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DISSERTATION

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# Aircraft Modifications

## Assessing the Current State of Air Force Aircraft Modifications and the Implications for Future Military Capability

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This document was submitted as a dissertation in September, 2006 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 Richard J. Hillestad (Chair), James N. Dertouzos, and Gregory G. Hildebrandt.



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## Summary

The purpose of this dissertation is to expand the analysis of aircraft modifications to include an aggregate perspective of all recent modifications. The objective is to formulate good policy in order to help direct the future of modernization within the Air Force. Specifically, it will use a dataset constructed during this thesis describing all aircraft modifications from the years 1996 through 2005 to examine the impact of aging on modifications costs, the efficiency of procurement and installation planning, the implementation of safety modifications, and some expectations for the future of aircraft modifications. This summary will state the four research questions addressed in this dissertation as well as a brief explanation of the methods and conclusions related to each question.

**What are the historical trends that have preceded the present environment for aircraft modifications in the Air Force?** Changing circumstances are a common occurrence for the United States military. For the Air Force in particular, things are changing in such a way that demands a response from the organizational structure. These changes include: new aircraft, a new standard of evolutionary acquisition, and aging aircraft. Each of these changes indicates that the Air Force modification policy will be increasingly important in the future.

New Aircraft - Cost and schedule overruns have hampered the ability of the Air Force to procure next-generation aircraft in support of modernization efforts. Reductions in planned replacement aircraft for existing aircraft necessitate the use of the legacy aircraft for longer periods of time. If the Air Force is to continue to improve capability and remain the world's most advanced air force, then aircraft modifications for these legacy aircraft will necessarily play an increasingly important role.

Evolutionary Acquisition - For the replacement aircraft that are being procured for the Air Force, there is a new acquisition method that also serves to increase the importance of future aircraft modifications. This new method of acquisition has been termed evolutionary acquisition. Evolutionary acquisition is intended to partition new acquisitions into categories of increased capability. This results in a heterogeneous fleet of aircraft with many different levels of capability corresponding to the different partitions of the acquisition program. The F-22 presents an example of how evolutionary acquisition will only make aircraft modifications a more important policy issue for the Air Force in that by 2011, the Air Force is planning to spend \$385 million to modify existing F-22s to reduce fleet heterogeneity.

Aging Aircraft - This research indicates that there is no increase in per-aircraft modifications costs with aircraft age at the aggregate level, but there may be alternative modeling and data techniques that will change this conclusion. The aggregate analysis conceals important phenomena occurring at the individual fleet level. While modifications are not as significant as operating and support costs from the standpoint of the total amount of obligations, the effect of age on aircraft modifications costs is expected to weigh significantly into analyses of alternatives and replacement decisions, and therefore may also provide an area for productive future research.

In light of these changes, the process for modifying Air Force aircraft is important to understand because it provides some important clues into the organization of efforts to change aircraft configurations as well as the decision process that creates the trends seen in the data. One important contribution of this research is the identification of the modification process as a subset of the larger organizational structure for changes to post-production aircraft. The current modification policy is foundational to the quantitative analysis

comprising the second half of this dissertation. It is the starting point for the changes in future policy suggested in the conclusions.

**Can aircraft modifications be implemented more efficiently?** When the frame of reference is limited to aircraft changes defined by the Air Force as Modifications, analysis suggests that installation and procurement schedules are codependent due to an Air Force requirement to install a modification kit in the same year it is procured. It is hypothesized that operational constraints limit the installation schedule and therefore limit the procurement schedules. This results in acquisition inefficiency. With aircraft modifications around \$2 billion per year, even small inefficiencies may be significant. This dissertation tests the effects on unit costs of changing the production and installation rate using regression techniques. Evidence presented in this research then suggests that an improvement to efficiency may be made if the constraint to install modifications in the same year they are procured is relaxed. Particularly, if acquisition planners are permitted to optimize procurement and installation separately, the Air Force will have more flexibility for both phases of a program and potentially realize a cost savings without adjusting the final outcome—resulting in an increase in modifications acquisition efficiency.

**Does current modification policy address safety modifications in an expedient manner?** Another conclusion that may be derived from the historical modifications data is that safety modifications are not installed any more quickly than are similarly sized non-safety modifications. Such a condition may be problematic if it does indeed signify a failure to implement the policy that safety modifications should be completed at the fastest rate possible. This conclusion warrants further analyses to determine a policy-relevant way to increase the completion of safety modifications if it is determined by policy-makers that the current rates are too low for Air Force needs. Another policy adjustment that

may be appropriate is the reduction or elimination of documentation required to designate a safety modification since it is not clear that such documentation does significantly affect the time in which a program is implemented.

**What are the future expectations for fighter modifications as a component of Air Force policy and doctrine?** The F-15 and F-16 fleets are arguably the two most important aircraft fleets in the Air Force. Despite the findings that aging does not increase aircraft modifications for all aircraft fleets, both the F-15 and F-16 fleets have exhibited a general upward trend in modifications since their inception in the Air Force. Even as the production of these aircraft has ceased and inventory levels have begun to decline, the upward trend is still significant. This has important implications for the future replacement aircraft that will be added to the Air Force inventory. Since the initial technology levels in these aircraft are significantly higher and the composite airframes also pose a higher risk for modifications requirements, it is important that the Air Force be prepared for the significant increase in modifications costs that may occur as these aircraft mature.

## Conclusions

- Aircraft modifications will become increasingly important as a tool of modernization for the US Air Force
- Policy adjustments to the procurement and implementation phase of a modification have the potential to increase modification efficiency
- The Air Force has historically been unable to implement important safety modifications as expediently as is hoped
- Total modifications expenditures for legacy and replacement Air Force fighters are expected to increase dramatically in future years