ACRP Problem Statement 17-03-06 **Recommended Allocation: --**

Accurate Measurement of Airport Operations Counts

ACRP Staff Comments

Related ACRP research includes ACRP Synthesis 4: Counting Aircraft Operations at Non-Towered Airports; ACRP Report 129: Evaluating Methods for Counting Aircraft Operations at Non-Towered Airports; and a soon-to-be published Graduate Research Awards paper entitled, "Air Traffic Controller's Perception Towards Remote Air Traffic Service Facility for Airports."

TRB Aviation Committee Comments

INTERGOVERNMENTAL RELATIONS IN AVIATION: Sufficient study of this topic has been done already (e.g., ACRP Synthesis 4: Counting Aircraft Operations at Non-Towered Airports and ACRP Report 129: Evaluating Methods for Counting Aircraft Operations at Non-Towered Airports), and there are options out there already (e.g., GARD and other systems). Also, the proposed tasks in the problem statement make it sound like the author wants TRB to pay for the R&D for a new technology. Our initial thought is this is too large of a project to be accurately and effectively addressed within the specified time and budget, although the analysis of using Mode C and Mode S capabilities would be very helpful, since other traffic counting methods have not been fully conclusive. But these would be accurate measurements only of IFR-equipped aircraft. Means to measure all aircraft, including VFR, still need to be addressed.

AVIATION SYSTEM PLANNING: The collection of accurate operational data for unattended airports is a recognized challenge, and there have been previous attempts to find a cost-effective means of doing so. However, the proposed research doesn't pursue the evaluation of various approaches to solving the problem, but rather suggests a single approach and would involve its development. The results may be very beneficial if it works out well.

Review Panel Recommendation and Comments

Not recommended. This study has low probability of producing useful information in a reasonable timeframe; hardware and software deployment costs are not part of ACRP.

AOC Disposition

There was no discussion. No funds were allocated.

17-03-06

Accurate Measurement of Airport Operations Counts

Background

The FAA annually invests approximately $3B in small commercial and general aviation airports, with additional infrastructure investments appropriated at the state level. Accurate airport operations counts are critical for fair and efficient allocation of federal and state funds for airport development and improvement. Of the 3,331 airports in the United States that constitute the National Plan of Integrated Airport Systems, however, only slightly more than 500 have either full- or part-time air traffic control facilities and associated personnel who are available to manually register those counts. There are several methods used to count aircraft operations at airports lacking full-time personnel; these are generally based on traditional statistical sampling techniques. Sample data is typically obtained by employing short-term contract staff to deploy acoustic and pneumatic counting devices and to provide human observations. Those methods were summarized in the recently-published ACRP Report 129, as noted later in this problem statement.

The sample sizes associated with these methods are inherently small due to financial constraints. Small sample sizes create difficulties in terms of estimation of the population mean and variance from the sample parameters because the normality assumption of the distribution of the sample means may not hold. In addition, because mechanical counting methods typically rely on either acoustic or pneumatic tube counters, such methods are not viable perdurable solutions due to the expense and inconvenience of deploying the devices on a large scale and lack of the long-term reliability of these devices as a result of aging and environmental conditions.

Research is needed to determine a means of using readily available Mode-C and Mode-S aircraft transponder signals to register operations counts at airports where full-time personnel or measuring devices are not available for that purpose. In fact, ACRP Report 129 made the following recommendation for future research: “As the deadline for incorporating ADS-B out technology into all aircraft that operate in specific U.S. airspace gets closer, this technology should be readdressed.” Such transponder signals are easily acquired in a passive manner by inexpensive ground-based receivers, and may be stored and aggregated to provide researchers with the ability to derive a rich range of related operational metrics. In addition, advanced statistical estimation methods need to be employed to provide a more accurate determination of actual operations counts from smaller datasets.

Objective

To develop a practical means of collecting aircraft operations count data using Mode-C and Mode-S transponder signals at otherwise unmonitored general aviation airports and accurately estimating actual counts from the data.

Proposed Tasks

1. Develop a distributed and remotely deployable hardware/software platform to collect transponder data from aircraft operating at general aviation airports.
2. Develop an algorithm to accurately estimate airport operations counts using the collected data.

Estimated Funding

The estimated cost of this project is $400,000. This includes hardware fabrication and deployment costs and personnel costs relative to hardware development and deployment, software design, data analysis and validation, travel, and administrative tasks.

Estimated Research Duration

It is anticipated that this project will require 15 months for completion.

Related Research

In a previous ACRP synthesis (M. Muia, "ACRP Synthesis of Airport Practice 4: Counting Aircraft Operations at Non-Towered Airports," *Transportation Research Board of the National Academies, Washington, DC,* 2007), Muia conducted a survey of current practices in the counting of operations at airports without operating control towers. More recently, and as noted earlier, ACRP Project 03-27 investigated the various counting methodologies in use in greater detail (M. Muia, TRB's Airport Cooperative Research Program (ACRP) Report 129, "Evaluating Methods for Counting Aircraft Operations at Non-Towered Airports," *Transportation Research Board of the National Academies, Washington, DC,* 2015). Ford and Shirack (M. Ford and R. Shirack, "Statistical Sampling of Aircraft Operations at Non-Towered Airports," DTIC Document, 1985) suggested an estimation procedure based on conventional sampling theory using stratified sampling in which the total number of annual operations is approximated by the sum of estimates within stratified samples, which are themselves based on sample means within those strata. The procedure also employs a confidence interval based on the *t*-statistic for the sample variances corrected for finite population.

Difficulties in the use of the standard acoustic and pneumatic counting devices that were found to be in widespread use in the ACRP studies were documented by Peeta and Zhang (S. Peeta and P. Zhang, "Counting Device Selection and Reliability: Synthesis Study," *Joint Transportation Research Program,* p. 332, 2002). In addition, there are difficulties associated with the sampling methodology suggested by Ford and Shirack. First, conventional sampling theory and the use of the *t*-distribution for small sample sizes assume that means of the samples from the overall population are normally distributed with standard deviation σ/ .¯According to Rider (P. R. Rider, "On the Distribution of the Ratio of Mean to Standard Deviation in Small Samples from Non-Normal Universes," *Biometrika,* vol. 21, pp. 124-143, 1929), while this assumption is justified for a normal population, it does not hold otherwise, and, while "Student's" probability integral gives better results in certain non-normal populations than does the Gaussian integral, it fails with sufficient frequency to warrant further investigation. In particular, the uniform distribution is more applicable to the estimation problem at hand, and therefore suggests application of a more appropriate estimation technique. Second, stratified sampling methods require the selection of homogeneous subgroups, which can be problematic without a thorough understanding of the widely-varying operational factors unique to a particular airport. These methods can also be difficult to implement as a result of the need to sample operations at different times and under different conditions, which leads to additional expense.

It is therefore suggested that research into improvements in both data acquisition technologies and in the statistical estimation methodology described by Ford and Shirack is warranted.

Process Used to Develop the Problem Statement

This problem statement was developed as a result of research collaboration between the Joint Transportation Research Program at Purdue University (Dr. Darcy M. Bullock, Director) and the Advanced Aviation Analytics Institute for Research, a Purdue University Center of Research Excellence (Professor John H. Mott, Director). Support and assistance will be provided by the Indiana Department of Transportation, Office of Aviation.

Person Submitting the Problem Statement and Date

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