonmonetary benefits that should be considered in the overall cost-effectiveness and value of FMS and consequently IPT.

The United States continues to place emphasis on enabling coalition operations as budget constraints (along with national guidance), which makes reliance on partner contributions and burden sharing all the more important. Furthermore, coalition support is a key component of current operations and appears to be of increasing value for future military operations. The United States continues to depend on materiel and personnel burden-sharing with our allies to offset the cost of operations. Additionally, an essential element in enabling more effective and efficient coalition operations is interoperability. Analysis of the impact of FMS on allied interoperability will inform policymakers of just one example of the more complex nonmonetary benefits of FMS and IPT that should be part of their decisionmaking.

We focus on partner interoperability for two reasons. One, it is an increasingly important consideration for service forces deploying and combatant commands in an era where the United States may not be able to shoulder military operations without allied support.19 Two, it has the potential to reduce costs without reducing effectiveness of the forces being employed, an objective shared with partner nations. Focusing on interoperability will ultimately contribute to strengthening our thesis by exploring an additional operational benefit of FMS and, consequently, IPT. There are limitations of existing literature on interoperability (as a result of, and as a reason for, FMS). Other benefits of FMS—such as strengthening the defense industrial base, fortifying bilateral relationships, and enhancing regional stability—have been examined more thoroughly.20 Another strong motivation for studying interoperability stems from the lack

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19 An important recent example of the value of FMS to interoperability is with Turkey’s attempt to purchase a Chinese missile defense system. See Nancy Montgomery, “‘Maddening’ Mission: Keeping NATO’s Interoperability on Track,” Stars and Stripes, May 2, 2014.
20 This notion was confirmed in interviews with national military representatives (AIRN A5/9 PPX, Spanish Air Force, NATO Air Command, Ramstein AFB, personal communication, March 28, 2014; FMAA/BEOP/Division Retex, French Air Force, personal communication, April 2, 2014; and COMOPSAIR/A3, Belgian Air Component, personal communication, March 31, 2014). Representatives from Spain and Belgium could not identify a major sale that was
of quantitative methodologies for assessing this relationship. Although we provide an overall framework and some qualitative analysis at the three levels of war, our quantitative approach addresses the tactical level.

Dissertation Outline

Chapter Two outlines the operation and authorization of, and policy for, FMS in general. Additionally, we describe key stakeholders in the process. The chapter focuses on the reasons for studying the international training aspect of FMS. We conclude with the historical background of interoperability.


There are, however, numerous interoperability maturity models that provide governments the ability to examine interoperability at various levels. For example, the U.S. Department of Defense (DoD) Levels of Information Systems Interoperability model was developed by the C4ISR Architecture Working Group (See C4ISR Architecture Working Group, Levels of Information Systems Interoperability, March 30, 1998). The model is strongly technological and focused on system and technical compatibility (See Thea Clark and Terry Moon, “Interoperability for Joint and Coalition Operations,” Australian Defence Force Journal, No. 151, 2001). In 2004, Fewell et al. proposed their Organizational Interoperability Model (See Suzanne Fewell et al., “Evaluation of Organisational Interoperability in a Network Centric Warfare Environment,” Ninth International Command and Control Research and Technology Symposium, Canberra, Defense Science and Technology Organization, 2004). This model focuses on unified, combined, collaborative, ad hoc, and independent levels of organizational interoperability. A study in the UK by QinetiQ took the organizational interoperability model and added further categories and indexes to allow for more structured assessments (See K. Stewart et al., “Non-Technical Interoperability in Multinational Forces,” Ninth International Command and Control Research and Technology Symposium, Farnbrough, UK: QinetiQ, 2004).
the cost to the USAF from discounted course pricing, and explore the costs above and beyond the full reimbursement rate. We also identify potential costs from the vicissitudes of the IPT enterprise.

To measure the savings to the USAF from allied participation in operations, Chapter Four examines one of many possible examples as a case study: the U.S.-led Operation Odyssey Dawn (OOD) and the NATO-led Operation Unified Protector (OUP).\textsuperscript{22} After outlining an innovative way of calculating this benefit of IPT, we compare the total cost and savings of FMS international training for those countries that participate with U.S. forces in operations. An analysis of the monetary costs and benefits associated with IPT has the potential to aid decision makers in better allocating and prioritizing resources for training. The analysis demonstrates this by focusing on a portion of the force (F-16) employed by both the U.S. and an extensive list of partners of varying capability.

While Chapters Three and Four assess the monetary cost and benefits of FMS, Chapter Five provides a qualitative approach at understanding one nonmonetary benefit of FMS: interoperability. It is the purpose of Chapter Five to analyze aspects of how technology and training, sold through U.S. FMS, affects allied interoperability with the United States. A more complete understanding of how these agreements affect interoperability may guide future policies aimed at prioritizing IPT and further improving allied interoperability and U.S. arms sales. By understanding the impact of FMS and consequently IPT on interoperability, we also strengthen the thesis that IPT costs are outweighed by operational benefits (such as interoperability).

The final chapter provides a summary of the findings, and it offers recommendations to policymakers. We highlight ways to improve the methodologies associated with each research question and outline areas for future research.

\textsuperscript{22} Note that the United States continued to participate in OUP.
2. Background and Motivation

Foreign Military Sales

FMS are a part of the Security Assistance program of the U.S. Department of State (DoS) and the primary means by which the United States sells defense articles and services to eligible foreign governments and international organizations. The articles may be provided from DoD stocks or from new procurement. If the FMS is a new procurement sale, the U.S. government agency or military department assigned to the case is authorized to enter into contractual agreements with the U.S. industry on behalf of the foreign government. This differs from direct commercial sales (DCS), which is the other major way in which foreign nations can obtain U.S. defense articles. DCS allow the foreign government or international organization to purchase directly from the U.S. industry with an export license issued by the DoS. DCS deliveries have been on the rise, and currently comprise roughly 50 percent of all defense articles and services delivered (as shown in Figure 2.1). We will focus on FMS, rather than DCS, because FMS is the primary and preferred method of foreign governments to purchase major defense equipment.\(^2\) It is also subject to discounts, specifically in training costs, that require the individual services to make up the difference between the discount and full prices from within their annual training budgets.

\(^2\) DoD is neutral regarding the customer’s choice to go through FMS or DCS channels. Although most defense systems can be purchased using either method, there are instances that restrict the process to FMS only, including presidential or legislative restrictions, military department policy, government-to-government agreement requirements, and interoperability/safety requirements. Historical examples of FMS only include man-portable air defense missiles, cryptographic equipment, and airborne early warning and control systems. Customers that use foreign military financing program (FMFP) funds typically are required to purchase through FMS because there is an expectation that the FMS process will be more efficient. FMS may also include offset agreements, although no offsets are permitted when funding is through FMFP. One reason international customers choose FMS over DCS is because DoD makes the purchases on the customer’s behalf using the same U.S. government regulations and procedures that DoD uses for its own procurement. For example, customer countries are aware that FMS materiel almost always comes with assured logistics support for the expected life of the equipment. FMS entitle foreign governments to the same benefits and protections built into DoD procurement. DCS can be the preferred method for those countries with extensive business ties to the West. Countries who are knowledgeable of U.S. law and financing may find the DCS process more flexible to achieve their aims. Another advantage of DCS is the possibility for trade-in or bartering involved as partial payment. Defense articles in production can typically be procured more quickly under DCS, as the FMS acquisition process involves the review and acceptance of the letter of offer and acceptance (LOA), contract negotiations, and production lead times. The FMS process integrates the customer’s priorities with the overall DoD acquisition priority. By contrast, the DCS process is quick in obtaining export licenses, contract negotiations, and production lead times. DSCA, Security Assistance Management Manual (SAMM), Manual 5105.38-M, Aug, 2014.
Statute Authority and Key Stakeholders

U.S. Code Title 22 provides congressional authority to conduct DoS Security Assistance programs. The programs are carried out through two basic laws, the Foreign Assistance Act of 1961 (FAA) and the Arms Export Control Act of 1976 (AECA). AECA enacted congressional legislative controls over export of defense articles and services. The Senate Foreign Relations Committee and the House Foreign Affairs Committee are responsible for foreign assistance and Security Assistance program authorization legislation. The Senate and House Armed Services Committees are responsible for defense programs authorization legislation. The term security cooperation is used within DoD, whereas the term security assistance is used within the DoS. It is important to note that these congressional committees play a role only in FMS authorization. Although Congress maintains legislative control over exports, FMS is a nonappropriated program, external to the U.S. budget, and the president is charged with signing off on spending for the program. Through Executive Order 11958, as amended, the President delegates selected functions in the AECA to the secretaries of State and Defense. They are required to provide reports to Congress and obtain specific congressional approval on certain exports or transfers.


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24 FAA, as amended: U.S. Code 22, Sec. 2151 et. seq.; AECA, as amended: U.S. Code 22, Sec. 2751 et. seq. AECA originally existed as the Foreign Military Sales Act of 1968. Before that, FMS authority came from the FAA.
The DoS has responsibilities relating to security assistance, which include managing the export of defense articles, services, training, and military technology.\textsuperscript{25} DoD has responsibilities relating to security cooperation, which include activities to encourage and enable international partners to work with the United States to achieve strategic objectives.\textsuperscript{26} The military departments and other DoD agencies involved in managing FMS programs are collectively called implementing agencies (IAs). The Army, Navy, and Air Force usually have the responsibility of being the IA in the process of FMS.\textsuperscript{27} The Air Force agency for all security cooperation programs is the Office of the Deputy Under Secretary of the Air Force for International Affairs (SAF/IA). The Assistant Secretary of the Air Force for Acquisition has oversight in the execution by virtue of having responsibility for Air Force acquisition. SAF/IA is supported by the Air Force Security Assistance Center at Wright-Patterson Air Force Base, Ohio, for most FMS and other logistics functions. The Air Force Security Assistance Training (AFSAT) squadron at Randolph Air Force Base (AFB), Texas, is in charge of planning and, with AETC, managing the Air Force international military training. It is organized under the authority of AETC.

\textsuperscript{25} Within DoS, the Political-Military Affairs Bureau uses the AECA and turns its requirements into a regulation called the International Traffic in Arms Regulations. The Bureau of Political-Military Affairs implements these responsibilities through its subordinate offices—the Office of Regional Security and Arms Transfers (which manages such government programs as FMS) and the Directorate of Defense Trade Controls (which manages such commercial programs as DCS, with respect to the implementation of the International Traffic in Arms Regulations). Security assistance is funded and authorized by DoS, but many aspects are administered by DoD. Defense Institute of Security Assistance Management (DISAM), “International Programs Security Requirements Course,” online course, June 2013a.

\textsuperscript{26} This includes all seven DoD-administered security assistance programs: FMS, International Military Education Training (IMET), Foreign Military Construction Services, FMFP, leases, Military Assistance Program, drawdowns, and excess defense articles. The Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics is responsible for the coordination of research, production, development, logistic support, and acquisition support for all international defense cooperative issues. The Under Secretary of Defense for Policy serves as the principal adviser to the Secretary of Defense for the integration of plans and policies with U.S. national security objectives, and is the interface for all DoD’s international programs. The two organizations under the Under Secretary of Defense for Policy with international programs responsibilities are the DSCA and the Defense Technology Security Administration, which administers the development and implementation of DoD technology security policies on international transfers of defense articles, services and technologies. The DSCA manages all DoD security assistance programs, including FMS and humanitarian assistance, as well as other international programs. The official source for DoD-wide security assistance and security cooperation policy, over which DSCA has responsibility, is the SAMM, which provides the basis for the rules and procedures for transferring defense articles, services, and training through the FMS program and other programs. DoD, \textit{Policy and Responsibilities Relating to Security Cooperation}, DoD Directive, DoDD 5132.03, October 24, 2008.

\textsuperscript{27} The military departments coordinate with DSCA and implement the FMS case. The IA does not have the authority to reject FMS Letters of Request (LORs) without first contacting DSCA. DSCA will coordinate with DoS and other agencies before notifying the customer of the disapproval. Congress can also object to a sale by passing a joint resolution. The President has the authority to approve limited assistance and sales without regard to any other laws when deemed important to U.S. national security interests.
Time Line of FMS

The U.S. government infrastructure supporting FMS utilizes the existing domestic structure of DoD. This means that, apart from the agencies created to oversee the FMS process, the acquisition, logistic support, training, and other services are carried out using the existing structure of the military departments and DoD agencies. The policies and organizational elements differ among DoD agencies. The process of FMS is complex and could take years for a major weapon system, but the general steps and timeline are simplified in Figure 2.2.

Figure 2.2. FMS Time Line and Process

**Precase Development**

As outlined in the blue boxes in Figure 2.2, the process begins with foreign governments seeing the necessity for new equipment, services, or training.\(^{28}\) It is important to understand the

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\(^{28}\) DISAM, 2013b.
eligibility requirements for the U.S. and foreign governments to be able to participate in FMS. According to AECA, defense articles and services can be furnished only for internal security, legitimate self-defense, preventing or hindering the proliferation of weapons of mass destruction and the means of delivering such weapons, permitting the recipient country to participate in regional arrangements consistent with the Charter of the United Nations, and supporting economic and social development activities by foreign military forces in less developed countries. In the Air Force SAF/IA works with DoS and the regional combatant commands as security assistance requests come into the department.

After deciding to apply through U.S. FMS to acquire defense equipment, the customer will submit an LOR to the U.S. government. The IA is responsible for ensuring that information from LORs is provided to the correct organizations. A customer’s LOR can ask for a P&A response or an LOA. The P&A is simply information-only; the LOA is asking for a formal sales offer. A country can request a team to review and assess the country’s military capabilities in support of their objectives with the purpose of helping to clarify customer’s requirements. This is funded by the FMS customer. There may also be times when the LOR must be accompanied by a CTA, which is prepared by the senior U.S. Embassy leadership in conjunction with the Security Cooperation Office (SCO).

29 FAA, Section 502; AECA, Section 4. There are many reasons why FMS would not be approved to a foreign nation; for example, harboring terrorists would disqualify a country from FMS. There are other eligibility requirements for foreign nations besides those found in section 3(a) of AECA: The President finds that it strengthens the security of the United States and promotes world peace; the country (or international organization) has agreed not to transfer title to, or possession of, any articles or services (including training) furnished to it by the United States, unless the consent of the President has first been obtained; the country (or international organization) has agreed to not use or permit the use of such articles or related training or other defense service for purposes other than those for which furnished, unless the consent of the President has first been obtained; the country (or international organization) has agreed to provide substantially the same degree of security protection afforded to such article or service by the U.S. government; the country (or international organization) is otherwise eligible to purchase defense articles or services.

30 The CTA must address such factors as planned end use, impact on recipient’s military capabilities, source of financing and economic impact on recipient nation, the recipient’s ability to keep and protect sensitive technology, and the human rights record of the country. Additional information may be required by DSCA, some of which can be supplied by the appropriate regional Combatant Commander. The SCO is a major player in FMS, as it acts as the primary interface with the host nation on all security assistance and security cooperation issues. The SCO is under the authority of the Senior Defense Official/Defense Attaché. The precase development time varies depending on the customer and the time needed for CTA to assist the host nation.
Case Development

As outlined in the green boxes in Figure 2.2, the IA must process the LOR to officially initiate the case. The time required to write an offer in the form of an LOA depends on the type and complexity of the case. The President (delegated to the Secretary of Defense) submits a numbered certification that details the justification and impact to Congress before issuing an FMS LOA to sell defense articles or services that go beyond a certain threshold. For example, defense articles or services for $50 million or more, or major defense equipment for $14 million or more, requires congressional approval. Approval must be provided by DoS to DoD prior to any congressional notification. Once a potential FMS is approved by DoS, DSCA provides the official notification to Congress. If the IA estimates that the LOR will result in an LOA that exceeds dollar thresholds specified in section 36(b) of the AECA, then notification must reach Congress within ten days of the LOR receipt.

The ultimate authority for sales resides with Congress, which has the power to regulate commerce with foreign nations. By February 1 of each year, the President submits the annual “Arms Sales Proposal,” which covers all FMS and DCS sales of major defense equipment (more than $7 million) and other defense-related articles eligible for approval during the current calendar year. Once approval has been given or the time expires, the DSCA Case Writing Division countersigns and releases the LOA to the customer for acceptance. All LOAs include an OED, which is usually 85 days from IA approval. The customer will sign the LOA and send the initial deposit to DFAS-IN, which releases the obligational authority to the corresponding IA.

Implementation, Execution, and Closure

As outlined in the red boxes in Figure 2.2, the receipt of the obligational authority to the IA is the beginning of the implementation phase, which IA issues within ten to 15 days. To carry out the sale, the IA negotiates the contract, submits requisitions, schedules training, and other matters. Case execution begins when requisitions for the LOA material, services, and training are processed against the case. This is the longest phase in an FMS case and can last many years for

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31 The person who processes the LOR is usually found at the IA’s security assistance headquarters and is referred to as the country director, country program director, country program manager, command country manager, or country desk officer.

32 For NATO countries and Japan, Australia, Republic of Korea, Israel, and New Zealand, the threshold is $100 million for major defense equipment and $25 million for congressional approval.

33 U.S. Constitution, Article 1, Section 8.

34 This report is referred to as the Javits Report. By policy, no sale or licensing notification will occur until this report is received by and briefed to Congress. Congress must be in session, so it typically takes 15 to 50 days for this process to occur. In the absence of a joint resolution by Congress objecting to a proposed LOA prior to the expiration of the statutory notification period, DSCA may countersign the LOA and release it to the IA at the end of the notification period.

35 This OED includes 25 days for U.S. administrative processing and 60 for the country review.
major systems. During this period, there are many coordinating organizations that must carry out actions in acquisition, finance, logistics, and training. As the LOA is being carried out, reports are given to DFAS-IN and a quarterly bill is issued to the customer. Once all of the equipment and services are rendered, the case is categorized as “supply and service complete.” Most countries participate in “accelerated case closure procedures,” which require the case to be closed within 24 months of the case being declared complete. The case remains “interim closed” until all final expenditures have been processed. Eventually a case will move into “final closed” status.36

FMS International Training

The USAF has a long history of providing international training to partner nations. The primary reason for doing so is to be able to increase the probability of successful military operations in a wartime scenario. The United States ultimately sells equipment to allies to improve international security, to encourage allies to share the burden of supporting operations, and to keep America safe during a war.37 International training is done with the intent to improve partner military capacity while improving political ties. The international training of pilots and aircrew as a result of foreign military sales is of particular interest to the USAF because it typically manages this training within its formal training enterprise along with the training of U.S. pilots and aircrew students.38

The Secretary of Defense has emphasized the need for DoD to develop a “partnering culture” with foreign militaries as a mainstay of the U.S. defense strategy.39 One aspect of creating a partnering strategy requires the ability to capitalize on FMS-directed international training that results from the sale of U.S. aircraft.40 SAF/IA has identified a lack of awareness on the overall value of FMS international training. This, in turn, drives a lack of stable international training capacity across the Future Years Defense Program. With the United States pursuing a vigorous sales strategy, the need to provide efficient training solutions with FMS is growing.

USAF planning and programing has not always directly addressed international training requirements when sizing USAF training capacity. The restricted planning horizon (due to gaps

36 DISAM, 2013a.
37 See the following scholarly sources for a further discussion on motivations for conducting military sales: Griswold, 1997; Hartung, 1991; Shapiro, 2012; Klare, 1984; Hartung, 1980; Waller, 2003; Wilson, 2001; Markusen, 2002; Lin, 2012.
38 The point being that there is not a separate foreign training enterprise.
40 For example, if the United States sells F-16s to a foreign government, the sale will usually include providing F-16 training to the international pilots of that country. The training is done in the United States.
in data and shortfalls in process) limits how FMS funds are applied to the program.\textsuperscript{41} The growing international demand for training has resulted in friction in the international training program because a deficient training capacity has not satisfied the international requirements in a timely manner.\textsuperscript{42} SAF/IA would benefit the most from an understanding of FMS costs and benefits: This executive agent is in a unique position to influence FMS training needs while advocating additional training capacity. Other key stakeholders involved with international training include AFSAT, AETC, and USAF HQ/A3O (Operations, Plans and Requirements, Headquarters U.S. Air Force).\textsuperscript{43} Key stakeholders attend a yearly Program Flying Training conference that leads to a document that describes the allocation of flying training slots in the execution year.\textsuperscript{44} For the slots that are allocated to international students, SAF/IA holds a management board meeting late in the budgeting year to determine which countries will receive these training course slots in the execution year.

The friction within the international training program is caused by a variety of issues. For example, the flow of international students through the training pipeline is prone to interruption and delay.\textsuperscript{45} This delay is partly due to variations in producing international pilots stemming from partner uncertainty on training needs, course variance (meaning international students have courses unique to their country’s training needs), student abilities (particularly language proficiency), and sales time lines. Often, countries are unable to reliably tell the Air Force their forecasted training needs. This creates fluctuations close to or during the execution year. Because demand from foreign countries varies, the Air Force has difficulty in rigidly planning for international aircrew training. Also, the courses offered to aircrews vary according to platform. Some courses, such as those for the F-16, train just the pilots. Mobility platforms, such as C-130J, require training of pilots and other crewmembers, such as the loadmaster. Coordination of concurrent training can be difficult, as the demand for the professional courses varies. For example, the high demand and finite training capacity for the loadmaster aircrew specialty makes it more difficult to include international students in training, thus delaying operational ability of

\textsuperscript{41} AETC AFSAT/FM, DoD, USAF, personal communication, October 30, 2013.

\textsuperscript{42} AETC AFSAT/FM, personal communication, 2013.

\textsuperscript{43} The AFSAT squadron is responsible for providing the LOA training data as part of an assessment of training needs when the sale of a weapon system takes place. (RAND discussion with AETC/IA and AFSAT, October 2012 and March 2013; DISAM, 2013b, page 5–11). AFSAT focuses on execution-year problems, which increases the difficulty in forecasting training requirements. AFSAT fills new training slots that become available at the last minute; they also find replacements for foreign students who do not show up for training. AETC is responsible for sustaining training and meeting training capacity for the Air Force. USAF HQ/A3O is the executive agency that assigns the number of slots for international training, usually as a percentage of the total flight training capacity. SAF/IA and AFSAT advocate to A3O directly for a percentage of the total flight training capacity.

\textsuperscript{44} Williams et al., 2014. See this document for more information on the budgeting and allocation process of international training.

\textsuperscript{45} Williams et al., 2014.
foreign C-130J aircraft. Further issues arise in planning and programming international training into the USAF’s current four-year planning horizon. From the beginning of an LOR to actual services delivered typically takes two years, but could be as little as nine months. In other words, the sales delivery time line can be set without considering the training available to meet the demand from the sale. All of these issues, coupled with the differences in foreign pilot preparedness and technical experience, create turbulence in the training pipeline and cause problems in resource allocation and planning. Demand for courses can exceed capacity at some times, while at others, slots saved for foreign pilots go unused or are abruptly cancelled, thus wasting resources. The end result is an international training program conducted along the margins of the USAF training enterprise even though the activity is funded primarily through extra-budget funding.

The priority of international training is a concern for those conducting the enterprise. According to AFSAT, AF/A3O-AT sets the FMS training requirements at the lowest priority for USAF training, falling below those of the major commands, Air Force Reserve Command, and sister services. There is a clause in the AECA stating that the sale of defense services (such as aircrew training) should not have adverse effect on U.S. combat readiness. Tension between the international training program and HQ USAF may arise if AETC uses this clause to train U.S. pilots at the expense of foreign slots agreed to in the FMS planning. If training of international students interferes with the operational readiness of U.S. forces, then the USAF can delay the commitment for a future training opportunity. Having a clear knowledge of the benefits of IPT may aid decisionmakers in understanding the priority that should be given to international training when appropriate—or at least aid in better allocation of training resources to mitigate the consequences of the AECA interpretation. These benefits are not only the monetary benefits but also the nonmonetary benefits, such as the impact of FMS on interoperability explored in Chapter Five.

**Historical Perspective on Interoperability**

Interoperability is defined as, “The ability of systems, units, or forces to provide data, information, materiel, and services to and accept the same from other systems, units, or forces and to use the data, information, materiel, and services so exchanged to enable them to operate

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46 AETC AFSAT/FM, personal communication, 2013.
47 Williams, et al., 2014.
48 “Sales of defense articles and defense services which could have significant adverse effect on the combat readiness of the Armed Forces of the United States shall be kept to an absolute minimum.” AECA, Section 2761(i), 1976 as amended.
effectively together.” For example, when two radios can communicate with each other, they are interoperable. Interoperability can be at various levels, such as the technical level of an instrument or equipment, or at the personnel level with procedures, language, and so on. This paper uses the modern warfare concept of tactical, operational, and strategic levels of war to examine the degree of interoperability at those levels. Interoperability began within U.S. forces and then among U.S. and coalition forces.

Interoperability within U.S. forces was not a significant concern during World War II because the government purchased practically all material for all the services at the same time and the services were largely interoperable—to a point. After the war, each service procured systems to optimally support its own activities, thereby diminishing interoperability. As a result, wars such as Korea and Vietnam were fought with each service conducting mostly independent operations. Prompted by the lack of interoperability during the Grenada invasion, the 1986 Goldwater-Nichols Act established that all future operations would be joint, laying the groundwork for interoperability among the services. The act established that interoperability will be a “key enabler for the conduct of effective, collaborate, multi-service military operations.” Operation Desert Storm was an eye-opening realization of the lack of interoperability between the strike assets of the Navy and the Air Force. One author states, “The fruits of integration were finally realized over Afghanistan in late 2001 and further clinched by the all but seamless joint combat performance in Operation IRAQI FREEDOM.” Interoperability among our allies has been an even more difficult and ongoing process than within the sister services.

Interoperability among the United States and its allies is best understood through the lens of NATO, a political organization created in 1949 with the purpose of defending the freedom and security of its members by political and military means. The following brief historical account of U.S.-allied interoperability will not only provide background, but also stress the importance of

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51 Faughn, 2002.


53 Although other nations outside of NATO have come to aid the United States in recent conflicts (e.g., Sweden in OOD), the United States has traditionally first and foremost called upon nations within the NATO alliance and the ABCA (American, British, Canada, Australia and New Zealand) program. The authors recognize the importance of alliances in Asia with Japan and South Korea, as well. However, these countries did not participate in Kosovo or Libya—and, as such, are not considered in this research. John Austin, *Globalization of the International Arms Industry: A Step Toward ABCA and NATO Interoperability?* Fort Leavenworth, Kan.: School of Advanced Military Studies, U.S. Army Command and General Staff College, 2008; Alejandro Serrano Martinez, *NATO’s Level of Ambition in Light of the Current Strategic Context*. Fort Leavenworth, Kan.: School of Advanced Military Studies, U.S. Army Command and General Staff College, May 2012.
interoperability post-World War II. A similar historical outline of major FMS events can be found in the appendix.

In 1948, the Air Standardization Coordinating Committee was formed among the United States, Britain, and Canada with the purpose of standardizing issues related to military aviation. In 1951, the Military Agency for Standardization—now called the NATO Standardization Agency—was established. The creation of this organization indicated the fundamental importance of multinational standardization in NATO operations. The Lisbon Conference in 1952 led to the development of an organizational construct within NATO that gave minimum conventional requirements to defend Europe against a Soviet conventional attack. Defense policy, strategy, standardization of arms and procedures, integration of training methods, and pooling of transportation and other logistic resources were discussed during the conference. In 1964, the armies of the United States, United Kingdom, Canada, and Australia formed a standardization program, known as the ABCA program. New Zealand joined in 2006.

The threat of the Soviet Union against Europe was the raison d’être for NATO, and it also guided strategy until the dissolution of the Warsaw Pact. After the fall of the Soviet Union, the Alliance began a move from policies centered on providing for a common defense toward the pursuit of complex collective responsibilities, the result being a U.S.-influenced Combined Joint Task Force concept. NATO identified numerous flaws regarding interoperability—as well as shortcomings of capabilities, such as secure communications—after Operation Desert Storm in 1991. President Clinton’s Policy on Conventional Arms Transfer in 1995 defined key goals for FMS, including “to help allies and friends deter or defend themselves against aggression, while promoting interoperability with U.S. forces when combined operations are required.” The same year saw the creation of the NATO Standardization Organization to develop concepts, doctrines, procedures, and designs intended to achieve and maintain interoperability. This organization

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54 Gary Illingworth, Command, Control (C2) and Coalition Interoperability Post ‘911’: Introducing the Network Centric Infrastructure for Command Control and Intelligence (NICCI), Rome, N.Y.: Air Force Research Laboratory, 2002.
57 Austin, 2008.
produces STANAGS. Operation Allied Force in 1999 highlighted the need for increased mobility of forces, improved technological equality between U.S. and European allies, and enhanced interoperability among its forces. The same year, NATO approved the Defense Capabilities Initiative at a Washington summit to improve capabilities with a “special focus on improving interoperability.” Also during 1999, the DoD Director of Interoperability department was created in the Pentagon to serve as the single focal point to coordinate all interoperability activities.

In response to the September 11 terrorist attacks in 2001, NATO invoked Article 5 (the self-defense clause stating that an attack on one is an attack on all); however, challenges in political support persisted in the trans-Atlantic link. Once forces were committed, nations proved unable to close the gap of capabilities with the United States and worked to improve the availability and interoperability of their forces. In 2002, NATO presented Prague Capabilities Commitment, further quantifying how Defense Capabilities Initiative goals would be achieved. In 2006, NATO affirmed its commitment to Prague Capabilities Commitment and set the goal to perform two major joint operations and six small joint operations simultaneously. In 2008, the Bucharest Summit stressed the urgency of NATO’s need to transform and modernize its force to meet emerging requirements and enhance interoperability.

The shared culture, values, and goals of NATO countries arguably bind the member countries together historically and in informal ways beyond the formal dictates of the treaty. The continued commitment of the United States and the NATO alliance to improve interoperability, and U.S. influence as a provider of security and stability, remain as important today as they have been throughout NATO’s 65-year history. Interoperability is an ever-relevant, longstanding, and complex issue that requires thought and deliberate planning by all parties to bring about. We now begin the cost-benefit analysis by analyzing the true cost of providing IPT. We do this by

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61 Austin, 2008.
64 Samuel Walker, *Interoperability at the Speed of Sound: Canada–United States Aerospace Cooperation Modernizing the CF-18 Hornet*, Kingston, Ontario, Canada: Centre for International Relations, Queen’s University, 2001.
67 A major joint operation is a military operation in which the Alliance commits a significant number of forces, normally for a long period, in undertaking an important effort in deployment and sustainment and the need for interoperability. NATO, “The DJSE Concept,” 2014. NATO developed the modular Deployable Joint Staff Element concept to match the operational C2 requirements for the multiple operations that the new level of ambition envisioned.
examining the various costs of the Air Force F-16 IPT courses within the partner nation FMS context.
3. Assessing the Full Costs to Train International Pilots

Introduction

This chapter examines the total cost of F-16 IPT. We first examine the known cost borne by the USAF for providing discounts to allies. We then demonstrate a methodology for assessing the costs above and beyond the full FMS reimbursement rate that could be applied at any location. Finally, we outline other potential costs from the nature of IPT.

By law, FMS is a nonappropriated program that operates under a mandated no-loss concept and an administrative no-gain policy. FMS cases are usually funded by a foreign nation’s own national funds or through the use of other funds in the form of grants or loans. IPT is tuition-based and usually accounted for on a cost-per-student or cost-per-student-week basis. Several factors influence the tuition rate, such as the source of financing, a country’s income, and whether it has signed a reciprocal training agreement with the United States. Five primary price schemes are established for international training, ranging from most reimbursed (most expensive) to least reimbursed as follows: FMS-Full, FMS-NATO, FMS-Incremental, FMS-FMF/Grant, and, finally, IMET rates. Due to the nature of U.S. alliances, few countries pay FMS-Full prices for courses. The NATO discount must be considered within the context of how the United States shares or avoids cost when in NATO member countries or other programs. Other discounts may be more of a subsidy for a discrete list of countries that would not otherwise afford the training.

The difference between the full price and the price actually paid by the foreign nation is a cost borne by the USAF within its internal service planning and programming training budgets. From discussions with AFSAT/FM and AETC/IA, many argue that the service-derived FMS-Full price does not capture all of the costs for a few reasons. First, no facilities costs are

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69 DISAM, 2013b.
71 DoD, 2012a.
72 Pricing for courses falls under full cost or incremental cost, with NATO, Incremental, Grant, and IMET rates all falling under incremental costs.
73 For our case study of F-16 training from 2006 to 2013, only the United Arab Emirates paid the FMS-Full rate. This represents 3 percent of all the training accomplished during that time. Defense Security Assistance Management (DSAMS), obtained from AETC/IA, October 2013.
74 AETC AFSAT/FM, DoD, USAF, personal communication, October 30, 2013. There are costs that, for legal reasons, cannot be added to the price of international training, also adding to the disparity between FMS-Full and actual costs.
included in the course pricing. Second, flying-hour rates and the actual flying-hour costs may be different depending on fluctuations of fuel costs because there are two sets of flying-hour factors, one for tuition pricing and one for regular costs.75 Finally, base operating support (BOS) costs in the past decade have been developed by air staff, which AFSAT/FM argues underestimates the BOS costs at specific locations.

The flow of international students through the training pipeline is prone to interruption due to partner uncertainty on the training needs, the platform course variance, student abilities, and the time line of sales. Ultimately, this leads to cancellations on the part of the U.S. or international governments, delays, administrative intervention, other scheduling problems, training inefficiencies, and potentially opportunity costs for the underutilized resources that the USAF must also pay for and manage. Therefore, we end this chapter with a discussion of the interruptions, delays, and general vicissitudes of international training. We do not estimate a dollar cost in this research, but outline this as an area for future study.

Data and Methodology

We focus on standard formal flying training. As a specific case to examine in detail, the F-16 international training conducted at the 162nd Fighter Wing ANG in Tucson, Ariz., is used to demonstrate the cost under various assumptions for training international pilots. We focus on the F-16 due to its prevalence on the international stage, as well as the higher cost required to train compared to mobility platforms such as the C-130 or C-17. There were also more F-16 international pilots trained from 2006 to 2013 than pilots for any other aircraft type.76 We were able to conduct interviews at the 162nd Fighter Wing (FW) with experts from the operations and financial management career fields.77 These interviews will help us put in context the cost figures calculated from the standard databases.

The DSAMS database is maintained by the DSCA, and is updated continually with input from all FMS-directed international training units. DSAMS keeps track of international students and the country, courses, and dates of their training. DSAMS also details the reimbursement paid to the USAF per student, but does not provide the course price offered. For that information, we use the Training-Military Articles and Services List (T-MASL). The T-MASL outlines pricing

75 The difference between the flying-hour rates charged and actual flying-hour costs are normally small. In 2008, however, the actual price of fuel was about double that of the charged price. The Air Force has since decided that if fuel prices were to change substantially enough, then fuel prices would be adjusted as students enter their training. Therefore the major above-and-beyond reimbursement costs come from BOS and facilities. In the case of the 162nd, they have smaller facilities costs than an active-duty base, so BOS is the main additional cost for the international training there. 162nd FW/CPTF, ANG, personal communication, July 23, 2014.

76 DSAMS, 2013

77 Interviews with experts at Little Rock (C-130J) were not possible due to the majority of experts being contractors and the unavailability of the information requested.
data for each course offered to international students, and is maintained by DSCA. Using DSAMS in conjunction with the T-MASL, we calculate the cost of discounted pricing, which is the difference between FMS-Full price and the actual price paid. This chapter does not include years prior to 2006, due to the limitations of the DSAMS database.\textsuperscript{78}

To capture the costs above and beyond FMS-Full price, we use the Air Force Total Ownership Cost (AFTOC) database. This database provides routine, timely Air Force costs and logistics data for all major Air Force systems. It is the primary tool to assist in analysis of infrastructure and weapon system costs. AFTOC provides a baseline for the total cost to operate the 162nd FW. We use the FMR to best align the cost factors from DSAMS and AFTOC from 2006 to 2013.\textsuperscript{79} The FMR is a DoD document that details the financial management and policy of security cooperation, including how course prices are set and what cost factors are included in tuition pricing.

AFTOC also provides flying hours for each wing; however, we require flying hours by each squadron and also by mission type to assess what percentage of flying hours were allocated to FMS training. With the percentage of flying hours for FMS training, we calculate the above-and-beyond costs and add them to the known costs to capture the total cost for IPT at the 162nd FW. For information on flying hours by aircraft and mission type, we use data from the Reliability and Maintainability Information System (REMIS) database, a logistical database that contains Air Force-wide inventory, status, utilization, maintenance, and configuration data. Air Force Material Command at Wright Patterson AFB is the executive agency over REMIS.

We conclude the chapter using DSAMS to outline potential costs from the vicissitudes of international training and suggest areas for future research. This methodology can be applied at any base; however, due to differences between the ANG (reserve forces organized under a state or territory governor) and active duty or Federal Reserve organizations, applying the findings of this case study to active duty bases may not be as accurate.\textsuperscript{80}

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\textsuperscript{78} Before 2005, data on international training was managed on a different database. The data was migrated as well possible in 2005 to the new DSAMS system. However, AFSAT and AETC/IA stated that using any data before 2006 would be difficult to obtain (as they do not maintain the previous database), and would be less complete than DSAMS data. They therefore advised against using data before from 2006.


\textsuperscript{80} Differences include separate funding sources (Title 32 for ANG and Title 10 for active duty), flying-hour rates, and different cost factors from having state employees (e.g. firefighters) as opposed to the Title 5 civilians and contractors that the active duty utilize. The Guard does not have money to cover shortfalls and hence does not perform activities if the money has not been programmed into their budget. Another difference worth mentioning is the level of foreign disclosure allowed under U.S. technology laws. Internationals could not train at Luke AFB or Shaw AFB if Tucson ANG were at capacity, due to a higher level of foreign disclosure and export restrictions from technological differences in air frames. AETC AFSAT/FM, DoD, USAF, personal communication, October 30, 2013.
Known Costs of Discounted Pricing for IPT

In this section we discuss the formulation and guidance on the cost of international training. We determine the cost borne by the Air Force due to discounted pricing at the 162nd FW. There are three categories for pricing tuition: direct, indirect, and other costs (as outlined in Table 3.1). Direct costs are costs that can be directly ascribed to training courses and to training students. Once identified, the direct cost is divided by the total number of students enrolled in a course to determine the cost per student for that course. Indirect costs are those of resources that are jointly used by all activities at an installation but are not specifically identifiable with any of the users. Other billable costs, such as the FMS administrative surcharge, are those required by legislation or policy that are additive to the cost of training an international student. Tuition is rate-based, course pricing is done on a composite rate based on the assigned manning, and the reimbursable rate is based on actual assignment.

Table 3.1. Tuition Rates Pricing Factors

<table>
<thead>
<tr>
<th>Direct Costs</th>
<th>Indirect</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructors</td>
<td>Indirect BOS costs</td>
<td>Attrition rate/liability statement</td>
</tr>
<tr>
<td>School support staff</td>
<td>Maintenance and repair of facilities</td>
<td>Field studies program</td>
</tr>
<tr>
<td>Temporary duty (TDY)</td>
<td>Indirect TDY</td>
<td>Shipment of retainable instructional materials</td>
</tr>
<tr>
<td>and per diem</td>
<td>Equipment overhaul and maintenance</td>
<td>FMS administrative surcharge</td>
</tr>
<tr>
<td>Simulators</td>
<td>Supplies, material, training aids, ammunition</td>
<td></td>
</tr>
</tbody>
</table>

The international F-16 training has a wide variety of courses offered depending on country needs. The average reimbursable rates for the F-16 major courses from 2006 to 2013 (in FY 2013 dollars) are shown in Table 3.2. Note that the variance of pricing within a particular

81 DoD, 2012.
82 DoD, 2012.
83 All costs in this document are calculated in FY 2013 dollars unless otherwise stated. The cost data from DSAMS and the T-MASL was inflated to FY 2013 dollars using the USAF Raw Inflation Indices. Because the DSAMS and T-MASL cost data did not break out proportion of O&M, military pay, and fuel per course, we assumed an inflation indices based on the average of the three major categories.
course is significant (especially the basic qualification course) due to the tailoring of courses for each country. The various basic qualification courses are the main courses attended by international pilots. About 75 percent of the F-16 pilots attend a version of the basic qualification course; many then go on to other courses. We have included the following courses for completeness: advanced weapons, seasoning, instructor pilot upgrade, instrument conversion, and flight lead upgrade. Note FMS-FMF/Grant and IMET do not vary for F-16 pilot training; however, this is not the case for all courses eligible for international training students.

<table>
<thead>
<tr>
<th>Course</th>
<th>FMS-Full</th>
<th>FMS-NATO</th>
<th>FMS-Incr</th>
<th>FMS-FMF/Grant</th>
<th>IMET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Qualification</td>
<td>$2,398,807</td>
<td>$2,169,254</td>
<td>$1,942,805</td>
<td>$1,894,771</td>
<td>$1,894,771</td>
</tr>
<tr>
<td>Advanced Weapons</td>
<td>$2,388,404</td>
<td>$2,168,985</td>
<td>$2,032,741</td>
<td>$1,985,599</td>
<td>$1,985,599</td>
</tr>
<tr>
<td>Seasoning</td>
<td>$1,116,774</td>
<td>$969,213</td>
<td>$881,152</td>
<td>$855,933</td>
<td>$855,933</td>
</tr>
<tr>
<td>IP Upgrade</td>
<td>$1,014,340</td>
<td>$934,618</td>
<td>$881,242</td>
<td>$846,394</td>
<td>$846,394</td>
</tr>
<tr>
<td>Conversion</td>
<td>$855,478</td>
<td>$781,058</td>
<td>$698,955</td>
<td>$682,138</td>
<td>$682,138</td>
</tr>
<tr>
<td>Flight Lead</td>
<td>$884,163</td>
<td>$811,882</td>
<td>$751,568</td>
<td>$732,543</td>
<td>$732,543</td>
</tr>
</tbody>
</table>


The FMS-Full price is the sum of the direct, indirect, and other cost categories. The NATO rate excludes indirect military and civilian pay—and for the F-16 international training, averages about a 10-percent discount from FMS-Full. The other price categories have savings independent of each other discounted from the full price. The FMS-Incremental price is further discounted along the various cost factors and averages about a 20-percent discount from FMS-Full. Military salaries are excluded from pricing when the training is funded with U.S.-appropriated funds, as is the case with the FMS-Grant and FMS-IMET, which are both discounted anywhere from about 20 to 30 percent from FMS-Full.

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84 DSAMS, 2013.
The vast majority of F-16 IPT is conducted with the NATO or Incremental price. Figure 3.1 shows the difference between the FMS-Full price and the actual price paid for F-16 IPT from 2006 to 2013. The average discount rate for the 368 F-16 international pilots trained was 16 percent. The total cost from discounting the course price during this period amounts to $133 million, or about $17 million a year, that the USAF paid out of its own budgets. The cost for discounted pricing per F-16 pilot is an average of $360,000.85

Costs Above and Beyond FMS-Full Price

There are many ways of estimating the costs above and beyond the FMS-Full reimbursement rate for training; however, we will use the AFTOC database to demonstrate just one way of estimating this cost. To use AFTOC, the AFTOC cost elements must generally align with the tuition rates’ pricing factors. For example, if the tuition pricing included large costs outside of those captured in AFTOC, then AFTOC would underestimate the above-and-beyond costs.86

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85 In Table 3.2, there are basically three categories of prices. For the basic qualification and advanced weapons course, the average cost for discounting is about $380,000. For the seasoning and IP upgrade, the average cost is about $170,000, and for the conversion and flight lead courses, the average cost is about $140,000.

86 AFSAT/FM stated that aligning all the cost factors between AFTOC and FMR Vol. 15 would be complicated; however, a general comparison would be beneficial as a first attempt at estimating costs no one is calculating. The Air Force does not have a job order cost accounting system that has the manpower to make such cost estimates. AFSAT/FM strongly felt that the FMS-Full price does not cover all the costs, but when asked to estimate how much
Table 3.3. AFTOC Cost Elements

<table>
<thead>
<tr>
<th>AFTOC Cost Element</th>
<th>Percent (2006-2013)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Unit Personnel</td>
<td>34.7%</td>
<td>Cost of operators, maintainers, and other support manpower assigned to operating units. May include military, civilian, and or contractor manpower.</td>
</tr>
<tr>
<td>2.0 Unit Operations</td>
<td>41.7%</td>
<td>Cost of unit operating material (including fuel), unit support services, and unit travel. Excludes all maintenance and repair material.</td>
</tr>
<tr>
<td>3.0 Maintenance</td>
<td>19.8%</td>
<td>Cost of all maintenance other than maintenance manpower assigned to operating units. May include contractor maintenance.</td>
</tr>
<tr>
<td>4.0 Sustaining Support</td>
<td>0.1%</td>
<td>Cost of support activities other than maintenance that can be attributed to a system and are provided by organizations other than operating units.</td>
</tr>
<tr>
<td>5.0 Continuing System Improvements</td>
<td>0.3%</td>
<td>Cost of hardware and software modifications to keep the system operating and operationally current.</td>
</tr>
<tr>
<td>6.0 Indirect Support</td>
<td>3.3%</td>
<td>Cost of support activities that provide general services that cannot be directly attributed to a system.</td>
</tr>
</tbody>
</table>


The AFTOC database provides O&S cost estimates on a unit level. We use data from the 162nd FW that includes the F-16C and F-16D operations at the Tucson, ANG.\(^87\) A breakdown of the cost elements, their description, and the percentage of total cost from 2006–2013 is presented in Table 3.3. Most cost elements in Table 3.1 can be categorized into a cost element in Table 3.3. The cost categories of: personnel, operations (including fuel), and maintenance account for the vast majority of costs for the F-16 tuition.\(^88\) Those elements also account for more than 95 percent of the total cost in AFTOC. Adding in the indirect BOS increases the overlap between AFTOC and the tuition rates pricing factors to 99.5 percent. Therefore, we assume that the FMS-Full price includes all of the AFTOC cost elements. Costs such as FMS administrative surcharge and the attrition rate/liability statement are not included in AFTOC; therefore our estimate may slightly underestimate the above-and-beyond costs for IPT.

\(^{87}\) The AFTOC data is just for the 162nd FW, F-16C and F-16D operations, and does not include the MQ-1, or RC-26 also at Tucson.

\(^{88}\) 162\(^{nd}\) FW/CPTF, ANG, personal communication, July 23, 2014.
Figure 3.2. Cost Estimates for FMS F-16 International Training, 2006–2013

Having made our assumption to justify using AFTOC, we now use AFTOC to estimate the above-and-beyond cost. Figure 3.2 shows the cost of training F-16 international pilots. The first bar represents the total cost incurred by the 162nd FW F-16C/D operations. This is adjusted for the dedicated Dutch squadron in the next bar, which operates out of the 162nd, uses its own aircraft and pays for its own fuel. It also pays for a percentage of the military and civilian pay, as well as BOS at the base. Because our analysis only includes the nondedicated, tuition-based FMS international training, we have accounted for the Dutch by taking out the portion they pay from the initial estimate of total 162nd FW base expenditure. Their fuel and aircraft expenditures are not included in AFTOC data.

The third bar is an estimate of the true cost for IPT at the 162nd FW. A fraction, based on the utilization of the F-16 for international training, is used to determine the portion of the overall AFTOC-adjusted cost apportioned to the FMS training. To know the magnitude of each portion, we used the REMIS database, which has aircraft utilization based on flying hours and mission type. We first removed the ANG Air Force Reserve Test Center, which is a tenant unit hosted by

89 The Dutch pay 17.5 percent of military and civilian pay, 13 percent of operating and maintenance expenses for mission and indirect BOS support, and 8 percent of Arizona state agreements, including utilities. This amount ranges from about $15 million to $30 million a year. 162nd FW/CPTF, ANG, personal communication, July 23, 2014.
the 162nd FW. The test center possesses seven F-16s and uses 12.35 percent of the flying hours at the 162nd FW to support their primary mission of F-16 operational flight program testing.\textsuperscript{90}

Next, we accounted for the U.S. training done in the 152nd and 195th Squadrons. After removing all the non-FMS flying hours within the 162nd, we are left with 59.4 percent that is attributable directly to FMS training. Therefore, we assume that the cost of 59.4 percent of the F-16 operations should be accounted to FMS training. This assumption yields $931 million in total cost from 2006 to 2013. The last two bars shown in Figure 3.2 are the FMS-Full price and the amount actually reimbursed for international training.

\textbf{Figure 3.3. Average Cost per F-16 International Pilot, 2006–2011}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.3.png}
\caption{Average Cost per F-16 International Pilot, 2006–2011}
\end{figure}


How much, then, has the USAF had to pay in costs not captured by the tuition price? Subtracting $715 million from the estimated true cost of IPT, $931 million, and dividing by the eight years covered by the data gives a yearly cost of $27 million. This figure includes the $17 million per year in discounts, and represents the total additional cost that the Air Force incurs from IPT at the Tucson ANG. This additional cost above FMS-Full price amounts to, on average, $228,000 per student. Adding both the average cost of discounted pricing per student to the

\textsuperscript{90} 162nd FW/OSF/OSA, ANG, personal communication, July 23, 2014.
average additional cost above FMS-Full yields a total average cost per student of $588,000. Figure 3.3 demonstrates the variability of the cost per student over time from 2006 to 2013. It is interesting to note that the cost per student has increased almost 50 percent from 2006 to 2013. This may reflect that training is becoming more expensive (e.g., fuel prices increase), or perhaps there are other factors that require further study to explain this trend. Better tracking of variable costs (e.g., fuel) would help in establishing prices. Therefore, to account for the above-and-beyond costs, the FMS-Full course price would need to increase by about 10 percent to break even. Note that there would still be losses due to any discounts offered to international partners.91

It is worth noting that changes have been made in the way costs have been reimbursed in the last few years at the 162nd FW. Classes with an odd number of students cost more due to student-instructor balance. For example, if only three students are in the class, and the student-to-instructor ratio is two to one, then two instructors would be needed for only three students. The last few years have seen improvements to the international course syllabi to account for odd-numbered rosters. The most recent change is the move to a system of direct reimbursement where costs are tracked on an individual student basis. Military and direct costs that were previously discounted, such as academic instruction, are being billed as of 2014. This has made a significant change for the 162nd ANG; under this new system, an increased percentage of cost was recovered when comparing FY 2013 to FY 2014. The FMS-NATO course price recovered an additional 3–4 percent, and the FMS-Incremental price recovered anywhere from 5 to 17 percent, depending on how many flying hours and academic class time was used by the country.92

Other International Training Issues

It is generally accepted by those in the international training enterprise that there are more interruptions, last-minute scheduling, delays, and other uncertainties in international training than in equivalent U.S. training.93 These vicissitudes could be considered a monetary cost of training, although calculating their magnitude may be difficult, if not impossible. Increased management and administration, delays in the pipeline, and the resulting training inefficiencies are part of international training and certainly draw resources to resolve. Even though we do not calculate a monetary value, this information may aid in assessing the overall costs and benefits of

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91 The full price would need to apply to all except for FMS-Grant funds, as DoD does not charge DoD. One possible solution to increase the price would be to have a dedicated tuition. This concept was under review by the DSCA around 2008 for the 162nd ANG. Under a dedicated tuition, there is more leeway to charge a higher reimbursement rate that is tantamount to FMS-Full price. However, in 2012, the 162nd was tasked with training a portion of U.S. students, and therefore it was not justifiable to have dedicated tuition.


international training. We now turn to one example of the vicissitudes of international training—pilot training cancellations.

**Figure 3.4. Tucson ANG F-16 Pilot Training Population vs. Canceled**

![Graph showing the flow of international students through the training at Tucson. Each month is represented from May 2006 through August 2013, and the number of students present at Tucson for training during any part of that month is shown with the blue line. The green line represents the number of additional students per month that would have been present; however, the customer canceled the training slot. The red line shows the number of additional pilots canceled by the U.S. government that would have been in training during those months. The chart clearly shows a major increase in U.S. government cancellations in 2012 and 2013; this was due to the added demand to train U.S. pilots at Tucson. Luke AFB was undergoing a transition to accommodate future F-35 training and the USAF did not have the capacity to sufficiently train all of the U.S. F-16 pilots at Luke as the service would have preferred. Therefore, approximately 25 U.S. students per year were trained at the 162nd. The demand to train U.S. pilots resulted in a 4-percent decrease in FMS training capacity and a 6-percent demand.]


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94 162nd FW/OSF/OSA, ANG, personal communication, July 23, 2014
95 Training 25 U.S. students per year will continue for the foreseeable future (162nd FW/OSF/OSA, ANG, personal communication, July 23, 2014).
decrease in currency training. In 2012, the 162nd lost a squadron and maintenance was cut. At the same time, Iraq was in need of training many initial F-16 pilots. However, many Iraqi pilots did not make it through language courses, or other prerequisites, hence, a large portion of cancellations are for Iraqi pilots. The cancellations represent more than 50 percent of the demand of pilot slots, but not necessarily 50 percent of the capacity. Pilots spend different amounts of time in the system and have varying requirements for allotted flying hours during any given time. Thus, individual pilots place varying demands on total capacity.⁹⁶

Historically, the international training requirements for the F-16 have been met without issue. The cost of all the cancellations and consequent turbulence within the system is difficult to assess. When demand for international training exceeds capacity as it did in 2012 and 2013, one of the additional costs is the political and sustainment repercussions from countries not being able to meet their training demand.⁹⁷ For example, the Norwegians must train six F-16 pilots per year for sustainment. The Air Force informed Norway that they would receive only two slots (instead of their requested six); this lack of Air Force training capacity to meet the Norway requirement in a timely manner became a Chief of Staff issue. The countries that do best with international training have a long, carefully planned program to sustain their human capital, such as Norway. However, priority historically goes to new customers who need an initial flux of people to operate and maintain the equipment.⁹⁸ Political fallout as a consequence of not meeting FMS-related training commitments is one major aspect of the vicissitudes of international training. If the United States fails to meet demand, countries could turn to alternative sources for training for the F-16, such as Turkey. This may result in, among other things, a loss of interoperability (discussed in Chapter Five).

When a student requires additional training, the cost of that training is reported from the training base to AFSAT/FM and then back to the major commands and is included in the final price. From 2006 to 2013, 2.5 percent of students had to repeat a course.⁹⁹ When students do not finish training, a charge is applied by the service against the FMS case.¹⁰⁰ Attriters are charged

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⁹⁶ Capacity at the 162nd ANG is best understood through what they call basic course equivalents (BCE). One BCE is the time it takes for a U.S. student to go through the basic F-16 qualification course. Different countries have modified programs that require more or less than one BCE. Total capacity at the Tucson ANG is typically around 71 BCE per year; 25 now go to train U.S. Guard and active duty. 162nd FW/OSF/OSA, ANG, personal communication, July 23, 2014.

⁹⁷ Not meeting the demand may mean that the experience level declines below expectations—or that as pilots leave, the unit may not be able to meet readiness requirements until they receive replacements.

⁹⁸ 162nd FW/OSF/OSA, ANG, personal communication, July 23, 2014

⁹⁹ DSAMS, 2013.

¹⁰⁰ Additionally, a 50-percent charge will apply for all confirmed training canceled or rescheduled with less than 60 days notification unless training is reallocated and filled by another international student. A penalty is applied to all training that falls within and outside the 60-day window if the training is part of a sequential pipeline that a student would attend as part of a complete curriculum.
no less than 50 percent with all the pricing and adjusting. The graph does not show if a fee was assessed for the cancellation (if it was within 60 days). Nor does it show the opportunity cost of these cancellations in the form of student slots that were not filled from a cancellation or repeat courses. These are considerations for future research and are certainly costs resulting from turbulence in the pipeline.

Summary

The USAF is absorbing costs from the discounted price schemes and from costs above and beyond the FMS-Full course price. By law, there are some costs that cannot be charged to allies. The U.S. government provides a discounted rate for our NATO allies, as well as further discounts to various countries under the incremental rate. This discounting results in a direct cost that the USAF incurs. This amount totaled, on average, $360,000 per student ($17 million a year) for the F-16 international training conducted at the Tucson ANG. We found that there was an additional $228,000 per student ($10.5 million a year) in costs above and beyond the reimbursement rate. This totals, on average, $588,000 per student in discounts and costs beyond FMS-Full that are borne by the USAF. To correct for this additional amount, the FMS-Full price would need to be increased by about 10 percent. The Air Force should consider calculating the above-and-beyond course price at each base to recoup costs where possible in this fiscally constrained environment. This information may also help adjust training programs or FMS processes to reduce total costs incurred by the Air Force—or at least make them more transparent for decisionmakers. Using direct reimbursement appears to have succeeded at the Tucson ANG, as more costs were being recovered in fiscal 2014.

We now turn to a case study where the construct of the NATO alliance and the pilots trained by the USAF within the alliance provided a direct benefit to the USAF: Operation Odyssey Dawn. The next chapter will provide one methodology for calculating monetary benefits of FMS-directed IPT, thus contributing to our understanding of the value of IPT.
4. Cost Savings from Operation Odyssey Dawn

Introduction

This chapter explores an innovative way of considering the benefits of IPT, and weighs the cost-effectiveness of IPT to the USAF. Intervention by partner nations in global conflicts creates savings for the USAF. To measure these savings, we examine one of potentially many examples: Operation Odyssey Dawn (OOD). In response to the uprising in Libya against Gadhafi, the UN Security Council on March 17, 2011, established a no-fly zone in Libyan airspace and authorized the international coalition to take all necessary measures to protect the civilian population. The United States established OOD, which commenced on March 19, and officially ended March 31, when the leadership transferred to NATO and military actions continued under Operation Unified Protector (OUP). Coalition forces involved in Libyan air operations include the United Kingdom, France, Spain, Denmark, Norway, Canada, Belgium, Italy, Netherlands, United Arab Emirates (UAE), and Qatar.

To calculate the number of aircraft that the United States would have had to deploy in an operation to perform the missions undertaken by the allies, it is tempting to simply determine the participating countries and the associated deployed aircraft, and assume that the USAF would have had to deploy the same number of aircraft. However, this one-for-one exchange will almost always overestimate USAF’s deployed aircraft for at least four reasons. First, some nations deploy aircraft but are only in the theater to “show their flag” for political reasons and may not provide the needed operational component for coalition forces. Second, some nations are relegated tasks that may not require full USAF capabilities, or that may be accomplished using a variant with less range, payload, or precision. Third, foreign variants of U.S. aircraft are sometimes not as fully equipped or logistically supported. The training and skill/experience level of foreign pilots and their support elements are different from their USAF counterparts. Finally, many nations may not possess the ability to sustain the same operational tempo (OPTEMPO) as the USAF. Thus, a methodology is required to derive U.S. equivalent aircraft that would have been required for the operation, given these considerations. A methodology is required that provides greater fidelity and more realistically relates partner capability to the U.S. force output than a simple one-to-one substation would provide.

101 This level of participation does have value. However, in measuring the operational capability of the force employment, the authors want to measure only the force that is employed.
102 In some cases, the one-for-one exchange may underestimate the number of U.S. aircraft if one or more of these conditions is reversed.
In this section, we will describe our methodology for calculating operational savings. The next section details the OOD case study with an extension to OUP. We focus on the F-16 Fighting Falcon to assess the FMS-derived operational benefit. The availability of data on F-16 participation, as well as its widespread use among partner nations, makes it an ideal candidate. In the section after that, we weigh the cost results from the previous chapter against the benefits calculated in this one to see if IPT is worth the cost to the USAF. Finally, we provide a summary and suggestions for improving our methodology.

Figure 4.1. Historical Analysis of FMS Partners in Recent Operations

The first step in determining savings is a historical analysis of the operation. Figure 4.1 shows the components of this analysis. We determine which coalition members to consider by gathering information on aircraft used, number of sorties, types of missions flown, and weapons expended. If a nation brought aircraft to the theater but did not fly any missions, we note their presence but, with no sorties flown, we do not include them further in the analysis because we are looking more narrowly at actual employment operations.\(^{103}\)

From the allied sorties flown, we calculate the equivalent U.S. sorties that would be required to accomplish the same tasks. This is done by using a quality or proficiency factor to adjust the coalition sorties to U.S. equivalent sorties. Various measures taken from the operation could be used for this proficiency factor, such as the average number of aircraft needed to accomplish a mission or the probability of target kill—or, conversely, target error. These measures account for differences in foreign aircraft variants; skill level of pilots; and the supporting operational elements involved in identifying, tracking, and differentiating valid targets. The result is an

\(^{103}\) While our cost analyses and potential USAF deployment cost savings are based only on the allied aircraft flown during the operation, there is a deterrence value of having allied fighters forward deployed who do not participate in combat sorties that is not captured by our analysis. These countries and the USAF still had to pay for training their pilots to operate all the FMS-procured aircraft, regardless of whether the fighters were forward deployed or sorties were flown in theater.
estimate of the comparable number of U.S. equivalent sorties that would have been needed to accomplish the same missions as the foreign aircraft.

**Figure 4.2. Methodology for Assessing the Contribution of FMS Partners in Recent Operations**

Next, we move to the operational and cost analysis as shown in the bottom of Figure 4.2. The first step in this analysis is to adjust the number of U.S. equivalent sorties to account for the difference between foreign and U.S. OPTEMPO. This allows us to determine the number of U.S. equivalent aircraft that would have been needed to replace the level of effort provided by the allies. The United States is generally more efficient in its squadron sustainment ground operations and sortie generation. U.S. airmen can potentially do the same field maintenance and refueling tasks as allied maintainers in a shorter amount of time between sorties. Alternatively, in the same duration of time, they can support a larger number of combat-coded aircraft.104 We assume the length of the operation remains the same and calculate the equivalent number of USAF aircraft that can be serviced. Different OPTEMPO rates can be used to include normal or

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104 In this case study, the United States was more efficient at ground operations; however, the methodology allows for instances where the United States is less efficient than the allies. The efficiency of ground operations should be considered on a case-by-case basis. One way to measure the efficiency of ground operations is through historical OPTEMPO rates.
surge operations, mission distances, and basing. Since some operational costs are aircraft-based and some are squadron-based, we also convert the number of USAF aircraft equivalents into USAF squadron equivalents.

The cost savings to the USAF is the one-time amount spent to deploy personnel and material and fly U.S. aircraft to fill the coalition partners’ comparable role in the operation. These costs borne by our allies are savings to the USAF; i.e., had the allies not participated in the operation, USAF outlays would have been necessary. We calculate the USAF operational savings to cover:

- Operations and support (O&S) costs to deploy the aircraft from their home base squadron location to the forward operating base (FOB)
- O&S costs of cargo aircraft used for transporting the remaining flight crews and squadron maintenance and support personnel from the continental United States (CONUS) to the theater FOB location
- Second-destination transportation and one-time set-up costs of forward basing the aircraft spares, ordnance, support equipment, and tools needed to maintain and operate the aircraft at this same location
- O&S costs for the aircraft needed to perform the missions within the theater, including the USAF squadron forward deployed military, civilian and government contractor personnel, and direct and support labor costs
- O&S costs for replenishing the aircraft spares and part material costs expended, as well as fuel consumption costs
- Ordnance procurement costs for replenishing the USAF weapons inventory for the same quantity expended over the course of the missions and sorties flown.

The sum of these estimates represents a minimum total USAF operational savings, or costs avoided, estimate. It does not include other contingency costs, such as the USAF share of daily expenditures for sustaining the forward operation locations’ base infrastructure or facilities (e.g., maintenance hangers, supply centers, squadron living quarters), base security and support personnel, or similar costs. We are trying to keep the analysis simple and focused on the operational activity primarily.

These contingency costs and other USAF potential savings from having allied participation either are not captured here, due to the underlying uncertainty and situation-specific factors that drive the magnitude of these cost savings, or they are not included, due to the difficulty in quantifying the associated benefits of the specific savings.

These costs borne by our allies are potential savings to the USAF—meaning that if the allies did not fight, the United States would need to fill those gaps and incur more cost in deployment and combat operations. In another sense, these costs are avoided by the U.S. through working alongside military partner nations that provide measurable capability in meeting operational requirements. To determine one benefit of FMS, these operational cost savings can be compared
to the noncompensated costs for training pilots.\textsuperscript{105} We now turn to our OOD example with an extended analysis for OUP.

\section*{Operation Odyssey Dawn Case Study}

OOD provides us with a recent example of USAF trained foreign pilots and FMS aircraft used to perform missions that reduced the need for deploying additional USAF aircraft. We defined an FMS aircraft as any aircraft manufactured by U.S. industry and sold through the DoD FMS program.\textsuperscript{106} Generally, the USAF provides a significant amount of foreign training as a consequence of each FMS case. This could include aircraft that the USAF does not fly, like the block 60 F-16E/F.

Figure 4.3 shows the number of FMS aircraft for each of the participant countries in OOD. Since our interest is in USAF FMS savings, we only briefly note here the participation of Navy FMS aircraft (the F-18 and the E-2). Of particular interest, Belgium, Denmark, Norway, and UAE each brought six F-16s to the conflict, making that the most numerous FMS aircraft flown by the allies. We will focus on the F-16, as opposed to the other aircraft, to continue our case study of the F-16 from the previous chapter. The United States brought F-16CMs and a number of F-16CJs.\textsuperscript{107} The F-16CJs are not comparable to the FMS F-16s because the F-16CJs flew missions to suppress enemy air defenses but none of the allied F-16s did. Additionally, the UAE did not drop any ordnance. So, we omit them from further analysis and focus on the 18 F-16MLUs flown by Belgium, Denmark, and Norway.\textsuperscript{108} The foreign F-16MLUs are comparable to the USAF F-16CMs in airframe characteristics.\textsuperscript{109} More important for our methodology and this example is that they flew similar air-to-ground missions during OOD. This is important because our analysis translates the contribution of an allied aircraft type into an equivalent U.S.

\textsuperscript{105} For example, the tuition rate for NATO pilots to attend the ANG International Basic Course for F-16C/D only covers 93 percent of the FMS full tuition rate. NATO gets a discounted reimbursement rate of roughly 94 percent for other courses, such as the T-6, T-38, IFF, and C-17, to name a few (see 162nd FW/HQ/FMB, “AFSAT Tuition Rates and Appropriations Summary 2012,” AF613, January 2013). There are other costs, such as base infrastructure and maintenance costs, that are not included in the tuition and would increase the percentage of cost borne by the USAF. Adjusting the benefit for various partner capabilities helps keep the comparison within a realistic operational context.

\textsuperscript{106} We include the UK E-3 in the chart even though they were purchased through DCS. In this methodology, one could include or exclude DCS aircraft, depending on the objectives of the analysis. We will only consider FMS cases from this point on and will exclude DCS aircraft because we are interested in comparing benefits of FMS aircraft to the FMS pilot training costs. The USAF does not train foreign pilots through the DCS process.


\textsuperscript{108} Jorge Benitez, “National Composition of NATO Strike Sorties in Libya,” Atlantic Council website, August 22, 2011.

\textsuperscript{109} Jane’s All the World’s Aircraft, \textit{Lockheed Martin F-16 Fighting Falcon}, Information Handling Services (IHS) website, Dec 2013.
aircraft that would have been needed had the allies not participated. Thus, airframes need to be comparable to reasonably estimate an equivalent U.S. requirement. Because the other USAF FMS aircraft were used in much smaller numbers, we will demonstrate our methodology using the F-16MLUs, but note here that the overall USAF savings in OOD is greater than just that for the F-16s.

Figure 4.3. Number of FMS Aircraft for Each Participant Country in Operation Odyssey Dawn

Figure 4.4 shows the F-16 sorties flown by Belgium, Denmark, and Norway (shown from top to bottom). There are other measures of levels of effort, such as hours flown, but sortie count is a well-recognized metric in the fighter community. The number of sorties flown by the coalition partnership is then converted into equivalent U.S. sorties required to accomplish the same tasks. A one-to-one assumption (i.e., if Denmark flew 43 sorties to accomplish their missions then the United States would also need to fly 43 sorties) is likely to be incorrect. This assumption may lead to a misrepresentation of the amount of effort the United States would need to put forth to accomplish the same missions. To capture the differences between aircraft systems

The 38 sorties by Belgium is an assumption based on the ratio of sorties completed during OOD and the sorties during OUP by Denmark and Norway. By the time OOD ended, the Norwegians had flown 5.2 percent of the total number of sorties they would fly, while the Danes had flown 7.7 percent of their sorties. With the knowledge that Belgium flew 620 sorties during the entirety of the conflict, we can assume they flew about 6.5 percent (average of Norway and Denmark) of their sorties during OOD. This results in Belgium flying 38 sorties during OOD and, thus, 582 sorties during OUP, for a total of 620 sorties.
and pilot training and skill, we use a “proficiency factor” to obtain an operational equivalence. For the proficiency factor to appropriately reflect differences in level of effort among countries, it is necessary to derive a quantifiable and comparable metric between countries.

Figure 4.4. Operation Odyssey Dawn FMS Aircraft Sorties by Mission Design Series (MDS) by Country

![Table showing aircraft missions and sorties by country](image)


For fighters, one measure that can be used to determine the proficiency factor is the flying hours allotted to pilots for training and operational experience. Table 4.1 shows the individual fighter-pilot flying hours for the year 2010. To put these into perspective, the NATO minimum requirement for fighter pilots is 180 hours per year, although this is not always achieved.\(^{111}\)

If the data were available, other measures, such as weapon delivery accuracy, could be used to better determine the operational quality differences among U.S. and foreign fighter pilots. For other aircraft, a measure related to their mission success could be used. For example, if our study were focusing on transports, a proficiency factor of pounds offloaded or volume transported over time per aircraft could be used. If tankers were involved, the factor might be pounds of fuel offloaded over time per aircraft. In general, the proficiency factor needs to represent the level of effort contributed by a country's aircraft. The point is that the methodology provides a means for moving beyond a simple one-for-one comparison and with additional information can help understand the operational value provided by specific partners relative to U.S. capability.

The number of allotted flying hours per fighter pilot has been shown to have a direct effect on the pilot’s capabilities.\(^{112}\) Although the number of flying hours per year is important, the type

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of aircraft (encompassing aircraft capabilities) and total pilot experience also play large roles in overall pilot effectiveness. Another difficulty in using this metric is that the allotted flying hours can change from year to year. For example, due to budget sequestration, the USAF reduced flying time in 2013 by 18 percent and cut 44,000 flying hours across 17 squadrons.113

Table 4.1 provides the proficiency factor that we will use in this example. It is based on the flying hours per pilot per year, normalized to the U.S. flying hour standard. This adjustment is made by using results from a study that shows that a 10-percent reduction in flying hours equates to a 2.5-percent reduction in pilot proficiency in bombing.114 Because we are focused on the bombing campaign, this is a reasonable approach to adjust foreign sorties to equivalent U.S. sorties. As already stated, we did not include other factors, such as lifetime pilot experience and differences among aircraft that might also affect the outcome. Thus, we are assuming that the U.S. F-16s and the coalition F-16s are roughly equivalent in capability.

Table 4.1. U.S. Normalized Flying-Hour Proficiency as the Proficiency Factor

<table>
<thead>
<tr>
<th>Country</th>
<th>Annual Pilot Flying Hours</th>
<th>Proficiency Factor For Strike Missions</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>189</td>
<td>100</td>
</tr>
<tr>
<td>Belgium</td>
<td>165</td>
<td>97.4</td>
</tr>
<tr>
<td>Denmark</td>
<td>165</td>
<td>97.4</td>
</tr>
<tr>
<td>Norway</td>
<td>180</td>
<td>99.0</td>
</tr>
</tbody>
</table>


The number of equivalent U.S. sorties is then calculated by multiplying each country’s sorties by their respective proficiency factor. Further adjustment to the proficiency factor could be made to capture these (or any other) differences. For example, the proficiency factor for the Danes is about 0.97. Since the Danes flew 43 sorties, the number of equivalent U.S. sorties is 43x0.97, or about 42 sorties.

Figure 4.5 shows the equivalent sorties for the United States using the U.S. normalized bombing proficiency, based on flying hours for the proficiency factor. Multiplying the 38 Belgian sorties by the Belgian multiplier of 0.97 gives an equivalent U.S. sortie requirement of 37 sorties. The Norwegians had a comparable flying hour schedule to the United States; therefore, the United States would need to fly all of the Norwegian sorties. Adding up all the U.S. equivalent sorties gives a total of 111 F-16C sorties that would have been required to replace the 113 F-16MLU sorties flown by Belgium, Denmark, and Norway.

114 Hammon and Horowitz, 1990. The authors note that as different data become available, the methodology can be adjusted and other comparisons can be attempted.
We applied the same method, using the same proficiency factor, to convert the number of allied ordnance dropped to the U.S. equivalent number of ordnance. The rationale for converting equivalent ordnance is the same for converting the sorties; the United States could drop less ordnance to destroy the targets the allies attacked. The United States could drop less ordnance to destroy the targets the allies attacked. Belgium, Denmark, and Norway dropped 130 total munitions. Denmark dropped the most, by far, with 107 bombs. The overall equivalent number of U.S. ordnance is 126; this will be used to calculate a component of savings to the USAF.

Figure 4.5. Coalition Sorties and Equivalent U.S. Sorties

<table>
<thead>
<tr>
<th>Historical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Norway</td>
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</table>

This proficiency factor captures some, but perhaps not all, of the differences between U.S. and coalition sorties. We therefore include some parametric analysis to show the sensitivity of

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115 We do not account for the situation where the United States would prefer entirely different ordnance from those used by the allies. For example, the United States may prefer an alternative weapon to the guided bomb unit (GBU)-49s dropped by Denmark. Our analysis uses the basic assumption that the United States replaces the allied weapons with exactly the same variant.

116 Sandli, 2011; Skjolden, 2011.
our results to the proficiency factor. This will show how U.S. operational savings change as the proficiency factor is changed to 90 percent, 80 percent, and 70 percent for our allies. In doing this, we want to be clear that we are in no way assuming that the U.S. allies only achieve a skill level at 90 percent, 80 percent, and 70 percent of the United States; rather, we perform these calculations to show what effect the proficiency factor has on the end costs to the United States.

Figure 4.6 shows the adjusted U.S. sorties by assuming proficiency factors of 90 percent, 80 percent, and 70 percent. For example, if Belgium, Denmark, and Norway were all 90 percent as effective as the United States, then the United States would only be required to fly 102 sorties instead of the 113 flown by the coalition.

The steps we have taken so far have led us through the historical analysis of OOD. We now turn to the operational and cost assessment.

**Figure 4.6. Parametric Proficiency Factor Adjusted U.S. Sorties**


The first step in the operational and cost assessment is to adjust the U.S. equivalent sorties to account for the ability of the United States to operate at a higher OPTEMPO than most of our allies. To find the OPTEMPO, we must estimate how many hours each sortie takes and use that to determine how many sorties can be flown in one day. We assume the time it takes to get to and from theatre is constant, and we will vary the loiter time in operations theatre to show the sensitivity of OPTEMPO to these conditions.

The OPTEMPO is influenced by the duration of the flights and, hence, by the basing of the aircraft. The Danes flew their missions from Sigonella, Italy; the Belgians from Araxos, Greece; and the Norwegians from Souda Bay, Greece. All three of these bases are closer in proximity to
Libya that the U.S. base of operations in Aviano, Italy. If the United States operated out of these bases, a higher OPTEMPO rate could have been achieved, which would reduce the number of F-16s needed. For example, increasing the OPTEMPO to 1 sortie/aircraft/day means that the required number of aircraft to fly 113 sorties in 13 days would be 113 sorties, divided by 13 days, divided by 1 sortie/aircraft/day, which equals 9 aircraft.

We now estimate the OPTEMPO rates for the United States under various assumptions. The average distance from Aviano AFB to Libya is about 1,000 miles. Assuming the F-16 flies at 425 mph, it takes roughly 4.5 hours to make the round trip. In theatre, we examined three different times-on-station: one hour, two hours, and three hours. We then used the historical data to calculate a U.S. OPTEMPO rate. Eight F-16Cs from Spangdahlem deployed to Aviano; these, along with the 12 F-16Cs already at Aviano, flew 580 hours in six days. We then simply divide the number of sorties by the 20 aircraft and divide again by six days to get the number of sorties per aircraft per day to get the OPTEMPO rate. Using the three different times-on-station gives us three different OPTEMPO rates of 0.88, 0.73, and 0.63 for an F-16C.

We now make an adjustment from the OPTEMPO to calculate the additional aircraft required. Assuming that these OPTEMPO rates are constant through the 13-day duration of OOD, it would take an additional ten, 12, or 14 F-16s to fly the 111 U.S. equivalent sorties, as shown in the blue bars in Figure 4.7. The other bars represent the changes to additional aircraft as the proficiency factor changes. Even under the most constraining assumptions, with the OPTEMPO rate at 0.88 and the allies at 70 percent of the proficiency of the United States, the number of U.S. equivalent aircraft needed is still seven. With a lower OPTEMPO rate and the assumption that the allies’ proficiency is on par with that of the United States, the equivalent number of U.S. aircraft is 12. We will assume an OPTEMPO of 0.73 sorties per day; thus, 12 extra F-16s are needed to cover the 18 F-16s from Denmark, Belgium, and Norway. We use this conservative assumption because there also is likely to be additional ground time between flights, decreasing the actual OPTEMPO rate. Furthermore, it would be reasonable to assume an average of two hours spent on station. Therefore, an extra U.S. squadron would have had to deploy to replace the allied F-16 missions. We assume that the primary authorized aircraft (PAA) in a U.S. squadron is 24 aircraft, and that typical deployment packages come in 6, 12, and 18 aircraft from the squadron from which they are deployed.

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117 Belgium started their combat operations on March 21, Denmark on March 23, and Norway on March 24. The OPTEMPO rate for Denmark was 0.79 sorties/day, Norway’s was 0.67, and Belgium’s was 0.58.
119 Two hours time-on-station is an appropriate estimation, based on conversations with pilots who flew during OOD. See COMOPSAIR A3, Belgian Air Component, “Feedback RAND Cooperation,” datasheet, March 31, 2014.
120 In AFTOC terminology, aircraft in a unit’s PAA include all primary flying mission aircraft, backup, attrition, and reconstitution reserve aircraft. The deployment increments for fighter squadrons may vary, however, based on
We now proceed with the cost analysis by examining the deployment costs shown in Table 4.2. Included are the expenses for round-trip travel of aircraft; crews and equipment; additional flying hours due to the operation; and the ordnance cost. We did not include extra personnel costs for hostile fire/imminent danger pay because OOD was a short conflict and, in many cases, these do not take effect until deployments exceed 31 days. (We include them later, in the deployment cost calculation for OUP.) It is important to note that we are only looking at the F-16 costs. We understand that there would be additional combat forces and support costs during the conflict, which are not captured here. One example of additional costs would be the infrastructure costs associated with having aircraft at that base. The approach seeks to define a construct that is both easy to understand and quantifiable.

prior USAF operations; squadrons deploy in increments of six, making six, 12, and 18 the typical total aircraft deployed from a squadron. The methodology allows for flexibility in the deployment increments. When the increments change, the user will need to adjust the costs accordingly.
The cost to deploy the aircraft to and from the theatre includes such factors as distance to area of operations, block speed, cost per flying hour, number of tankers required to refuel, tanker cost per flying hour, number of personnel deployed, transportation cost per person, short tons of equipment needed, and transportation cost per ton to airlift the equipment. To estimate the travel distance from CONUS to Europe, we took the average distance from Los Angeles to Venice and from New York to London (4,811 miles).\textsuperscript{121} We calculated the hours required to fly this distance and multiplied that by the cost per flying hour for the F-16.\textsuperscript{122} We assumed that one tanker would be needed for aerial refueling for every three F-16s. We then calculated the cost of flying these tankers for the same duration as the F-16s, and allotted 290 personnel deployed to support the 12 F-16s.\textsuperscript{123} Each person costs an average of $1,318 to fly one-way into theatre.\textsuperscript{124} Additionally,

\textsuperscript{121} This methodology is close to estimates used by U.S. Transportation Command (USTRANSCOM) in their planning for operational deployments.
\textsuperscript{122} SAF/FMC, 2011.
\textsuperscript{123} MEFPAK, 2013.
266 short tons of equipment are needed, at a cost of $5,000 per short ton.\textsuperscript{125} Adding up all these expenses gives us a two-way transportation cost of $6.03 million.

The additional flying cost was calculated by assuming that each of the 111 U.S. equivalent missions lasts an average of 6.5 hours, resulting in the OPTEMPO rate of 0.73. This gives a total of 722 hours flown during the 13 days. However, this does not take into account that these planes would have flown a certain number of hours during those 13 days in a home station. To capture the additional flying-hour cost of war, we needed to subtract out the nominal peacetime flying-hour cost for 13 days. We calculated this by taking the average flying hours per year of a squadron of F-16s (11,215 hours) and multiplying it by the fraction of days per year of the conflict (13/365). This gave us an amount of 400 hours and, therefore, a difference of 322 additional flying hours.\textsuperscript{126} For an F-16, each flying hour costs $9,479.\textsuperscript{127} Multiplying the cost per flying hour by additional flying hours gives the additional flying cost of about $3 million.

For the ordnance cost in OOD and OUP, we estimated the average cost of a guided bomb because the breakdown of individual weapons dropped by country is not available. We estimated the average cost of a guided bomb to be $52,000.\textsuperscript{128} This results in an estimated $6.5 million needed to drop the 126 U.S. equivalent bombs.

One could argue that because the F-16s are based in Aviano, no transportation costs are necessary because the aircraft are already in place. If that is the case, then the operational savings would amount to $9.6 million for the additional flying hours and ordnance expended. However, we assume that these aircraft are in addition to those used by the United States and must be deployed from CONUS to fill the gap that would have been created had the allies not participated in the operation. The deployment cost for 12 F-16s totals $15.6 million for the 13 days of the operations as shown in Figure 4.8. To show the variation in cost, 18 deployed aircraft, which could be assumed to replace allied contributions one for one, would cost the United States a total of about $18 million. In the rare case where an entire squadron of 24 might need to be deployed, the cost rises to about $20 million. It is rare that the entire squadron deploys due to readiness of crews and aircraft.

\textsuperscript{124} FY 2012 USATRANSCOM tariff rates are derived from Headquarters (HQ) USTRANSCOM, “FY 2012 U.S. Transportation Command Tariff Rates,” spreadsheet data file, as of October 12, 2011.
\textsuperscript{125} HQ USTRANSCOM, 2011; MEFPAK, 2013.
\textsuperscript{126} This additional flying-hour estimate probably underestimates the actual additional flying hours during the deployment because the nominal flying hours for a fighter squadron includes average flying hours both at home and at forward deployed locations.
\textsuperscript{127} SAF/FMC, 2011.
\textsuperscript{128} This cost is the average of the GBU-10, 12, 24, 28, and 31. It does not include any of the more expensive stand-off weapons, such as the joint air-to-surface standoff missile or joint standoff weapon (JSOW).
We applied the same methodology for assessing the FMS F-16 savings in OOD to OUP, which occurred from April 1 to October 31, 2011. During OUP, the Danes flew 556 sorties and dropped 816 bombs; the Norwegians flew 615 sorties and dropped 588 bombs; and the Belgians flew 582 F-16 sorties and dropped 473 bombs.\(^{129}\) We then used the same proficiency factors and U.S. OPTEMPO rates to calculate the estimated number of U.S. F-16s necessary to fulfill the role of the 18 F-16s provided by Belgium, Denmark, and Norway over the 214-day period.\(^{130}\) The United States would need to field 9, 11, or 13 F-16s respectively, depending on the OPTEMPO (0.88, 0.73, 0.63 sorties/day), which means 12 F-16s are needed, considering that deployment packages come in 6, 12, and 18. We assumed that the United States would retain the 12 F-16s from OOD for OUP and that no additional transportation costs would be required—meaning we assumed that once the aircraft arrived from CONUS to Aviano, they stayed through


\(^{130}\) Belgium and Norway did not stay all 214 days of OUP; however, we are assuming for ease of calculation that the United States will perform the sorties over the entirety of OUP.
OUP. The deployment costs over this greater time period in OUP come principally from the flying-hour costs and ordnance costs, and minimally from the transportation costs and extra pay for officers in combat. We averaged out the final cost savings per month for each of the three savings calculations shown in Figure 4.9. The cost savings per month is about $22 million.

Figure 4.9. Additional U.S. Savings for FMS F-16s in Operation Unified Protector


Assessing the Costs and Benefits of IPT

Is FMS-directed IPT worth the additional expense to the USAF? That is the primary question of this dissertation and the subject of this section. We continue the case study of Belgium, Denmark, and Norway to assess the costs and benefits of IPT. We then review how to generalize the methodology to the greater international community.

We must equate the number of foreign pilots needed for OOD and OUP with the number of pilots trained for those countries to make comparisons about the costs and benefits of IPT. To do this, we first must make assumptions about the number of pilots needed. We will then examine the net savings per pilot during OOD and then add in the savings from OUP. We continue to breakout the known costs from price discounts and the above-and-beyond costs.
**OOD Net Savings**

As noted earlier in this chapter, Belgium, Denmark, and Norway each provided six F-16 aircraft for the operation. We could assume that the only pilots needed were those required to fly the six aircraft from each country. Using a crew ratio of 1.25, this would mean that eight pilots per country, or 24 total pilots, were needed to fly the aircraft. Alternatively, we may consider that, to get at the true cost-benefit, we have to include all F-16 pilots the United States trained for that country during a certain time period. We have data spanning a five-year period from 2006 to 2011, during which the United States trained 44 pilots from these three countries. The aggregate cost savings for OOD are shown in Figure 4.10.

![Figure 4.10. Aggregate Cost-Benefit Analysis of OOD (Belgium, Denmark, Norway)](image)

**Figure 4.10. Aggregate Cost-Benefit Analysis of OOD (Belgium, Denmark, Norway)**


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132 Methodology also used in Williams, et al, 2014
The total cost to train 44 F-16 pilots from Belgium, Denmark, and Norway from 2006 to 2011 was $91 million. Belgium, Denmark, and Norway paid the FMS-NATO rate and reimbursed $81 million, therefore $10 million was absorbed by the USAF. An additional $10 million was also borne by the USAF in above-and-beyond costs, making the total cost to the USAF $20 million to train the 44 pilots. Using the same cost factors, it would require $11 million to train 24 pilots. Having Belgian, Danish, and Norwegian participation in OOD resulted in savings of about $16 million. Note that because FMS-NATO rate reimburses about 6 percent more than the average reimbursement, the above-and-beyond cost to train NATO pilots is actually slightly more than the cost of providing the NATO discount. The net savings per pilot are shown in Table 4.3.

<table>
<thead>
<tr>
<th>Table 4.3. Net Savings of OOD per F-16 Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>24 Pilots</td>
</tr>
<tr>
<td>44 Pilots</td>
</tr>
<tr>
<td>Known cost</td>
</tr>
<tr>
<td>$427,963</td>
</tr>
<tr>
<td>$131,836</td>
</tr>
<tr>
<td>Known and above-and-beyond cost</td>
</tr>
<tr>
<td>$199,362</td>
</tr>
<tr>
<td>($96,765)</td>
</tr>
</tbody>
</table>


There are net savings per pilot in all cases except for that of the 44 pilots trained with known and above-and-beyond costs included. When considering both types of costs, the IPT training only begins to have net costs for the USAF at 35 pilots. Therefore, any assumptions of training 35 pilots or less will yield positive net savings to the USAF from OOD. We will now consider the additional savings in the hundreds of millions when considering both OOD and OUP together.

**OOD and OUP Net Savings**

The savings for OOD were extended greatly when considering the savings for the subsequent OUP. One way of considering the cost benefit of these operations is to weigh the savings from OOD and OUP against the cost to train all the F-16 pilots within those air forces. Using this assumption is appropriate, as one may consider that every pilot is needed to maintain Air Force readiness and capability in general. Fighter squadrons generally have a mix of experience levels, which as a set, works to sustain the desired level of unit readiness into the future. Without all the pilots, operations such as OOD may not be possible. We do not have data on the exact number of pilots trained before 2006; however, we may make assumptions about the total amount of pilots

based on the crew ratio and the number of currently operational F-16s within those air forces. Belgium has 54 operational F-16s, Denmark has 62, and Norway has 57. Using the crew ratio of 1.25, this amounts to a total of 217 pilots. Figure 4.11 shows the aggregate savings from comparing OOD and OUP to the cost of training 217 pilots at the FMS-NATO rate.

Figure 4.11. Aggregate Cost-Benefit Comparison of OOD and OUP (BE, DK, NO)


It is worth the $98 million cost absorbed by the USAF when considering the $170 million in benefits from OOD and OUP. In fact, the USAF could train 159 more NATO pilots before the costs outweigh the benefits from OOD and OUP. The net savings per pilot are shown in Table 4.4.

Table 4.4. Net Savings of OOD and OUP per F-16 Pilot

<table>
<thead>
<tr>
<th>Cost</th>
<th>24 Pilots</th>
<th>44 Pilots</th>
<th>217 Pilots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known cost</td>
<td>$6,859,818</td>
<td>$3,640,121</td>
<td>$559,895</td>
</tr>
<tr>
<td>Known and above-and-beyond</td>
<td>$6,631,217</td>
<td>$3,411,520</td>
<td>$331,294</td>
</tr>
</tbody>
</table>

As expected, the savings for 24 and 44 pilots trained are greatly increased when considering OOD and OUP. Participation from Belgium, Denmark, and Norway in OOD and OUP offset all training costs absorbed by the USAF for training all their pilots. We therefore conclude that costs of IPT were worth it for Belgium, Denmark, and Norway.

**Generalized Methodology to Determine Value of IPT for Any Country and Operation**

Comparing the net costs of training pilots that ultimately contribute to cost avoidance can help decisionmakers determine if IPT is worthwhile. The cost savings are highly dependent upon the savings from the specific operation and other assumptions, such as number of pilots trained (which also varies greatly for country and platform). The results of this case study may be applicable to NATO countries that participate at essentially the same level in coalition operations as Belgium, Denmark, and Norway. However, knowing that IPT for Belgium, Denmark, and Norway is worth the additional cost to the USAF may or may not help decisionmakers when considering other countries outside of NATO. Therefore, we now outline the steps to perform this cost-benefit analysis for any nation and any operation as shown in Figure 4.12. The operational value summary chart describes how costs and savings per pilot change as various parameters change.

The costs per pilot are based on the number of pilots trained for a specific platform, the discount rate, and the above-and-beyond FMS-Full costs. The number of pilots trained may be based on a few assumptions. How many pilots were needed for the particular operation? How many pilots were trained over a certain time period? Or how many pilots in total are there for the country? The reimbursement rate (FMS-Full to IMET) over the assumed time period is subtracted from the FMS-Full rate to get the cost of providing a discount. A larger discount results in more cost per pilot. A methodology such as the one presented in Chapter Three is then used to calculate the above-and-beyond cost for the base, platform, and time frame of interest. The two aggregate costs (known and above-and-beyond) are added and divided by the number of pilots trained to get the cost per pilot.

The savings part of Figure 4.12 is based on the methodology presented earlier in this chapter. As allied aircraft, sorties, and proficiency and OPTEMPO factors increase, so do the savings as indicated by the arrows. The result of the combination of those factors is the conversion of allied aircraft to U.S. equivalent squadrons and deployment packages within those squadrons. Likewise, some missions require deployment of ordnance; this ordnance must be converted to U.S. equivalent ordnance using a proficiency factor. The higher the number of ordnance dropped and proficiency factor used, the more savings to the USAF.
Once U.S. equivalent squadron and deployment packages are known, the savings then depend highly on the scenario. There are more savings to the USAF with increasing distances the U.S. equivalent squadrons would have had to travel to get to and from the operating base. As the intensity and duration of the conflict increase, so do the savings in the way of additional flying-hour costs. The addition of the transportation costs, flying-hour costs, and ordnance costs are the three major categories of cost savings. The ordnance expended and the additional flying-hour costs outweigh the transportation costs as conflicts become longer and more intense.

The aggregate savings to the USAF from allied participation in an operation are then compared with the costs. To compare the costs on a per-pilot basis, the aggregate savings are divided by the same number of pilots assumed to calculate the cost per pilot. The net savings are then calculated by subtracting the cost per pilot from the savings per pilot.

**Summary**

The final savings estimate for the USAF is $170 million from OOD and OUP or about $22 million per month. These savings estimates can be compared to the noncompensated cost of
training FMS pilots to determine the net monetary benefit to the USAF.\textsuperscript{135} We realize that the operational savings are only one aspect of the benefits of FMS.

We have presented a prototype FMS operational savings methodology. The approach requires historical data capturing the countries, aircraft, and sorties flown in an operation. To determine the number of equivalent U.S. aircraft needed to accomplish the same missions as our allies, we associate a U.S. aircraft type with each foreign aircraft, possibly for each mission type flown by the foreign aircraft. Sorties flown by the allies are adjusted by a proficiency factor to account for capability differences with the United States. Ordnance expenditures are also adjusted by the proficiency factor, accounting for proficiency differences. Additionally, a second adjustment is made to the sorties to capture generally higher U.S. OPTEMPO. We then derive deployment costs for the needed U.S. equivalent aircraft. Transportation and ordnance costs are calculated for the deployment savings.

The methodology presented in this chapter provides a first-order methodology to determine the operational savings.\textsuperscript{136} Throughout this chapter, we have noted improvements that would enhance the methodology and expand the costs considered and simplify the process of supplying data. Our methodology could be improved in three ways. First, a more detailed method than the average sortie rate could be used for the OPTEMPO adjustment. For example, a sortie time line could be used to determine the number of aircraft needed to support the largest number of sorties on a given day. Second, we could develop a time line for the savings over the duration of the operation. Finally, multiple operations could be combined to calculate the savings in a year or similar period of time. We have noted that we did not include some additional deployment costs to capture the fuel, personnel, maintenance, basing, and tanker expenses during the operation that exceed those same costs if the aircraft had stay at home station. The OOD and OUP cases have provided a significant and enlightening case study of the potential operational and deployment savings for the Air Force as a result of our allies participating in FMS programs.

We have considered one way of assessing the monetary benefits of IPT and compared them to the costs of IPT. Our case study resulted in an overall positive value of IPT for Belgium, Denmark, and Norway. We have outlined the methodology for determining the net savings of IPT per pilot for any operation or country. However, our methodology only captures one way of assessing the monetary benefits of IPT. There are additional benefits of FMS-directed IPT that should be considered to augment its value to the USAF and help decisionmakers better prioritize

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\textsuperscript{135} There is further detailed discussion of the training costs of FMS in Williams et al., 2014.

\textsuperscript{136} This methodology does not account for countries that we train that do not participate with the USAF in combat operations (net cost to USAF). This analysis assumes that there would have been no participation in the conflict if these countries had not received USAF training. To a certain extent that is true for the case of the F-16, where the USAF is the primary training agency for most F-16 operators. In the case of Belgium, Denmark, and Norway this assumption is correct. There could have been other partner contributions, including participation with other aircraft that is not accounted for in this methodology. Lastly, this methodology does not account for the fact that pilots that participated in OOD may also participate in other operations, thus creating even greater benefits from FMS and IPT.
requests for training when making enterprise decisions. To this end, we now expand our research to demonstrate one additional benefit of FMS and IPT: interoperability. The goal of the next chapter is not only to increase awareness of the additional nonmonetary benefits, but also explore the impact of FMS on interoperability at a level previously unexplored.
5. Nonmonetary FMS Benefits: Interoperability

Introduction

In a realistic battle scenario, the Airborne Warning and Control System (AWACS) and Joint Surveillance Targeting Attack Radar System (JSTARS) are providing surveillance and reconnaissance. The Moving Target Indicator on the JSTARS detects a possible missile launcher moving into a position to fire. The information is sent back to the coalition’s Air Operations Center (AOC) for battlespace awareness, and the AOC then can direct another air asset, such as an unmanned aerial vehicle (UAV), to obtain more target identification. The UAV confirms the target, and the information is validated at the AOC and processed as a priority target. C2 nodes ensure the information is transmitted to the appropriate battlespace platforms. AOC planners find that the closest air asset available is an allied F-16 and recommend diverting this air asset. Coordination with the allied representatives in the AOC occurs to ensure that the appropriate national caveats or rules of engagement are met and that the target is one that stands up to the ally’s political and military objectives. The information is passed on to all C2 nodes, along with the allied F-16’s callsign and controlling agency. AWACS contacts the striker F-16 and diverts it to the target using a datalink, such as Link 16. AWACS coordinates with airborne tankers if extra fuel for the F-16 is necessary. JSTARS provides the final target location, heading, speed, and other information until the F-16’s onboard sensors and targeting pod take over final acquisition and tracking of the target. The allied F-16 then drops a precision munition and destroys the missile launcher, reporting the battle damage assessment back to JSTARS.

This scenario requires decentralized execution and involvement of the AOC and many air assets. These interactions and communications require not only technological compatibility, but also a certain level of training and doctrinal compatibility. In other words, this scenario is an example of interoperability. It also provides an operational context, albeit operationally complex. It helps one understand the objective requirement for FMS combat training courses. It also demonstrates the additional value to the USAF if coalition partners can perform roles seamlessly alongside U.S. forces. The definition of interoperability used by DoD and NATO is:

the ability of systems, units, or forces to provide data, information, materiel, and services to and accept the same from other systems, units, or forces and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together. ¹³⁷

This scenario was not possible with most U.S. allies more than a decade ago and still is not possible with all allies today. The activity requires close collaboration among various aircraft.

¹³⁷ DoD, Joint Chiefs of Staff, 2011.
types, ground/naval forces, and operational level command and control elements not thought possible until relatively recently. Even within U.S. sister services, interoperability on this scale was not achieved and proven until operations in Afghanistan in 2001. Interoperability has multiple and complex political, economic, and warfighting dimensions at all levels of war.\footnote{138 Eric Larson et al., \textit{Interoperability of U.S. and NATO Allied Air Forces: Supporting Data and Case Studies}, Santa Monica, Calif.: RAND Corporation, MR-1603-AF, 2003.} For example, consideration must be taken to coordinate with countries in developing an approved target list with all the national caveats and differences in political will, doctrine, and force capability. In other situations, information essential to conducting an effective operation does not meet “releasability” requirements for sharing with coalition partners. Interoperability is paramount for intelligence gathering, exploitation, and dissemination, as well as for preventing duplication of effort, reducing potential fratricide, deconflicting targeting operations, enhancing battlespace awareness, and many other important aspects of warfighting. With constantly changing technology and warfighting requirements, there is an ever-present need for the United States and its allies to maintain and improve their composite interoperability.

**Methodology**

The goal of this chapter is to assess the impact of U.S. FMS on allied interoperability. Our hypothesis is that FMS does have a significant impact on interoperability and that interoperability provides value to the USAF as described in the example above. The impact of FMS on interoperability is not immediately obvious and is hard to quantify because it cannot be measured directly. We propose an approach that relies on an overarching rhetorical argument supported by both qualitative and quantitative analysis. Our argument justifying the hypothesis comes in two parts. First, FMS has allowed our allies to purchase equipment and the associated training that has enabled a variety of key warfighting functions. We show this with both historical analysis and with conclusions drawn from structured interviews with NATO military leaders. Second, the increase in warfighting functions has a direct impact on increasing partner interoperability when working together. This assertion is justified with both quantitative and qualitative analysis. Surrogate measures are used as indicators of improvements in interoperability. From these two arguments together, we conclude that FMS has enabled greater allied interoperability.

We use Operation Allied Force (OAF), the air operation over Kosovo in 1999, and OOD and OUP, the air operations over Libya in 2011 as the case study operations in our analysis. The FMS between the operations and the warfighting capabilities and interoperability during these operations serve as the context for our discussion. We begin by providing a more detailed overview of our methodology along with the reasons for choosing these two operations for our
case study. We outline FMS activity from 1999 to 2011 and examine how those items affected the difference in warfighting capability from Kosovo to Libya. We discuss how to define and propose measures for assessing interoperability. We use these measures to determine the level of interoperability for each conflict in general and specifically for allied countries with FMS. We also assess the change in interoperability from Kosovo and Libya using historical research and structured interviews with military leaders to determine if, overall, interoperability increased, decreased, or could not be distinguished between these conflicts. Finally, we draw conclusions about the impact of FMS on interoperability by using our logical argument that FMS affects warfighting capabilities and those capabilities increase interoperability, therefore FMS affects interoperability.

Our analysis will use process-tracing over time of allied countries participating in an initial operation (Kosovo in 1999) and a similar, later operation (Libya in 2011) to assess the impact of FMS on interoperability. Process tracing is a method for establishing an uninterrupted causal path between FMS and observed interoperability effects.139 We do this by linking the purchase of FMS items to the warfighting capability, and then link that capability to the interoperability outcome.140 Although our purpose is to establish, if possible, the direct effect of FMS (the primary independent variable) on interoperability (the dependent variable), we do note some of the indirect effects from other variables.

At least two points of comparison are needed to measure the impact of FMS sales on interoperability. We have chosen to use air operations during the Kosovo conflict in 1999 and during the Libya conflict in 2011 as the comparative points in the analysis.141 Operation Allied Force (OAF) is the NATO codename for the military operation against the Federal Republic of Yugoslavia during the Kosovo War. The excessive and indiscriminate use of force by Serbs under Milosevic against ethnic Albanians resulted in UN Security Council Resolution 1199 on September 23, 1998, which demanded that all parties cease hostilities and maintain a ceasefire. By mid-October, with violence continuing, NATO authorized potential air strikes and established an air surveillance mission to monitor Serbian activities.142 The failure of Milosevic


140 We recognize that there are other causal mechanisms besides FMS that have also affected interoperability. Because our goal is only to show the causal relationship between FMS and interoperability, it is unnecessary for this purpose to determine the impact of other possible causal variables on interoperability.

141 We use the terms Kosovo and Libya because they are broader than just OAF and OOD, the U.S.-led operations. For example, the Libya operation includes the simultaneous operations from allied partners: Opération Harmattan by France; Operation Ellamy by the United Kingdom; and Operation Mobile for the Canadian participation. Even though some allies had their own operation, interoperability was still required at times with U.S. forces. We outline this through an example with the French Air Force later in the document. The focus is on interoperability with U.S. forces and hence we will primarily use data from OAF and OOD.

142 Curtis, 2013
to withdraw forces from Kosovo led NATO to begin a 77-day air campaign from March 24 to June 10, 1999. The bombings led to the withdrawal of Yugoslav forces from Kosovo.

In response to the uprising in Libya against Gadhafi, the UN Security Council established a no-fly zone in Libyan airspace on March 17, 2011, and authorized the international coalition to take all necessary measures to protect the civilian population. The United States established OOD, which commenced March 19 and officially ended March 31, when the leadership of the operation transferred to NATO and military actions continued under codename OUP until October 31, 2011.

The conflicts over Kosovo and Libya were chosen for a number of reasons. The Libya conflict is relatively recent, while the Kosovo conflict is far enough in the past to ensure a probable change in warfighting capability and interoperability due to the influences of FMS and other factors. The similarities between the conflicts are a major factor in their selection in order to reduce scenario biases. Both were primarily large-scale air campaigns with little to no ground forces. Both had a significant number of air-to-ground strike sorties. In both operations, the United States led as the major contributor and had military personnel at key positions of leadership in air operations. In both campaigns, allied air forces from Belgium, Denmark, Norway, the UK, France, Canada, Italy, and Spain were employed with U.S. air forces. The intent in both campaigns was to utilize air power to achieve a rapid coercive effect by using precision weapons to strike targets and exert pressure on Milosevic and Gadhafi to test their political and military will. Allied airpower achieved NATO goals in both Kosovo and Libya.

Our process-tracing begins with an historical examination of FMS items purchased by our allies during the intervening period between Kosovo and Libya operations. This data, in conjunction with semi-structured interviews with the country representatives, provides a link from FMS to enhanced warfighting capabilities. The methodology for this research is to combine the comparative case studies of allied countries (measuring the dependent variable) with the historical analysis of process-tracing (linking independent variables with the dependent variable). There are simply too many FMS items sold during the interim period between Kosovo and Libya to include them all in the analysis, therefore, we have carefully selected a handful of FMS items based on expert opinion. This also allows us to roll up equipment sales into categories and focus on the major systems. While helpful in our analysis this approach is


145 This combined methodology was used in Collier and Collier, 1991.

146 Expert opinion comes from discussions with RAND staff and with Air Force officers from France, Spain, Canada, and Belgium.
probably more helpful to decisionmakers than a detailed examination of individual weapon systems. Our categories are the sale of precision munitions, advanced targeting pods (ATPs), data links, and aircraft. As part of aircraft sales, we include international training done in the United States that results from the sale of aircraft as well as allied air exercises, which are indirectly affected by aircraft sales.

In determining the impact of warfighting capability on interoperability, it is important to recognize that there are different causal explanations that exist for similar outcomes. Outcomes can flow from the convergence of multiple conditions, independent variables, or causal chains. Every situation can vary in significant ways that may not only complicate calculations, but also make it difficult to compare operations or events. This is particularly true of the quantitative analysis we perform showing a significant rise in warfighting capability between 1999 and 2011 that we will argue indicates a rise in interoperability. One way to establish causation is to acquire expert opinion regarding reasons for the changes in interoperability. To this end, we conduct interviews to determine causes for the measures and reasons for changes in interoperability. We conducted semi-structured interviews with military personnel from Belgium, France, Canada, and Spain, and draw conclusions based on our measurements in conjunction with the interviews. This approach also helps provide an operational context for interoperability as the term is understood and qualified by the foreign partner operational community.

Once we have established the relationship between FMS and enhanced warfighting capability, then the relationship between warfighting capability and interoperability, we will conclude that FMS does indeed enhance interoperability. We now turn to the first step in this argument, establishing the relationship between FMS and enhanced allied warfighting capability.

Enhanced Allied Warfighting Capabilities: FMS from Kosovo to Libya

A direct effect of FMS is the sale of technologies or items that affect warfighting capability. Direct-effect FMS items include precision munitions, advanced targeting pods, data links, and aircraft. The sale of aircraft also leads to increased international training done in the United States and influences the participation in air exercises. The participation in international aerial exercises is an indirect effect of FMS, as is the increase in IMET. We have included data from all countries that purchased the FMS item, not only those who participated in Kosovo and Libya. We have done this to add context and provide information that may be useful in the further study of this topic.

147 According to interviews with foreign military leaders, the foremost of the other factors outside of FMS that affects interoperability are the NATO STANAGS. We have therefore included a discussion of STANAGS in the appendix.

148 See the appendix for further details on the interview protocol. The representative from Canada did not have access to enough information to be included in much of this analysis.
**Precision Munitions: JDAM**

The warfighting capabilities of precision-strike and dynamic targeting would be greatly hampered without the use of precision guided munitions (PGM). A PGM, also known as a smart munition or smart weapon, is guided by a mechanism (i.e., radio, laser, Global Positioning System [GPS]) to hit a specific target and minimize the unintended collateral damage around the target. The use of PGMs has steadily increased over the years, with our allies switching from uncontrolled dumb bombs to PGMs (as shown in Figure 5.1).

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Figure 5.1. Allied Percentage of Precision Munitions Used Over Time

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FMS sales of PGMs to our NATO allies allowed the role of the allies to expand from Kosovo to Libya. Precision-strike capabilities were no longer just the realm of the United States, Britain, and France. Table 5.1 demonstrates the progress among allies from the Gulf War to Libya, with OOD being the first operation to use 100-percent PGMs from all participants involved. The ability to perform precision-strike missions was enabled by technology (including targeting

---

150 McCullough, 2011.
pods and improved radar) as well as the sale of PGMs through the FMS program and the associated required training.153

Table 5.1. Precision-Strike Ability Among Case-Study NATO Partners

<table>
<thead>
<tr>
<th></th>
<th>UK</th>
<th>France</th>
<th>Italy</th>
<th>Belgium</th>
<th>Denmark</th>
<th>Norway</th>
<th>Canada</th>
<th>Spain</th>
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</table>


Table 5.2 shows the countries that have purchased precision munitions through FMS and also highlights the case study countries. The Joint Direct Attack Munition (JDAM) is the most widely exported PGM and the current weapon of choice for the Air Force. It did not exist during the Gulf War and could only be used by the B-2 stealth bomber during OAF in 1999.154 The JDAM makes for a good case study because it became available after OAF. The JDAM is guided by GPS, providing advantages over laser-guided weapons when there is cloud cover or other weather conditions.155 The JDAM is also fairly inexpensive compared with other precision munitions. Table 5.3 shows the year of initial order (not necessarily delivery) of the JDAM, as well as the total quantity purchased since the initial year.

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<th>Countries</th>
<th>JDAM</th>
<th>LJDAM</th>
<th>GBU-10</th>
<th>GBU-12</th>
<th>GBU-24</th>
<th>GBU-49</th>
<th>GBU-50</th>
<th>CBU-97 (SFW)</th>
<th>AGM-154 (JSOW)</th>
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**Table 5.2. U.S. Most Widely Exported Precision Munitions by Country**

Table 5.3. International JDAM Customers and Quantities

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<thead>
<tr>
<th>Country</th>
<th>Year of Initial Order</th>
<th>Quantity</th>
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<td>450</td>
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<tr>
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<td>2002</td>
<td>484</td>
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<td>Netherlands</td>
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<tr>
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<td>2006</td>
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</tr>
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<td>Spain</td>
<td>2006</td>
<td>40</td>
</tr>
<tr>
<td>Greece</td>
<td>2007</td>
<td>100</td>
</tr>
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<td>Saudi Arabia</td>
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<tr>
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<td>10</td>
</tr>
<tr>
<td>Canada</td>
<td>2011</td>
<td>533</td>
</tr>
<tr>
<td>Iraq</td>
<td>2012</td>
<td>358</td>
</tr>
</tbody>
</table>

SOURCES: DoD, 2012b; GlobalSecurity.org, undated-b; Military Periscope, 2010a.

PGMs with advanced mission planning and command and control capability improve warfighting capabilities enabling precision strike and dynamic targeting.\(^{156}\) With precision weapons, the partners increase their ability to contribute to a campaign, and the capabilities gap between the United States and allies is reduced. Without precision munitions, the ability to destroy mobile and dynamic targets is greatly reduced. Precision munitions are also essential in precision strikes, especially due to the strict rules of engagement concerning collateral damage in

\(^{156}\) Westhauser, 1998.
modern warfare. The benefits of using precision munitions were seen in Libya. Many allies acquired precision munitions and the ability to use them after Kosovo, and they demonstrated that ability during OOD.

During OOD and OUP, many of the allies ran low on precision munitions. They were able to acquire more through FMS or use weapons from other countries as orders were being filled. On April 11, 2011 Denmark ordered 210 of the 484 total JDAMs to bolster their nearly depleted supply of precision munitions.\textsuperscript{157} Norway purchased 254 of the 284 JDAMs on April 26. Canada purchased all 533 JDAM kits on August 11. Belgium purchased 120 more JDAMs on September 8. The ability to exchange or use equipment from other forces is a key aspect of interoperability. With the same precision weapons, the United States or another ally can provide munitions when another country is running low, allowing that country to order more munitions thus preventing a potential pause in the conflict.

\textit{Targeting Pods: Sniper ATP and LITENING ATP}

ATPs are externally mounted target designation instruments used by fighters with a ground-attack role to identify targets. ATPs significantly enhance an aircraft’s strike capability by adding such capabilities as stabilized long-range laser tracking and target illumination, high-performance day/night surveillance, and GPS targeting capabilities.\textsuperscript{158} Through targeting pods, fighter aircraft are able to drop precision munitions, such as the JDAM. Precision-strike capability, dynamic targeting and targeting as a whole are all enhanced with the use of a targeting pod.

The two main targeting pods sold through U.S. FMS are the Lockheed Martin Sniper ATP and the Northrop Grumman/RAFAEL LITENING ATP. Table 5.4 shows the number of pods per country and the initial purchase year of the pods through FMS. Without the ATPs during operations in Libya, the coalition would not have been able to carry out dynamic targeting or any of the SCAR missions.\textsuperscript{159} Nations would therefore have been reduced to preplanned strike missions, not just significantly reducing precision associated with the actual release, but also reducing efficiency relative to forces using the advanced pods. Targeting pods also increase interoperability directly via direct exchange of equipment. For example, the Belgians obtained Sniper pods in 2007 and were able to exchange pods with the Norwegians in Afghanistan, demonstrating benefits of interoperability of aircraft and targeting pods.\textsuperscript{160}

\begin{itemize}
  \item DoD, 2012b; GlobalSecurity.org, undated-b; Military Periscope, 2010a.
  \item COMOPSAIR/A3, personal communication, 2014.
\end{itemize}

65
Table 5.4. Sniper and Litening Targeting Pods

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<thead>
<tr>
<th>FMS Customer</th>
<th>AN/AAQ-33 Sniper ATP</th>
<th>AN/AAQ-28(V) Litening ATP</th>
<th>Initial Year Purchase</th>
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**Tactical Data Links: Link 16**

The Link 16 tactical data link was instrumental in establishing a tactical data network that enhanced situational awareness and enabled the ability of aircraft to engage dynamic targets during Libya. Every case study country was equipped with Link 16 after the Kosovo conflict and before operations in Libya.

The need for near-real-time exchange of data among data systems became apparent after the Gulf War.\(^{161}\) Several data link communication systems have been developed to support tactical communications over the years; however, Link 16 is currently the most widely deployed tactical

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\(^{161}\) Hura et al., 2000.
data link among air assets. For our purposes, Link 16 will be defined, as per STANAG 5516, as one of the digital services of the Joint Tactical Information Distribution System (JTIDS) or Multifunctional Information Distribution System (MIDS). Link 16 is an encrypted, jam-resistant, nodeless tactical digital data link network. Tactical data links, such as Link 16, are one of the key enablers for network-centric warfare, a concept related to interoperability that is generally understood to mean the ability to collect and exploit information from multiple sources. This is a major advantage of fifth-generation and the advanced fourth-generation-plus aircraft, where the network ability is a designed-in capability. The idea behind Link 16 is to enable military aircraft, ships, and ground forces to exchange their tactical picture in near-real time. Link 16 supports text message and imagery exchange, facilitating assignment of missions. With Link 16, the airborne or ground-based C2 assets can send targets electronically to the fighter or bomber aircraft, saving time, reducing fratricide and attrition, and enhancing situational awareness.

Link 16 technology was developed in the U.S. JTIDS program, which began in 1975. The first JTIDS terminals were installed only on the U.S. Airborne Warning and Control System (AWACS) and at U.S., UK, and NATO ground-control facilities. The MIDS program was designed to put small, lightweight Link 16 terminals on U.S. and allied fighter aircraft. The USAF decided to acquire Link 16 terminals for the F-16 in 1998, and the decision was made the following year to integrate the capability into a large number of platforms, including the U.S. F/A-18, Spanish EF-18, Italian Tornado, French Rafale, and Euro Fighter-2000 (Typhoon) aircraft.

MIDS orders have gone out to about 30 countries, as illustrated in Table 5.5. The table also shows the method of sale (either FMS or DCS), and highlights the eight countries that participated in both Kosovo and Libya. All of the allied fighters in our case study were not equipped with Link 16 capabilities during OAF but were equipped with the capabilities in the Libya conflict.

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162 Despite its advantages, Link 16 is not a complete solution to the USAF’s data links. Lt. Gen Lord, the Air Force’s Chief Information Officer, spoke of the multiple data links found in the air forces that have trouble connecting to one another—Link 16, Link-11, Intra Flight Data Link, and the Multi-Function Advanced Datalink. See John Reed, “All U.S. Aircraft Could Talk to Each Other, Someday,” DoD Buzz Online Defense and Acquisition Journal, April 2, 2011.

163 Hura et al., 2000.


166 Hura et al., 2000.

Table 5.5. MIDS Quantity by Country

<table>
<thead>
<tr>
<th>Country</th>
<th>FY Initial Order</th>
<th>FMS</th>
<th>DCS</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>France*</td>
<td>2000</td>
<td>234</td>
<td></td>
<td>234</td>
</tr>
<tr>
<td>Italy*</td>
<td>2000</td>
<td>146</td>
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<tr>
<td>Spain*</td>
<td>2000</td>
<td>136</td>
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<td>136</td>
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<tr>
<td>Germany*</td>
<td>2000</td>
<td>197</td>
<td></td>
<td>197</td>
</tr>
<tr>
<td>UK</td>
<td>2000</td>
<td></td>
<td>227</td>
<td>227</td>
</tr>
<tr>
<td>Denmark</td>
<td>2002</td>
<td>3</td>
<td>68</td>
<td>71</td>
</tr>
<tr>
<td>Canada</td>
<td>2004</td>
<td>125</td>
<td></td>
<td>125</td>
</tr>
<tr>
<td>Belgium</td>
<td>2004</td>
<td>82</td>
<td>2</td>
<td>84</td>
</tr>
<tr>
<td>Poland</td>
<td>2004</td>
<td>71</td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>Japan</td>
<td>2004</td>
<td>100</td>
<td>2</td>
<td>102</td>
</tr>
<tr>
<td>Switzerland</td>
<td>2004</td>
<td>55</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2004</td>
<td>193</td>
<td></td>
<td>193</td>
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<td>2005</td>
<td>314</td>
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<td>320</td>
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<tr>
<td>Australia</td>
<td>2005</td>
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<td>2</td>
<td>181</td>
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<tr>
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<td>2005</td>
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<td>Portugal</td>
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<tr>
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<td>2006</td>
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<tr>
<td>Sweden</td>
<td>2006</td>
<td>28</td>
<td>140</td>
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<tr>
<td>Saudi Arabia</td>
<td>2007</td>
<td>322</td>
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<td>Finland</td>
<td>2007</td>
<td>116</td>
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<td>2007</td>
<td>5</td>
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<tr>
<td>Hungary</td>
<td>2008</td>
<td>22</td>
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<td>22</td>
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<tr>
<td>Austria</td>
<td>2008</td>
<td>24</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>South Korea</td>
<td>2009</td>
<td>24</td>
<td>129</td>
<td>153</td>
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<tr>
<td>Norway</td>
<td>2009</td>
<td>77</td>
<td>31</td>
<td>108</td>
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<tr>
<td>Morocco</td>
<td>2010</td>
<td>30</td>
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<tr>
<td>Singapore</td>
<td>2010</td>
<td>46</td>
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<tr>
<td>UAE</td>
<td>2011</td>
<td>116</td>
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<tr>
<td>Jordan</td>
<td>2012</td>
<td>10</td>
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<td>10</td>
</tr>
<tr>
<td>Oman</td>
<td>2013</td>
<td>32</td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>

NOTE: Sales are over multiple years and FMS cases. FY initial order does not mean Initial Operating Capability (IOC). Some sales have yet to be delivered.
* Formed the consortium providing MIDS for European requirements. Plans were made earlier than 2000 for MIDS; however, 2000 was the first production year.

The difference that Link 16 made to the warfighting capability within OOD is evident from interviews with Spain, Belgium, and France. It was named the most important technical improvement by all three countries due to the situational awareness provided during the conflict. Link 16 enabled easy and secure communication with other airborne assets, making dynamic targeting feasible. In addition, it helped reduce the potential error at several points in the C2-to-aircraft targeting workflow. Without Link 16, the strike control and reconnaissance mission would have taken much longer.

An after-action report by the French Rafale detachment illustrates the warfighting success of Link 16. It indicated the use of Link 16 during the operation in processing dynamic targets as the pilots described how they received coordinates from an AWACS or other aircraft, accepted the assignments with the push of a button, and the coordinates were automatically programmed into the weapons. Link 16 was also used to deconflict assignments with other aircraft without using radios. The Royal Air Force also processed a large majority of dynamic targets, indicating the success of Link 16 for their operation. It is clear that without Link 16, dynamic targeting and a secure tactical data network would not have been feasible. French, Belgian, and Spanish military representatives named Link 16 as the primary FMS item that led to improvements in warfighting during the Libya conflict.

**Aircraft**

The sale of aircraft has an impact on warfighting capability for a number of reasons. FMS of aircraft may increase the capability of the partner air forces by providing a new technology, thus expanding the role (e.g., precision strikes) that a nation may take in a coalition. The aircraft becomes an enabler to have other systems (e.g., targeting pods, radars, data links) built in and function with existing allied systems. FMS of aircraft directly leads to international training done in the United States and promotes the sale of munitions. Along with the sale of aircraft typically come tactics, techniques, and procedures (TTPs) and other standardization documents depending on the partner nation. The sale of aircraft could also include a common roadmap for further upgrades and continued U.S. support. A good example of this is the F-16 for the Belgians. Although Belgian F-16s were already bought prior to Kosovo, the common roadmap for purchase of the F-16 for members of the European partner air forces has greatly helped the Belgian Air Component, along with the United States, to upgrade the F-16. Consecutive midlife upgrades that occurred after Kosovo enhanced the avionics and other aspects of their F-16. They point to the joint helmet mounted cueing system as another key upgrade. In 2001, day and night capabilities became possible with night-vision goggles. In 2002, JDAM was acquired, and in 2004, the process for Link 16 integration started. In 2007, the Sniper ATP was bought.

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169 “UAE AF,” 2011.
Belgians attribute this cooperation to the common roadmap for the original F-16 acquisition and production process.

Another important advance in warfighting for air components in a coalition is the disclosure of TTPs. The specific platform’s TTPs, such as the AFTTP 3-1 and 3-3 for U.S. origin aircraft, arguably have a large impact at the strike end of warfighting. The USAF began disclosing TTPs through the Deputy Under Secretary of the Air Force for International Affairs (SAF/IA) in 1997. There are certainly “U.S. only” tactics, which are omitted, and the remaining information is released on a tiered system based on the specific FMS country purchasing the equipment. AFTTP 3-1, Volume 1 (common to all platforms) has a summary of the disclosed information for each country. USAF pilots know what has been disclosed to other countries, and there is a reasonable expectation that the foreign country will meet the standards set in the FMS TTP. The system for TTP disclosure has been a success with more than 25 countries involved. Belgian and Spanish representatives both discussed the benefits of obtaining AFTTP 3-1 with the purchase of the F-16 and F-18, respectively. Both stated the increase in warfighting capability from having a common set of TTPs was a result of both having U.S. aircraft and receiving U.S. training.

FMS of aircraft help create a more interoperable force structure with fewer differences. For example, in 1970, there were no fewer than 16 different types of fighter aircraft in NATO, but by the 1990s, 12 types of aircraft formed the backbone of European airpower. Now, NATO is dominated by only a handful of fighters such as the F-16, F-18, Eurofighter, Tornado, Mirage 2000, and Rafale fighters. As the number and types of systems decrease, the likelihood of an interoperable force structure increases. When other nations have U.S. aircraft, this allows the United States and allies to have synergistic gains in logistics, spare parts, and base support for the aircraft. For example, the established Saudi F-15 supply chain allowed the United States to respond more quickly during the initial days of Desert Shield. During the Kosovo conflict, the Belgian and Danish air forces had a joint operation, flying the same F-16s and sharing maintainers and spare parts.

171 Undersander, 2005.
173 There is even a trend among former Soviet bloc countries that join NATO (such as Poland) to transfer from Soviet-era fighters to western fighters that are common in NATO.
175 We note here that there are potentially multiple variants of an MDS requiring significant differences to operate and maintain.
Aircraft also have indirect effects by increasing the total IMET and influencing participation in aerial exercises. Common training and military exercises, in turn, increase warfighting capability. We will now examine these indirect effects.

**Aircraft: IMET & International Air Exercises**

Another way in which aircraft sales influence warfighting capability is through the training that accompanies aircraft purchases through FMS. For example, from 2006 to 2013, the sales of F-16, C-130, and C-17 aircraft through FMS resulted in more than 800 pilots from 31 different countries being trained at three locations (Little Rock AFB, Altus AFB, and with the Tucson ANG).\(^\text{177}\) None of the initial aircraft purchases for Belgium, Denmark, Norway, UK, France, Italy, Spain, or Canada were between 1999 and 2011.\(^\text{178}\) As such, we expanded the research (see appendix) to other countries and found that the acquisition of aircraft leads to a significant increase (as much as three to six times the amount) in the overall Air Force IMET completed by that country for a time. The increase cannot simply be accounted for by pilots but also includes aircrew, maintainers, support personnel, and more.

Training aircrews in the United States increases warfighting capability with other nations for a number of reasons. One major benefit is that foreign pilots become accustomed to the standard operating procedures and TTPs normal to U.S. aircrews during their training. Foreign pilots interact with U.S. pilots, which leaders consider an important part of warfighting learning. Language proficiency of foreign aircrews also improves with training in the United States, thus potentially increasing communication abilities during a wartime scenario. The benefit also extends to planning and logistics support, as national forces adapt the training and make it their own. Further, foreign officers are exposed to American culture in a way that may promote partnerships into the future. As countries send their AF personnel to the United States to train, they benefit from U.S. interaction and training and become better warfighters with the United States.

FMS of aircraft have an indirect impact on the participation in international air exercises where U.S. training is reinforced. For example, Poland and the UAE, two of the top participants in U.S. air exercises since 2006, did not obtain F-16s until this last decade. Chile acquired ten F-16s in 2006. Since then, Chile has participated in more air exercises with the United States than any other Latin American country.\(^\text{179}\) The purchase of F-16s starting in the late 90s by the Kingdom of Jordan has since resulted in increased relations with the U.S. and participation in

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\(^{177}\) DSAMS, obtained from AETC/IA, October 2013.

\(^{178}\) These countries did have IMET students; however, we are trying to measure the change in aircraft purchases and IMET. The number of IMET students for these countries is relatively consistent as initial aircraft purchases were made before 1999 and each country has a well-planned flow of IMET students to meet human capital needs.

multinational air exercises. Figure 5.2 shows the top countries, as well as all of our case study countries, that have participated in air exercises with the United States from 2006 to 2011. The countries’ most dominant fighters are also depicted to show the prevalence of FMS aircraft among the top participants.

**Figure 5.2. Highest Participators in Aerial Exercises where United States is Involved 2006–2011**


International air exercises increase warfighting capabilities for a number of reasons. In a RAND report detailing the costs and benefits of the U.S. Air Force’s partner activities in Europe, the study showed that partner activities, especially air exercises, enhance partner training, build

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180 In 1994, King Hussein of Jordan ended 40 years of hostility by signing a peace treaty with Israel (See Jane’s All the World’s Aircraft, 2013). Jordan began the process to purchase F-16A/B Fighting Falcons shortly thereafter, with the support of Israel. In 1996, the United States leased 16 F-16s to Jordan under the F-16 Peace Falcon program, which included funding for aircraft upgrades, engine modifications, spare parts procurement, and pilot/maintenance training (Jane’s All the World’s Aircraft, 2013). That year, military exercises began between the United States and Jordan under the name Infinite Moonlight (see GlobalSecurity.org, *Infinite Moonlight*, undated-a). Jordan has since acquired a total of 64 F-16 airframes, most of which are resales from the Belgian, Dutch, and Danish air forces. The United States must approve all resales as part of the end-use agreement of FMS aircraft. In the last decade, Jordan has participated in five major air exercises, more than any other country in the Middle East with the exception of the UAE, which obtained 80 F-16E/F from 2003 to 2006.
enduring relationships, and enable continued access to personnel and facilities in the region. The study concluded that operational effectiveness has been increased due to the training, exercises, and standardized TTPs. The study further found that high-payoff activities included exercises related to fighter aircraft and expeditionary airlift.

USAF exercises in Europe helped make NATO operations over Libya possible. One example of an exercise is Austere Challenge, a U.S. European Command three-star joint and combined exercise that executes a full-scale operation at the joint task force level. The planning, execution, and relationship-building of such an exercise cannot be overstated and had a positive effect on Joint Task Force Odyssey Dawn, as many of the key players had worked together at previous Austere Challenge exercises. Military officials from Belgium, France, and Spain also affirmed the importance of multinational exercises in developing trust and increasing warfighting capability through training with an emphasis on TTPs.

International air exercises increase interoperability for a number of reasons. They are recognized as demonstrating an ally’s assurance and willingness to fight alongside the United States and vice versa. Exercises can improve defense capabilities and show levels of interoperability between U.S. and allied forces over time. Conducting exercises not only trains personnel, but also helps identify equipment and system interoperability shortfalls within an optional context so they can be fixed well before combat activity. Many joint air exercises are held principally to strengthen interoperability. For example, Chile held and led during the SALITRE II coalition air exercise during October 2009 with participants from the United States, France, Brazil, and Argentina. SALITRE II focused on search and rescue, aerial refueling, and combined air operations training, with an emphasis on interoperability. Even if the joint air exercise is not expressly held for the purpose of interoperability, the contact between nations and the cooperation required to hold joint exercises increases interoperability.

182 The study also mentioned multiple challenges with fighter interoperability events, including lack of ranges, the need to “dial back” skills and tactics, and restrictions in the AOR on important training regimens.
183 Moroney et al., 2012.
184 James, Holcomb, and Manske, 2012.
189 Speaking about Anatolian Falcon 2012, a joint F-16 air exercise between the United States and Turkey, Lt Col Paul Murray stated that, “Probably the most important success we've had towards interoperability is the personal
Assessing the Impact of Warfighting Capability on Interoperability

We have thus covered how FMS affects warfighting capabilities. The goal of this next section is to link that warfighting capability with changes in interoperability. However, we must first measure interoperability, which is difficult because of the many interactions within and among nations that may influence interoperability. We measure interoperability by examining changes in interoperability as the result of comparisons between operations. The factors we use must have an appropriate operational weight and be understood within the context of military operations by decisionmakers. Modern military theory divides war into the tactical, operational, and strategic levels. Therefore, we will examine each level and the surrogate measures we believe quantitatively capture a change in a country’s level of interoperability at that level when augmented by historical information. We focus more on the tactical level for this study because the information, interviews, and data support it more than the others. Table 5.6 outlines the levels of interoperability, along with a description of the levels and the proposed ways of measuring each level quantifiably. It is also important to note that the levels are not isolated, but have interacting effects.

relationships we've made. Those personal relationships are the key to interoperability.” Daryl Knee, “Successful Exercise Enhances Global Bonds, Interoperability,” U.S. European Command, March 2012. Another example is the U.S. cooperation with Poland. Admiral James Stavridis, the Supreme Allied Commander Europe and U.S. European Command commander, stated there are three key benefits from having joint exercises with Poland: interoperability by sharing tactics, participating in border defense of NATO, and—most important—people-to-people contact of U.S. airmen working with Polish airmen. The sale of F-16s to Poland increased military exercises—Poland had its first F-16 aerial exercise with the United States in 2007 and has since participated in eight aerial exercises, including Red Flag in 2012. IISS, The Military Balance, Vols. 106–113, 2006–2013.  

Tactical Interoperability

The tactical level of war deals with the prosecution of maneuvers, engagements, and battles. Examples of tactical level interoperability include conducting operations with forces of varying performance capabilities, automated tools, and communications systems. This includes targeting systems, data networks, and secure communications with airborne assets.

The ability to execute all mission types—such as strike control and reconnaissance (SCAR), combat air patrol (CAP), defensive counter air (DCA), offensive counter air (OCA), and air-to-air refueling—is a good indication of interoperability. The idea is that if a country is able to carry out a certain mission with success, the minimum interoperability requirements, at least, were met to perform that mission. To do air-to-air refueling, for example, the probe and drogue systems must be interoperable for the tasks required, along with the communication systems of the tanker and fighter. The notion of measuring interoperability through mission ability for fighter aircraft is captured in two metrics: strike sorties and dynamic targeting, as shown in

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192 Hura et al., 2000.
193 COMOPSAIR/A3, personal communication, March 31, 2014; FMAA/BEOP/Division Retex, personal communication, April 2, 2014.
Figure 5.3. This figure represents a hypothetical scenario and the way in which each metric might be calculated. SCAR and OCA fall under strike sorties, while CAP and DCA are nonstrike sorties. We propose using strike sorties and dynamic targeting to further enhance our ability to assess one aspect of tactical interoperability. Both these have very specific measurable outcomes and sufficient operational weight. We will explain each metric in more detail.

**Figure 5.3. Ability to Execute Missions Can Represent Tactical Level of Interoperability**

*Strike sorties to total fighter sorties:* A strike sortie is defined as any sortie in which munitions are on board the aircraft and the purpose of the mission is to identify and destroy a target.\(^{194}\) This does not necessarily mean that any munitions were dropped. The ratio of strike sorties to total fighter sorties can begin to explain interoperability by revealing the capability of a country to carry out certain missions. In many cases, countries are relegated to combat air patrol sorties or other nonstrike sorties because of shortcomings in warfighting capabilities, such as communications or sensors, precision munitions (types and number available or capability to carry), and all-weather and night capabilities.\(^{195}\)

As mentioned earlier, there are reasons each event or military operation requires careful analysis before comparing outcomes. In many cases, there are political reasons not associated with a nation’s actual military capability and/or interoperability shortcomings that explain why a


country does not carry out strike sorties. For example, Italy refrained from strike sorties for much of the operation in Libya because of political and historical ties between the two nations. Spanish Air Force participation in Libya also excluded strike sorties for political reasons. This metric may only be relevant in an air-to-ground campaign where the air threat is low. Strike sorties to total fighter sorties is a good start in assessing the possibility of greater interoperability, but by itself, it may be too simplistic a metric to gauge the level of tactical and operational interoperability. Thus, we must have a greater understanding of what happens in planning and during strike sorties. To achieve this, we will look at dynamic targeting.

Dynamic target sorties to strike sorties (or dynamic targets to total targets): An Air Land Sea Application Center publication defines a time-critical target (TCT) (also known as a dynamic target) as a “lucrative, fleeting, air, land, or sea target of such high priority to friendly forces that the JFC/component commander designates it as requiring immediate response. TCTs [dynamic targets] pose, or will pose, an imminent threat to friendly forces or present an exceptional operational or tactical opportunity.” Dynamic targets are previously unanticipated, unplanned, or newly detected targets and are of such importance that they warrant immediate prosecution without a preplanned air tasking order (ATO). The amount of mobile and flexible targets has increased since the Gulf War, as the vulnerability of fixed targets from precision-guided munitions (PGMs) is well-known by adversaries. Therefore, dynamic targeting will most likely play a central role in future conflicts.

One reason why dynamic targets require a high level of interoperability is because the execution requires compatible communication systems and accurate and usable information, usually through such systems as AWACS, JSTARS, RC-135 Rivet Joint, UAVs, or other C2 and intelligence, surveillance, and reconnaissance (ISR) capability. The speed of response is also a factor in meeting the need to act quickly within the time required to meet the targeting need. Dynamic targeting also often involves ground forces, such as TACPs and joint terminal attack controllers, thus complicating the web of communications necessary for the precision required when troops are in contact. The partnership or alliance rules of engagement help define

198 DCA missions, which are nonstrike missions, may require more interoperability in an environment where the air threat is high.
201 Kevin Fox, Dynamic Targeting: Are We Ready? Maxwell, Ala.: Air Command and Staff College, Air University, April 1999.
procedures and special instructions for meeting execution thresholds for releasing weapons or otherwise committing assets to a target that emerges in the battlespace.

With a preplanned ATO, fighter aircraft are given targeting information in advance. The fighter aircraft may be able to find and destroy the target with little communication with other airborne assets (especially true if the target is fixed; e.g., buildings). Therefore, under most circumstances, processing a dynamic target requires more communication and coordination with other platforms—and, thus, more interoperability—than the prosecution of preplanned targets. The greater complications of processing dynamic targets over preplanned targets are demonstrated in the counter-SCUD (surface-to-surface missile) efforts during the Gulf War. The difficulty lay in aligning the accurate target information, situational awareness, C2 assets, and attack platform in a fluid battlespace. During the Gulf War, it was difficult to judge the effectiveness against countering the SCUD threat because the objectives were originally to target fixed sites of ballistic missile production facilities and launch capabilities, rather than the mobile SCUD launchers. After-action reports showed no “technical” evidence that a single SCUD Transporter Erector Launcher was actually destroyed, despite claims of more than 100 kills by aircrews. This failure stands in stark contrast to the success that U.S. aircraft had in destroying the preplanned fixed targets with precision weapons.

During interviews with military personnel from Spain, Belgium, and France, country representatives were asked to critically examine the feasibility of using strike sorties and dynamic targeting as measures for interoperability. Although largely in agreement, interviewees expressed some reservation with the proposed metrics, in that they are not only a matter of interoperability but also a reflection of aircrew training and political constraints (such as limited overfly, munitions availability, or other geopolitical concerns). Also, depending on the adversary, the nature of the operation may confound the dynamic-targeting metric. Adversaries that are more mobile will force the United States and its allies to engage in more dynamic targeting. It is important, therefore, to compare like campaigns with sufficiently similar political conditions, targets and defenses so that the measures are appropriate in reflecting change over time.

It is also essential to augment these measures with interviews or other historical records that can illuminate the primary reasons that could account for the quantitative results. For example, Spain did not have any strike sorties during OOD. Without acquiring more information, one could wrongfully assume that Spain’s interoperability was low. Knowing that Spain’s national

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203 Fox, 1999.
204 Fox, 1999.
caveats prohibited strike sorties reveals that interoperability was not the primary reason for a lack of strike sorties. Spain was able to accomplish other combat tasks within the operation that would have diluted the strike forces that were used from other countries if Spanish capability were not deployed. The interviews helped control for these differences among the different partners. With quantitative analysis and interviews together, we are able to tell a clearer story about the impact of warfighting capability on interoperability.

**Operational Interoperability**

The operational level of war is concerned with employing military forces in a theater of war or theater of operations.\(^{206}\) Operational level interoperability deals with force planning, C2, information dissemination, and security.\(^{207}\) The main issues surround the operation-level information- and intelligence-sharing between nations. Examples during OAF and OOD include ISR requests-for-information and product distribution, NATO-wide systems of communication (e.g., Combined Air Operations Center), and transmission of ATOs. The ability to engage in aerial refueling with other nations and the level of language proficiency are also considerations of operational interoperability. One suggested way of quantifying operational interoperability is to measure the OPTEMPO of an engagement.\(^{208}\) Partners may experience a difference in the daily cycle of planning, generating sorties, and recovering aircraft corresponding to their level of operational interoperability.

**Strategic Interoperability**

The strategic level of war focuses on supporting and defining national policy.\(^{209}\) Examples of the strategic level of interoperability are coalition building, access restrictions, C2 decisionmaking, changing political objectives, and evolving force structure requirements.\(^{210}\) Examples of strategic interoperability during OAF and OOD include integrating participants and nations, national political and military caveats, and compliance with NATO STANAGS. One way of measuring strategic interoperability would be to assess the percentage of STANAG compliance that a country has achieved. This percentage would give an idea of how a country follows NATO policy and guidelines, and is a first step at understanding strategic

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\(^{207}\) Hura, 2000.

\(^{208}\) FMAA/BEOP/Division Retex, French Air Force, “US FMS & Military Interoperability,” datasheet, April 2, 2014. We only make mention of OPTEMPO; we do not have the supporting data and do not consider OPTEMPO during our analysis.


\(^{210}\) Hura, 2000.
interoperability. We note STANAGS as a potential measure but do not consider percentage of STANAG compliance in our analysis. Further research for this metric is needed.

Below, we will examine the historical record on interoperability first in Kosovo, then in Libya. Our structured interviews add to interoperability insights about both of these operations although we only perform the quantitative analysis for the tactical interoperability.211 First, we will briefly describe the operation, and then outline the historical information regarding interoperability. We will then apply this methodology to affirm if interoperability increased, decreased, or had no noticeable change from Kosovo to Libya.

Interoperability in Kosovo

Even though OAF benefited from almost 50 years of NATO training, exercises, and interoperability standards, serious interoperability shortcomings were manifest throughout the operation.212 General Hugh Shelton, Chairman of the Joint Chiefs of Staff, said that “Kosovo revealed a host of technical and training problems, shortcomings in the equipment of given allies, and the inability to create the kind of fusion of command, control, communications, computers, intelligence, battle management, and strategic reconnaissance systems needed to fight with maximum effectiveness and interoperability.”213 We will present the general shortfalls of interoperability at the tactical, operational, and strategic levels, then focus strike sorties and dynamic targeting.

Tactical

- There was a shortfall with precision-strike capability.214 Targeting pods and precision munitions were only used by a few allies.
- General lack of training and use of TTPs at the tactical level.215
- There was a need to acquire systems and capabilities directly relating to the targeting process, such as obtaining a Forward Looking Infrared targeting pod and accompanying avionics.216

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211 Sufficient data for a quantitative analysis of operational or strategic interoperability requires greater access to data than was available during this analysis. We believe that further research into these areas would strengthen the thesis put forth in this dissertation.


216 Cordesman, 2001, p. 274.
• A joint data network was established, but it was composed of “disparate tactical digital systems with multiple transmission systems and message formats.”\(^\text{217}\)

• Aircraft lacked jam-resistant radios and adequate Identification Friend or Foe (IFF) equipment, thus hampering communication to airborne assets and complicating the ability of battle managers to maintain an accurate picture of air operations. \(^\text{218}\)

• As operations shifted to flex-targeting (dynamic targets), the lack of a secure voice communication data link aboard all allied aircraft became an issue for effective operations. Orders had to be sent unencrypted to aircraft, allowing the enemy to monitor them on open frequencies. \(^\text{219}\) In many cases, the unencrypted messaging allowed opportunities for the targeted units to flee or hide before the attack platform could engage them. After the war, several NATO and U.S. commanders indicated that the lack of secure communications often allowed the Yugoslav forces to adjust their plans accordingly. \(^\text{220}\) The report concluded that a joint, secure, tactical data link, such as Link 16 (used in Libya and described later in this chapter), is needed across all strike platforms to allow real-time data exchange. \(^\text{221}\)

**Operational**

• There were inconsistent data requirements and electronic data formats between systems. \(^\text{222}\)

• A single, integrated data network and network security was lacking. \(^\text{223}\)

• NATO Command, Control, Communications and Computers (C4) capability was limited due to problems with sharing bandwidths and C4 assets. \(^\text{224}\) Some bandwidths were limited to 64 kilobits per second; with the overwhelming volume of information that needed to be transmitted (e.g., target lists, daily ATOs) some information had to be printed and hand-delivered to allied counterparts.

• There were releasability issues regarding the ATOs. The United States was reluctant to disseminate information on the B-2 and F-117, as well as employment of the Tomahawk Land-Attack Cruise Missile. The result was two ATOs, one for the United States only


\(^{218}\) Jumper, 1999.


\(^{221}\) DoD, 2000.

\(^{222}\) DoD, 2000.

\(^{223}\) DoD, 2000.

\(^{224}\) DoD, 2000.
and another for NATO, creating confusion for NATO radar operators as U.S. assets appeared with no warning.225

- The United States restricted battle damage assessments, resulting in unnecessary restrikes of targets because NATO planners were not able to assess the damage properly.226
- An ad hoc system of passing information through liaison personnel created a stovepipe system that decreased OPTEMPO and increased workload and potential for error at the joint task force headquarters.227

**Strategic**

- There was a lack of compliance with NATO STANAGS.228
- Spectrum management created issues within combined and joint task forces.229 Principle NATO member-states had differing political, business, and financial agendas, which heavily affected willingness to engage certain targets.230

**Strike Sorties and Dynamic Targeting**

Allied performance for strike sorties was uneven, with the coalition faring better against fixed targets than mobile targets.231 During OAF, many of the allies flew CAP sorties and the ability to process dynamic targets was low.232 Although the allied forces flew thousands of ground-attack sorties, only 93 tanks, 153 armored combat vehicles, 389 artillery pieces and mortars, and 339 other military vehicles were destroyed.233 As one report puts it, “some allied aircraft deployed with such limited capabilities that they were infrequently tasked to attack the more demanding flex targets.”234

We use Belgian and French involvement to demonstrate the quantification of interoperability at the tactical level.235 The French Air Force had 1,089 (65 percent) strike sorties of their 1,675

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228 DoD, 2000.
235 Data on strike sorties and dynamic targeting was provided by Belgium and France. Spain did not participate in strike sorties in OOD, and Canadian participation was not releasable. Interviews with military members of the UK,
fighter sorties, and just 22 (2 percent) of the strike sorties engaged dynamic targets.\textsuperscript{236} Of the 679 Belgian fighter sorties, 122 (18 percent) were strike sorties and none included dynamic targets.\textsuperscript{237} Aircraft that could not participate in strike sorties were limited to the air superiority role. CAP sorties were disproportionately flown by Europeans nations such as Belgium, Denmark, and Norway, who could not fly at night or in adverse weather, and could not deliver PGMs.\textsuperscript{238} Other nations, such as Canada and Spain, had PGM capability, but there were other limitations to their contribution. Spain was mainly limited due to their lack of Have Quick UHF radios and lack of Mode 4 IFF beacons. Canada’s strike sorties were limited due to the number of Forward Looking Infrared targeting pods, having 13 that had been purchased in 1996.\textsuperscript{239} Canada’s CF-18s had a target error rate of 65–70 percent with laser-guided bombs, which coincided with most NATO allies.\textsuperscript{240} The exact numbers of strike sorties for Canada and Spain are not publicly available.

Table 5.7 summarizes the interoperability challenges during Kosovo. The conflict became a catalyst for change among many nations who recognized their shortcomings. We now move forward more than a decade, to the Libya conflict.
Table 5.7. Interoperability during Kosovo

<table>
<thead>
<tr>
<th>Levels of Warfighting</th>
<th>IO Shortfalls During Kosovo at Level of Warfighting</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactical</td>
<td>• Precision Strike • Targeting • Joint data network • Jam-resistant radios and IFF • Dynamic targeting • Training and TTPs</td>
<td>• France: 1,089/1,675 (65%) Strike sorties, 22/1,089 (2%) Dynamic targeting • Belgium: 122/679 (18%) Strike sorties, 0% Dynamic targeting</td>
</tr>
<tr>
<td>Operational</td>
<td>• Command and control • Information dissemination and security • ISR and ATO distribution • OPTEMPO</td>
<td>• Unavailable</td>
</tr>
<tr>
<td>Strategic</td>
<td>• Coalition building • National political and military caveats • Standardization agreements</td>
<td>• Unavailable</td>
</tr>
</tbody>
</table>


Interoperability in Libya

The overall success in achieving strategic objectives during the Libya conflict was in part due to the interoperability of allied forces. In one report hailing the success of interoperability in OOD, the authors point out that although joint and combined operations are inherently complex, U.S. forces benefit from the broad experience from past coalition warfare.241 General Carter Ham, USA, the commander of AFRICOM during OOD, pointed out many shortfalls of the operations but praised the overall level of interoperability and coordination as the “ideal” for future operations.242 In a summary on war fighting from 2002 to 2012, a Joint and Coalition Operations Analysis report states that, despite challenges with interoperability, the United States learned to operate more effectively with coalition partners over time.243 Although operations in Libya were successful, there are sources that point out the deficiencies in interoperability and the

need for further allied improvement. Robert Gates said NATO’s serious capability gaps and other institutional shortcomings were laid bare by the Libya operation.244 The following summarizes the expert opinions on the successes and shortcomings of interoperability during Libya.

**Tactical**

- There was frequencies deconfliction.245
- Difficulty was experienced communicating through secure radios due to the differences in cryptology.246

**Operational**

- ISR that was collected from platforms generally became confined to U.S.-only channels.247
- An AOC that would normally surge 300 sorties a day struggled to launch 150 sorties under NATO leadership.248
- Problems with classified communication, especially transmitting ATOs and other mission information, resulted in information being routed through liaison officers to aircrews.249

**Strategic**

- There were challenges with integrating more and more new types of systems, platforms, and nations.250
- Nations had their own political chain of command and national caveats for processing appropriate targets, which resulted in a reduced ability to process targets quickly.251

**Strike Sorties and Dynamic Targeting**

The ability of the United States and its allies to engage in dynamic targeting grew between the Kosovo and Libya operations.252 Air Vice Marshal Greg Bagwell has said that during OOD,

244 Gates, 2011.
245 Greenleaf, 2013.
246 Greenleaf, 2013.
249 Greenleaf, 2013.
250 Major General Margaret Woodward, Seventeenth Air Force Commander and the joint force air component commander (JFACC) during OOD, quoted in Daadler, 2012.
251 James, Holcomb and Manske, 2012.
90 percent of the Royal Air Force strike missions were conducted against dynamic targets. In testimony given to Congress, it was noted that France and Britain demonstrated their willingness to “step up” during operations in Libya, and a number of smaller nations also contributed vital niche capabilities, including Norway, Belgium, Italy, and Denmark. Of the 3,835 French strike sorties, 3,312 (86 percent) were strike missions, and of those, 1,788 (54 percent) were against dynamic targets. Of the 620 Belgian fighter sorties, 589 (95 percent) were strike missions, with a marked improvement in dynamic targeting at 383 sorties (65 percent).

Table 5.8 summarizes the interoperability challenges during Libya. We will now compare Kosovo and Libya.

<table>
<thead>
<tr>
<th>Levels of Warfighting</th>
<th>IO Shortfalls During Libya at Level of Warfighting</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactical</td>
<td>• Secure radio cryptology</td>
<td>• France: 3,312/3,835 (86%) Strike sorties; 1,788/3,312 (54%) Dynamic targeting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Belgium: 589/620 (95%) Strike sorties; 383/589 (65%) Dynamic targeting</td>
</tr>
<tr>
<td>Operational</td>
<td>• C2</td>
<td>• Unavailable</td>
</tr>
<tr>
<td></td>
<td>• Information dissemination and security</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• ISR and ATO distribution</td>
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<tr>
<td></td>
<td>• OPTEMPO</td>
<td></td>
</tr>
<tr>
<td>Strategic</td>
<td>• Coalition building</td>
<td>• Unavailable</td>
</tr>
<tr>
<td></td>
<td>• National political and military caveats</td>
<td></td>
</tr>
</tbody>
</table>


253 “UAE AF,” The Aviationist, August 2011.
Comparison of Interoperability: Kosovo to Libya

Our analysis shows that there was an increase in interoperability between the United States and allies from Kosovo to Libya. Our research encompassed information from leaders, after-action reports, various studies, and interviews and is divided into the tactical, operational, and strategic levels of war. We focused primarily at the tactical level of war, analyzing strike sorties and dynamic targeting to further support findings from the literature and interviews with foreign military leaders.

Table 5.9. Interoperability Comparison from Kosovo to Libya

<table>
<thead>
<tr>
<th>Level of Warfighting</th>
<th>IO Shortfalls During Kosovo at Level of Warfighting</th>
<th>IO Shortfalls During Libya at Level of Warfighting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tactical</strong></td>
<td>• Jam-resistant radios and IFF</td>
<td>• Secure radio cryptology</td>
</tr>
<tr>
<td></td>
<td>• Precision Strike</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Targeting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Joint data network</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dynamic targeting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Training and TTPs</td>
<td></td>
</tr>
<tr>
<td><strong>Operational</strong></td>
<td>• C2</td>
<td>• C2</td>
</tr>
<tr>
<td></td>
<td>• Information and security dissemination</td>
<td>• Information and security dissemination</td>
</tr>
<tr>
<td></td>
<td>• ISR and ATO distribution</td>
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<td></td>
<td>• OPTEMPO</td>
<td>• OPTEMPO</td>
</tr>
<tr>
<td><strong>Strategic</strong></td>
<td>• Coalition building</td>
<td>• Coalition building</td>
</tr>
<tr>
<td></td>
<td>• National political and military caveats</td>
<td>• National political and military caveats</td>
</tr>
<tr>
<td></td>
<td>• Standardization agreements</td>
<td></td>
</tr>
</tbody>
</table>


We compare shortfalls between Kosovo and Libya as shown in Table 5.9. The tactical level of interoperability improved due to increases in the following warfighting capabilities: precision-strike capabilities, targeting, data networks, dynamic targeting, and training and TTPs. In the absence of these capabilities being reported as shortfalls during Libya, we assume an increase from Kosovo to Libya. Furthermore, there is evidence the capabilities improved by examining the systems purchased through FMS. The widespread tactical data link integration and targeting pod use enabled precision-strike and dynamic-targeting improvements. Allies acquired jam-
resistant radios with adequate IFF equipment which meant orders were no longer sent unencrypted to aircraft. Part of the process of operating more effectively over time came from the implementation of TTPs during training exercises and other multinational events. All of these improvements in warfighting directly enabled interoperability between forces at the tactical level of war.

We further affirm that tactical interoperability increased because of Belgian and French improvements in precision-strike capabilities and dynamic targeting. The percentage of strike sorties, as well as dynamic targeting, increased from Kosovo to Libya for both France and Belgium individually and combined (as shown in Figure 5.4). The percentage of strike sorties increased by 37 percent and dynamic targeting increased by 48 percent from Kosovo to Libya for Belgium and France together. This quantitative analysis supports the after-action reports and other literature which affirmed qualitatively that strike sorties and dynamic targeting improved from Kosovo to Libya.

From the historical analysis, it appears that there are similar, persisting interoperability problems at the operational and strategic levels. There appear to be improvements with STANAG compliance; however, the change is difficult to measure. During interviews with military representatives from Spain, Canada, Belgium, and France, it was their expert opinion that interoperability, as per the NATO definition, increased for their air forces from Kosovo to Libya.

Figure 5.4. Percentage of Belgian and French Strike Sorties and Dynamic Targeting

![Figure 5.4. Percentage of Belgian and French Strike Sorties and Dynamic Targeting](image)

We conclude that increased allied warfighting capability increased interoperability from Kosovo to Libya. This assessment is based on information from leaders, after-action reports, various studies, and interviews with military representatives from countries that participated in both operations. We further support our conclusion with quantitative improvements in precision-strike and dynamic-targeting measures for Belgium and France. We have thus far shown how FMS impacts warfighting capabilities, and how warfighting capabilities impact interoperability. We now conclude this logical argument by linking the FMS items sold from Kosovo to Libya with the tactical interoperability improvements enabled by the warfighting capabilities.

Linking FMS with Interoperability

There is a link between FMS and improved allied warfighting capabilities from Kosovo to Libya. The FMS item on the left of Table 5.10 is correlated with the warfighting capabilities that positively impact tactical interoperability along the top right. The table shows which countries were involved in the purchase of the FMS item during the interim between Kosovo and Libya. None of the case study countries bought fighter aircraft from the United States between 1999 and 2011; however, they did participate in air exercises and IMET, which had an effect on enhancing warfighting skills through training and the execution of TTPs. We now use process tracing by demonstrating how each FMS item causally impacted the tactical interoperability outcome.

Table 5.10. Impact of FMS on Tactical Interoperability

<table>
<thead>
<tr>
<th>U.S. FMS Equipment, Training, and Effects</th>
<th>Countries Involved with FMS</th>
<th>Warfighting Capabilities / Tactical IO Improvements from Kosovo to Libya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision munitions: Joint Direct Attack Munition (JDAM)</td>
<td>BE, ES, IT, NO, DK, CA</td>
<td>Precision strike, X; Dynamic targeting, X; Joint data networks, X; Targeting, X; Training and TTPs, X</td>
</tr>
<tr>
<td>Advanced targeting pods (ATPs): Sniper and Litening</td>
<td>BE, ES, IT, NO, DK, CA</td>
<td>Precision strike, X; Dynamic targeting, X; Joint data networks, X; Targeting, X</td>
</tr>
<tr>
<td>Tactical data link: Link 16</td>
<td>BE, FR, ES, IT, NO, DK, CA</td>
<td>Precision strike, X; Dynamic targeting, X; Targeting, X; Training and TTPs, X</td>
</tr>
<tr>
<td>Aircraft IMET</td>
<td>BE, ES, IT, NO, DK, CA</td>
<td>Precision strike, X; Dynamic targeting, X; Joint data networks, X; Targeting, X; Training and TTPs, X</td>
</tr>
<tr>
<td>Air exercises</td>
<td>UK, FR, BE, ES, IT, NO, DK, CA</td>
<td>Precision strike, X; Dynamic targeting, X; Joint data networks, X; Targeting, X; Training and TTPs, X</td>
</tr>
</tbody>
</table>

PGMs form the basis for an enhanced precision strike and dynamic targeting capability. There was a 70 percent increase in precision munition use from Kosovo to Libya (see Figure 5.1). Belgium, Denmark, and Norway all acquired precision strike and dynamic targeting capabilities from Kosovo to Libya due in part to the acquisition of JDAM through FMS. Nearly 2,700 JDAMs were procured between Kosovo and Libya by case study allies (see Table 5.3). The JDAM was the weapon of choice for precision ground attack during the Libya conflict. Without the PGMs, precision strike and dynamic targeting would not have been possible, and interoperability between forces would have been reduced. Precision strike and dynamic targeting also require the use an advance targeting pod.

Nearly 100 Litening and Sniper ATPs were acquired by case study countries between Kosovo and Libya (see Table 5.4). These pods, along with precision munitions, and the associated training, enabled more nations to participate in precision-strike sorties and dynamic targeting during operations in Libya. Targeting in general by platforms would not have possible without a targeting pod.

The joint tactical data network that was lacking in OAF was realized with the widespread use of Link 16 during OOD. All case study allies were equipped with Link 16 capabilities between Kosovo and Libya (see Table 5.5). Without Link 16, the situational awareness and interoperability of allies would have been significantly worse. The capability among partners allowed a more challenging set of rules of engagement, which allowed a more efficient and effective fighting force once airborne. Dynamic-targeting abilities were greatly improved through Link 16, precision munitions, and targeting pods. Without Link 16, a targeting pod, and PGMs, a country does not meet modern warfare standards and is “not interoperable.”

Air exercises and IMET helped improve the training provided allied aircrews and enhanced the execution of TTPs during wartime operations, arguably having an impact on allied interoperability during the Libya conflict. Case study countries participated in an average of eight multinational air exercises with the U.S. from 2006 – 2011 leading up to the Libya conflict (see Figure 5.2). Air exercises and IMET are influenced to a certain extent by major FMS, such as those of aircraft, particularly fighters.

The purchase of FMS led to enhancements in warfighting capabilities from Kosovo to Libya. We have shown both quantitatively and qualitatively that this in turn leads to enhanced interoperability.

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257 COMOPSAIR/A3, personal communication, 2014.
Summary

We have demonstrated a two-part methodological approach to analyzing the impact of FMS on interoperability. First we showed how FMS affects certain warfighting capabilities. We then connected those warfighting capabilities with improvements to interoperability. Thus, we have shown that FMS has a positive impact on interoperability.

Interoperability is a force multiplier on the battlefield through the efficient use of support resources. It is important, therefore, to understand the relationship between the sale of U.S. equipment and the effect that FMS programs have on improving warfighting interoperability with partner nations. The research shows that FMS played a large role in advancing interoperability from Kosovo through Libya. We cannot account for all causal factors; there are other variables that may have influenced the increase in interoperability from Kosovo to Libya. However, our goal was not to derive the level of interoperability from all possible factors, but only to show that FMS has a positive impact on allied warfighting capability and interoperability. We attempted to minimize other causal factors by ensuring that the selected operations were similar and that we support the historical analysis with structured interviews with military leaders. We are confident that our methodology of combining comparative case studies with the historical analysis of process-tracing minimized other causal factors. Therefore, we conclude that one major benefit of FMS is the impact on increasing interoperability in combined operations, thus improving coalition operational capability.

Our thesis is that FMS-directed IPT is worth the cost incurred to the USAF. This chapter took an approach at assessing a benefit that not only encompasses IPT, but also provides implications to the USAF for the broader FMS program. FMS of aircraft and other systems should be actively pursued by Air Force leaders in a position to influence FMS decisionmaking. Understanding how FMS impacts interoperability is a contribution to literature, and this research provides a valuable case study example with operations in Kosovo and Libya. This chapter has bolstered the thesis that IPT is worth the cost incurred to the USAF by examining a nonmonetary benefit of FMS and consequently IPT that has not traditionally been considered. As allies purchase U.S. equipment and the USAF provides the corresponding training, we can reasonably assume an increase in interoperability between the allied Air Force and the USAF.
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6. Summary, Conclusions and Additional Work

This research has shown that USAF costs to train international pilots are offset by value received in operations. As part of the methodology, we calculated the monetary benefits and costs of FMS-directed international training to the USAF. Additionally, a case study provides an example of a nonmonetary benefit of FMS by examining the impact of FMS on allied interoperability. These benefits and costs should be of use in the calculus of arms sales, in the policies directed at FMS international training, in the Air Force training program strategic planning, and perhaps in determining the course price offered to international students. Also, given the cost analysis relating to partner force operational integration and interoperability, the information will help shape advanced training programs and/or help inform future U.S. and coalition operations planning. In this chapter, we will summarize our research on the monetary costs to the USAF of training foreign pilots. We review the operational savings associated with FMS and compare the costs and benefits of FMS for Belgium, Denmark, and Norway. We discuss one aspect of the nonoperational benefits—interoperability—to derive a fuller understanding of the value of IPT. We will then identify the significance and limitations of the findings and provide our recommendations to policymakers. We outline areas for further research for each methodology presented in this dissertation.

Monetary Cost: F-16 IPT

Currently, the USAF cost of providing F-16 IPT is about one-half to three-quarters of a million dollars per pilot. The costs per pilot have increased 50 percent since 2006. In assessing costs for international training, we selected the F-16 training at Tucson ANG as a case study. We found that international students at Tucson paid, on average, 16 percent less than the full reimbursement rate. The difference between the FMS-Full price and the actual amount paid for F-16 training conducted at Tucson ANG from 2006 to 2013 was about $17 million a year. This amounts to an average additional cost of $360,000 per international pilot trained. It is generally accepted that there are costs above and beyond the reimbursement rate for international training. Under the assumption that the overall cost of IPT is approximately proportional to the fraction of aircraft utilization (sorties and hours flown) for IPT courses, the difference between FMS-Full price and the overall cost is an additional $10 million a year. This yields an average cost per student of $228,000. Adding in the current discounted rate to the cost above and beyond reimbursements brings the total cost for IPT at Tucson to $27 million a year, or $588,000 per student. To account for the additional cost above FMS-Full price, we recommend that the USAF use the methodology outlined in this dissertation or a similar methodology to more thoroughly capture the cost of IPT. If the historical conditions continue in the future, this would place the cost of IPT at about 10 percent above the current calculation for the FMS-Full price.
Monetary Benefits: Operational Savings

Unknowingly, the USAF has successfully recouped its investment in IPT through avoiding deploying additional forces or realizing operational savings from working alongside foreign partners utilizing Air Force training through FMS. Small campaigns can offset the IPT costs of dozens of pilots, while larger campaigns can offset the IPT costs of hundreds of pilots. U.S. military allies have participated with the United States in many operations in the past. Allied participation is important not only to gain international support and legitimacy, but also to decrease the level of effort that the U.S. military must exert to achieve strategic goals. We provide a method for quantifying coalition involvement in U.S. military operations. We analyze OOD and OUP and calculate the cost to the USAF of replacing allied F-16 participation. We adjust for aircraft, aircrew, basing, and OPTEMPO differences to determine the equivalent number of U.S. F-16s that would have been necessary. We estimate $170 million in savings to the USAF by avoiding what would have required an expanded deployment of F-16s during OOD and OUP. We recommend that policymakers for the USAF consider the monetary benefits of coalition involvement to properly assess and pursue an FMS strategy.

Other savings may be considered to augment the value for the USAF in participating in FMS international training. As the USAF experiences austere fiscal challenges, its war plan assumptions must rely on allied contributions more heavily. The methodology helped individualize each allied contribution appropriate to their capabilities and capacity to sustain OPTEMPO. Having the confidence of continued allied participation may lower operational risk and perhaps even allow an earlier retirement of aircraft in the force structure. For example, having an assurance that the allies will provide F-16s in a conflict may allow the United States to reconsider the risk associated with retiring F-16s before the gap is filled by the F-35 as a money-saving measure. If an earlier retirement occurs, additional monetary savings would accrue from saved annual flying hours, operations and maintenance—and, perhaps, personnel costs. This approach may help when considering these many factors and contribute to a better-informed decision. A more detailed future analysis might indicate other specialties where the security assistance impact on cost and value are greater for the Air Force.

Comparing the costs to train pilots from Belgium, Denmark, and Norway with the savings from OOD and OUP revealed that a small operation such as OOD can offset some or all of the costs of training dozens of pilots. The net savings per pilot are greatly increased when adding in a protracted campaign, such as OUP, which could offset the cost to train hundreds of pilots. From 2006 to 2013, it cost the USAF an additional $10 million to train the F-16 pilots from Belgium, Denmark, and Norway. This is the cost incurred from giving these nations the NATO discount price. This figure increases to about $20 million when adding the above and beyond costs calculated in this dissertation to the cost of providing discounts. Having Belgian, Danish, and Norwegian participation in OOD resulted in savings of $16 million. Additionally, the savings are $170 million for both OOD and OUP combined. Assuming that the USAF trained all
currently operational pilots in the Belgian, Danish, and Norwegian air forces, the savings from OUP far outweigh the cost to train these 217 pilots. We conclude that IPT was worth the additional cost to the USAF of training pilots from Belgium, Denmark, and Norway as long as allied operations continued with some regularity in the future. We would expect equal savings for NATO countries that provide similar support in coalition operations in the future.

**Nonmonetary Benefits: Interoperability**

The benefits of FMS and IPT are even greater when considering other nonmonetary benefits, such as interoperability. The analysis of interoperability makes visible the operational context and aspects of coalition operations not captured with the operational savings methodology that examined partner contributions alone. The effectiveness of our allies to deter and defeat our enemies is related to the capability and interoperability of their forces acting in concert with U.S. forces and each other. Selling our equipment increases coalition interoperability. We show this first by demonstrating the link between FMS and warfighting capability, and then we link those capabilities to interoperability outcomes.

We examined case study countries that participated in the conflicts in both Kosovo in 1999 and Libya in 2011. The sale of U.S. technology through the FMS program from Kosovo to Libya was found to directly contribute to increases in warfighting capability. Specifically, this study found that the FMS of Link 16, Sniper and Litening targeting pods, and such precision munitions as JDAM made tactical warfighting improvements possible. Additionally, we found that the sale of aircraft enables indirect improvements to warfighting through the TTPs (e.g., 3–1), gains in logistics and spare parts, and by enabling and promoting other technological improvements. These advanced systems help create a partner capability of increased technical sophistication compatible with newer, fifth-generation platforms. FMS also promote increased IMET and international air exercise participation. According to interviews with allied military personnel, IMET and international air exercises increase warfighting capability through training and exposure to U.S. doctrine and personnel.

We provide a methodology that could be used to measure interoperability between similar operations and increase our understanding of the effects of FMS on interoperability. We examined three levels of warfare within the national security strategy: tactical, operational, and strategic. Deriving quantifiable measures at each of these levels is challenging because of the complexities and uncertainties of international conflict. An example of a quantifiable, surrogate measure for tactical interoperability is the percentages of strike to nonstrike sorties and of dynamic targets to preplanned targets. These percentages reflect a country’s mission capability with fighter aircraft and represent the dynamic targeting and precision strike warfighting capability. Interviews suggested using OPTEMPO and percentage of STANAG compliance as measures for operational and strategic interoperability, although firm data was unavailable to do so in this report.
We explore the air wars over Kosovo and Libya to measure and compare the various levels of interoperability between the United States and allies. We found that definitive improvements were made in tactical interoperability from Kosovo to Libya for two reasons. First, through interviews and historical research, we found major improvements with joint data networks, targeting, precision-strike capabilities, dynamic targeting, and training and TTPs. These improvements are at the tactical level of interoperability. Second, we quantitatively calculated interoperability improvements for France and Belgium using the strike sortie and dynamic-targeting warfighting metrics. When comparing Kosovo to Libya, France increased strike sorties by 21 percent and dynamic targeting by 52 percent. Belgium increased strike sorties by 77 percent and dynamic targeting by 65 percent. Responses to our structured interviews with military experts from some of the participating countries confirmed that this increase was, in large measure, enabled by FMS from 1999 to 2011. While each nation must also take credit for these successes in managing its national forces, FMS and specifically the training conducted by the USAF played a significant part in quickly moving ahead to the point where an operation such as OOD could be conducted. We thus quantitatively tie FMS to the positive interoperability outcome through dynamic targeting and precision strike warfighting capabilities and qualitatively through historical analysis and structured interviews. We conclude that FMS has a significant positive impact on increasing interoperability.

Recommendations

This research was motivated by the limited understanding of the value of IPT within the USAF generally and also at some of the highest levels. With FMS on the rise, budget constraints, and finite USAF training capacity, providing a more holistic appraisal of the costs and benefits of IPT will strengthen well-informed decisionmaking. The case studies provide policymakers with valuable examples on which to base future decisions affecting planning, budgeting, and prioritization of IPT. This research creates a background for the operational advocacy for training partners. We now present the policy relevant recommendations from this research.

- The USAF should consider IPT a valuable investment for future operations. Costs of IPT are offset by participation in U.S. coalitions. There is monetary value from partner participation in operations, as well as additional value in nonmonetary benefits such as interoperability. These benefits should be included in the calculus that goes into the resource decisionmaking process. Specifically, we recommend that SAF/IA use the methodologies presented in this research to help develop supporting arguments when advocating for corporate resources. Through FMS and subsequent training, this research has shown that there are expected gains in interoperability and hence operational effectiveness. IPT specifically improves operational effectiveness between the U.S. and allies through the training received in U.S. doctrine and TTPs related to the specific platform. There are tradeoffs for expanding IPT at the expense of pilot training for U.S.
personnel. A balance must be maintained to ensure U.S. readiness while also maximizing the ability to train foreign pilots. Further study regarding the scheduling of foreign pilots may aid in maximizing foreign pilot participation. In conjunction, policymakers should also consider methods for planning and budgeting foreign training earlier in the four year planning cycle (see Williams, et al. for further detail).

- This research suggests that the USAF can more effectively build partnership capacity by giving higher priority to countries that are likely to 1) participate in and provide greater U.S. support for coalition operations and 2) increase interoperability through sustained FMS programs. Decisionmakers should not only take into consideration the current and projected geopolitical conditions, but the current military capabilities and historical operational experience with allies as part of their calculus in determining priorities. For example, combatant commanders have a primary role in working with allies and are in a position to recommend FMS or training to allies in order to shape future allied force structure. They have a role in advocacy, prioritization, and vying for resources to achieve U.S. national objectives. With an emphasis on enhancing interoperability, commanders could consider FMS and the corresponding training as a positive selection criterion for including allies during coalition operations. The ability to operate effectively and reduce the friction of warfighting for the United States and allies requires interoperability at all levels of war. The biggest return on the IPT investment will be for countries that are not only likely to participate with the United States, but can maintain a high level of operational capability and interoperability.

- The USAF has taken steps to recover more of the costs of IPT by moving to a system of direct reimbursement. We recommend that the USAF continues to redefine, where possible, FMS prices charged. Our research suggests that the true cost for IPT is 10 percent greater than the previously calculated FMS-Full price for F-16 IPT.

Further Research

The methodology for assessing the cost of international training should be expanded to more fully understand the costs of other IMET training and IPT at other locations in the United States. AFSAT/FM recommended encompassing, at a minimum, a guard base, an academic location, a technical training center such as Keesler AFB or Goodfellow AFB, and a specialized undergraduate pilot training base. The analysis would need to be expanded to determine the overall costs and potential benefits of international training as a whole. This may help shape future course pricing at various locations.
Another major area for future research is developing the scheduling and allocation for IPT course slots. When committing to international training slots in formal courses, the necessary strategic planning would insure the required slots are available in a timely manner. Scheduling foreign pilots for training currently causes friction in the planning process and additional administrative needs. Aircrew training slot allocation is complicated by the fact that the international training commitment and priority is not considered until the current budget year. In *Valued Partners: Quantifying the Value of Foreign Military Training to the USAF*, Williams et al. find that the information from signed or potential training requirements is not considered early enough in the corporate process. By the budget year, the training capacity has been set by the level of Air Force funding. IPT often occurs as an afterthought and only provides slots to international students when U.S. students cannot readily use those slots.

We recommend that follow-on research be done to incorporate the results of the operational cost savings method to address a larger USAF cost-benefit assessment. There are many nonmonetary benefits for the USAF in participating in FMS international training. These were not considered in this document due to the complexity, subjective nature, and uncertainty of the financial impact. These political, military, and economic benefits from FMS should be studied further to more fully capture benefits to the USAF. Among the questions to consider are:

- To what extent do FMS increase the likelihood of allied participation in conflicts, as well as the willingness of allies to allow U.S. planes to overfly airspace or to temporarily base aircraft in that country?
- How can the Air Force gauge which countries will be more or less willing to participate in future coalition operations?
- To what extent do FMS lower unit costs or enhance technology for weapon systems that the USAF is purchasing?

Further research is needed to assess the potential USAF cost savings (or avoidance) of not engaging in conflicts, and whether that offsets the USAF FMS aircraft pilot training cost expenditures that are not covered as part of the FMS aircraft contractual agreements. Future

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258 AFSAT and AETC/IA discussed the value of looking into the distinct challenges of the F-16, C-130J, and C-17 international training. However, they pointed out that their biggest concern is for the C-130J in the upcoming years, as it would continue to be the “hot commodity” until the AM-400 comes out. The USAF requirements for training F-16 pilots will plateau, while the FMS requirement for C-130J will go up. One issue with the C-130 is that they can train the front half and not train the back half of a C-130. When this occurs, the country can lag indefinitely on training the back half. One issue with the C-17 and C-130J is that international customers have been included immediately, even when the Air Force has not finished all of its buys. The production line for the C-17 may shut down, so it may not be as prudent to model that airframe. However, the C-130J has a name for longevity and utility, and may continue to have a high demand. The USAF is budget-constrained to maintain currency, and the projection is that it will utilize all C-130J simulators. As the USAF looks at saving money by using simulators, there will not be enough capacity for internationals. Therefore, another major area of research should be the C-130J international training.
work is needed to include the benefit of combat flying experience when valuing IPT. For example, when countries participate with the United States in coalition operations, we may calculate the replacement cost (as outlined in Chapter Four); however, this does not capture the loss of combat experience from not participating in the operation. How valuable is the combat experience for the United States and its allies, and should that be a consideration for prioritization of IPT?

Further research is warranted to explore quantification of interoperability and assess its monetary value, if any, to the USAF. We outlined ways to quantify interoperability at the tactical, operational, and strategic levels of war. We suggested using OPTEMPO as a metric for operational interoperability, and NATO STANAG compliance for strategic level interoperability. Both of these metrics require additional research to validate, and further research could be done to explore other metrics at all levels of war. One could argue that interoperability clearly improves the efficiency of joint operations, thus reducing the amount of time and resource consumption (cost) to achieve objectives. Fewer sorties would save service life consumption, as well as weapons expenditure. A monetary benefit for interoperability could be calculated using the methodology in this paper to analyze degrees of interoperability and the costs avoided during a campaign. Campaign durations or number of targets destroyed could be analyzed in parallel with metrics such as strike sorties and dynamic-targeting capability. Many factors are involved, but some are more quantifiable than others, such as the presence of Link 16, targeting pods, and precision weapons. A more in-depth analysis might yield new insights and/or a methodology similar to that presented in this dissertation.

Finally, we recommend that our monetary cost-benefit analysis (as outlined in Figure 4.12) be expanded for a variety of partners and operations. Research is needed to compare savings from different partner nations within various operations. This may aid in understanding the net savings in general for NATO and non-NATO allies. Other nonmonetary benefits of FMS may also be monetized and incorporated into the value of courses like IPT. These benefits include (but are not limited to) defense industrial base, regional security, and bilateral defense relationships. A much broader analysis of the monetary and nonmonetary benefits of FMS and IPT will enable better decisionmaking in planning, programming, budgeting, and running the IPT enterprise, thus improving the operational effectiveness of international coalitions when training is put into action.
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T-MASL—See Training-Military Articles and Services List.


USAFAF—See U.S. Air Forces Africa.

USAFRICOM—See U.S. Africa Command.


U.S. Constitution, Article 1, section 8.


Appendix

Time Line of Major Events for FMS

The following historical outline is presented not only to provide background on FMS, but also to highlight important events that have affected U.S. FMS, especially with NATO. Also included are major points focused on shortfalls in NATO spending and capabilities. Budgetary considerations within NATO are as relevant today as they were during the organization’s formation and have a direct effect on defense spending and, consequently, FMS.259

- 1948: Under the Truman Doctrine, the United States started assisting allied and friendly nations to meet Europe’s immediate postwar needs.260
- 1949: The North Atlantic Treaty signed, marking the official formation of NATO.
- 1950: The Pleven Plan was proposed to create the European Defense Community. 261
- 1961: The Foreign Assistance Act of 1961 was signed into law. 262 President John F. Kennedy also delivered the “Twin Pillars” speech, calling for Europe to enhance its share of contributions.263
- 1969: The Nixon Doctrine resulted in dramatic increases in arms sales and training for key regional allies.264
- 1976: The AECA reformed arms sales through a set of specific guidelines.265
- 1977: President Jimmy Carter called for NATO defense spending to be at 3 percent above inflation.266
- 1991: After the collapse of Soviet Union, a new strategic concept expressing NATO’s role in emerging security environment was formed.267

259 Montgomery, 2014.
262 FAA, Section 2151.
265 AECA, Section 2751.
266 Russo, 2012.
• 2010: At the Lisbon Conference, NATO designed a new strategic concept to broaden global partnerships and increase operational effectiveness in the 21st century, marking the first major NATO strategic revision since 1999.\textsuperscript{268}

• 2012: At the Chicago Summit, the Alliance announced the establishment of its Alliance Ground Surveillance System, which included the acquisition of unmanned aerial vehicles.\textsuperscript{269}

FMS Aircraft Sales and IMET

We broadened the research to explore how FMS aircraft sales (through IMET) might affect interoperability generally. We examined the countries of Chile, Iraq, Morocco, Oman, Poland, and India to see if the recent sales of F-16, C-130, C-17, and KC-135 aircraft have increased air force IMET for each country. One reason for selecting these countries is that the IMET data is only consistent and available since 2005.\textsuperscript{270} These countries have all obtained these MDS aircraft within that time frame.

Figure A.1 shows the Air Force IMET courses from 2005 to 2013. The F-16, C-130, C-17, and KC-135 acquisitions are shown with the corresponding courses that pertained to pilots. These courses range from their initial English language training at the Defense Language Institute to their MDS qualification courses. The data suggest that acquisition of aircraft lead to an increase in the overall international training done by that country for a period of time. This increase is not simply due to the training of pilots: The sale of aircraft increases the immediate need for the country to train aircrew, maintenance, and other types of supporting personnel.

Poland is a good example of how the sale of F-16s can affect interoperability by increasing IMET and partnership-building activity. In 2002, the F-16C/D Block 52+ beat out the fierce European competition and was chosen as the new multirole fighter for Poland under the Peace Sky program, with deliveries starting in 2006. General Tom Hobbins, then the Allied Air Component Commander and U.S. Air Force in Europe Commander, stated that Poland’s acquisition of the F-16 would cement the U.S.-Polish relationship for decades to come,\textsuperscript{271} and that the acquisition of the 48 F-16s would improve interoperability between Poland and NATO, especially for the air policing mission. Polish pilots and maintainers began training with

\textsuperscript{268} Serrano, 2012.
\textsuperscript{269} Hallams, 2013. Also announced were plans for NATO Forces 2020, a vision for generating “modern, tightly connected forces equipped, trained, exercised and commanded so that they can operate together and with partners in any environment.”
\textsuperscript{270} Data is from DSAMS, which went through a transition in 2005 from an older database that representatives from AETC/IA, in an interview conducted in October 2013, recommended not using.
American counterparts in the United States—11 F-16 pilots trained that year with the Arizona Air National Guard. Additional training as a result of FMS may ultimately increase interoperability.

**Figure A.1: FMS Aircraft Purchases Increase Number of Air Force IMET Courses**

![Bar charts showing FMS aircraft purchases increase number of Air Force IMET courses for Morocco, Poland, Chile, Oman, India, and Iraq.]


**Protocol for Interviews with Foreign Military Leaders**

We conducted interviews with representatives from Belgium, France, Spain, and Canada. We obtained permission and coordination for the interviews through the Office of the National Military Representative at Supreme Headquarters Allied Powers Europe in Belgium. We list the questions asked and then provide a table detailing the general free response to each question. The table details the response according to categories used in the qualitative analysis found in

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272 Carlos, 2006.
Chapter Five. The structured interviews lasted one to two hours, during which the following nine questions were asked:

1. What are the major factors in achieving interoperability (IO) with the United States? Which ones play the largest role in IO at each level of war?
2. What are the primary reasons for purchasing U.S. military technology? Does IO factor into that calculation? If so, is it a major priority?
3. What are the major U.S. items purchased from 1999–2011 that have affected the operational effectiveness of your Air Force?
4. What do you think are the major technologies that are required to be interoperable with the United States when trying to carry out strike sorties/dynamic targeting?
5. How would you measure IO at a coalition level? Specifically, how would you measure IO at the tactical, operational, and strategic levels of war?
6. Has IO changed from Kosovo to Libya? If so, how and why?
7. What still needs to be done to improve air interoperability at the tactical or operational level?
8. What fighter missions require a high degree of IO? Why?
9. The following data is requested for operations in Kosovo and Libya:
   - Number of strike sorties for fighters
   - Number of nonstrike sorties for fighters
   - Number of dynamic targeting sorties (or dynamic targets destroyed)
   - Number of preplanned targeting sorties (or fixed targets destroyed)
1. At the tactical and operational levels of war, the following factors were mentioned for achieving IO:
   - technology
   - air exercise
   - international training.
   Technology (especially similar weapons systems), along with the tactics and procedures governing the technology, were ranked first for affecting the tactical/operational levels of war. Air exercises were a close second, followed by the international training.

At the strategic level of war, the following factors were mentioned for achieving IO:
   - STANAGS
   - reciprocal agreements and political ties (trust).

2. In general, weapons systems are purchased for the full logistic and tactical support the United States provides through FMS. The following areas were also mentioned in particular:
   - ease of acquisition, spare parts, and tactical update programs
   - countries recognize that buyers may benefit from the research and development in which the United States invests
   - partners recognize the economies of scale, where higher numbers mean decreased costs
   - IO with the United States is of secondary importance when purchasing FMS.

3. There was overlap with major FMS items purchased during the interim from Kosovo to Libya for Spain, Canada, and Belgium. Each of them mentioned the following:
   - Link 16
   - precision munitions
   - targeting pods
   - aircraft upgrades, such as the joint helmet mounted cueing system, and avionics updates and upgrades.

4. Major technologies or characteristics required for strike sorties and dynamic targeting include anything regarding:
   - ISR distribution
   - secure communications (Link 16 datalink)
   - training
   - weapon systems (e.g., high-resolution targeting pod and precision munitions)
   - air-to-air refueling (AAR) capability.
Respondents suggested IO at the tactical level could be measured by:
- mission capability (brief, execute, debrief certain missions for the specific platform).

Respondents suggested IO at the operational level could be measured by:
- operational tempo (OPTEMPO)
- ability to support a mutual logistic support system including being able to exchange spare parts, and support major equipment and weapons.

Respondents suggested IO at the strategic level could be measured by:
- compliance to NATO STANAGS.

There was a strong consensus among participants that IO increased from Kosovo to Libya. Specifically, the following areas were highlighted:
- joint data networks (secure communications and intelligence chains) targeting from a platform
- precision strike capability
- dynamic targeting capability
- training and TTPs.

Participants outlined areas that need improvement in IO within NATO as follows:
- coordination with the political and military intents of operations (more interoperability would be achieved with fewer national caveats and more cohesive and similar rules of engagement)
- improvements needed with formats and protocols for communications systems
- Greater level of similarity in tactics and doctrine needed within NATO.

Strike sorties (OCA, SCAR) require a higher level of IO than nonstrike sorties (DCA, CAP), according to participants. AAR was also mentioned as requiring a high level of IO. (See Chapter Five for a more complete discussion.)

(See Chapter Five for a more complete discussion.)

Interoperability and NATO STANAGS

STANAGS are largely outside and independent of FMS. However, we examine the importance of NATO STANAGS because these agreements can lead to FMS purchases as countries strive for standardization by conforming to certain technical requirements (e.g., STANAG 5516, which governs Link 16). We also discuss STANAGS briefly due to their importance in establishing interoperability according to foreign military leaders.
As the number of coalition partners increases, it is increasingly important to ensure interoperability through standardization solutions. Operational effectiveness requires agreed-upon standardized doctrine, tactics, equipment, communications mechanisms, practices, and procedures. Gregory Saunders, director of the Defense Standardization Program Office, stated that standardization is one of the key enablers of interoperability within a coalition. However, he also stated that interoperability requires more than agreed-upon standardization documents.

Examples of contributions of standardization to military operations are “innumerable,” and essential to multinational interoperability, according to Cihangir Aksit, director of the NATO Standardization Agency. There are more than 2,000 STANAGS and more than 8,000 supporting Allied Publications available for all NATO nations and partners. These documents focus on improving interoperability and cooperation, and eliminating wasteful duplication in research and development, production, and procurement. However, the biggest issue with STANAGS is that “standardization is a voluntary process.”

It is difficult to assess the impact of, and adherence to, STANAGS when the implementation and enforcement is not consistent across countries. STANAGS are readily signed by member nations but are rarely fully implemented. NATO does not have penalties for members who do not follow them. The result is standardization at limited levels, depending on the participant. The constant improvements in technology and shrinking defense budgets make implementing standardization a daunting challenge. As technology changes, so do standards, and defining the standards to interface the new with the old has proven to be a massive endeavor.

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273 Saunders, 2011.
274 Saunders, 2011.
275 Saunders, 2011.
277 Aksit, 2011.
278 Austin, 2008.
280 Allied Joint Publication 01 (B) NATO Allied Joint Doctrine, United Kingdom: Ministry of Defence, 2002, p. 240.
281 Faughn, 2002.