About the Journal of Air Transportation

Development

Scope

Dissemination

Organizations

Editors

Personnel

THE JOURNAL

The *Journal of Air Transportation (JAT)* mission is to provide the global community immediate key resource information in all areas of air transportation. Our goal is to be recognized as the preeminent scholarly journal in the aeronautical aspects of transportation. As an international and interdisciplinary journal, the *JAT* provides a forum for peer-reviewed articles in all areas of aviation and space transportation research, policy, theory, case study, practice, and issues. While maintaining a broad scope, a key focal point of the journal is in the area of aviation administration and policy.

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Development

The *JAT* was conceptualized to fulfill an international void of scholarly publications in this area as identified by the primary organizers. It is envisioned that aviation leaders will utilize the *JAT* as a key decision-making tool. Scholarly rigor and standards will be uncompromised with regular evaluation by the Editorial Board and Panel of Reviewers.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Scope

The *JAT* will accept manuscripts on all topics that relate to air transportation, both technical and non-technical. The Panel of Reviewers represents the interdisciplinary nature of air transportation to ensure review by recognized experts. Broad categories of appropriate topics include, but are not limited to:

- Aviation Administration, Management, Economics, Education, Policy, Engineering, Technology, and Science
- Intermodal Transportation
- Aerospace Education and Flight
- Airports and Air Traffic Control
- Air Transportation Systems: Domestic, International, Comparative
- Aviation/Aerospace Psychology, Human Factors, Safety, and Human Resources
- Avionics, Computing, and Simulation
- Space Transportation Safety, Communication, and the Future
- Other areas of air and space transportation research, policy, theory, case study, practice, and issues

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Dissemination

The *JAT* is catalogued at key research libraries world wide, including the U.S. Library of Congress. It is also indexed in Aviation Tradescan, EBSCO On-line, the National Research Council TRIS Index, and ERIC Resources in Education. In addition, the *JAT* is available through interlibrary loan at the University of Nebraska at Omaha Library and the Transport and Telecommunications Institute in Latvia via accessing the global OCLC inter-library loan network. A permanent archive is maintained at the University of Nebraska at Omaha. Annual subscriptions are available for U.S. $35 for individuals and U.S. $68 for institutions. For subscriptions outside the U.S. add $20. Payments may be made by check or purchase order payable to the UNO Aviation Institute.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Organizations

Host Organizations:
University of Nebraska at Omaha (UNO) - Nancy Belck, Chancellor; Derek Hodgson, Vice-Chancellor for Academic Affairs.
Co-Sponsor Organizations:
American Society for Public Administration - Transportation Section - Jeremy Plant, Chair, Transportation Section
Air Transport Research Society - Tae Oum, Chair
NASA Kansas Space Grant Consortium - David Downing, Director
NASA Nebraska Space Grant Consortium - Brent Bowen, Director
NASA Space Grant and Fellowship Program, Aerospace Working Group – Diane DeTroye, Interim Program Director
Transport and Telecommunications Institute, Latvia - Eugenye Kopitov, Rector
World Aerospace Education Organization - Kamal Naguib, Chairman
Supporting Organizations:
Aviation Institute, UNO - Brent Bowen, Director
Center for Public Affairs Research, UNO - Jerome Deichert, Director
College of Public Affairs and Community Service, UNO - B.J. Reed, Dean
School of Public Administration, UNO - Russell Smith, Chair
University Library, UNO - Janice Boyer, Dean

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Editors

Brent D. Bowen
Dr. Brent Bowen is Director and Distinguished Professor, Aviation Institute, School of Public Administration, University of Nebraska at Omaha, and the University's Director of Aviation and Transportation Policy and Research. Bowen attained his doctorate in Higher Education and Aviation from Oklahoma State University and a Master of Business Administration degree from Oklahoma City University. His Federal Aviation Administration certifications include Airline Transport Pilot, Certified Flight Instructor (Gold Seal), Advanced Instrument Ground Instructor, Aviation Safety Counselor, and Aerospace Education Counselor. Dr. Bowen's research on the development of the national Airline Quality Rating is regularly featured in numerous national and international media, as well as refereed academic publications. Dr. Bowen has in excess of 250 publications, papers, and program appearances to his credit. His research interests focus on aviation applications of public productivity enhancement and marketing in the areas of service quality evaluation, forecasting, and student recruitment/retention in collegiate aviation programs. He is also well published in areas related to effective teaching and has pioneered new pedagogical techniques. Dr. Bowen has been recognized with awards of achievement and commendation from the American Marketing Association, American Institute of Aeronautics and Astronautics, Federal Aviation Administration, Embry-Riddle Aeronautical University, W. Frank Barton School of Business, Travel and Transportation Research Association, World Aerospace Education Association, and others.

Igor Kabashkin
Dr. Igor Kabashkin is Vice Rector of the Transport and Telecommunications Institute, Latvia, and a Professor in the Aviation Maintenance Department and member of the Technical Committee on Transport of the European Commission for Cooperation in the Field of Scientific and Technical Research. Kabashkin received his Doctor Degree in Aviation from Moscow Civil Engineering Institute, a High Doctor Degree in Aviation from Moscow Aviation Institute, and a Doctor Habilitus Degree in Engineering from Riga Aviation University and Latvian Academy of Science. His research interests include analysis and modeling of complex technical systems, information technology applications, reliability of technical systems, radio and telecommunication systems, and information and quality control systems. Dr. Kabashkin has published over 274 scientific papers, 19 scientific and teaching books, and holds 67 patents and certificates of invention.

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

JAT Personnel

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Editorial Board

Membership on the *JAT* Editorial Board is by invitation and approval of the board. This appointment should be viewed as professional recognition of significant career achievement and high academic/industry distinction. Applicants will generally be senior faculty members (graduate faculty standing where applicable), or persons who have attained substantial industry or public service achievement in the case of practitioner members. Term of appointment is three years with opportunity to request renewal. For membership consideration, submit a curriculum vita or industry resume and statement of interest to: Dr. Brent Bowen, Executive Editor.

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Return

Exit

Panel of Reviewers

Reviewers are appointed by the Editor to represent all elements of aviation and space transportation scholarship and practice. An appointment to the Panel of Reviewers recognizes professional and academic achievement. Appointments are for a three-year term with the option of renewal. For membership consideration, submit a curriculum vita or industry resumé to Dr. Brent Bowen, Executive Editor.

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

DATA MINING METHODS APPLIED TO FLIGHT OPERATIONS QUALITY ASSURANCE DATA: A COMPARISON TO STANDARD STATISTICAL METHODS

Alan J. Stolzer
Saint Louis University
St. Louis, MO

Carl Halford
Saint Louis University
St. Louis, MO

ABSTRACT

In a previous study, multiple regression techniques were applied to Flight Operations Quality Assurance-derived data to develop parsimonious model(s) for fuel consumption on the Boeing 757 airplane. The present study examined several data mining algorithms, including neural networks, on the fuel consumption problem and compared them to the multiple regression results obtained earlier. Using regression methods, parsimonious models were obtained that explained approximately 85% of the variation in fuel flow. In general data mining methods were more effective in predicting fuel consumption. Classification and Regression Tree methods reported correlation coefficients of .91 to .92, and General Linear Models and Multilayer Perceptron neural networks reported correlation coefficients of about .99. These data mining models show great promise for use in further examining large FOQA databases for operational and safety improvements.

Alan Stolzer holds a Ph.D. in Technology Management—Quality Systems from Indiana State University. He holds FAA Airline Transport Pilot, Certified Flight Instructor, and Aircraft Mechanic certificates. He holds Quality Engineering, Manager, and Auditor certifications from ASQ, and a Project Manager certification from PMI. He is the Director of the Quality Engineering Systems in Transportation (QUEST) Research Center.

Carl Halford is the Research Manager at SLU's Center for Quality Engineering Systems in Transportation. Mr. Halford holds an Airline Transport Pilot certificate, with an assortment of type ratings, and has over 9000 hours of flight time in a variety of aircraft. Halford is a certified Manager of Quality/Organizational Excellence and Quality Auditor, and has been a Certified ISO 9001:2000 Lead Auditor.

INTRODUCTION

One might wonder what mining the genome, re-engineering the immigration system, and ensuring our homeland security have in common. The answer is data mining (DM).

Unlocking the secrets of the human gene is expected to yield great benefits for scientists and pharmaceutical companies battling diseases. But cataloging the estimated 100,000 human genes is no small task. Consider the fact that every human cell has 23 pairs of chromosomes containing about 3.5 billion pairs of nucleotides. The genes that carry code to make protein amount to less than 3% of all genes; the remaining 97% is genetic noise. These protein-producing genes are those that result in cancer and genetic problems when they go awry, and it is these genes that need to be understood by scientists. Unfortunately, the signals in the genes have a language all their own, and they are hidden and noisy. Among the tools used to analyze these signals is a form of DM called artificial neural networks. Neural networks help scientists locate the genes of interest through pattern recognition and understand their function—knowledge which may lead to breakthroughs in combating these health crises (Regalado, 1999).

DM is also playing a role in our efforts to control the immigration problem and ensure our homeland security. All 19 hijackers involved in the attacks on the U.S. on September 11, 2001, entered the country legally. There was no information available to the authorities that would have suggested that allowing them to enter the country was inconsistent with our national security interests. Strickland and Willard (2002) assert that effective, preventive homeland security requires a fundamental re-engineering of the immigration system based on the concept of having better information achieved through effective DM methods and processes to assure quality information. These authors propose a vastly improved system of ‘knowledge development tools’ to mine new data sources and identify visa applicants that warrant attention.

DM has been gaining popularity in numerous other industries in recent years, including the transportation industry. Studies of DM methods to improve traffic safety programs (Solomon, Nguyen, Liebowitz, & Agresti, 2006), applying DM techniques to forecast the number of airline passengers in Saudi Arabia (BaFail, 2004), and many others, are evidenced in the literature. Many of these studies seek to make greater use of existing databases to learn more about the problem or issue at hand than more traditional methods have afforded, or to discover what results DM methods might yield on previously performed studies. The present study seeks to do the latter using Stolzer’s (2003) work to create a statistical model for predicting fuel consumption on the Boeing 757 aircraft fleet within an air carrier's operating environment.

PURPOSE OF THE STUDY

This study uses the comprehensive suite of DM tools contained in StatSoft's *STATISTICA* (2003) software to create models for predicting fuel consumption, and compares the results to those of a previous study. The earlier study developed parsimonious models for fuel consumption using multiple regression analysis to analyze Flight Operations Quality Assurance (FOQA)-derived data, with the objective of being able to identify outliers (specific flights) with respect to fuel consumption. Specifically, the goal of the present study was to ascertain whether DM methods produce fuel consumption models with superior predictive capability than traditional statistical methods such as multiple regression techniques. To accomplish this goal, we evaluated and benchmarked the results of the different DM methods offered within *STATISTICA*; and determined the optimum DM method.

BACKGROUND

What is data mining?

Data mining is an analytic process designed to explore large amounts of data in search of consistent patterns and/or systematic relationships between variables (StatSoft, 2003). It is used for such broad areas as accurately evaluating insurance risk, predicting customer demand for goods and services, predicting the prices of stocks and commodities, monitoring expensive and critical equipment, conducting yield analysis and quality control, and predicting credit risk.

Traditional statistical techniques are not as useful on very large databases because all mean comparisons are significant and standard measures of variability are extremely small. Due in part to this limitation, DM techniques increased in popularity in the mid to late 1990s. DM tools are based on standard statistical techniques and artificial intelligence analysis techniques, and are applied to large databases for the purpose of teasing out otherwise undiscovered data attributes, trends and patterns. There are numerous methods of DM; the following is only the most cursory overview of several of the more popular methods.

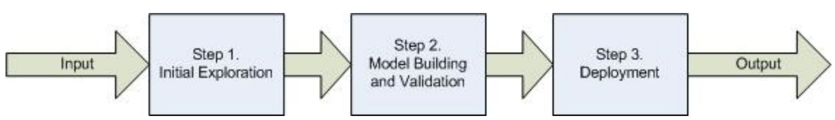
1. *Regression modeling* normally begins with a hypothesis which is tested by this common statistical technique. Linear regression (commonly used for prediction) and logistic regression (used for estimating probabilities of events) are two examples of regression modeling.

2. *Visualization* is an important concept in DM. Through the study of multidimensional graphs the analysis is able to detect trends, patterns, or relationships.
3. *Cluster analysis* is an exploratory data analysis tool that consists of several different algorithms and methods for grouping objects of similar kind into respective categories. The goal of cluster analysis is to sort different objects into groups in a way that the degree of association between two objects is maximal if they belong to the same group and minimal if they do not. Cluster analysis can be used to discover structures in data without explaining why they exist.
4. *Decision trees* are very popular classification models. They are called decision trees because the resulting model is presented in the form of a tree structure. The visual presentation makes the decision tree model very easy to understand. Decision tree methods include Classification and Regression Trees (C&RT) and Chi-squared Automatic Interaction Detection (CHAID).
5. *Neural networks* are analytic techniques that are intended to simulate cognitive functions. These techniques learn with each iteration through the data, and are capable of predicting new observations (on specific variables) from other observations (on the same or other variables).

Steps in DM

There are three basic stages to most DM projects, as depicted in Figure 1: initial exploration; model building and validation; and deployment. Initial exploration refers to the preparation of the data, which may include cleaning of the data, data transformations, selecting subsets of records, and performing feature selection operations. Model building and validation involves evaluating various models for predictive performance and choosing the most appropriate one for the project. Deployment refers to the application of the chosen model or models to generate predictions or estimates of the outcome.

Figure 1. Steps in Data Mining



Crucial concepts in DM

Of course, not all projects are the same and few involve the full range of DM tools and methods, but some familiarity with the crucial concepts in DM is important. These concepts are summarized below (StatSoft, 2003; Wang, 2003).

1. *Data preparation, cleaning, and transformation*. Many times this is the most time-consuming aspect of the project, and one that is often given little attention. Data that is collected via an automatic process, which probably includes most input data in DM projects, frequently contains data that contain out of range values, impossible data combinations, and other irregularities. Various methods are employed to clean the data to make it usable, or to eliminate the data from the analysis.
2. *Feature selection*. A feature selection technique enables the analyst to include the best variables for the project when the data set includes more variables than can be reasonably used.
3. *Feature extraction*. Feature extraction techniques attempt to aggregate the predictors in some way in order to extract the common information contained in them that is most useful for model building. Typical methods include Factor Analysis and Principal Components Analysis, Multidimensional Scaling, Partial Least Squares methods, and others.
4. *Predictive DM*. This type of DM project is intended to develop statistical or neural network models that can be used to predict objects of interest.
5. *Sampling, training, and testing (hold-out) samples*. In most DM projects, only a randomly chosen subset of the data is used. This enables the analyst to evaluate multiple methods using different samples, and then test these methods to gain insight into the predictive capability of the results.
6. *Over-sampling particular strata to over-represent rare events (stratified sampling).* Sometimes it is necessary to employ stratified sampling to systematically over-sample rare events of interest. This precludes predictions of a no response for all cases if simple random sampling were used when, in fact, these (rare) events are present.
7. *Machine learning*. Machine learning refers to the application of generic model-fitting or classification algorithms for predictive DM, and reminds us that the emphasis in DM is *accuracy* of prediction rather than having a clear and interpretable understanding of the prediction.
8. *Deployment*. Deployment is the application of a trained model so that predictions can be obtained for new data.

STATISTICA

STATISTICA, a suite of analytic software products produced by StatSoft (2003), was used for this study. *STATISTICA* provides a comprehensive array of data analysis, data management, data visualization, and DM procedures. Its techniques include a wide selection of predictive modeling, clustering, classification, and exploratory techniques in a single software platform. *STATISTICA* includes an extensive array of analytic, graphical, and data management functions, as well as DM and machine learning algorithms, including: support vector machines, EM (Expectation Maximization) and k-Means clustering, CART, generalized additive models, independent component analysis, stochastic gradient boosted trees, ensembles of neural networks, automatic feature selection, MARSplines (Multivariate Adaptive Regression Splines), CHAID trees, nearest neighbor methods, association rules, random forests, and others (StatSoft, 2003).

Articles/studies on DM for airline safety

Today DM techniques are used for many different purposes in many industries, including the aviation industry. For example, an exploratory study on FOQA database at a major air carrier took place in 2005 (Global Aviation Information Network, 2005). The cooperative study involved the air carrier, the Federal Aviation Administration (FAA), the Global Aviation Information Network, and a DM software provider, and was intended to provide guidance on tools that may be useful in enhancing the current analysis of airline digital flight data. This study focused on principal components analysis, correlation of different events, conditional (Trellis) graphics, tree-based models, and neural networks. In part, the DM study found that certain methods showed promise in improving efficiency by automating some of the query and output process. Principal components analysis and clustering methods were deemed helpful for data reduction and characterization of correlation structures. Tree-based models provided a modeling structure for understanding the relationship between flight events and flight parameters, and for assessing the importance of variables. Neural network models were deemed less useful due to their inability to distinguish between landing approaches that resulted in a successful landing from those that resulted in a go around. The study also noted an additional disadvantage that neural networks are more difficult to interpret than tree-based models.

Another similar study funded by the FAA involved the analysis of FOQA data on the airline's Boeing 777 and 747 fleets. The objective of this study was to determine whether DM techniques can help improve airline or system safety by identifying risks, and assess the effectiveness of operational changes. Three learning algorithms, that is, decision trees, clustering and association rules, were applied to the data. In general, the DM tools identified many interesting patterns and associations beneath the surface that had not been identified by the air carrier's flight data monitoring program (Global Aviation Information Network, 2004).

Helicopter health and usage management systems also generate large amounts of data that are used mainly for diagnostic purposes to detect helicopter faults. An initiative by the Ministry of Defense in the United Kingdom has been to apply tools that improved analysis capability, increase levels of automation, and provide enhanced use of resources. The study evaluated several supervised and unsupervised methods, and also explored fusing the results of unsupervised techniques with the judgments of other mathematical and artificial intelligence tools, such as logic, fuzzy logic, and Bayesian networks (Knight, Cook, & Azzam, 2005).

PREVIOUS STUDY

Our previous study was designed to develop a parsimonious model(s) for fuel consumption using multiple regression analysis to analyze FOQA-derived data, with the objective of being able to identify outliers (specific flights) with respect to fuel consumption (Stolzer, 2003). The data used for the study were provided by a major air carrier, and consisted of 1,863 routine passenger-carrying flights on Boeing 757 aircraft.

Depending on the aircraft involved, data is captured on a few dozen to thousands of parameters (e.g., altitude, airspeed, throttle position, aileron deflection) each second; more than 180 parameters were contained in the subject dataset. Since the object of interest was limited to predicting fuel flow, the vast majority of these parameters were eliminated based on relevance. Following a reasoned elimination of other variables due to multicollinearity, curvilinearity, skewness and other adverse conditions, the remaining variables (i.e., 10) were entered into a standard, non-stepwise regression with fuel flow (ff) as the dependent variable. Since there is fuel flow on two engines on a Boeing 757 aircraft and parameters are recorded for each, two equations were produced; one for engine 1 (ENG1ff) and one for engine 2 (ENG2ff).

Fuel flow was best predicted by calibrated airspeed (CAS), gross weight (GWeight), and engine N2 (ENG*x*n2; i.e., high compressor speed, see Table 1 for a definition of each of the FOQA parameters used in the study). The resulting equations were as follows:

ENG1ff: – 9170.077 + 10.943 CAS + 0.008657 GWeight + 93.701 ENG1n2, with an R^2 (coefficient of determination) of .853

ENG2ff: – 9347.178 + 10.835 CAS + 0.008726 GWeight + 95.616 ENG2n2, with an R^2 of .872

The models formulated were checked for adequacy through the examination of residuals, and testing for a linear fit of the predictors to the dependent variable. Based on an analysis of residuals and tests for linear fit, there did not appear to be any correlation between random errors, the variables appeared to be linearly related, and there appeared to be reasonably consistent variances in the data for both models.

To validate the models, data on 179 additional flights were obtained. These data were fitted using the derived models and the performance of both models suggested that they were likely to be successful as predictors. In fact, the R^2 on engines 1 and 2 with the new data were 86.3% and 87.2%, respectively, which was approximately equivalent to the fit of the original data.

Table 1. Flight Operations Quality Assurance (FOQA) Parameters

FOQA Parameter Name	Definition
Mach	Mach
CAS	Calibrated airspeed
TAT	Total air temperature
ALT	Altitude
GWeight	Gross weight
ENG1epr, ENG2epr	Engine 1 and 2exhaust pressure ratio
ENG1ff, ENG2ff	Engine 1 and 2 fuel flow
ENG1n1, ENG2n1	Engine 1 and 2 low compressor speed
ENG1n2, ENG2n2	Engine 1 and 2 high compressor speed
ENG1egt, ENG2egt	Engine 1 and 2 exhaust gas temperature
AOA	Angle of attack
ATTroll	Angle of bank
ATTpitch	Pitch attitude
SFCstab	Stabilizer position
CTLspdbrk	Speedbrake control position
SFCalrn	Left aileron position
SFCalrnrt	Right aileron position
SFCrudder	Rudder position
SFCelev	Left elevator position
SFCelevrt	Right elevator position
SFCflap	Flap position

METHODOLOGY

In the previous study, much effort was made to transform the data that was problematic or to perform a reasoned elimination of some of the variables. In fact, a nontrivial number of variables had to be eliminated in order to avoid violations of assumptions and, thus, have confidence in the results. Admittedly, this had the effect of reducing the performance of the regression models, but the trade-off between model performance and confidence in the result is a conundrum routinely faced by analysts. By contrast, DM methods are generally robust to non-linear data, complex relationships, and non-normal distributions; thus, no pre-processing or transformations were performed as part of the DM project.

It should be noted that the regression analyses performed in the previous study were ultimately performed using clean data that met all reasonable assumptions for regression studies, and so a high predictive capability of the models was anticipated even though only a small subset of predictors were used. Given these conditions, it was not anticipated that DM methods would perform significantly better than multiple linear regression since the regression models' explained variance was .853 (ENG1ff) and .872 (ENG2ff).

To facilitate the desired comparison, a standard recursive partitioning (i.e., tree) method called Classification and Regression Tree Models (C&RT) was performed due to its popularity and ease of interpretation. The C&RT method builds classification and regression trees for predicting variables. *STATISTICA* contains numerous algorithms for predicting continuous or categorical variables from a set of continuous predictors and/or categorical factor effects. Each child node in the tree diagram represents a bivariate split on one of the predictors. Terminal nodes indicate actual predicted values for sets of cases. The dendrograms created in this process are quite easy to review and interpret to understand the sets of if/then statements created by the model.

This was followed by an Advanced Comprehensive Regression Models (ACRM) project. This model has several pre-arranged nodes for fitting linear, nonlinear, regression-tree, CHAID and Exhaustive CHAID, and different neural network architectures to a continuous dependent variable, and for automatically generating deployment information.

Finally, *STATISTICA*'s Intelligent Problem Solver (IPS) procedure was used. The IPS is a sophisticated tool for the creation and testing of neural networks for data analysis and prediction problems. It designs a number of networks to solve the problem, copies these into the current network set, and then selects those networks into the results dialog, allowing testing to be performed in a variety of ways. These latter two projects are *STATISTICA* methods that allow a comparison of numerous DM algorithms simultaneously on a dataset.

In addition to standard analysis techniques, goodness of fit tests were run to compare the performance of various methods.

RESULTS

Initial exploration

The analyst is familiar with the dataset since it was used in the previous study; however, it was examined again for out of range values, impossible data combinations, and other irregularities. It was determined that the dataset was more than adequate for the present study.

Model building and validation (and deployment)

C&RTs were performed. The C&RT method was run using V-fold cross-validation (a technique where repeated (v) random samples are drawn from the data for the analysis). The variables contained in the tree diagram for the Engine 1 model included CAS, GWeight, ENG1n1, ENG1egt, and ALT. A goodness of fit test performed on this model yields the results as depicted in Table 2.

Table 2. Summary of Goodness of Fit—Engine 1 Fuel Flow

Factor	Predicted
Mean Square Error	13449.18
Mean Absolute Error	89.06
Mean Relative Squared Error	0.00
Mean Relative Absolute Error	0.03
Correlation Coefficient	0.92

The C&RT analysis was also performed on the ENG2ff model. The tree diagram for ENG2ff included CAS, GWeight, ENG2n1, and ENG2n2. A goodness of fit test performed on this model yields the results as depicted in Table 3.

Table 3. Summary of Goodness of Fit—Engine 2 Fuel Flow

Factor	Predicted
Mean Square Error	13674.90
Mean Absolute Error	89.25
Mean Relative Squared Error	0.00
Mean Relative Absolute Error	0.03
Correlation Coefficient	0.91

The next method used was *STATISTICA*'s ACRM project. This model fits several DM methods to a continuous dependent variable, and automatically generates deployment information. Figure 3 depicts the *STATISTICA* workspace as it is configured to run this project.

Figure 2. STATISTICA Workspace for Advanced Comprehensive Regression Model Project

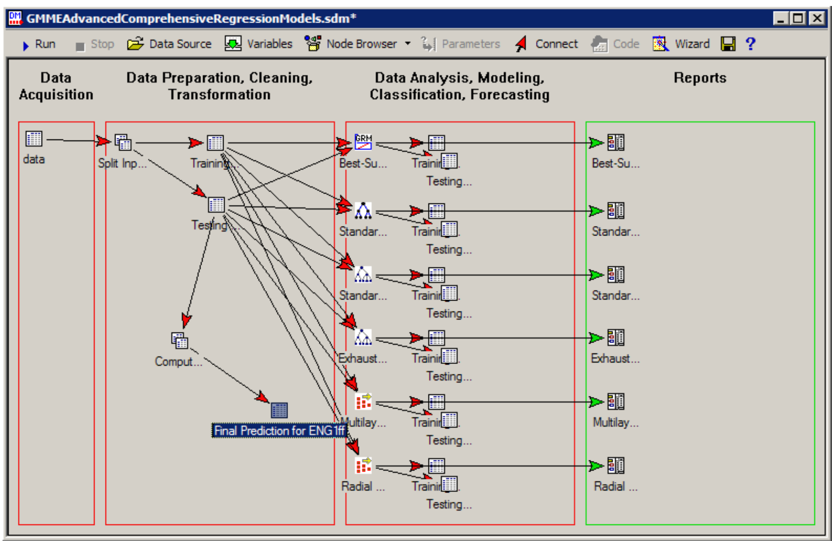


Table 4 contains the summary output from goodness of fit tests on the various methods explored by the ACRM tool on ENG1ff.

Table 4. Summary of Goodness of Fit for Engine 1 Fuel Flow: Advanced Comprehensive Regression Model

Factor	GLM Predicted	Trees Predicted	CHAID Predicted	ECHAID Predicted	MLP Predicted	RBF Predicted
Mean Square Error	670.201	9025.980	56545.54	46538.480	553.511	55059.900
Mean Absolute Error	19.253	71.926	181.990	166.860	17.7905	181.690
Mean Relative Squared Error	0.000	0.001	0.000	0.000	0.000	0.000
Mean Relative Absolute Error	0.006	0.021	0.050	0.050	0.005	0.050
Correlation Coefficient	0.996	0.941	0.530	0.640	0.997	0.550

GLM – Generalized Linear Model
CHAID - Chi-squared Automatic Interaction Detection Model
ECHAID - Exhaustive Chi-square Automatic Interaction Detection Model
MLP - Multilayer Perceptron Model
RBF - Radial Basis Function Model

Both the Generalized Linear Model (GLM) and the Multilayer Perceptron (MLP) had very high correlation coefficients exceeding 0.995 and relatively low error measures. Figure 4 depicts a plot of the predicted variable versus the observed, and Figure 5 depicts a plot of the residuals versus the observed variable for the GLM for ENG1ff.

Figure 3. General Linear Model of Engine 1 Fuel Flow: Predicted versus Observed

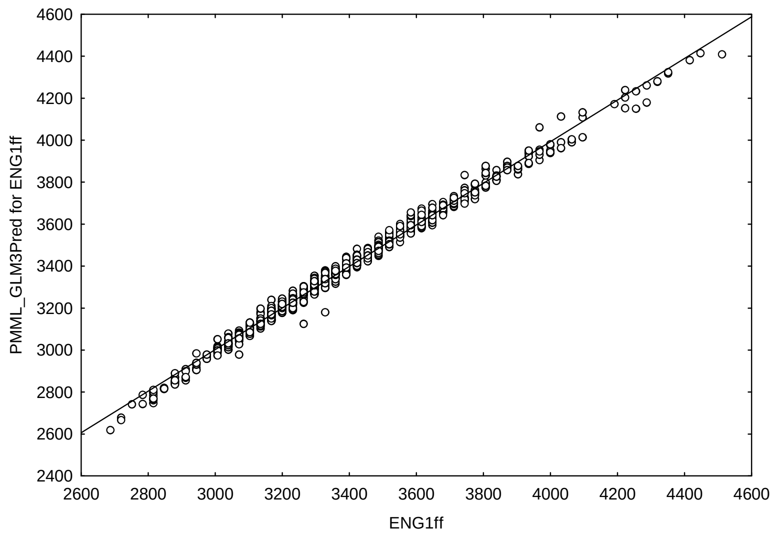


Figure 4. General Linear Model of Engine 1 Fuel Flow: Residuals versus Observed

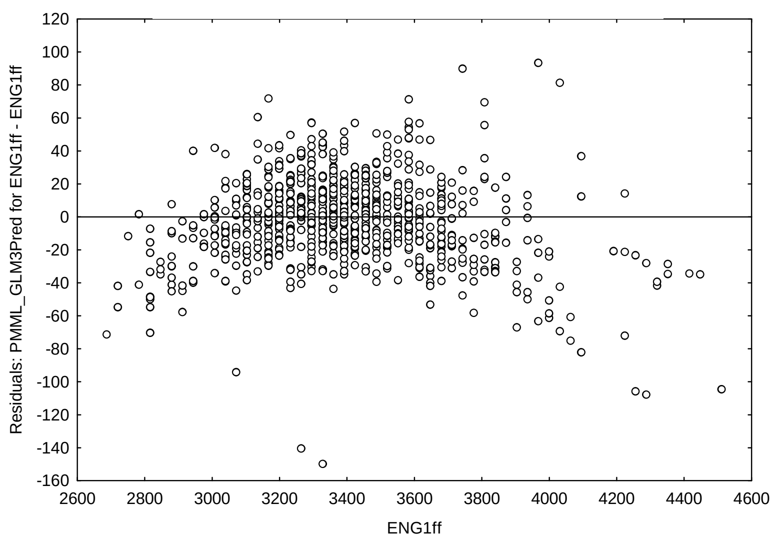


Figure 5. Multilayer Perceptron for Engine 1 Fuel Flow: Predicted versus Observed

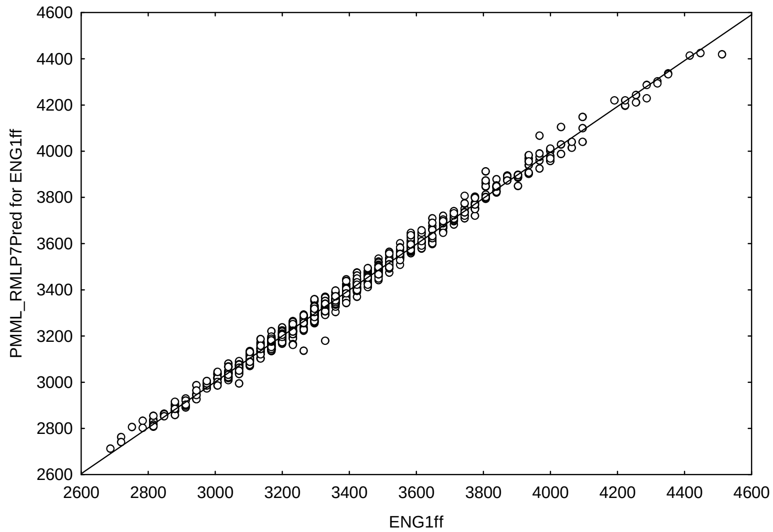


Figure 6. Multilayer Perceptron for Engine 1 Fuel Flow: Residuals versus Observed

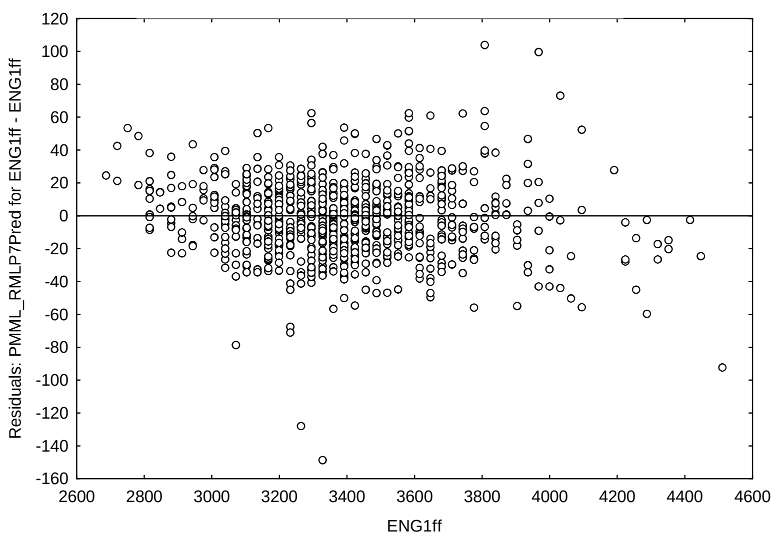


Figure 6 depicts a plot of the predicted variable versus the observed variable, and Figure 7 depicts a plot of the residuals versus the observed for the MLP.

Table 5 contains the summary output from goodness of fit tests on the various methods explored by the ACRM tool on the ENG2ff model. As with the ENG1ff model it can be concluded that the GLM and the MLP models provided the best predictive capability for ENG2ff of the models tested.

Table 5. Summary of Goodness of Fit for Engine 2 Fuel Flow: Advanced Comprehensive Regression Model

Factor	GLM Predicted	Trees Predicted	CHAID Predicted	ECHAID Predicted	MLP Predicted	RBF Predicted
Mean Square Error	633.783	8899.214	42906.560	38836.210	786.319	32815.580
Mean Absolute Error	18.734	68.991	159.980	150.560	19.877	129.160
Mean Relative Squared	0.000	0.001	0.000	0.000	0.000	0.000
Mean Relative Absolute Error	0.006	0.020	0.050	0.040	0.006	0.040
Correlation Coefficient	0.996	0.945	0.690	0.720	0.995	0.770

GLM – Generalized Linear Model
CHAID - Chi-squared Automatic Interaction Detection Model
ECHAID - Exhaustive Chi-square Automatic Interaction Detection Model
MLP - Multilayer Perceptron Model
RBF - Radial Basis Function Model

The final procedure used was STATISTICA’s IPS. The IPS creates and tests several neural networks for data analysis and prediction problems. Tables 6 and 7 are summaries of a goodness of fit analyses for the five models retained for ENG1ff and ENG2ff, respectively.

Table 6. Summary of Goodness of Fit for Engine 1 Fuel Flow: Intelligent Problem Solver

Factor	ENG1ff Model 1 GLM	ENG1ff Model 2 MLP	ENG1ff Model 3 MLP	ENG1ff Model 4 RBF	ENG1ff Model 5 RBF
Mean Square Error	683.411	690.712	711.707	6043.053	4424.089
Mean Absolute Error	19.061	19.030	20.130	48.525	50.813
Mean Relative Squared Error	0.000	0.000	0.000	0.000	0.000
Mean Relative Absolute Error	0.006	0.006	0.006	0.014	0.015
Correlation Coefficient	0.996	0.996	0.995	0.961	0.971

ENG1ff – Engine 1 Fuel Flow
GLM – General Linear Model
MLP – Multilayer Perceptron Model
RBF - Radial Basis Function Model

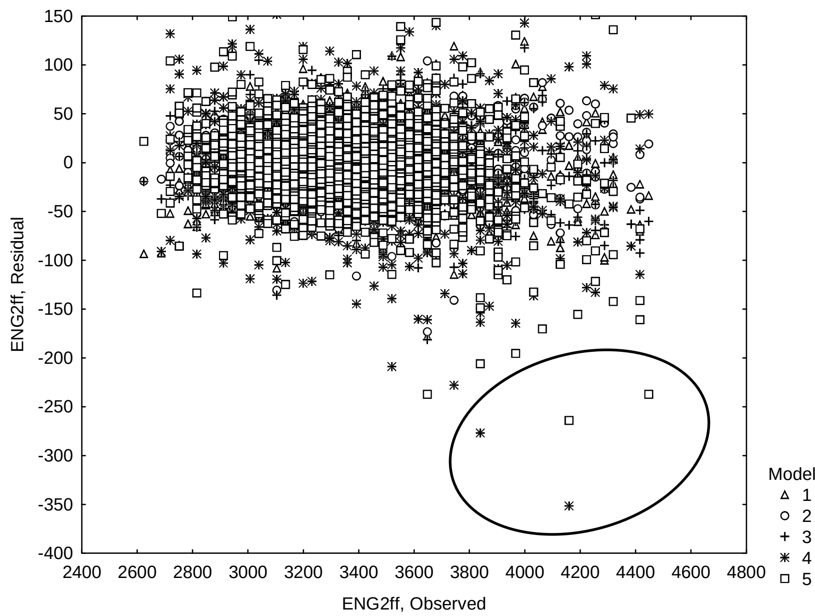
Table 7. Summary of Goodness of Fit for Engine 2 Fuel Flow: Intelligent Problem Solver

Factor	ENG2ff Model 1 Linear	ENG2ff Model 2 MLP	ENG2ff Model 3 MLP	ENG2ff Model 4 RBF	ENG2ff Model 5 RBF
Mean Square Error	736.102	600.180	660.567	1802.759	1706.794
Mean Absolute Error	20.319	18.778	19.273	29.733	28.654
Mean Relative Squared Error	0.000	0.000	0.000	0.000	0.000
Mean Relative Absolute Error	0.006	0.006	0.006	0.009	0.008
Correlation Coefficient	0.995	0.996	0.996	0.988	0.989

ENG2ff – Engine 2 Fuel Flow
GLM – General Linear Model
MLP – Multilayer Perceptron Model
RBF - Radial Basis Function Model

Figure 7 presents a composite graph of all five models evaluated depicting observed versus residuals for the ENG2ff model. This graph shows a fairly tight pattern of observations with only few possible outliers, which are mostly found in Models 4 and 5 - the two Radial Basis Function (RBF) models.

Figure 7. Composite Graph of all Five Models Evaluated Depicting Observed versus Residuals for the Engine 2 Fuel Flow Model



DISCUSSION

An earlier study was performed using multiple regression methods to predict fuel consumption on an air carrier's Boeing 757 fleet of aircraft. It was determined that some of the data generated by the FOQA system violated assumptions of regression methods, and attempts to transform the data were minimally successful. To ensure a high level of confidence in the results, those data were removed from further consideration. The remaining data produced models with excellent predictive capability. Specifically, the ENG1ff and ENG2ff models had correlation coefficients of .853 and .872 respectively, and tested on new data at approximately these values.

The goal of the present study was to evaluate various DM techniques on the same dataset used in the previous study. A recursive partitioning method, C&RT, and *STATISTICA*'s ACRM and IPS algorithms were deployed on the data. Since DM methods are generally robust to data condition problems, no additional analysis was performed on the data.

The recursive partitioning method, C&RT, produced excellent results, that is, correlation coefficients of .92 and .91. Further, the dendrograms produced by the C&RT are easy to interpret (these graphics are difficult to extract from the software in a readable format and, thus, are not included in this manuscript). For example, it can easily be determined that the first node generated in the ENG2ff dendrogram is based on variable CAS, the bivariate nodes from CAS are GWeight and CAS, the nodes from GWeight are ENG2n1 and GWeight, and so on. This information enables the analyst to better understand the classifications being determined by the algorithm.

The ACRMs also produced excellent results on the data. The correlation coefficients reported by each of the models were very high. The GLM reported correlation coefficients of .996 for both ENG1ff and ENG2ff, and the MLP reported correlation coefficients of .997 and .995 for ENG1ff and ENG2ff, respectively. These values significantly exceed those obtained by standard multiple regression methods. The error values for the GLM and the MLP models were also low relative to the other models examined.

The IPS model produced five models with no correlation coefficients less than .961. As with the ACRM results, the GLM and MLP models were the best performers, with all correlation coefficients exceeding .995.

CONCLUSIONS AND NEXT STEPS

The purpose of the study was to compare DM methods against standard multiple regression methods using FOQA data on a fuel consumption study. The study examined several DM methods, and several performed very well in predicting fuel consumption. In general, CR&T, GLM, MLP, and RBF methods performed much better than standard multiple regression methods in predicting the dependent variable. As with other neural networks, interpretation of results is more difficult than with traditional statistical tools, and would require knowledge of the underlying theory.

It was determined that DM holds great potential for exploring large datasets, such as are generated in a FOQA program, and learning more from the data than can be accomplished using standard statistical tools alone. Further, this project suggests that DM techniques might be utilized effectively on air carrier-generated datasets to improve operational efficiency and safety.

The broader goal of this work is the creation of a practical tool that can be used by airlines to quickly identify aircraft with outlier fuel burns. This is not a trivial problem. While aircraft manufacturers provide detailed performance information and airlines routinely compute fuel consumption statistics for their fleets, the factors that contribute to any one flight's fuel consumption are quite variable. Differences between flights in load, cruise altitude, temperature and chosen cruise airspeed cause noticeable changes in fuel flow, making the identification of anomalous rates of fuel consumption difficult.

The accuracy with which the GLM and MLP neural network models predict fuel flow give encouragement that these models, coupled with other statistical tools such as process control charts, will enable the analyst to sensitively detect adverse trends, caused perhaps by out of trim conditions, improper loading, or engine foreign object damage. Testing whether such a fuel consumption anomaly detector can be constructed is the next project in this research effort.

REFERENCES

BaFail, O. (2004). Applying data mining techniques to forecast number of airline passengers in Saudi Arabia (domestic and international travels). *Journal of Air Transportation 9*(1), 100-116.

Global Aviation Information Network. (2004). *Application of Smiths Aerospace data mining algorithms to British Airways 777 and 747 FDM data: A technology demonstration in partnership with the Federal Aviation Administration and the Global Aviation Information Network.* Retrieved July 1, 2006, from http://www.gainweb.org/

Global Aviation Information Network. (2005). *Application of Insightful Corporation's data mining algorithms to FOQA data at JetBlue Airways: A technology demonstration in partnership with the Federal Aviation Administration and the Global Aviation Information Network.* Retrieved July 1, 2006, from http://www.gainweb.org/

Knight, P., Cook, J., & Azzam, H. (2005). Intelligent management of helicopter health and usage management systems data. *Proceedings of the Institution of Mechanical Engineers 219* (Part G: Journal of Aerospace Engineering), 507-524.

Regalado, A. (1999). Mining the genome. *Technology Review 102*(5), 56-62.

Solomon, S., Nguyen, H., Liebowitz, J., & Agresti, W. (2006). Using data mining to improve traffic safety programs. *Industrial Management & Data Systems 106*(5), 621-643.

StatSoft. (2003). *STATISTICA data miner (version 7.1)* [computer software]. Tulsa, OK.

Stolzer, A. (2003). Fuel consumption modeling of a transport category aircraft: A flight operations quality assurance (FOQA) analysis. *Journal of Air Transportation 8*(2), 3-18.

Strickland, L. S., & Willard, J. (2002). Re-engineering the immigration system: A case for data mining and information assurance to enhance homeland security—part I: Identifying the current problems. *Bulletin of the American Society for Information Science and Technology 29*(1), 16-22.

Wang, J. (2003). *Data mining: Challenges and opportunities*. Hershey, PA: Idea Group Publishing.

FINANCIAL COMPARISONS ACROSS DIFFERENT BUSINESS MODELS IN THE CANADIAN AIRLINE INDUSTRY

Triant Flouris
San Jose State University
San Jose, California, USA

Thomas Walker
Concordia University
Montreal, Quebec, Canada

ABSTRACT

This paper examines the accounting and stock price performance of two Canadian airlines, WestJet and Air Canada, over a five year period, taking into account the aftermath of the systemic shock to the airline industry produced by the September 11, 2001 (9-11), terrorist attacks and subsequent events such as the 2002 SARS outbreak, the wars in Afghanistan and Iraq, and the accompanying rise in jet fuel prices. Our study focuses on the viability of low-cost versus conventional-cost business models in Canada under the current business environment and the ability of airlines to withstand and effectively respond to catastrophic industry events. Furthermore, we link the effectiveness of the airlines' responses to these events to specific elements of their respective business models. We test our hypothesis through a case study. We focus on WestJet as a typical low-cost airline and compare its accounting and stock performance to Air Canada, a legacy carrier and rival in several business sectors. We find WestJet to be much less affected by catastrophic industry events. By decomposing each airline's return volatility, we observe that WestJet's systematic and unsystematic risk increased only slightly during the industry's post-9-11 turmoil when compared to Air Canada. In addition, we find that both WestJet's accounting and stock performance have been highly superior to those of Air Canada. We argue that WestJet's business model provides the firm with significantly more financial and operational flexibility than its legacy rival, Air Canada. WestJet's lower operating costs, high consumer trust, product offering, corporate structure, workforce and work practices, as well as operational procedures are all factors that appear to contribute to its relative success.

Triant Flouris' (Ph.D., USC) research interests include low cost and legacy airline financial and strategic analysis, aviation economics, strategic management, aviation business modeling, and international aviation governance. He is on the editorial board of the Journal of Air Transportation, a reviewer for several transportation and aviation journals, and the author of two books, one on EU industrial policy and one on aviation strategic management as well as co-editor of a book on aviation policy. He has published numerous academic journal articles on

INTRODUCTION

The extant aviation literature includes several studies that discuss the advantages and disadvantages of the distinct business models employed by low-cost and full-service carriers.[1] Earlier studies by Lawton (2002, 2003) discuss the strategies that both types of airlines have pursued in reaction to the September 11, 2001 (9-11) attacks and outline how those airlines have fared after 9-11. Although Lawton provides a brief review of the airlines' stock performance, his discussion is mostly qualitative in nature. Carter and Simkins (2004) provide a quantitative analysis of the stock performance of a sample of United States airlines to the events of 9-11, but do not focus on performance differences between low-cost versus full-service airlines. More recently, Flouris and Walker (2005a, 2005b) analyze performance differences between low-cost and full-service carriers in a risk-adjusted event study framework. All of these studies focus exclusively on the U.S. airline industry, however, and only consider the stock price performance of the sampled airlines. We add to the literature by providing the first comprehensive analysis of low-cost versus legacy carrier performance outside of the U.S. and by analyzing not only the stock price performance following such catastrophic events as 9-11 but also the impact of 9-11 and

Triant Flouris (cont'd) several topics in aviation management, several book chapters, articles appearing in aviation encyclopedias, and several technical reports and short articles. He is a Commercial Pilot and Certified Flight and Ground Instructor with over 4,400 hours of total flight time. Triant has served as director of the International Aviation MBA Program at Concordia University and as associate and assistant professor of aviation management at Auburn University as well as a management consultant. He serves as alternate representative of the Republic of Cyprus to the International Civil Aviation Organization (ICAO) and is a professor of aviation management and director of the aviation program at San Jose State University.

Thomas Walker is a native of Germany. He received a Ph.D. degree in Finance and an MBA degree in Finance and International Business from Washington State University (WSU) in Pullman, WA, and a B.Sc. in Wirtschaftsinformatik (Management Information Systems) from the Technical University of Darmstadt, Germany. Dr. Walker joined Concordia University in Montreal, Canada, as an Assistant Professor in 2001. Prior to his academic career, he worked for several years in the German consulting and industrial sector at such firms as Mercedes Benz, Utility Consultants International, Lahmeyer International, Telnet, and KPMG Peat Marwick. His research interests are in IPO underpricing, securities regulation and litigation, institutional ownership, insider trading, and aviation finance.

[1] In line with other authors, we also use the terms *legacy*, *conventional-cost*, *traditional-cost* or *full-fare* when referring to full-service carriers and *LCC* or *low-fare* when referring to low-cost carriers.

similar events on the accounting performance and risk profile, that is, the systematic and unsystematic return volatility, of the affected airlines. Our results are very consistent and provide interesting insights into the Canadian airline industry and into the differences between the two business models used by Air Canada and WestJet. In addition, our small sample size allows for a firm-by-firm discussion of special circumstances that affect each airline. These firm-specific discussions reveal several important facts that are usually not addressed in large-sample studies. As such, our approach is consistent with earlier studies by Bowen, Castanias, and Daley (1983), Hill and Schneeweis (1983), Shelor, Anderson, and Cross (1992), and Lamb (1995) who employ small sample studies to investigate the impact of an event or a series of events on a firm's performance and risk exposure.

Given the existence of varied regulatory frameworks across countries, a comprehensive large sample analysis of the performance differences between two business models is likely to yield biased and inconsistent results. Thus, we follow the extant literature and employ a case study in which we focus on a set of two airlines which, aside from their business model, are largely comparable. As such, our study is part of a series of similar case studies employing small sample comparisons of airlines in one country at a time.

Our methodological approach proceeds as follows. We first examine the short-term and long-term stock price performance as well as the accounting performance of WestJet and Air Canada during the post-9-11 period.[2] We then analyze how 9-11 impacted the risk, that is, the systematic and unsystematic volatility of the airlines' stock returns. We choose WestJet as a low-cost carrier representative and Air Canada as a firm that follows a full-service business model. These two airlines are the only firms in the Canadian airline industry that are publicly traded. As such, our paper is a complete account of the Canadian airline industry in terms of the firms for which stock price and accounting data are available.

When analyzing a firm's accounting performance around a particular event we can gain valuable insights into how the event impacted the firm's revenues, profitability, liquidity, as well as a variety of other performance measures. Because such an analysis only employs historical data, however,

---

[2] For brevity and expositional convenience we will hereafter refer to the pre-9-11 and post-9-11 periods. It should be noted, however, that our study does not only consider the industry's reaction to the terrorist attacks of September 11, 2001. Rather, the post-9-11 period also includes such critical events as the 2002 SARS outbreak, the wars in Afghanistan and Iraq, and the accompanying rise in jet fuel prices. Thus, our study focuses not on a single event but on a series of events that have dramatically altered the industry landscape in recent years.

it provides little insight into the expected future performance of the firm. To examine the impact of a catastrophic industry event on the future prospects of our sample airlines we analyze their stock performance before and after the event. Because stock market participants base their valuation of a company's stock on the firm's expected future cash flows rather than on historical information, an event study of a firm's stock price performance reflects how the market as a whole anticipates the firm to do in the future. Lawton (2003) advances the argument that low-cost carriers were in a position to go on the offensive and aggressively exploit the changed industry climate after 9-11 by renegotiating labor contracts, by negotiating lower prices for new airplanes in what had suddenly become a buyer's market for new aircraft, and by pursuing aggressive pricing strategies to increase their market share relative to legacy carriers. Legacy carriers, being exposed to a significantly higher overhead burden, were forced into defensive strategies that provided them with little operational flexibility. These developments are difficult to observe in the airlines' accounting figures in the short term but—if they are perceived to change a firm's future cash flows—should be reflected in the market's valuation of the firm's stock.

When investigating the impact of catastrophic industry events on each airline's risk, we consider both the systematic and unsystematic volatility of the stocks' returns. This allows us to differentiate between risk factors that affected the market as a whole and risk factors that affected the firms specifically.

Although we employ only a small sample, our results are highly consistent.[3] We observe that WestJet performed significantly better after 9-11 than its mainstream competitor in almost all aspects of accounting performance. During 2001, arguably one of the worst years in global aviation history, WestJet remained profitable. Only three airlines in the U.S. (JetBlue, Southwest, and Air Tran[4]) and a handful globally were also profitable in 2001. In 2002, WestJet continued to fare better than its full-service competitor. In addition, its stock held up significantly better than the

[3] Note that with a bigger sample, one could perform a regression analysis of the airlines' accounting performance and abnormal returns after 9-11 on a variety of firm characteristics. This would allow for a more exact measurement of how each aspect of a firm's operations contributes to its success or failure. Unfortunately, such an analysis is not possible given that there are not enough low-cost and conventional-cost carriers in either the U.S. or Canada to form a broad enough sample that would allow for such an analysis. Thus, our analysis focuses on examining a small sample of airlines that have clearly different business models but are otherwise comparable with respect to size and pre-9-11 performance.

[4] These airlines also follow different variations of a low-cost business model.

stock of Air Canada and showed a significantly smaller increase in unsystematic risk after 9-11. Our discussion elaborates on the qualitative aspects that sets these airlines apart and drives their performance differences.

Our findings provide empirical support for the qualitative discussion in Lawton (2003). In addition, they help explain the success of WestJet. We do not advocate that the low-cost model is uniform in the way it manifests in the market. Our argument is that the low-cost model, in its generic manifestation, can be differentiated from the full-service model along three management dimensions. They include adopting a viable strategic position, leveraging organizational capabilities, and reconceiving the value equation. These dimensions, coupled with the unique operational features that low-cost airlines have (pricing structure, fleet composition, route structure, choice of airports, distribution, and productivity) help explain, theoretically, why low-cost carriers are in the position to outperform their full-service rivals.

Zorn (2001) argues that low-cost carriers are more resilient than legacy carriers in times of economic downturn. Our analysis focusing on WestJet's performance validates this point, and Zorn's analysis helps us demonstrate it theoretically. Zorn cites several reasons for the resilience of low-cost carriers in times of recession: first, a lower overall and more variable cost structure; second, a lower breakeven load factor, and, third, business and leisure traveler migration from conventional-cost airlines to low-cost airlines. Our financial analysis substantiates this point to its fullest. We find that markets value low-cost airline stocks as growth stocks, whereas conventional-cost airline stocks are treated as cyclical.[5] Even though affected, low-cost carriers emerged from 9-11 in a stronger market position than their full-fare rivals. Given the Canadian evidence provided by this study, as well as the results of earlier U.S. studies by Flouris and Walker (2005a, 2005b) and anecdotal evidence from various other countries, our findings can likely be extended to the global airline industry in that the low-cost model outperforms the legacy model across our study parameters in the way it responds to catastrophic industry events.

The paper is organized as follows. We begin with a brief description of WestJet's business model and compare it to the business model of Air Canada. We highlight several key aspects of WestJet's strategy, and make comparisons across carriers that are representative of the successful low-cost business model. The following sections provide a description of the data and explain the methodology used to test several hypotheses concerning the

---

[5] Although we only report results for WestJet in this study, the accounting and stock price performance of other North American low-cost airlines such as Southwest, Air Tran and JetBlue in recent years was also remarkable relative to most other airlines in the region.

accounting and stock performance of our sample airlines. Results are presented. Findings are summarized in the final section.

THE LOW-COST BUSINESS MODEL

In this section we outline some of the common characteristics of the low-cost business model that WestJet and other LCCs such as easyJet, Ryanair, Southwest, JetBlue, and Air Tran have successfully employed in recent years. Researchers such as Lennane (2000) have documented several advantages of the low-cost business model. Our goal in this study is to examine how and why low-cost carriers outperform legacy carriers in times of crisis. While our empirical analysis focuses on WestJet, there is a large body of anecdotal evidence that suggests that other low-cost carriers—in several countries—have also fared significantly better after 9-11 than their full-service peers.[6] There are many factors that set the low-cost business model apart from the full-service model. Although it is impossible to determine to what degree each factor contributes to the continued out-performance of low-cost carriers after catastrophic industry events, it is clear that the low-cost business model provides distinct advantages over the business model of full-service carriers in times of crisis. We first summarize some of our empirical findings and then discuss the main differentiating factors between the two business models as they relate to our study.

Our empirical analysis suggests that one of the primary factors that contributed to WestJet's superior stock performance was its superior ability to cover both short-term and long-term liabilities. As we will discuss in more detail below, WestJet not only had a higher current ratio, that is, a healthier proportion of current assets relative to current liabilities, immediately prior to 9-11 but also a lower debt ratio. Both factors likely put both bond and stock investors at ease as they could be somewhat confident that WestJet would not falter under the pressures that 9-11 put on the airline industry. In comparison, Air Canada had significantly fewer current assets on hand and was financially much more leveraged, which may have caused investors to shy away from it more quickly. WestJet also benefited from considerably healthier profitability ratios prior to 9-11, as reflected in a higher return on assets and net profit margin. Arguably, profitability is a good indicator of long-term liquidity. Thus, WestJet's higher profitability likely reduced the perceived default risk for the firm even further. Although WestJet already performed better pre-9-11 our results suggest that the performance gap widened even further afterwards. Naturally, the question arises about what may have caused WestJet's out-performance of Air Canada.

---

[6] See, for example, Lawton (2003).

According to a Unisys Global Transportation report, ". . . the only prerequisite to economic success is to achieve a low cost base from which to build a desired service offering" (Unisys, 2003). This statement dismisses claims by full-service airlines that industry malaise is due to exogenous factors such as terrorist threats, rising oil prices, the wars in Afghanistan and Iraq, or SARS and is valid vis-à-vis the Canadian airline industry experience. Since Air Canada acquired Canadian Airlines, the integration of the two companies did not produce the cost savings expected. Despite having over 70% market share in Canada, the airline lost C$82 million in 2000, the year before 9-11 happened.

Business models create a simplified description of the strategy of a profit-oriented enterprise. The low-cost airlines' business model consists of a variety of characteristics, which includes price as its single most important product feature. In addition, most low-cost airlines are distinguishable from full-service carriers in terms of their product offering, corporate structure, workforce and work practices, and their operational procedures.

We argue that most of these factors can also explain why WestJet and other low-cost airlines have done so well during the recent industry crisis when compared to full-service carriers. The key qualitative factors that appear to set WestJet apart from legacy carriers such as Air Canada appear to be: (a) its focus on the core product (air transportation) without costly service offerings such as airport lounges, (b) the lower cost structure through the use of cheaper airports, online booking and a uniform fleet, (c) a lower and more flexible price structure, and (d) higher productivity through faster turnaround times and better use of its workforce.

By boosting the profitability of WestJet and by having positive effects on other measures of accounting performance, irrespective of the industry climate, these factors translate into good performance even during difficult times for the airline industry.

As our discussion points out, the full-service model employed by Air Canada, though reengineered after its emergence from bankruptcy protection in 2004, is still inherently inflexible (naturally) when confronted with sudden demand shocks and exposes the airlines to a significantly higher overhead burden that is difficult to cope with when unit sales, that is, bookings, drop. WestJet benefits from a lower overhead burden and more operational flexibility which allows it to weather difficult times better than its full-service competitor.

WestJet completed its initial public offering of 2.5 million common shares in July 1999 and transitioned to a public company. The capital raised from the offering was used for the purchase of additional aircraft, as well as the building of a new head office and hangar facilities in Calgary. In February of 2002, they offered an additional three million common shares yielding net proceeds of $78.9 million. WestJet "celebrated its 27th quarter of profitability with its third quarter 2003 results" (WestJet, 2007). The following sections explore the performance differences quantitatively, both from an accounting standpoint and from the stock market's perspective.

DATA

We use accounting data from January 2000 to December 2003. We collected this data from year-end income statements and balance sheets, which are available online through Hoover's Online database (www.hoovers.com).

For our analysis of relative stock performances pre- and post-9-11, we use daily price data (adjusted for dividends and stock splits) from January 1999 to April 2004, which we retrieved from the Center for Research in Security Prices at the University of Chicago Graduate School of Business (CRSP) database and the Toronto Stock Exchange (TSE).[7] To measure market performance during our sample period, we use the TSE 300 market index. Finally, we use weekly data on annualized 3-month Treasury Bill yields as calculated by the Bank of Canada as a proxy for the risk-free interest rate during our sample period.

METHODOLOGY

Financial markets bring together potential investors who vote every day on the future profitability of the firm and the relative merits of managers' strategic decisions. Simply put, if investors think that corporate decisions will lead to increases in long-run profitability, news of events such as a takeover will cause a firm's stock price to rise. Conversely, news that investors believe will lower future profits will result in a fall in a firm's equity value.

The finance literature refers to the idea that news is quickly impounded in security prices as the efficient market hypothesis, first described by Fama, Fisher, and Jensen (1969). The assumption that markets are efficient implies that security prices reflect all relevant information known to investors and thus provide us with the best estimate of a firm's future profitability. There is significant empirical support for the efficient market hypothesis including the Carter and Simkins' (2004) study of airline stocks following catastrophic events. We add to Carter and Simkins' findings by focusing specifically on performance differences between low-cost and traditional-cost airlines. In addition, our study is the first to examine the accounting performance of

---

[7] Note that our sample period is naturally truncated by the fact that Air Canada filed for bankruptcy protection on April 1, 2004. Thus, we restrict our analysis to the stock price and accounting performance prior to that date.

Canadian airlines post-9-11, and to examine how 9-11 influenced the systematic and unsystematic volatility of their returns.

If we assume that markets are efficient, and therefore set rational prices, we can measure whether the corporate strategy of a low-cost carrier such as WestJet, post-9-11, was in the best interest of shareholders by comparing the firm's profitability and stock price performance in the months after 9-11 to the performance of an airline that follows a conventional-cost business model (Air Canada).

Financial ratio analysis

To evaluate the accounting performance of our sample airlines we focus on examining some of the most frequently used financial ratios. Financial ratios can be grouped into four categories: (a) liquidity ratios, (b) activity ratios, (c) financing ratios, and (d) profitability ratios. Liquidity ratios provide measures of a company's ability to satisfy short-term obligations. Activity ratios measure a company's efficiency in managing its assets. Financing ratios provide some indication of the riskiness of a company with regard to paying its long-term debts. Finally, profitability ratios assist in evaluating various aspects of a company's profit-making activities.

It is important to remember that when using financial ratios to assess the overall financial stability of a company, more than one ratio should be considered when formulating an accurate opinion. For example, a company's solvency ratios may be ideal, but if the ratios that help analyze profitability and activity are bad (profits are down and sales are stagnant), a much different opinion would be formulated.

Our comparison employs both a cross-sectional and a time-series analysis. Cross-sectional analysis consists of comparing the financial ratios of different firms in the same industry at the same point in time. Time-series analysis consists of comparing the firms' accounting performance ratios over time.

Tyran (1986), Lev (1994) and Gibson (1997) describe a plethora of financial ratios that fall under the aforementioned categories. For briefness, we only report those ratios here that we feel to be most insightful.[8] The

[8] Note also that many ratios that are frequently used for manufacturing firms are of little importance in the airline industry. For this reason, we do not discuss such ratios as inventory turnover, accounts receivable turnover or accounts payable turnover. For the same reason, we do not differentiate between a firm's current ratio and acid test ratio. The acid test ratio is similar to the current ratio but eliminates the inventory figure in the current assets section of the balance sheet. Given that inventory is typically negligible for airlines this differentiation provides little additional insight.

following list outlines the calculation of each ratio and discusses their meaning.

Liquidity ratios

Current Ratio. The current ratio measures the ability of the firm to pay its current bills while still allowing for a safety margin above the required amount needed to pay current obligations. We calculate the current ratio as Current Ratio = Current Assets / Current Liabilities.

Activity ratios

Total Asset Turnover. The total asset turnover is a measure of how efficiently and effectively a company uses its assets to generate sales. The higher the total asset turnover ratio, the more efficiently a firm's assets have been used. We calculate the total asset turnover as Total Asset Turnover = Sales / Total Assets.

Financing ratios

Debt Ratio. This is a simple but effective ratio that indicates the firm's debt-paying ability in the long run. The ratio represents the percentage of assets financed by creditors, and helps to determine how well the creditors are protected in case of insolvency. The higher the ratio, the greater the degree of outside financing by creditors. A high debt ratio indicates that the firm is more leveraged (has more debt) and is risky for creditors. We calculate the debt ratio as Debt Ratio = Total Liabilities / Total Assets.

Interest Coverage Ratio. The interest coverage ratio (sometimes referred to as times interest earned) measures the ability of the firm to service all debts. The figure measures how many times interest payments could be made with a firm's earnings before interest expenses and taxes are paid. The higher the ratio, the more likely the firm can meet its obligations. We calculate the interest coverage ratio as Interest Coverage Ratio = Earnings Before Interest and Taxes (EBIT) / Interest.

Profitability ratios

Net Profit Margin. The net profit margin measures the amount of profits available to shareholders after interest and taxes have been deducted on the income statement. We calculate the net profit margin as Net Profit Margin = Net Income / Sales.

Return on Assets (ROA). The return on assets measures the firm's ability to utilize its assets to create profits by comparing profits with the assets that generate profits. We calculate the return on assets as ROA = Net Income / Total Assets.

Return on Equity (ROE). The return on equity measures the return earned on the owners' equity in the firm. The higher the rate the better the firm has increased wealth to shareholders. We calculate the return on equity as ROE = Net Income / Stockholders' Equity.

Stock performance analysis

To examine the impact of 9-11 on the stock performance of our sample airlines, we follow the event study procedure described in Brown and Warner (1985), Peterson (1989), and Schweitzer (1989). Event study methodology measures the abnormal return of the stock, as the difference between the *actual return* and the *expected return*, around the time of the event. If an announcement such as news of increased profits is taken as good news, abnormal returns will be positive, signaling the market's belief that firm value has increased. A negative abnormal return is evidence of bad news, indicating that the market believes the event will decrease the firm's future profitability.

To estimate the abnormal return of a stock on day t, we subtract the expected return on the stock from its actual return on that day:

$$AR_t = r_t - E(r_t) \qquad (1)$$

where AR_t is the abnormal stock return, r_t is the actual stock return, and $E(r_t)$ is the expected stock return, all on day t. In turn, we assume that the return of a stock is conditional on the return of the market and model $E(r_t)$ as:

$$E(r_t) = r_{f,t} + \beta_t [E(r_{m,t}) - r_{f,t}] \qquad (2)$$

where $E(r_{m,t})$ is the expected return of the market on day t, $r_{f,t}$ represents the risk-free rate as measured by the return on 90-day Canadian Treasury Bills on day t, and β_t is the estimated slope coefficient from a linear regression of the stock's past returns on the returns of the market.[9]

[9] Equation 2 is also called the capital asset pricing model (CAPM) and is based on Sharpe (1964) and Lintner (1965). In this paper, we estimate the capital asset pricing model using both 60 and 360 daily returns that precede our event window. We employ a linear market model that illustrates the relationship between an airline's stock return and the market (as proxied by the TSE 300 index) during a normal period.

We calculate daily abnormal returns for WestJet and Air Canada post-9-11.[10] In addition, we measure cumulative abnormal returns, $CAR_{t,t+n}$, the sum of abnormal returns over a window of n days, as:

$$CAR_{t,t+n} = \sum_{i=t}^{t+n} AR_i \tag{3}$$

Cumulative abnormal returns enable us to measure the market's reaction to the performance of the airline in a time frame that encompasses the entire period from the event under study to the present.

Earlier industry research has largely focused on airline stock returns following a plane crash. Davidson, Chandy, and Cross (1987), Lin, Thiengtham, and Walker (2005), and Pukthuanthong, Thiengtham, and Walker (2007) find statistically significant negative returns for airlines on the day of the crash. This appears to be a short-term effect, however, and is reversed on the days following the event. Chance and Ferris (1987) examine 46 plane crashes, and discover that in 29 cases the carrier has a significant negative return. A crash does not appear to have an effect beyond the initial reaction, nor does it affect the stock price of the airline's competitors. Chance and Ferris also find a negative correlation between the airline's abnormal return and the number of fatalities in the crash.[11]

More recently, Carter and Simkins (2004) investigated the stock market's reaction to 9-11. They note the potential psychological effects of the attack and test whether financial markets react rationally to news of the event. Carter and Simkins find that despite the psychological horrors the market was able to discern among airlines based on firm characteristics, including the ability to cover short-term obligations. Their results support rational pricing and have important implications for our work.

To serve as a further control in estimating the market's reaction to 9-11, our analysis compares the abnormal returns of WestJet's stock to the abnormal returns of Air Canada. We choose WestJet because it is uses a low-cost business model, and Air Canada because it uses a conventional-cost model and has done so quite successfully. These firms should provide a good benchmark for examining industry reaction to the set of relevant

---

[10] Because Canadian stock markets were closed following 9-11 and did not reopen until September 13, 2001, we define September 13, 2001, as the first day of our post-9-11 event window.

[11] Other studies that examine the consequences of airplane accidents for airlines include Borenstein and Zimmerman (1988), Mitchell and Maloney (1989), and Bosch, Eckard, and Singal (1998).

events. We do not consider CanJet and JetsGo[12] because they are not publicly traded and Air Trans since it derives a significant portion of its revenues from chartered flights.

Adjusting for risk

In considering risk changes, we calculate beta, the part of a firm's risk that is related to changes in the market. It is a measure of systematic risk, the risk that investors must be compensated for, and, thus, is related to a firm's cost of capital. If 9-11 led to the airline industry being a more risky business, we would expect airlines' betas to increase after 9-11. An airline's beta, β_i, can be found by regressing the airline's daily stock returns against the daily stock returns on the market as in the following regression model:

$$r_i = \alpha + \beta_i r_m + e_i \tag{4}$$

where α is the intercept, β_i is the slope coefficient that represents the sensitivity of the stock's returns to the returns on the market, r_m, and e_i represents the firm-specific residual, that is, the part of a firm's return that cannot be captured by the regression model. An alternative method for calculating a firm's beta coefficient employs the following formula:

$$\beta_i = cov(r_i, r_m) / \sigma_m^2 \tag{5}$$

where $cov(r_i, r_m)$ is the covariance between firm i's returns and the returns on the market, and σ_m^2 is the variance of market returns. Both Equation 4 and Equation 5 will result in the same beta estimates and may be used interchangeably. We use beta coefficients to adjust the expected returns in our event study for risk as in Equation 2 and to distinguish between a firm's systematic and unsystematic return volatility as discussed below.

Cornell, Hirshleifer, and James (1997) review many of the practical issues in beta selection and the application of regression-based asset-pricing models to estimating equity cost of capital. They provide assistance for resolving many of the conventional problems with beta estimation, such as selection of the risk-free rate, the time period for estimation, and the inclusion or exclusion of dividends.

Corgel and Djoganopoulos (2000) perform direct statistical comparisons of beta estimates calculated by large financial data vendors such as Bloomberg, Compustat, Dow Jones, and Ibbotson. They find that the

---

[12] Both of these airlines have ceased operations since the first draft of this paper was written.

different procedures used by these commercial services produce the same results when simple tests of differences of means are used to evaluate them. They observe that most data vendors use ordinary least squares (OLS) regressions of the returns of the firm against those of the market, where the security's return serves as the dependent variable, and the independent variable is a user-selected index. They point out, however, that users of financial software packages typically have some flexibility and can select the time period for estimation, the market index against which they want to measure returns, the data frequency (daily, weekly, monthly, etc.), and whether they want to include dividends or not.

Because the finance literature is divided on the issue whether short-term or long-term estimates should be used in CAPM estimation, we use a rolling window of both 60 and 360 calendar day returns to calculate covariances and variances. Most authors and financial data vendors use long-term betas calculated over periods of three and more years, but given the rapidly changing environment for the airline industry, we found short-term estimates to be more appropriate.

Expected market returns: Historical versus prospective estimates

Before we can address the question of how we estimate expected market returns, we have to define the market. In his famous critique of CAPM testing, Richard Roll (1977) indicates that the market portfolio to be used in CAPM estimation should contain all financial and non-financial assets available to investors and states that an accurate test of the CAPM will never be possible because of this requirement.

Despite Roll's criticism, most authors and financial data services use only country-specific common stocks to proxy for the market portfolio and rely heavily on the TSE 300 to represent the Canadian market. We follow this approach and use the TSE 300 market index for calculating both our beta estimates and market returns.

When developing an estimate of the expected market return [$E(r_m)$], one has to decide whether to use historical data, assuming that past performance is the best predictor of future performance, or make an attempt to forecast a return for the market, which would require an accurate estimate of future dividend growth. As with most other studies in this field, we do not consider ourselves wise enough to forecast future market returns, but rather rely on past returns as an estimate of future returns. Another question we had to address in our estimation was which time period to use to calculate past market returns. Given the fact that 9-11 occurred relatively recently and that our return data are thus limited, we decided to use the geometric average of market returns during the past 360 calendar days as an estimate of future market returns. To test the robustness of our results, we also calculated 60-

calendar-day returns, but arrived at the same conclusions as we did with our long-term estimates.

Systematic versus unsystematic volatility

The systematic risk of a security is that part of the total risk that is associated with the movements in the underlying market. The unsystematic risk of a company's stock is that part of total risk which is specific to that company. To examine the effect of 9-11 on both the systematic and unsystematic volatility of our sample firms, we partition the variance of a firm's stock returns (σ_i^2) into its two components, systematic variance ($\beta_i^2\sigma_m^2$) and unsystematic variance ($\sigma_{e_i}^2$), based on the formula:

$$\sigma_i^2 = \beta_i^2\sigma_m^2 + \sigma_{e_i}^2 \quad (6)$$

where β_i and σ_m^2 are as defined above and $\sigma_{e_i}^2$ represents the variance of the error terms, e_i, in our regression model in Equation 4.

An important statistic that emerges from the regression is the coefficient of determination R squared (R^2). While the statistical explanation of the R^2 is that it provides a measure of the goodness of fit of the regression, the economic rationale is that it provides an estimate of the proportion of the risk of a firm that can be attributed to market risk. The balance ($1-R^2$) can then be attributed to firm-specific risk.

There are two additional alternatives for calculating the R^2 which we present here for completeness. One alternative illustrates the economic interpretability clearly:

$$R^2 = \frac{\beta_i^2\sigma_m^2}{\sigma_i^2} \quad (7)$$

As we can observe, in this case the R^2 is simply calculated by dividing the systematic risk of a firm's returns by the total risk as calculated in Equation 6. The other alternative employs the correlation coefficient $\rho_{i,m}$ between firm i's returns and the returns on the market:

$$\rho_{i,m} = \frac{\text{cov}(r_i, r_m)}{\sigma_i\sigma_m} \quad (8)$$

where σ_i and σ_m represent the standard deviation of the returns for firm i and the market, respectively.

If we square the correlation coefficient $\rho_{i,m}$ we can observe that the term $\rho_{i,m}^2$ is equivalent to the R^2. Again, all three approaches may be used interchangeably and yield the same results. As noted above, the R^2 and (1-R^2) simply provide a proportional decomposition of a firm's total variance σ_i^2 into its two risk components, $\beta_i^2\sigma_m^2$ and $\sigma_{e_i}^2$, and may be interpreted as percentage weights.

RESULTS

Accounting performance

The first part of our analysis focuses on the relative performance of WestJet and Air Canada from an accounting standpoint, by comparing various accounting measures and financial ratios for the two firms over time. An analysis of the stock performance and return volatility of the two airlines follows in the next section.

The accounting figures and financial ratios in the following table are based on year-end income statements and balance sheets from January 2000 to December 2003 that we retrieved from Hoover's Online database. As we can see, despite 9-11, WestJet managed to remain profitable on slightly declining sales, while Air Canada registered significant losses on falling revenues.

WestJet's current ratio is consistently above that of Air Canada and—despite a slight decline in 2001 and 2003—improves significantly in 2003.

Table 1. Selected Accounting Data and Financial Ratios for WestJet and Air Canada Airlines, 2000-2003

Time Period	**2000**	**2001**	**2002**	**2003**
Panel A: WestJet				
Total Revenue (C$ Million)	332.5	478.4	680.0	859.6
Net Income (C$ Million)	30.3	37.2	51.8	60.5
Current Ratio	1.0	0.9	0.8	1.2
Total Asset Turnover	1.0	1.2	0.9	0.6
Interest Coverage Ratio	18.9	12.5	12.8	4.9
Debt Ratio	46.3%	43.6%	54.6%	60.7%
Net Profit Margin	9.1%	7.8%	7.6%	7.0%
Return on Assets (ROA)	9.0%	9.4%	6.6%	4.1%
Return on Equity (ROE)	16.7%	16.7%	14.6%	10.4%
Panel B: Air Canada				
Total Revenue (C$ Million)	9295.5	9,607.0	9,826.0	8,368.0
Net Income (C$ Million)	(112.5)	(1,253.8)	(828.0)	(1,867.0)
Current Ratio	0.7	0.8	0.7	0.7
Total Asset Turnover	1.0	1.1	1.3	1.2
Interest Coverage Ratio	0.0	-2.6	-1.0	-6.8 *
Debt Ratio	102.2%	110.6%	130.9%	160.1%
Net Profit Margin	-1.2%	-13.1%	-8.4%	-22.3%
Return on Assets (ROA)	-1.2%	-14.1%	-11.2%	-27.0%
Return on Equity (ROE)	n.m.	n.m.	n.m.	n.m.

Note. n.m. = not meaningful

* As a result of its April 1, 2003, bankruptcy filing, Air Canada ceased to accrue interest on unsecured debt that is subject to compromise. While under creditor protection, Air Canada only reported interest expenses to the extent that they will be paid under the plan of arrangement or that it is probable that it will be an allowed claim. Approximately C$179 million of interest expense on unsecured debt would have been recorded in addition to the C$85 million on its income statement had the filings not occurred. We use the sum of these two numbers, that is, C$264 million, to calculate the interest coverage ratio in 2003.

A comparison of the activity ratios shows that WestJet's asset turnover ratio weakens after the catastrophic industry events. This is not the case for Air Canada. A look at the financing ratios, however, points a very different picture for our sample airlines. Although WestJet's interest coverage ratio drops significantly during our sample period (from 18.9 in 2000 to 4.9 in 2003), the firm remains in a good position to cover its interest expenses. On the other hand, the impact of 9-11 on the interest coverage ratio of Air Canada is tremendous: the airline had interest coverage ratios below 1 throughout our sample period, indicating that they experienced significant difficulties in making their interest payments. This ultimately resulted in Air Canada's bankruptcy filing on April 1, 2003.

Even before 9-11, Air Canada had a significantly higher debt ratio than WestJet. In fact, throughout our sample period, Air Canada's debt ratio exceeds 100%, fueled by a deficit in its shareholder equity. The high leverage and the accompanying financial risk are likely to be one of the reasons for the quick deterioration of Air Canada's financial ratios. By 2003, the debt ratio of WestJet rose to 60.7% (from 46.3% in 2000). In comparison, Air Canada's shareholder's equity deficit grew so large that in 2003 its debt ratio exceeded 160%.

The profitability ratios (ROA, ROE and profit margin) of WestJet are comparatively healthy after 9-11, although they remain below the profitability levels that WestJet showed in 2000. In contrast, Air Canada shows very strong signs of weakening post-9-11.[13]

Overall, our financial ratio analysis paints a grim picture for Air Canada while we observe only a slight deterioration in the accounting performance for WestJet. In its 2002 annual report, Air Canada emphasizes cost-cutting as one of the primary goals for the near future. Because cost cutting measures and other managerial actions generally take some time to be reflected on a firm's financial statements, it is difficult to determine their success through a short-term financial ratio analysis. If investors perceive such actions to be effective, however, they will be reflected in the financial performance of the firm's stock. Since financial theory suggests that the price of a stock should be equal to the present value of all future dividends, a stock performance analysis generally provides a good insight into how the financial markets expect a firm to do in the future.

For firms entering bankruptcy protection, a stock price analysis also provides a reasonable estimate of the market's expectation about the future of the firm, that is, whether or not it can successfully emerge from the bankruptcy. Air Canada filed for bankruptcy protection on April 1, 2003.

---

[13] Note that we do not report the return on equity (ROE) for Air Canada in Table 1. Given that Air Canada carries a deficit in shareholder equity on its balance sheet throughout our sample period, this ratio is not meaningful.

Thus stock prices after this date reflect investors' consensus estimate of a successful emergence from bankruptcy. Although the firm successfully renegotiated labor contracts and locked in new financing arrangements (including a new C$850 million financing arrangement with Deutsche Bank and a C$250 equity million infusion by Cerberus Capital Management), any hopes of a stock price recovery were tainted when Air Canada received court approval to have its stocks cancelled. The company emerged from bankruptcy protection on September 30, 2004, and ACE Holdings, the new parent firm of the airline, quickly gained investor interest, with its Class B shares trading at C$35.75 at the end of December 2004—a premium of C$15 above their offering price. Since then, the shares have traded largely sideways, closing at a price of C$33.98 on January 31, 2007.

Stock performance and return volatility

In order to examine how the financial markets reacted to 9-11 and whether investors put more confidence into low-cost carriers such as WestJet than into airlines that follow a conventional-cost model such as Air Canada, we examine the stock price performance of the two airlines pre- and post-9-11. Table 2 presents quarterly and yearly returns for the airlines and the market as proxied by the TSE 300 index.

The data clearly show the impact of 9-11 on the airline industry and the market. We observe a highly negative return for the airlines and the market index during the third quarter of 2001, followed by several quarters of high volatility when compared to the pre-9-11 period. Air Canada's stock price declined by more than 58.3% in the third quarter of 2001, while WestJet's stock dropped to a much lesser extent (31.5%).

Since the returns in Table 2 are not adjusted for risk, we are not yet in a position to draw any conclusions about the significance of these performance differences. Before we can evaluate the impact of 9-11 on the risk-adjusted stock price performance of our sample airlines, we first examine how 9-11 impacted the airlines' beta coefficients and the systematic and unsystematic volatility of their returns.

Table 2. Quarterly and Yearly Return Data for WestJet and Air Canada Airlines, 1999-2004

Quarter	WestJet	Air Canada	Market Index
1999-Q1	N/A	8.94%	1.73%
1999-Q2	N/A	-7.46%	6.25%
1999-Q3	21.61% *	61.29%	-0.75%
1999-Q4	22.70%	9.00%	20.93%
1999 Total	22.16%	15.38%	6.72%
2000-Q1	18.02%	42.20%	12.46%
2000-Q2	53.37%	25.81%	7.75%
2000-Q3	4.44%	-22.56%	1.79%
2000-Q4	-1.06%	-9.27%	-13.92%
2000 Total	16.95%	5.88%	1.51%
2001-Q1	-20.43%	-42.34%	-14.84%
2001-Q2	31.62%	10.51%	1.69%
2001-Q3	-31.50%	-58.30%	-11.60%
2001-Q4	42.51%	37.91%	12.43%
2001 Total	0.55%	-22.20%	-3.68%
2002-Q1	25.16%	37.65%	2.12%
2002-Q2	-30.25%	2.03%	-8.99%
2002-Q3	-12.29%	-31.91%	-13.51%
2002-Q4	-11.26%	-1.04%	7.02%
2002 Total	-9.21%	-1.37%	-3.69%
2003-Q1	-2.79%	-55.79%	-4.10%
2003-Q2	1.78%	-36.19%	10.09%
2003-Q3	52.07%	-15.67%	6.27%
2003-Q4	17.08%	17.70%	10.78%
2003 Total	15.21%	-27.26%	5.59%
2004-Q1	-7.73%	-0.75%	4.44%

* Note that WestJet went public on July 13, 1999. Thus, our return calculations for the third quarter of 1999 are based on WestJet's price data after that date, excluding its initial public offering (IPO) under pricing return of 25%.

Risk analysis

To measure differences in risk levels between the airlines and examine how those risk levels changed after 9-11, we first calculate beta coefficients for the airlines pre-9-11 and post-9-11 following the regression model in Equation 2. The resulting beta estimates are presented in Table 3.

Undoubtedly, 9-11 had a significant impact on both the economy as a whole and the airline industry in particular. By differentiating between systematic and unsystematic risk in Table 3 we can examine the impact of 9-11 on return volatility in more detail.[14]

Although Roll (1986) discusses the possibility that unsystematic volatility may be noise, or in his words "frenzy unrelated to concrete information" (p. 204), recent empirical evidence by Morck, Yeung and Yu (2000) and Durnev, Morck and Yeung (2004) provides support for the notion that firm-specific return variation gauges the extent to which information about a firm is quickly and accurately reflected in stock prices.

Table 3. Stock Return Volatility Pre- and Post-9-11 for WestJet and Air Canada Airlines, Estimated Over Periods of 60 and 360 Days

	WestJet	**Air Canada**	**WestJet**	**Air Canada**
	60 Calendar Days Pre-9-11		360 Calendar Days Pre-9-11	
Beta (β_i)	0.118	0.251	0.093	0.503
Total risk (σ_i^2)	6.76	6.25	6.71	10.45
Systematic risk $(\beta_i^2 \sigma_m^2)$	0.01	0.04	0.02	0.58
Unsystematic risk $(\sigma_{e_i}^2)$	6.75	6.21	6.69	9.87
Proportion of systematic risk $(\rho_{i,m}^2 = R^2)$	0.0013	0.0061	0.0029	0.0550
Proportion of unsystematic risk $(1-R^2)$	0.9987	0.9939	0.9971	0.9450
	60 Calendar Days Post-9-11		360 Calendar Days Post-9-11	
Beta (β_i)	1.106	2.169	0.790	1.467
Total risk (σ_i^2)	19.72	102.05	9.99	36.86
Systematic risk $(\beta_i^2 \sigma_m^2)$	1.74	6.70	0.62	2.15
Unsystematic risk $(\sigma_{e_i}^2)$	17.98	95.35	9.36	34.71
Proportion of systematic risk $(\rho_{i,m}^2 = R^2)$	0.0883	0.0657	0.0625	0.0584
Proportion of unsystematic risk $(1-R^2)$	0.9117	0.9343	0.9375	0.9416

[14] Note that a recent study by Hilliard and Savickas (2002) proposes an alternative method for examining the impact of an event on a firm's unsystematic volatility. Preliminary tests on our sample suggested no significant quantitative or qualitative differences in the results under either method. For briefness, we limit our discussion to the method presented here.

Not surprisingly, we find that the beta coefficients of both airlines increased considerably after 9-11. During the 360 calendar days prior to 9-11, WestJet had a beta of 0.093, compared to a beta of 0.503 for Air Canada. When performing the same analysis for the 360–day period after 9-11, we observe that WestJet's beta increased to 0.79, while Air Canada had a post-9-11 beta of 1.47. The differences are even more extreme when decomposing the airlines' total return variation as in Equation 6. Here, we observe a significant increase in the total risk for each airline, especially for Air Canada. In addition, we observe that systematic risk accounts for a significantly larger proportion of total return variation in the post-9-11 period. For WestJet, the increase is particularly large, as the coefficient of determination, R^2, rises more than twenty-fold (from 0.0029 during the 360 days prior to 9-11 to 0.0625 during the same period afterwards). For Air Canada, the increase in the systematic risk component is approximately 6.1%.

Overall, we observe that the return variability for Air Canada appears to be primarily driven by firm-specific, that is, unsystematic, risk factors. The returns for WestJet, on the other hand, appear to be more and more driven by market wide risk factors.

There are two conclusions that can be drawn from our volatility analysis. First, the betas of both sample airlines have increased significantly, and are particularly high for Air Canada. With a beta of 0.093 prior to 9-11, WestJet showed little dependency on the overall market. Even though its beta remains below 1, it is now much more affected by return fluctuations in the market. If the betas remain at these elevated levels and the CAPM holds, then we can expect both airlines to be significantly more sensitive to the overall market than prior to 9-11.

Second, although the total risk of each airline has increased significantly after 9-11, the proportion of systematic risk increased for both airlines, particularly for WestJet. This suggests that market volatility has a much bigger influence on the return of each airline and bodes well for poorly diversified investors or sector-specific funds as—according to the CAPM—they should get rewarded for a larger proportion of the total risk they bear.

Risk-adjusted stock performance

To calculate how the returns compare between the airlines after adjusting for risk, we employ event study methodology and calculate the risk-adjusted cumulative abnormal returns for each airline pre- and post-9-11 in a CAPM framework. We use 90-day treasury bill rates as a proxy for the risk-free rate and historical market returns based on 60 and 360 calendar days to forecast expected market returns. Table 4 presents non-risk-adjusted returns of the airlines for various time periods after 9-11.

We observe that both airlines were negatively impacted by 9-11, with Air Canada performing the worst, losing over 23% on the first trading day following 9-11 and over 78% during the following 30 months. In comparison, WestJet lost only 12% on the first trading day after 9-11 and actually gained 58% within 30 months after the event. Both airlines show a medium-term recovery three to six months after 9-11, followed by a repeated downturn after 18 months, from which Air Canada was never able to recover.

Table 4. Non-Risk-Adjusted Returns Following 9-11, for WestJet and Air Canada Airlines

Non-Risk-Adjusted Returns Following September 11, 2001			
Time Elapsed Since 9-11	WestJet	Air Canada	Market
1 Day *	-12.3%	-23.1%	-3.3%
1 Week	-22.9%	-33.6%	-5.9%
2 Weeks	-14.9%	-45.3%	-11.3%
1 Month	-2.9%	-64.1%	-3.9%
2 Months	12.5%	-41.9%	-1.6%
3 Months	24.7%	-22.2%	2.5%
6 Months	62.9%	2.5%	7.7%
1 Year	4.7%	-13.3%	-9.9%
18 Months	-8.6%	-55.6%	-14.3%
2 Years	41.9%	-78.9%	3.5%
30 Months	58.3%	-78.3%	19.1%

* Note that the Canadian markets were closed for two business days following September 11, 2001. Thus, we calculate 1-day performance as the return from the close of trading on September 10 to the close of trading on September 13, 2001.

Table 5 presents risk-adjusted returns following 9-11 using 60-day trailing betas and market risk premiums estimated using 60-day historical returns. Although negative in the short run, we find that the risk-adjusted cumulative abnormal returns (CARs) for WestJet are positive in the medium and long run (1 to 30 months after 9-11). Although Air Canada shows some positive CARs in the medium term (3 months to 1 year after 9-11), they become negative in the long run.

Table 5. Risk-Adjusted Returns Following 9-11 Using Short-Term Estimates, for WestJet and Air Canada Airlines

Risk-Adjusted Returns Following September 11, 2001 (Using 60-Day Trailing Betas and Market Risk Premiums Estimated Using 60-Day Historical Returns)		
Time Elapsed Since September 11, 2001	WestJet	Air Canada
1 Week	-24.48%	-34.86%
2 Weeks	-4.79%	-59.47%
1 Month	2.84%	-86.37%
2 Months	22.08%	-23.89%
3 Months	34.46%	13.77%
6 Months	73.60%	16.46%
1 Year	40.56%	20.84%
18 Months	35.27%	-17.43%
2 Years	73.99%	-58.80%
30 Months	64.40%	-65.00%

Table 6 presents a long-term approach for estimating the inputs in our CAPM model. Here, we calculate risk-adjusted returns by using 360-day trailing betas and market risk premiums based on 360-day historical returns.

Table 6. Risk-Adjusted Returns Following 9-11 Using Long-Term Estimates, for WestJet and Air Canada Airlines

Risk-Adjusted Returns Following September 11, 2001 (Using 360-Day Trailing Betas and Market Risk Premiums Estimated Using 360-Day Historical Returns)		
Time Elapsed Since September 11, 2001	WestJet	Air Canada
1 Week	-24.71%	-35.41%
2 Weeks	-5.58%	-61.91%
1 Month	1.04%	-89.91%
2 Months	17.42%	-29.56%
3 Months	28.97%	6.47%
6 Months	63.32%	35.27%
1 Year	27.24%	3.41%
18 Months	23.34%	-4.63%
2 Years	75.24%	-20.20%
30 Months	67.06%	-52.38%

The results are similar to those presented in Table 5: WestJet clearly outperforms Air Canada on a risk-adjusted basis after 9-11. It is noteworthy, however, that Air Canada's underperformance is somewhat tamed when we use long-term estimates in our calculations.

CONCLUSIONS

Notwithstanding the fact that WestJet has been an innovative operation and, as the numbers and our analysis shows, has been quite successful even during difficult times, will it be able to maintain its success in the future? Will customers continue to remain loyal? Will the firm prevail in case investor confidence if the aviation industry deteriorates even further? Will the firm prevail if serious safety concerns arise about its operation or the operation of low-cost carriers in general?

Besides WestJet in Canada, other low-cost airlines such as Virgin Blue in Australia, AirAsia in Malaysia and Thailand, RyanAir and easyJet in Europe, and JetBlue and Southwest in the U.S. have been similarly successful. In Canada, we may see the emergence of additional low-cost airlines. Also, legacy carriers such as Air Canada have worked very hard to reinvent themselves as low-cost airlines. Especially in North America, currently, the service offering of LCCs and legacy airlines is virtually identical in regard to their domestic service, with legacy airlines still offering an international and in some cases global network as a significant point of differentiation with LCCs that typically have limited or no international networks.

We explain WestJet's overall success from an operational standpoint. WestJet has a lower and more variable cost structure and a lower breakeven load factor, which allows it to react to a changing environment more quickly than conventional airlines. In addition, WestJet benefits from the migration of leisure and even business travelers from conventional-cost airlines to low-cost airlines. Our financial analysis substantiates these qualitative observations. Financial markets appear to have more confidence in the flexibility and continued growth potential of WestJet than its traditional-cost counterpart Air Canada (which is treated as cyclical). Even though affected, WestJet and similar low-cost carriers in the U.S. emerged from such crises as 9-11, the 2002 SARS outbreak, the wars in Afghanistan and Iraq, rising jet fuel prices, and temporary demand declines caused by heightened fear of additional terrorist attacks in a stronger market position than their conventional-cost rivals (see also Flouris & Walker, 2005a, 2005b). From a management standpoint, we believe that adopting a viable strategic position, leveraging organizational capabilities, and reconceiving the value equation are critical in defining the comparative advantage of low-cost carriers.

REFERENCES

Bank of Canada (http://www.bankofcanada.ca/en/rates/index.html#interest), accessed July 5, 2004.

Borenstein, S., & Zimmerman, M. (1988). Market incentives for safe commercial airline operation. *American Economic Review, 78* (5), 913-935.

Bosch, J.-C., Eckard, E., & Singal, V. (1998). The competitive impact of air crashes: Stock market evidence. *Journal of Law and Economics, 41* (2), 503-519.

Bowen, R., Castanias, R., & Daley, L. (1983). Intra-industry effects of the accident at Three-Mile Island. *Journal of Financial and Quantitative Analysis, 18* (1), 87-112.

Brown, S., & Warner, J. (1985). Using daily stock returns: The case of event studies. *Journal of Financial Economics, 14* (1), 3-31.

Carter, D., & Simkins, B. (2004). The market's reaction to the unexpected, catastrophic events: The case of airline stock returns and the September 11th attacks. *Quarterly Review of Economics and Finance, 44* (4), 539-558.

Chance, D., & Ferris, S. (1987). The effect of aviation disasters on the air transport industry: A financial market perspective. *Journal of Transport Economics and Policy, 21* (2), 151-165.

Corgel, J., & Djoganopoulos, C. (2000). Equity REIT beta estimation. *Financial Analysts Journal, 56* (1), 70-80.

Cornell, B., Hirshleifer, J., & James, E. (1997). Estimating the cost of equity capital. *Contemporary Finance Digest, 1* (1), 5-26.

CRSP (Center for Research in Security Prices), http://www.crsp.com, accessed April 20, 2005.

Davidson, W., Chandy, P., & Cross, M. (1987). Large losses, risk management and stock returns in the airline industry. *Journal of Risk and Insurance, 54* (1), 162-172.

Durnev, A., Morck, R., & Yeung, B. (2004). Value enhancing capital budgeting and firm-specific stock return variation. *Journal of Finance, 59* (1), 65-105.

Fama, E., Fisher, L., & Jensen, M. (1969). The adjustment of stock prices to new information. *International Economic Review, 10* (1), 1-21.

Flouris, T., & Walker, T. (2005a). Confidence in airline performance in difficult market conditions: An analysis of JetBlue's financial market performance. *Journal of Air Transportation, 10* (1), 38-57.

Flouris, T., & Walker, T. (2005b). The financial performance of low-cost and full-service airlines in times of crisis. *Canadian Journal of Administrative Sciences, 22* (1), 73-91.

Gibson, C. (1997). Financial statement analysis: Using financial accounting information. Cincinnati, OH: South-Western College Publishing.

Hill, J., & Schneeweis, T. (1983). The effect of Three Mile Island on electric utility stock prices: A note. *Journal of Finance, 38* (4), 1285-1292.

Hilliard, J., & Savickas, R. (2002). On the statistical significance of event effects on unsystematic volatility. *Journal of Financial Research, 25* (4), 447-462.

Hoover's, Inc. (http://www.hoovers.com/business-directory/--Index__0,Page__1,--/free-co-alpha-dir.xhtml), accessed June 1, 2004.

Lamb, R. (1995). An exposure-based analysis of property-liability insurer stock values around Hurricane Andrew. *Journal of Risk and Insurance, 62* (1), 111-123.

Lawton, T. (2002). Cleared for take-off: Structure and strategy in the low-fare airline business. London, UK: Ashgate Publishing Limited.

Lawton, T. (2003). Managing proactively in turbulent times: Insights from the low-fare airline business. *The Irish Journal of Management, 24* (1), 173-193.

Lennane, A. (2000). Super Models. AirFinance Journal, 225 (1), 28.

Lev, B. (1994). Financial statement analysis: A new approach. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Lin, Y., Thiengtham, D., & Walker, T. (2005). On the performance of airlines and airplane manufacturers following aviation disasters. *Canadian Journal of Administrative Sciences, 22* (1), 21-34.

Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics, 47* (1), 13-37.

Mitchell, M., & Maloney, M. (1989). Crisis in the cockpit? The role of market forces in promoting air travel safety. *Journal of Law and Economics, 32* (2), 329-355.

Morck, R., Yeung, B., & Yu, W. (2000). The information content of stock markets: Why do emerging markets have synchronous stock price movements? *Journal of Financial Economics, 58* (1), 215-260.

Peterson, P. (1989). Event studies: A review of issues and methodology. *Quarterly Journal of Business and Economics, 28* (1), 36-66.

Pukthuanthong, K., Thiengtham, D., & Walker, T. (2007). The role of aviation laws and legal liability in airline disasters: A financial market perspective. *International Review of Law and Economics* (forthcoming).

Roll, R. (1977). A critique of the asset pricing theory's tests - Part I: On past and potential testability of the theory. *Journal of Financial Economics, 4* (2), 129-176.

Roll, R. (1986). The hubris hypothesis of corporate takeovers. *Journal of Business, 59* (2), 197-216.

Schweitzer, R. (1989). How do stock returns react to special events. *Business Review, Federal Reserve Bank of Philadelphia,* July/August, 17-26.

Sharpe, W. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance, 19* (3), 425-442.

Shelor, R., Anderson, D., & Cross, M. (1992). Gaining from loss: Property-liability insurer stock values in the aftermath of the 1989 California earthquake. *Journal of Risk and Insurance, 59* (3), 476-487.

TSE (Toronto Stock Exchange). http://www.tsx.com, accessed July 4, 2004.

Tyran, M. (1986). Handbook of business and financial ratios. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Unisys (2003, April). R2A Scorecard, (1) 6.

Westjet website: (http://c3dsp.westjet.com/guest/about/historyTemplate.jsp;jsessionid=G1rSJSFSWDGbqjnQGNwpHv48QPjLsQSGZvp8FR0v115VCmbyjTjY!377473935), accessed May 7 2007.

Zorn, B. (2001). Comparing low cost markets in the USA, UK, and Europe. Presentation at the University of Amsterdam, Amsterdam, Holland, February 27.

CARVING A NICHE FOR THE NO-FRILLS CARRIER, AIR ARABIA, IN OIL-RICH SKIES

Donelda S. McKechnie
American University of Sharjah
United Arab Emirates

Jim Grant
American University of Sharjah
United Arab Emirates

Mona Fahmi
Procter and Gamble
Cairo, Egypt

ABSTRACT

The concept of introducing a no-frills airline to the wealthy Arab region presented its risks. This independent study sought to position the new airline in the marketplace. After three focus groups and 400 self-administered surveys, safety (#1) and price (#2) are low-fare carrier considerations whereas safety (#1), punctuality (#2) and price (#3) apply for full-fare airlines. Recommended ways for the no-frills carrier to reach the market include newspaper ads, travel agent sales, online bookings, and call centers. Additionally, respondents appeared to evaluate this low-fare carrier as if it is a full-service airline.

Dr. Donelda McKechnie is Assistant Professor of Marketing at American University of Sharjah, UAE. Her interests include service encounters research (particularly business to business context between organizations/institutions and contract workers), services and hospitality, and any culturally diverse topics within the fast changing and dynamic UAE environment.

Dr. Jim Grant is Professor of Marketing and Management at American University of Sharjah, UAE. His interests include sales and sales management, sport marketing, and marketing strategy. In particular he is interested in the application of marketing activities to the rapidly expanding UAE and Arab business practices.

Ms. Mona Fahmi is currently a Marketing Research Manager at Procter and Gamble, Egypt. She has an MBA from American University of Cairo, Egypt. Her interests include consumer-related research particularly in the MENA (Middle East and North Africa) and Gulf (GCC) countries.

INTRODUCTION

The no-frills sector of the airline industry has become more established, which has resulted in increasing competition between low-cost and full-service carriers. Attention has focused on the successes and failures of the no-frills airlines; their operations have been analyzed, compared and reviewed (Gilbert, Child & Bennett, 2001; Jarach, 2004; Lawton, 2003). The successful Southwest airlines model has often been the benchmark for no-frills operations throughout the world (Leavy, 2003), and the template continues to be copied in many countries (Jarach, 2004). The announcement that the low-fare, no-frills model was being introduced into the oil-rich Middle East market appeared to be a contradiction.

This study focused on consumer response to the no-frills carrier, Air Arabia, beginning its air service from Sharjah airport in United Arab Emirates (UAE). The research was guided by two objectives. First, would the traveling public be receptive to the low-fare airline? Second, would eight typical factors used by customers when considering a full-service carrier have (dis)similar responses when the no-frills airline was an option? The startup presented a window of opportunity to pursue a study about the western culture low-cost, no-frills airline template being introduced to the Arab world for the first time. Additionally, Air Arabia was entering a market that was already dominated by Emirates Airlines, one of the world’s best.

LITERATURE REVIEW

A low-cost airline business model is typically a niche strategy. "It is aimed at getting benefit from offer vacuums and from the service for pariah customers, starting from visiting friends and relatives, ethnic and leisure based movements and later climbing up to reach cost-conscious business travelers" (Jarach, 2004, p. 25). The emphasis on costs makes the distinction between full-service and no-frills. Jarach explained that the low-fare, low-cost operations require "a much more radically deeper reengineering of the entire value proposition and are not definitively sensitive only to one shot actions" (p. 26).

If an airline is classified as a low-cost carrier, then it must pursue a low-cost operational structure. This means offering fares lower than the full-service scheduled airlines’ ticket prices (Gilbert, Child & Bennett, 2001). Combining comparative tables about full-fare and low-fare airlines (Gilbert, Child & Bennett, 2001, p, 314; Lawton, 2003, p. 178) noted that no-frills carriers were distinguished by few if any amenities and point-to-point transportation (see Table 1).

A low-cost carrier will take market share from an incumbent at market entry in addition to carving out a new market space (Jarach, 2004; Lawton, 2003). However, pursuing a low price strategy has the potential to put the company at risk (Garda & Marn, 1993). Thus, low-cost carriers' marketing strategies include advertising and promotions concentrated in secondary airports' catchment areas to building a corporate culture that is fun and exciting for passengers (Gilbert, Child & Bennett, 2001).

Table 1. Comparison of Characteristics of Low-Fare Airlines and Full-Fare Airlines

Low-fare Airline	Full-fare Airline
Simple brand-low-fare	Complex brand—price + service
Online and direct booking	Mainly travel agents
Reservations by telephone and Internet	
Simple ticket price structure and ticket less check-in	Complex fare structures Tickets produced for each booking
Use of secondary, low-charging airports (some exceptions)	Focus on primary airports
Located around major population centers	
High aircraft utilization—quick gate turnaround time	Lower utilization of aircraft
Do not interline; point-to-point service Offers non-stop routes	Interlining important part of service; hub and spoke services
Simple product—all additional services and facilities charged for, e.g., credit card bookings, late check-in, meals	Complex integrated service product(s), e.g., ticket flexibility, business lounges, frequent flyer program
Focus on ancillary revenue generation—advertising ('the plane as a billboard'), on board retailing (more common in Europe)	Focus on primary product
Mainly short-haul focus	Short and long haul
Common fleet type acquired at very good rates	Mixed fleet
Single type of aircraft	
Single class configuration	Cabins are usually divided into two or three classes to allow for different degrees of in-flight service
No complimentary in-flight meal service	Complimentary in-flight meal and drink(s)
Aggressive yield management by implementing various price levels and capacities depending on load factors and when tickets are purchased	Yield management by filling up set-price classes in order of bookings
Minimum cabin crew on board	Cabin crew more numerous as required
Only operate core activities. Outsource most operations	Less outsourcing of operations

Low ticket prices do not preclude no-frills carriers being concerned about value propositions that satisfy passengers' needs and wants (Lawton, 2003). Regular industry surveys question whether people are willing to fly with a low-cost airline. They focus on efficiency factors such as punctuality, scheduling, seating, and routes (Gilbert, Child & Bennett, 2001). Measuring willingness to fly alternately addresses the uncertainty felt by the public when choosing to travel by air (Lawton, 2003).

Beyond the basic efficiency factors, Bruning (1997) identified that customers' choice was also affected by country of origin and national loyalty. The traditional *one carrier, one flag carrier* model (Jarach, 2004, p. 29) identified that an airline's country-of-origin cued passenger expectations which in turn contributed to the carrier's reputation. Bruning (1997) explained that national loyalty stemmed from ethnocentrism and reference group manifestations that linked to in-group identity. Country of origin was the cue held globally whereas national loyalty stemmed from the felt identity of those who lived in the country or those who were born to the country.

METHODOLOGY

The study

Data collection for this study was conducted in two stages. The first stage was three focus group discussions. The second stage was a self-administered survey distributed throughout various public locations, that is, shopping malls and coffee houses, in the two emirates of Dubai and Sharjah.

Focus groups

Five people participated in each of the three focus groups. The first group was of single people still living at home but likely to use the airline for travel to visit relatives. The second group was of couples where one or both potentially traveled to nearby countries on business and/or purchased air travel for family holidays. The third group was of students living in the university dormitory who traveled by air between home and school. The groups were chosen following the literature search as likely passenger segments that would consider flying no-frills (Jarach, 2004). Low-fare, no-frills air travel was being introduced to the region for the first time when this study took place. Topics discussed included customers' expectations, concerns and likelihood of traveling with a no-frills airline.

The focus group respondents felt that the startup airline would appeal to three groups of people: (a) the price sensitive, that is, the UAE working class who have low household income levels and the laborer expatriates who travel only to their home country for vacations; (b) the frequent flyers, that is, students traveling to home during holiday periods and business travelers whose companies were locally rather than internationally based; and (c) the leisure travelers, that is, families flying to vacation destinations.

The focus group discussants concluded that that the most likely passengers would be the frequent flyer students and leisure travelers. The close proximity of the UAE to other countries in the region means students can fly home for weekend visits; quick trips are not a burden to the family financial resources. It was not feasible to include laborers as respondents. The cultural barriers that surround laborer employment mean that they work long hours, six or more days a week; they return to their barrack type housing by company bus at the end of the day.

Questionnaire

Questionnaire development followed the focus group sessions. The survey instrument asked about eight factors: (a) price of the ticket, (b) social class of fellow passengers, (c) punctuality of on-time departures and arrivals, (d) time that flights were scheduled to depart/arrive, (e) safety, (f) service on board, (g) seat size and spacing, and (h) entertainment facilities offered on the aircraft. Answer options were a 5-point Likert scale with 1 meaning not very important to 5 meaning very important and 3 meaning neutral. Respondents were asked to consider the eight factors as independent. Each factor was given equal weight.

The eight factors were set in two sets of questions. The first group related to traveling with any airline (*eight factors, any airline*). The second set referred to traveling with a no-frills carrier (*eight factors, no-frills*). The two sections were separated to prevent respondents from duplicating their replies from one series of factors to the other. The questionnaire was pre-tested by ten people from the sample population. Minor changes were made before the final self-administered document was distributed. Convenience was the primary sampling method although judgment of the fieldworkers was also required.

Analysis

The data was first explored for normalcy. It was not normally distributed according to the Kolmogorov-Smirnov and Shapiro Wilk tests; the p value was $< .05$. Had the p value been non-significant, $> .05$, then it would have fit the criteria for normal distribution (Field, 2000). Two non-parametric tests were used: chi-square for goodness of fit and the Wilcoxon Signed-Ranks test for comparing two sets of scores from the same subjects. Mean and median were obtained for the eight factors, any airline, and the eight factors, no-frills.

THE FINDINGS

The respondents

The demographic questions were limited to age, marital status, where respondents lived and the frequency of travel. Regarding age, 47% were 21 years or younger, 32% were 22-35 years and 21% were 36 years and older; the percentages reflected the country demographics. For marital status, 62% were single and 38% were married or divorced. Less than 30% of the 360 respondents lived in university residences. Selecting one or more of the three reasons respondents would travel by air, they said (a) flying home, including visits to relatives, (88%); (b) flying for holiday travel (56%); and (c) flying for business (19%). The UAE population is dominated by expatriates, which explained the high percentage of those flying home. The UAE geographic location means frequent vacation trips to other countries are accessible and quite common, which accounted for the high percentage of those flying for holiday. Thus, the respondents were representative of the potential passengers who would travel with an airline that served nearby destinations.

Segmenting by age, income and frequency of travel

The variable "would consider flying no-frills" was cross tabulated with age. As shown in Table 2, the break point for decreasing percentages was 21 years and younger, (75% saying yes) and 22 years and older (67% saying yes). In the regional culture, which includes Arabs and South Asians, people marry at a young age and by the end of the university years they have family responsibilities. Before graduation, air travel is typically paid by parents who choose low fare options. Later, when purchasing their own tickets, people seek the Arab hospitality service standards offered by full-service airlines. Although the chi-square was not significant, the p value was close at .052 for the cross-tabulation.

As noted in Table 2, the willingness to fly no-frills decreased as respondents' income increased. Those earning less than 5,000 UAE Dirhams (AED) per month (AED5,000 = US$1,370.00) said they would likely fly no-frills (80%). Similar percentages were obtained for the other income categories: AED5,001-10,000 (70%) and AED10,001-15,000 (71%). In the AED15,001+ per month income group only 46% said they would consider flying no-frills. Chi-square for "would consider flying no-frills" and income was significant at p = .000.

As indicated in Table 2, the three categories for travel frequency (flying home, flying for holiday and flying for business) were cross tabulated with the variable "would consider flying no-frills." Respondents were less likely to consider the no-frills option as the number of trips per year increased. The break point for flying home was 1-3 trips per year (75%); flying for holiday was 1-2 trips (50%) and flying for business, 1 trip (18%). Chi square was significant at p = .034 for traveling for holiday and p = .001 for traveling for business.

Table 2. Percentage of respondents who would consider flying no-frills by age, income and travel frequency

Age % Yes (in years)	Income % Yes (in AED)	Travel frequency % Yes (trips per year)		
21 & younger 75%	< 5000 80%	Flying home	For holiday	For business
22 & older 67%	5001-10000 70%	0 trips 12%	0 trips 45%	0 trips 82%
	10001-15000 71%	1-3 trips 75%	1-2 trips 50%	1+ trips 18%
	15001 + 46%	4+ trips 13%	3+ trips 5%	
p = .052	p = .000		p = .034	p = .001

Factors to consider – product and price

The eight usage factors focused on elements of product and price. Data analysis was conducted first for the any airline group. Next, the no-frills group was considered. All were framed in individual questions "how important is *factor* to you, on a scale of 1-5." The results, as reported in Table 3, include: (a) percentage of respondents who selected important or very important (answer options 4 and 5), (b) the mean and median of the 1-5 scale; (c) the position ranking the mean of each factor closest to the very important (answer option 5) end of the scale; (d) standard deviation; and (e) cross-tabulation of factor importance with yes responses to variables "would consider flying any airline" or "would consider flying no-frills."

Airline safety was the most important factor to respondents, regardless of the carrier type (4.22 mean, SD 1.063 for any airline and 4.18 mean, SD 1.057 for no-frills). The factor of least concern was entertainment facilities (3.21 mean, SD 1.182 for any airline and 3.12 mean, SD 1.234 for no-frills). Overall, the mean responses for the any airline factors were incrementally higher in importance, that is, closer to 5.0, than what respondents had to say about the no-frills factors. Cronbach's alpha was used to assess the internal reliability of the sixteen factors with a result of .803.

For any airline, punctuality (mean 3.95, SD .957) was the second highest rated factor (closer to 5.0), followed by ticket price (mean 3.91, SD .961) at third. For a no-frills carrier, ticket price (mean 3.94, SD 1.053) was the second highest rated factor and punctuality (mean 3.83, SD .991) was third. The other factors, that is, social class of fellow passengers, time that flights were scheduled to depart/arrive, service on board, seat size/seat spacing and entertainment facilities held the same fourth to eighth position for both any airline and a no-frills airline. But there was significant statistical difference with ticket price, social class of other passengers, punctuality, flight timings, service and seat spacing.

The Wilcoxon non-parametric test for two related samples determined that three factors (see Table 3) had z scores with significant p values: price (z

= -2.095, p = .036), punctuality (z = -2.221, p = .026) and service (z = -2.770, p = .006). The test statistic for each was based on the positive ranks. This concluded that when respondents were choosing to fly any airline, then price, punctuality and service were more likely to be considered and compared as a means of obtaining the best fare and service options. Alternately, when choosing to fly a no-frills airline, passengers already knew what to expect (for price, it was low-fare, for punctuality, the flights were point-to-point, and for service, it was no-frills). Additionally, the more robust parametric paired samples test was run for the two sets of eight factors. Significant p values were obtained for price (t = 2.121, p = .035), punctuality (t = 2.222, p = .027) and service (t = 2.753, p = .006).

The dichotomous yes-no question "would you consider flying Air Arabia" was cross tabulated with each of the eight factors for any airline and then for a no-frills airline. For any airline, chi square significance was obtained for price (p = .000), punctuality (p = .015), service on board (p = .004) and seat spacing (p =.013). For a no-frills airline, chi square significance was obtained on the following cross-tabulations: price (p = .004), other passengers (p = .014), punctuality (p = .036), flight timings (p = .009), service on board (p = .030) and seat spacing (p = .023). Only safety and entertainment did not have significant p values.

Table 3: Factors considered for any airline and for no-frills carrier

any airline							no-frills carrier					
%[(a)]	Mean[(b)]	Rank[(c)]	SD	Median	Cross-tab[(d)]	**Factors**	%[(a)]	Mean[(b)]	Rank[(c)]	SD	Median	Cross-tab[(d)]
71	3.91	3rd	0.961	4	77% p = .000	**Ticket Price**	67	3.94	2nd	1.053	4	72% p = .004
						(z = -2.095, p = .036)						
50	3.40	7th	1.054	3	47%	**Other Passengers**	46	3.39	7th	1.091	3	43% p = .014
71	3.95	2nd	0.957	4	74% p = .015	**Punctuality**	65	3.83	3rd	0.991	4	69% p = .036
						(z = -2.221, p = .026)						
55	3.50	5th	1.241	4	54%	**Flight Timings**	52	3.49	5th	1.180	4	51% p = .009
77	4.22	1st	1.063	5	76%	**Safety**	74	4.18	1st	1.057	5	77%
60	3.71	4th	1.050	4	55% p = .004	**Service**	55	3.57	4th	1.144	4	50% p = .030
						(z = -2.770, p = .006)						
51	3.48	6th	1.095	4	49% p = .013	**Seat spacing**	50	3.43	6th	1.102	4	48% p = .023
43	321	8th	1.182	3	43%	**Entertainment**	40	3.12	8th	1.234	3	41%

(a) % of respondents answering "important" and "very important" for the factor;
(b) mean for all respondents answers on the 5-point Likert scale;
(c) the mean values' position closest to 5.0 meaning very important;
(d) % = respondents who answered "important" or "very important" to the factor and "yes" to "would fly no-frills" cross-tabulation; p value is chi square results

Reaching the market – promotion and place

Promotion activities that would reach the target marketing were required when no-frills air travel was being introduced to the Arab region. Respondents favored advertisements through newspapers (80%) and television (64%). Directed promotion to specific target segments received limited support. For example, campus or university publications were supported by only 30% of the student-aged respondents while respondents in business (29%) felt that business magazines had limited value.

The preferred communication medium for making reservations was through a travel agent (58%). This was followed by booking online (51%). Speaking to an agent at a call centre was third (48%). Chi square significance ($p = .001$) was obtained for the cross-tabulation age and booking online. Two groups, 21 years and younger (52%) and 22-35 years (62%), indicated higher preferences for reserving air travel via the Internet than did the 36 years of age and older segment (34%).

DISCUSSION

Given that it was only days before the airline commenced flights, surprisingly 46% had not heard of the airline. However, when told of the startup, 40% expected the airline to be successful while 35% said they did not know. In the marketplace, it was noticeable that promotional activities, including advertising and news releases, were scarce. The Internet site for reservations was made operational only a few short weeks before the first flight; the call centre was opened only two weeks in advance. A multi-page insert in an Arabic version of a local newspaper announced when flight operations had begun. No insert was included in the English language version of the same paper. Thus, a large consumer segment was excluded as the target from the promotional material.

Response to the importance of the eight factors, for both any airline and no-frills, cross tabulated with the variable "would you consider flying Air Arabia" indicated that respondents assessed Air Arabia similar to any airline when considering ticket price, punctuality and safety (see Table 3). The findings implied initial hesitation towards Air Arabia until the traveling public was more familiar with the carrier or until the airline built its reputation.

The non-parametric Wilcoxon Signed Ranks test for the eight factors, any airline and the eight factors, no-frills identified significant z scores for price, punctuality and service, based on positive ranks. The interpretation was that respondents expected low fares from a no-frills carrier. Customers were more likely to question the ticket prices being charged by a full-service carrier. The same for service; the traveling public knew what to expect from a no-frills carrier, but comparatively assessed the service offerings when flying full-service. For punctuality, respondents were more likely to question whether flights arrived/departed on-time for full-service than for no-frills. Since the low-cost airline was point-to-point, it stands to reason that punctuality would not be as critical. On the other hand, if making connections, departure/arrival punctuality would be an important factor.

It was not unexpected that respondents preferred to make travel plans through agents. Ticket fare structure can be discounted at the point of purchase in the UAE, and travel agents tend to engage in discounting. The low response to promotions through student media and business publications indicated that the mass market appeal of newspapers was the more likely medium used by the traveling public when searching for fare specials and holiday flights.

As noted previously in this paper, the sequence of the eight factors for any airline was the same for the eight factors for a no-frills airline for position one and positions four through eight. This was an indication that the traveling public has many points of reference to be satisfied regardless of airline type. Additionally, the cross-tabulation of "would consider flying no-frills" with the eight factors produced chi square significant results for all except safety and entertainment on board. Arguably, this indicated that the respondents had high customer satisfaction expectations about the Air Arabia startup.

Overall, respondents appeared to be more critical of the new carrier, Air Arabia. The question was whether country-of-origin and national loyalty cues had contributed to their critical answers. The UAE is made up of seven emirates; each functions to some extent as its own country. Each emirate has its own cultural identity and government under the umbrella auspices of the richer, more established emirate of Abu Dhabi. Air Arabia established operations from the Emirate of Sharjah, which is less westernized and modern than its neighbor, Dubai. Sharjah also carries a stigma that it is regressive and restrictive due to the conservative dress codes and alcohol prohibition. The fact that respondents appeared to set higher standards for the no-frills startup suggested that country-of-origin cues (Air Arabia originating from Sharjah) influenced the results. National loyalty (pride in a national carrier) would be expected to offset country-of-origin concerns. If this had been the case, there would have been fewer significant chi-square cross-tabulations when the traveling public considered whether to fly Air Arabia.

When considering the potential market segments available to the low-fare, no-frills carrier, age and income were strong demographic factors: the lower the age and the lower the income, the more likely to use. However, this does not preclude attracting passengers from other segments as noted in the results. At the time of writing, Air Arabia has seemingly acknowledged the age variable given that their marketing now incorporates South Park-type characters attired in traditional Arab garments. Linking the adult animation figures to the Arab culture in such a way may arguably be considered as country-of-origin or national unity cues.

Limitations and future research

No study, including this one, is without limitations. Central to the research were the eight factors as they applied to any airline and to no-frills service. Each was approached as being independent and isolated one from the other. Under actual conditions, people searching for air travel may incorporate two or more and thus weight each differently rather than equally. A more in-depth examination of the factors would provide valuable insight about passenger preferences when no-frills air service is a travel option. Additionally, the eight factors were not all encompassing; this study focused on the ones most common from the literature (Gilbert, Child & Bennett, 2001) and likely the most fundamental.

Future studies would include gender and nationality. Had these demographics been included, more information would have been available about consumer segments. It may be argued that the sample was not truly representative of the population. Being aware that convenience and judgment sampling presented this risk, every effort was made to approach a variety of people to overcome the bias.

The timing of the study had its limitations. Air Arabia was about to launch and yet the public was largely unaware of the startup. This weakness was offset by the fact that respondents based their answers on personal reflection. Respondents had not been swayed by marketing efforts announcing the new carrier. The next research would involve the same set of eight factors studied more in-depth. Country-of-origin and national loyalty would be key issues to pursue.

CONCLUSION

Overall, the research results supported the view that Air Arabia would be able to compete successfully in the Arab region over the long term. Respondents, representing the traveling public expressed their willingness to consider a low-fare, no-frills option when making air reservations. Additionally, they expressed their confidence in the startup as noted in the similar percentages attributed to the eight factors, any airline and the eight factors, no-frills. No factor had results that indicated uncertainties and/or generated negative comparisons with full-service carriers.

The findings indicated that Air Arabia had the opportunity to pursue a greater share of the traveling public market through (a) increasing promotions to create awareness and (b) addressing the factors that concerned people when considering an airline. For example, the initial marketing efforts could have given safety assurances by mentioning that (a) experienced Canadian pilots were at the controls, (b) Airbus A-320 planes were latest off the assembly line, and (c) ground personnel had undergone extensive training to be qualified. The intended message would have been directed at overcoming and/or negating any hesitation felt by prospective passengers.

Given the nature of the UAE air industry and open skies policy, Air Arabia would be wise to operate within the criteria of a low-cost carrier as defined earlier in this paper. This would provide the differentiation they need in the very competitive marketplace. Maintaining this niche focus becomes more important as Emirates Airline is successfully transitioning the low-cost model of the short-haul carriers, that is, Southwest and easyJet into the full-service offering, long-haul industry. Under such operational guidelines, there is the expectation that ticket prices will be set to compete on the low-cost template (EasyOz, 2005, p. 70).

At the time of startup there was much skepticism whether this low-fare, no-frills airline would be able to attract customers. Public sentiment was that the typical passenger would be the student, and the low income laborer who returned to his/her home every few years. Since this research was conducted, Air Arabia has become a successful operator in the regional air industry. The marketing efforts were revamped and intensified to focus on broadening appeal to the traveling public. Additionally, service was scrutinized so as not to lose customers back to the full-service carriers. Air Arabia continues to operate in the low-fare, low-cost niche. Every year they expand their route network.

REFERENCES

Bruning, E. R. (1997) Country of origin, national loyalty and product choice, The case of international air travel. *International Marketing Review, 14*(1), 59-74.

EasyOz, Low-cost is coming to long-haul flights. Next could be low-fares. (2005). *Economist, October 29*, 70-71.

Field, A. (2000) Discovering statistics using SPSS for Windows. London, UK: Sage Publications.

Garda, R. A., & Marn, M. V. (1993). Marketing in transition: Price Wars. *McKinsey Quarterly, 3*, 87-100

Gilbert, D., Child, D., & Bennett, M. (2001) A qualitative study of the current practices of no-frills airlines operating in the UK. *Journal of Vacation Marketing, 7*(4), 302-315.

Jarach, D. (2004). Future scenarios for the European airline industry: A marketing-based perspective. *Journal of Air Transportation, 9*(2), 23-39.

Lawton, T. C. (2003). Managing proactively in turbulent times: Insights from the low-fare airline business. *Irish Journal of Management, 24*(1), 173-193.

Leavy, B. (2003). Assessing your strategic alternatives from both a market position and core competence perspective. *Strategy and Leadership, 31*(6), 29-35.

SITUATIONAL LEADERSHIP IN AIR TRAFFIC CONTROL

Marcus Arvidsson
Lund University
Lund, Sweden

Curt R. Johansson
Lund University
Lund, Sweden

Åsa Ek
Lund University
Lund, Sweden

Roland Akselsson
Lund University
Lund, Sweden

ABSTRACT

In high-risk environments such as air traffic control, leadership on different levels plays a certain role in establishing, promoting, and maintaining a good safety culture. The current study aimed to investigate how leadership styles, leadership style adaptability, and over and under task leadership behavior differed across situations, operative conditions, leadership structures, and working tasks in an air traffic control setting. Study locations were two air traffic control centers in Sweden with different operational conditions and leadership structures, and an administrative air traffic management unit. Leadership was measured with a questionnaire based on Leader Effectiveness and Adaptability Description (LEAD; Blanchard, Zigarmi & Zigarmi, 2003; Hersey & Blanchard, 1988). The results showed that the situation had strong impact on the leadership in which the leadership behavior was more relationship oriented in Success and Group situations than in Hardship and Individual situations. The leadership adaptability was further superior in Success and Individual situations compared with Hardship and Group situations. Operational conditions, leadership structures and working tasks were, on the other hand, not associated with leadership behavior.

Marcus Arvidsson, Ph.D., is a research associate at the Department of Psychology, Work and Organizational Psychology division at Lund University, Sweden. His research focus is mainly directed towards different organizational aspects and their relation to change processes and

INTRODUCTION

Leadership on different levels is believed to be a key factor in almost any organizational success (Moy, 2004; Silverthorne, 2001; Weil, Bogue & Morton, 2001). Bennis and Nanus (1985) suggested that one of the most important predictors of organizational achievement is effective leadership and that ineffective leadership often is a predictor of an organizational failure. In a high-risk environment, leadership on different levels seems to play a certain role in establishing, promoting, and maintaining a good safety culture, which is repeatedly stressed in the literature (Flin, 2003; Guldenmund, 2000). According to Bently and Haslam (2001), the management impact on safety arises both from their attitudes and their actions. The UK Health and Safety Regulator (HSE, 1999) points at management commitment, management style, and visible management as organizational factors that are associated with a safety culture. Several studies have also shown that safety is related to first-line supervisors' leadership style and team management skills (Flin, 2003). Further, the managers' commitment to safety and their attitudes concerning safety-related matters is of critical importance for a successful safety management system (Bailey, 1997; Clarke, 1999; Kirwan, 1998; O'Toole, 2002) and supervisors, site managers, and senior managers, all have significant positions in a safety management system (Flin, 2003).

Marcus Arvidsson (cont'd) safety culture within the aviation sector. He is a member of the of the multidisciplinary research centre Change@Work, the Lund HOFRIM group (Human and Organizational Factors in Risk Management) and the Swedish Centre for Aviation Research.

Curt R. Johansson, Ph.D., is professor in Work and Organizational Psychology at the Department of Psychology, Lund University, Sweden. He is member of the multidisciplinary research center Change@Work at Lund University and member of the Swedish National Committee for Psychological Sciences at the Royal Swedish Academy of Sciences. His main research interests are technological and organizational change processes, team and crew resource management, risk analysis and incident reporting.

Åsa Ek, Ph.D., is a research associate at the Department of Design Sciences, Division of Ergonomics and Aerosol Technology, Lund University, Sweden. Her research area is safety culture and safety management in organizations related to transport. She belongs to the Lund HOFRIM group (Human and Organizational Factors in Risk Management) and to LUCRAM, the Lund University Centre for Risk Analysis and Risk Management.

Roland Akselsson, PhD and MB, is professor in Ergonomics and Aerosol Technology at the Department of Design Sciences, Lund University, Sweden. He is member of Change@Work (director), LUCRAM (deputy director), and Metalund (project group leader) - three multidisciplinary centers at Lund University with focus on change processes, risk management and medicine and technology for work life and society, respectively. He is also a leader in the Lund HOFRIM group (Human and Organizational Factors in Risk Management). His main research interests are human and organizational factors in risk management.

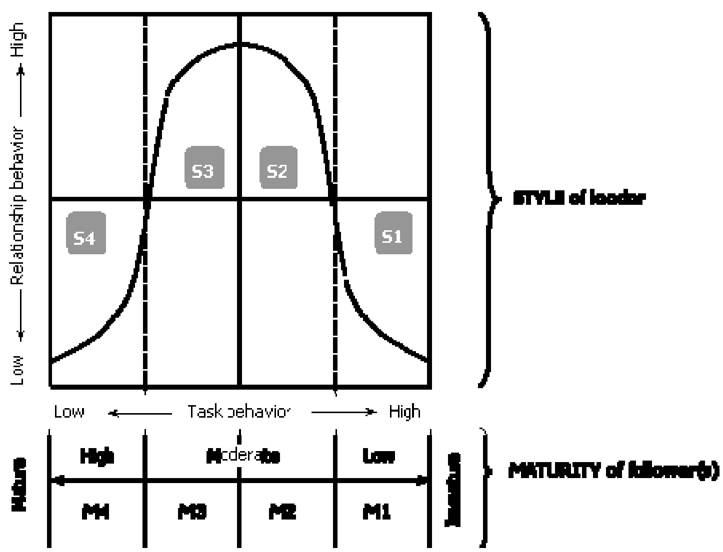
There is additional support in the literature which demonstrates that leadership can influence work-related stress in the psychosocial work environment. A supportive leadership style maintained by the leaders can act as a buffer for reducing work-related stress among employees in a demanding work environment (Bakker, Killmer, Siegriest & Schaufeli, 2000). According to Rowney and Cahoon (1988), leadership practices make a difference in the prevention or occurrence of stress and can help employees cope with stress factors. Leaders who allow employees a greater participation in decision-making and encourage a two-way communication process tend to generate a favorable climate among staff, characterized by less interpersonal conflict and hostility, and fewer non cooperative relationships (Oaklander & Fleishman, 1964). Assigning tasks, specifying procedures, and clarifying expectations have also been shown to result in reduced role ambiguity and increased job satisfaction among high occupational level employees (Gray-Toft & Anderson, 1985). On the other hand, the leadership can increase stress if it is too much control-oriented and structuring. A leader who constantly gives subordinates demanding instructions generates detectable physiological symptoms of stress among the staff (McCormick & Powell, 1988).

It is thus important for all organizations to understand the role of leadership and that they identify the styles of leadership most effective to their business. The role of leadership and of leadership style may be even more significant in high-technology companies because of their unique business environments (Silverthorne, 2001). In a high-risk environment, such as air traffic control, the role of leadership and leadership style should be no less important, since the operational work is conducted in a high-technology environment with great risk involved.

The Swedish Air Navigation Service Provider, which operates in a high-risk environment, has succeeded in creating an overall positive safety culture (Ek, Arvidsson, Akselsson, & Johansson, 2002) and psychosocial work environment (Arvidsson, Johansson, Ek, Akselsson, & Josefsson, 2004). The general purpose of this study is to investigate and describe situational leadership characteristics and leadership styles in this distinctive environment.

The theory is based on task and relationship leadership behavior and subordinate maturity (Blanchard & Johnson, 2000; Hersey & Blanchard, 1996; Hersey, Blanchard & Johnson, 2006). *Task behavior* is described as the extent to which leaders are likely to organize and define the roles of the members of their group, to explain what activities each has to do and when, where, and how tasks are to be accomplished. *Relationship behavior* is referring to the extent to which leaders are likely to maintain a personal relationship between themselves and members of their group by opening up channels of communications, providing socio-emotional support, and facilitating behavior. *Maturity* refers to the followers' experience, willingness and ability to take responsibility. The level of maturity determines the appropriate combination of task and relationship behavior for the leader (see Figure 1). The *leadership style profile* is thus a description of how task and relationship behavior are used separately and in combination.

Figure 1. The Situational Leadership Model (Hersey & Blanchard, 1996; Hersey, Blanchard & Johnson, 2006)



The theory attempts to provide leaders with some understanding of the relationship between an effective leadership style and the level of maturity of their co-workers. Because abilities and motives among co-workers vary the leader must have sensitivity and diagnostic ability to perceive and appreciate these differences. Yet, even with good diagnostic skills, leaders may still be not effective unless they can adapt their leadership style to meet the demands of their environment (Hersey & Blanchard, 1996; Hersey, Blanchard & Johnson, 2006). This implies that if the needs and motives among co-workers are different they must be treated differently. The *leadership style adaptability* is the measure of the leader's ability to use an appropriate leadership style in a given situation. *Over and under task behavior* indicates how a possible lack of leadership style adaptability is constituted and should be interpreted. Over task behavior occurs when the current leadership style is more task oriented than appropriate in a given situation, and under task behavior occurs when the current leadership style is less task oriented than appropriate.

STUDY LOCATIONS

To study situational leadership abilities, a group of team managers (TMs) were assessed by their team members at two Air Traffic Control Centers (ATCC) in Sweden, referred to as the *en route ATCC* and the *arrival-and-departure ATCC*. A group of department managers were further assessed by their department members at the Air Navigation Services (ANS) organizational unit, which is part of the Swedish LFV Group of Airports and ANS (Luftfartsverket) central head office. At the en route ATCC, the air traffic control work mainly consists of surveillance of en route air traffic, passing by on high altitude. At the arrival-and-departure ATCC the air traffic control work is more active since most of the work is connected to air traffic arriving and departing from different airports in the area. Each team is managed by a TM. The teams have only a tactical function to coordinate individuals with different working tasks and positions. Accordingly, they do not primarily serve as operative air traffic control units. The aim is to shorten information paths and make each employee enjoy greater participation and influence concerning the ATCC's overall operations and long term development. The TM's primary task involves human resource management, employee training and employee development, work scheduling, etc.

At the arrival-and-departure ATCC, each TM also holds the position as watch supervisor (WS). WS can be described as an operative management position. For each shift a WS has responsibility for the operative work and care for such things as air traffic distribution in different sectors and that the work is conducted in a safe manner within the existing regulatory framework.

At the en route ATCC, the TM position does not imply the position as WS. Instead, the TMs are regular air traffic controllers or air traffic control assistants with no operative management tasks.

The study further involves the ANS unit, dealing with general air traffic management issues such as air traffic flow and airspace management. The work is exclusively administrative; no operative air traffic control is conducted. The two ATCCs and the ANS unit differ mainly from each other with respect to working tasks and methods. The organizational structure can be described as consisting of different small departments managed by a department leader with ordinary supervising tasks.

HYPOTHESES

Apart from the followers' maturity, other factors in the environment can have an impact on the leadership style adaptability and the leadership style profile. The working situation itself can be characterized by Success or Hardship and leadership actions can occur in Group or Individual situations.

Hypothesis Ia therefore states that the *leadership style adaptability, over and under task behaviors and leadership style profiles are dependent on the working situation and thus differ in Group or Individual situations.*

Hypothesis Ib states that the *leadership style adaptability, over and under task behaviors and leadership style profiles are dependent on the working situation and thus differ in situations characterized by Success or Hardship*.

It is further assumed that the different leadership conditions at the two ATCCs will affect leadership performance.

Hypothesis II therefore states that the *leadership style profiles differ according to operational leadership conditions*.

Further it is assumed that the different working tasks and organizational structure at the ANS unit compared with the two ATCCs will affect the leadership.

Hypothesis III thus states that the *leadership style profiles will differ due to working tasks and organizational structures*.

The TMs at the arrival-and-departure ATCC who also holds the WS position practice leadership actions more frequently than the TM at the en route ATCC. Thus this group has more leadership experience with respect to both task requirements and relationship requirements and might therefore be more sensitive to followers' maturity also when they act as TM than TMs at the en route ATCC. The department managers at the ANS unit are, in addition, full time leaders with constant responsibility for the daily work and the department's performance which provide them with regular leadership experience.

Hypothesis IV therefore states that the *leadership style adaptability is assessed as more effective by organizational member's with more experienced leaders.*

Hypothesis V states further that *more experienced TMs and department managers will practice less over and under task behaviors than the less experienced TMs*, since these leadership aspects are related to the leadership style adaptability.

METHOD

Participants

The questionnaire used in the study was distributed to all 635 employees at the three units; 309 completed questionnaires were returned. Of these, 108 were filled out by employees at the en route ATCC, 102 by employees at the arrival-and-departure ATCC, and 99 by employees at the ANS unit. Altogether 39 respondents dropped out for reasons such as maternity/paternity leave, on leave for sickness, training, vacation, etc. This resulted in a final response rate of 53% for the en route ATCC, 49% for the arrival-and-departure ATCC, and 54% for the ANS unit. At the en route ATCC, 52 respondents (48%) were men and 56 women (52%); at the arrival-and-departure ATCC 53 were men (52%) and 49 women (48%); and at the ANS unit, 76 were men (76%) and 23 women (24%). Age, length of service, and position of the staff at the three units are presented in Table 1. The number of teams at the en route ATCC was 16, at the arrival-and-departure ATCC was 8 and at the ANS unit was 13.

Table 1. Age, Length of Service of the Staff at the Three Air Traffic Management Units: The en route Air Traffic Control Center, the Arrival-and-Departure Air Traffic Control Center, and the Air Navigation Services Unit

Age	21-30 years	31-40 years	41-50 years	>50 years
En route ATCC	23 (20%)	45 (42%)	20 (19%)	20 (19%)
Arr./dep. ATCC	34 (33%)	37 (36%)	18 (18%)	13 (13%)
ANS unit	10 (10%)	22 (22%)	25 (26%)	42 (42 %)
Length of service	0-24 months	2-5 years	6-10 years	>10 years
En route ATCC	2 (2%)	24 (22%)	13 (12%)	69 (64%)
Arr./dep. ATCC	2 (2%)	25 (24 %)	19 (19%)	56 (55%)
ANS unit.	10 (10%)	16 (17%)	7 (7%)	66 (66%)

Instrument

Situational leadership was measured with the questionnaire LEAD (Blanchard, Zigarmi & Zigarmi, 2003; Hersey & Blanchard, 1988) in a modified version (Holmkvist, 2000). The questionnaire consists of 32 items, reflecting different situations, which are described to the respondent. Each item is answered by one of four alternatives. The respondent is asked to choose the alternative that best describes the respondent's expected behavior of their leader in each situation (see Appendix). Each item concerns leadership in Group or Individual situations or in terms of Success or Hardship. The method is therefore managing four types of situations: Group or Individual situations and situations characterized by Success or Hardship.

Leadership measures and statistical analysis

For each study location and for each type of situation, the leadership style profiles were calculated as mean scores of the occurrence of each of four possible leadership styles S1-S4. S1 indicated high task/low relationship behavior, S2 high task/high relationship behavior, S3 low task behavior/high relationship and S4 low task/low relationship behavior (Hersey, Blanchard & Johnson, 2006). T-test for dependent samples was used to test for statistically significant differences between Success situations versus Hardship situations and between Individual situations and Group situations for each leadership style (Hypothesis Ia and Hypothesis Ib, respectively). T-test for independent samples was used to calculate statistically significant differences in the occurrence of each leadership style between the three study locations (Hypotheses II and III).

Leadership data were also calculated as mean scores with respect to leadership style adaptability for each situation and study location. The leadership style adaptability scale ranges from -32 (no adaptability) to +32 (full adaptability) for each situation. The weighting is based on the Situational Leadership Theory (Hersey, Blanchard & Johnson, 2006) and the leader with the highest probability of success of the alternatives offered in the given situation is always weighted +2. The leadership behavior with the lowest probability of success is always weighted -2. The second best alternative is weighted +1 and the third is weighted -1. T-test for independent samples was used to test for statistically significant differences in leadership style adaptability between the three study locations for each situation (Hypotheses I and IV).

For each study location and for each type of situation, the LEAD data were further calculated as mean scores concerning over and under task behaviors. The over and under task behavior scales range respectively, from 0 (no over or under task behavior) to 24 (maximum over or under task behavior) for each situation and are based on the leadership style adaptability. When the leadership style adaptability in a given situation is weighted +2 the over and under task behavior is 0. When the leadership style adaptability is weighted +1 the over or under task behavior is weighted +1, when -1 then +2 and when -2 then +3. T-test for independent samples was used to test for statistically significant differences in over and under task behavior between the three units and for each situation (Hypotheses I and V).

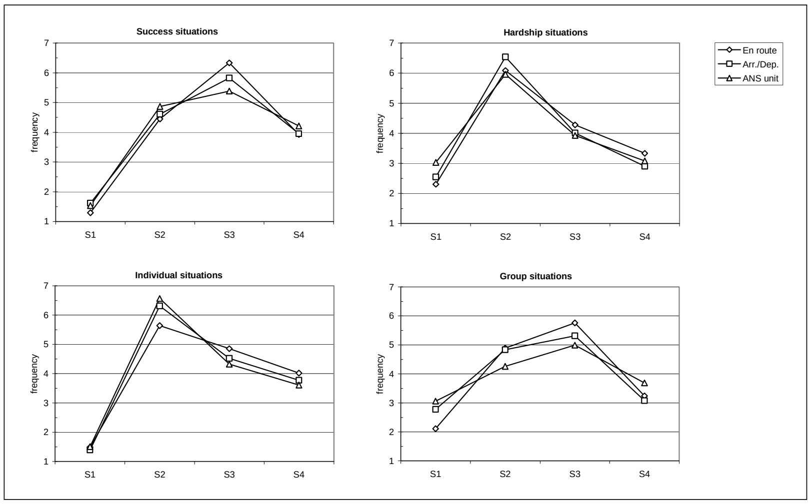
RESULTS

Leadership style profiles – Hypotheses I, II and III

For all situations and study locations, the two most seldom-used leadership styles were S1—high task/low relationship behavior, and S4—

low relationship/low task behavior, according to Figure 2. For Success and Group situations, the overall most frequently-used leadership style was S3—high relationship/low task behavior, and the second most frequently-used was S2—high task/high relationship behavior. In Hardship and Individual situations the most frequent leadership style used was S2—high task/high relationship behavior, and the second most frequent used was S3—high relationship/low task behavior.

Figure 2. Leadership Style Profiles in Success, Hardship, Individual and Group Situations for each Study Location.



When the three study locations were compared according to leadership styles in different situations, only leadership style S1—high task/low relationship behavior for Group situations, became statistically significant different in the comparison between the two ATCCs according to Table 2. This result indicates that the TMs at the arrival-and-departure ATCC more often used leadership style S1—high task/low relationship behavior in Group situations, compared with the TMs at the en route ATCC. In the comparison between the en route ATCC and the ANS unit, four differences became statistically significant. In Success situations, the leadership style S3—high relationship/low task behavior was more often used by the TMs at the en route ATCC than by the department managers at the ANS unit. On the other hand, the department managers at the ANS unit more often used leadership style S1—high task/low relationship behavior in Hardship situations, S2—high task/high relationship behavior in Individual situations and S1—high task/low relationship behavior in Group situations, compared with the TMs at the en route ATCC. In the comparison between the arrival-and-departure ATCC and the ANS unit no differences were statistically significant.

Table 2. Mean and Standard Deviation for the Occurrence of each Leadership Style in Success and Hardship Situations and in Individual and Group Situations at the Tree Study Locations and T-values for Differences between the Three Study Locations

Situation	Style	M			SD			t-value		
		E.r.	A.d.	ANS	E.r.	A.d.	ANS	E.r. / A.d.	E.r. / ANS	A.d./ ANS
								df=208	df=205	df=199
Success	S1	1.30	1.62	1.54	1.40	1.77	1.62	-1.46	-1.14	0.34
	S2	4.44	4.61	4.87	2.33	2.41	2.49	-0.50	-1.27	-0.76
	S3	6.33	5.82	5.38	2.92	2.59	2.87	1.34	2.36*	1.14
	S4	3.93	3.95	4.21	3.26	3.23	2.65	-0.06	-0.69	-0.63
Hardship	S1	2.31	2.55	3.03	2.34	2.19	2.78	-0.78	-2.03*	-1.36
	S2	6.08	6.54	5.96	2.81	2.38	2.49	-1.26	0.33	1.69
	S3	4.28	4.01	3.93	2.25	2.20	2.28	0.87	1.11	0.25
	S4	3.33	2.90	3.08	2.47	2.08	2.25	1.37	0.77	-0.59
Individual	S1	1.49	1.39	1.51	1.72	1.61	1.91	0.43	-0.06	-0.45
	S2	5.64	6.31	6.57	2.54	2.81	2.76	-1.83	-2.52*	-0.64
	S3	4.85	4.52	4.32	2.30	2.14	2.28	1.08	1.66	0.63
	S4	4.02	3.77	3.61	2.67	2.70	2.27	0.66	1.19	0.48
Group	S1	2.11	2.77	3.06	1.97	2.32	2.67	-2.24*	-2.93**	-0.81
	S2	4.89	4.83	4.26	2.49	2.22	2.12	0.17	1.94	1.86
	S3	5.76	5.31	4.99	2.90	2.57	2.92	1.18	1.90	0.84
	S4	3.24	3.08	3.69	2.71	2.42	2.25	0.46	-1.28	-1.85

For each leadership style S1-S4, there was a statistically significant difference in the mean occurrence of each leadership style between Success and Hardship situations according to Table 3. Also in the comparison between Individual situations and Group situations the mean occurrence of each leadership style was statistically significant.

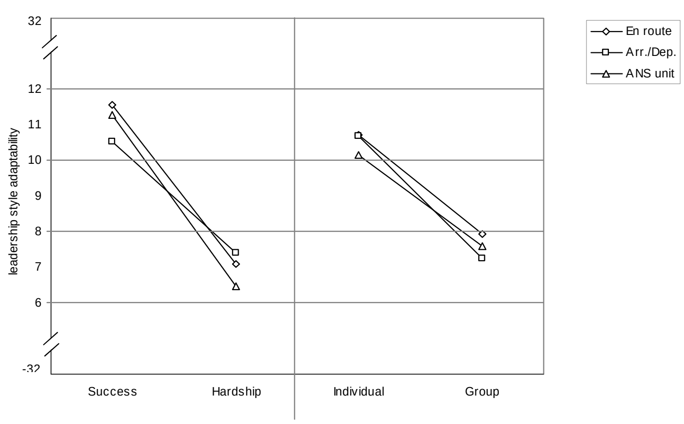
Table 3. Mean and Standard Deviation for the Occurrence of each Leadership Style in Success and Hardship Situations and in Individual and Group Situations and T-values for Differences between Success Situations versus Hardship Situations and between Individual Situations and Group Situations

Style	M				SD				t-value	
	Suc.	Hard.	Ind.	Grp.	Suc.	Hard.	Ind.	Grp.	Suc. / Hard.	Ind. / Grp.
									df=308	df=308
S1	1.48	2.62	1.46	2.63	1.60	2.46	1.75	2.35	-9.26***	-9.53***
S2	4.63	6.19	6.16	4.67	2.40	2.58	2.72	2.30	-9.81***	9.05***
S3	5.86	4.08	4.57	5.37	2.82	2.24	2.24	2.81	10.55***	-4.71***
S4	4.03	3.11	3.81	3.33	3.06	2.28	2.55	2.48	5.02***	3.27**

Leadership style adaptability – Hypotheses I and IV

The results indicated that the leadership style adaptability was superior in Success and Individual situations compared with Hardship and Group situations, as Figure 3 illustrates. The differences between Success and Hardship situations were statistically significant [$t(308) = 10.14$, $p \leq 0.001$)], as well as the differences between Individual and Group situations [$t(308) = 7.18$, $p \leq 0.001$].

Figure 3. Leadership Style Adaptability for the Three Study Locations in Success vs. Hardship Situations and Individual vs. Group Situations.



According to Table 4, no statistically significant differences concerning leadership style adaptability were found in any of the four studied situations in the comparisons among the three study locations.

Table 4. Mean and Standard Deviation for Leadership Style Adaptability for each Study Location and Situation and T-values for Differences in Leadership Style Adaptability between the Three Study Locations

Situation	M			SD			t-value		
	E.r.	A.d.	ANS	E.r.	A.d.	ANS	E.r. / A.d.	E.r. / ANS	A.d. / ANS
							df=208	df=205	df=199
Success	11.56	10.53	11.27	6.20	6.29	5.78	1.20	0.35	-0.87
Hardship	7.09	7.40	6.46	6.91	7.63	6.03	-0.31	0.69	0.96
Individual	10.71	10.69	10.14	6.68	7.61	6.45	0.03	0.63	0.55
Group	7.94	7.25	7.60	6.06	6.36	5.73	0.82	0.42	-0.41

Note. A.d. refers to Arrival-and-departure air traffic control center, E.r. refers to En route air traffic control center, ANS refers to air navigation services unit.

Over and under task behavior – Hypotheses I and IV

The results indicated that the frequency of over and under task behavior was dependent on the situation, according to Figure 4. Thus, the comparisons between Success and Hardship situations concerning over task behavior turned out to be statistically significantly different [$t(308) = 6.55$, $p \leq 0.001$] as well as concerning under task behavior [$t(308) = 2.10$, $p \leq 0.05$]. Further, comparison between Individual and Group situations concerning over task behavior was statistically significantly different [$t(308)= 4.63$, $p \leq 0.001$]. No statistically significant differences appeared in the comparison between Individual and Group situations concerning under task behavior.

The under task behavior was more dominant than the over task behavior according to Figure 4, and the difference between under and over task behavior was statistically significant for Success situations [$t(308)= 7.90$, $p \leq 0.001$], Hardship situations [$t(308) = 4.96$, $p \leq 0.001$], Individual situations [$t(308) = 7.82$, $p \leq 0.001$] and for Group situations [$t(308)= 5.51$, $p \leq 0.001$].

Figure 4. Over and Under Task Behavior for each Study Location in Success vs. Hardship Situations and in Individual vs. Group Situations.

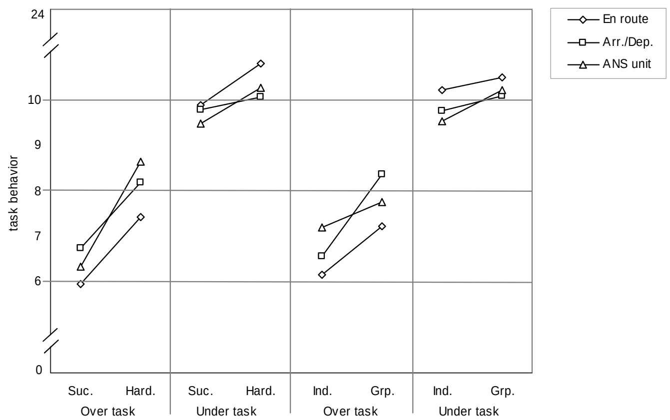


Table 5. Mean and standard deviation for over and under task behavior in Success and Hardship situations, and in Individual and Group situations at each study location and T-values for differences in over and under task behavior between the three study locations

Task behavior	Situation	M			SD			t-value		
		E.r.	A.d.	ANS	E. r.	A.d.	ANS	E.r. / A.d.	E.r. / ANS	A.d. / ANS
								df=208	df=205	df=199
Over	Suc.	5.94	6.74	6.34	3.69	3.97	3.97	-1.50	-0.75	0.70
	Hard.	7.44	8.20	8.64	3.82	4.21	4.78	-1.37	-2.01	-0.69
Under	Suc.	9.90	9.79	9.49	4.96	5.23	4.10	0.15	0.63	0.45
	Hard.	10.81	10.06	10.27	5.68	5.09	4.86	1.00	0.72	-0.30
Over	Ind.	6.17	6.56	7.21	3.34	3.90	3.72	-0.78	-2.13	-1.22
	Grp.	7.21	8.37	7.77	3.87	4.16	4.82	-2.09	-0.92	0.95
Under	Ind.	10.21	9.75	9.55	4.99	5.45	4.34	0.64	1.02	0.30
	Grp.	10.49	10.10	10.22	4.89	4.61	4.78	0.60	0.40	-0.19

Note. A.d. refers to Arrival-and-departure air traffic control center, E.r. refers to En route air traffic control center, ANS refers to Air Navigation Services unit.

When the three study locations were compared concerning over and under task behavior in different situations, no statistically significant differences appeared, according to Table 5.

DISCUSSION

According to Hypotheses Ia and Ib, it was assumed that the leadership style adaptability, leadership style profiles, and over and under task behavior should differ in Group or Individual situations, and in situations characterized by Success or Hardship. The results gave strong support for these hypotheses. The results indicated that the frequency of leadership styles in use were statistically significantly different among all situations, and the leadership style adaptability was assessed as superior in Success and Individual situations compared with Hardship and Group situations. The same pattern holds true for over and under task behavior, which both were statistically less frequent in Success situations, compared with Hardship situations. In Individual situations over task behavior was also less frequent than in Group situations. Further support for Hypothesis I was found in the overall results, which showed that the two most seldom-used leadership styles were S1—high task/low relationship behavior, and S4—low relationship/low task behavior. For Success and Group situations, the overall most frequently used leadership style was S3—high relationship/low task behavior, and the second most frequently-used was S2—high task/high relationship behavior. In Hardship and Individual situations, the most frequent leadership style used was S2—high task/high relationship behavior, and the second most frequently-used was S3—high relationship/low task behavior. This indicates that the leadership was more relationship-oriented and supportive in Success situations and Group situations and more task oriented in Individual situations and in Hardship situations.

It was further assumed according to Hypothesis II, that the leadership style profiles should differ between the two ATCCs because of different leadership structures and operational conditions. This hypothesis was not supported, since only one significant difference was found between these two study locations. When the en route ATCC was compared with the ANS unit, according to Hypothesis III, four statistically significant differences appeared. At the ANS unit the leadership style S—high task/low relationship behavior, was assessed as more frequent in Hardship and Group situations, compared with the en route ATCC. The leadership style S2—high task/high relationship behavior, in Individual situations, was further assessed as more frequently used by the staff at the ANS unit. On the other hand, the en route ATCC assessed the leadership style S3—high relationship/low task behavior, as more used by the leaders than the ANS unit did. Even though some differences appeared, no obvious pattern emerged that clearly distinguished these two units from each other. Since these analyses further included a large number of comparisons, there is a possibility that some statistically significant differences are due to chance. In the comparison between the arrival-and-departure ATCC, and the ANS unit, no differences were statistically significant. Thus, these results did not unequivocally support the assumption that the leadership behavior at the three units differed in a systematic way. Instead, the leadership style profiles were similar at the three units as Figure 2 shows. Therefore, we conclude that the air traffic control work and the air traffic management have a stronger effect on the leadership style than differences in the leadership conditions and work tasks, for the three organizations reviewed by this study.

The leadership style S3—high relationship/low task behavior, which was most frequently used in Success and Group situations, is referred to as a participative leadership style by Hersey, Blanchard & Johnson (2006). Participative leadership is known from other studies to generate a favorable climate among the staff, characterized by less interpersonal conflicts and better cooperative relationships (Oklander & Fleishman, 1964), which is positive for the psychosocial work environment. A supportive leadership style can further act as a buffer for reducing work-related stress according to Bakker et al. (2000). Since no strong support was found for Hypothesis II or Hypothesis III, a supportive leadership style seems to be promoted by the leaders at all units in Group and in Success situations. It is probably easier for a leader to release control and task-oriented behavior in a favorable situation, and give more responsibility to a group of followers than to a single individual. The results give further support for this view since the leadership was assessed as more task-oriented in Individual situations and in Hardship situations. Even though a supportive and participative leadership can be favorable for the psychosocial work environment, a task-oriented leadership is sometimes suitable and assigning tasks, specifying procedures, and clarifying expectations can, according to Gray-Toft & Anderson (1985), result in reduced role ambiguity and increased job satisfaction. The key is to adjust the leadership to fit the current situation and the maturity level among the followers.

The ability to do so seems to be dependent on the situation, according to the present results. As mentioned previously, the leadership style adaptability was statistically significantly more accurate in Success and Individual situations than in Hardship and Group situations. The leadership adaptation process seems, therefore, to be more complex when facing a group, and in situations where problems are present in the environment. According to Hypothesis IV, the leadership style adaptability was assumed to be more efficient among the department managers at the ANS unit and TMs at the arrival-and-departure ATCC compared with the TMs at the en route ATCC. This was because the department managers at the ANS unit constantly practice leadership and the TMs at the arrival-and-departure ATCC have an air traffic control operative management function that the TMs at the en route ATCC do not have. The results did not indicate that this should be the case, however. No differences between the three units were statistically significant, which implies that the leadership style adaptability was not affected by the different leadership conditions or the amount of leadership conducted. This might be somewhat surprising, but the administrative character of air traffic control work could, as previously mentioned, have an impact on the leadership practice. Since most of the activities in air traffic control involve great risks, the work is performed within a strict regulatory framework with standardized routines. The leadership actions could therefore be affected by the extensively standardized work environment and administrative procedures since the leader have no impact on the regulatory framework. The space that will allow leadership adaptation is limited, at least in the operative work. In addition, the air traffic controllers are well-trained and confident in their profession. No one knows better than them how to control the air traffic within their current sector. The leader has not the same overview or situational awareness concerning the current traffic as the air traffic controller. In that sense, the air traffic controllers are extremely mature in relation to their work tasks and current air traffic situation, whereby leadership adaptation becomes almost irrelevant.

As mentioned previously, the most seldom practiced leadership style was S1—high task/low relationship behavior, which implies that the amount of task-oriented leadership was limited. The assessment of over and under task behavior gave further support for this view since the occurrence of under task behavior was statistically significant more often in all situations measured. Since for safety reasons, air traffic control work is conducted within a strict framework of rules and regulations, a more task-oriented behavior could be expected. Even if the evidence on exactly how leadership influences organizational safety is less clear, it is apparent that psychologists attempting to measure safety culture believe that managerial actions and their commitment to safety are core components in the safety culture (Flin, 2003). Past research by Zohar (2002) implies that a leadership behavior that closely monitors workers' safety-related behavior can significantly improve the organizational safety. Despite this, the positive safety culture assessed in the Swedish ANS does not seem to be affected by the lack of task oriented leadership style among the TMs. A close monitoring of the safety work does not, however, necessarily contradict a more relationship-oriented leadership style. As mentioned previously, the air traffic controllers are further well trained and thereby mature in relation to their work, whereby no task oriented leadership is needed.

It was further assumed, according to Hypothesis V, that the department managers at the ANS unit and the TMs at the arrival-and-departure ATCC should practice less over and under task behavior, compared with the TMs at the en route ATCC, since this behavior is related to the leadership adaptability. The results gave no support for this hypothesis, however. Since no differences were found in the leadership style adaptability this result might not be surprising.

The results from this study describe the situational leadership as rather homogenous over the three study locations despite differences in the leadership conditions. It is therefore assumed that the characteristics of air traffic control had a greater impact on the leadership performance than local differences in the organization. Large differences existed, on the other hand, between different types of leadership situations, with more accurate leadership adaptability in Success and Individual situations and a more supportive and relationship-oriented leadership in Success and Group situations.

Even if past research has shown that the safety culture and the psychosocial work environment in many aspects are dependent on the leadership performance, it is hard to know whether, and in what way, the leadership described in this study has contributed to the overall positive safety culture and psychosocial work environment that exists in the Swedish ANS (Ek et al., 2002; Arvidsson et al., 2003). Thus, more research is needed to study the linkage between specific leadership styles and safety-related organizational aspects and working environment in air traffic control.

The extent to which the results can be applied to other industries or settings is also an issue that needs to be considered. There are many characteristics in this environment that does not apply to other business environments, for example, the regulatory framework, standardized work procedures, etc. Air traffic control shares, in addition, certain conditions with other highly regulated environments that are automated and include significant risk factors. Therefore, some of the knowledge gained in these studies may be valuable also outside the area of air traffic control.

REFERENCES

Arvidsson, M., Johansson, C. R., Ek, Å., Akselsson, R., & Josefsson, B. (2004). *Relationship between safety culture and psychosocial work environment in air traffic control.* Proceedings of the 2004 International Conference on Human-Computer Interaction in Aeronautics. Toulouse: Eurisco.

Bailey, C. (1997). Managerial factors related to safety program effectiveness: an update on the Minnesota perception survey. *Professional Safety, 8*, 33–35.

Bakker, A. B., Killmer, C. H., Siegriest, J., & Schaufeli, W. B. (2000). Effort reward imbalance and burnout among nurses. *Journal of Advanced Nursing, 31,* 884-891.

Bennis, W., & Nanus, B. (1985). *Leaders: The strategies for taking charge*. New York: Harper Row.

Bently, T., & Haslam, R. (2001). A comparison of safety practices used by manager of high and low accident rate post offices. *Safety Science, 37*, 19-37.

Blanchard, K., & Johnson, S. (2000). *The one minute manger*. Harpercollins Publishers: London.

Blanchard, K., Zigarmi, P., & Zigarmi, D. (2003). *Situational leadership II*. San Diego, CA: The Ken Blanchard's Companies.

Clarke, S. (1999). Perception of organizational safety: implications for the development of safety culture. *Journal of Organizational Behavior, 20*, 185−198.

Ek. Å., Arvidsson, M., Akselsson, R., & Johansson, C. R. (2002). Safety culture in the Swedish air navigation services. In C. Weikert, E. Torkelsson, & J. Pryce (Eds.), *Occupational health psychology: Empowerment, participation & health at work* (pp. 58-61), Nottingham: I-WHO Publications.

Flin, R. (2003). "Danger-men at work": Management influence on safety. *Human Factors and Ergonomics in Manufacturing, 13(4)*, 261-268.

Gray-Toft, P., & Anderson, J. G. (1985). Organizational stress in the hospital: development of a model for diagnosis and prediction. *Health Services Research*, 19, 753-774.

Guldenmund, F. W. (2000). The nature of safety culture: A review of theory and research. *Safety Science, 34*, 215-257.

Hersey, P., & Blanchard, K. (1996). *Management of organizational behavior*. New Jersey: Prentice-Hall Inc.

Hersey, P., Blanchard, K., & Johnson, D. (2006). *Management of organizational behavior: Utilizing human resources*. Academic Internet Publishers Incorporated.

Hersey, P., & Blanchard, K. (1988). *LEAD questionnaires*. Escondido, CA: Center for Leadership Studies Press.

Holmkvist, H. O. (2000). *Din Ledarstil*. [Your leadership style]. Lund, Sweden: Polygonen AB. (In Swedish).

HSE. (1999). *Reducing error and influencing behaviour.* Suffolk: HSE Books.

Kirwan, B. (1998). Safety management assessment and task analysis—A missing link. In: Hale, A., Baram, M. (Eds.), *Safety management: The challenge of change* (pp. 67-91). Oxford: Elsevier Science Ltd.

McCormick, C. P., & Powell, B. (1988). Management for the 1990s. *Newsweek, 4,* 47-48.

Morley, I. E., & Hosking, D-M. (2003). Leadership, learning and negotiation in a social psychology of organizing. In N. Bennet, & L. Anderson (Eds.), *Rethinking educational leadership: Challenging the conventions* (pp. 43-59). London: Sage Publications Ltd.

Moy, R. L. (2004). Investment leadership: Building a winning culture for long-term success. *Financial Analysts Journal, 60*, 94-95.

Oaklander, H., & Fleishman, E. A. (1964). Patterns of leadership related to organizational stress in hospital settings. *Administrative Science Quarterly, 8,* 520-532.

O'Toole, M. (2002). The relationship between employees' perceptions of safety and organizational culture. *Journal of Safety Research, 33*, 231–243.

Rowney, J. I. A., & Cahoon, A. R. (1988). OD for managers: Some fall-out from empirical results. *Leadership & Organization Development Journal, 7*, 15-17.

Silverthorne, C. (2001). Situational leadership style as a predictor of success and productivity among Taiwanese business organizations. *Journal of Psychology, 135*, 399-413.

Weil, P. A., Bogue, R. J., & Morton, R. L. (2001). *Achieving success through community leadership*. Chicago: Health Administration Press.

Zohar, D. (2002). Modifying supervisory practices to improve sub-unit safety, a leadership-based intervention model. *Journal of Applied Psychology, 87*, 156-163.

APPENDIX

Example of LEAD question

Situation

The project group that your leader is supervising has come to a dead end. The group has misunderstood parts of the project definition and puts the blame on poor briefing. Meetings are used for pseudo-activities.

Alternative actions

A. Your leader gathers the group and ensures that everybody who has any views is allowed to speak his mind. Your leader responds to misapprehensions, supports realistic proposals and shares her or his experience.

B. At a meeting your leader makes a point of bringing out the group's own resources for solving the problems.

C. Your leader collects the group as soon as possible and finds out what has gone wrong. He or she clarifies the project description until convinced that everyone has understood.

D. Your leader helps the group to understand why the group has got into trouble and supports their own way of grappling with the problems.

THE VERY LIGHT JET ARRIVES: STAKEHOLDERS AND THEIR PERCEPTIONS

Richard Cobb
Jacksonville State University
Jacksonville, Alabama

James L. Thomas
Jacksonville State University
Jacksonville, Alabama

Laura A. Cobb
Auburn University
Auburn, Alabama

ABSTRACT

This article summarizes the initial results of a systematic study that addressed issues related to the direct and indirect market impact of very light jet (VLJ) aircraft. Although reports in the popular press offer wide-ranging estimates of the impact that these new jets will have on existing air travel, no systematic data exists that may be of use to all potential stakeholders. This introductory study serves to describe potential VLJ users and their perceptions of this new type of aircraft.

Richard Cobb (Ph.D., The University of Alabama) is a professor of management at Jacksonville State University. His research has appeared in such publications as *Simulation, Quality Progress, Academy of Strategic Management, Journal of Air Transport Management*, and the *Journal of the International Academy for Case Studies*. He has been published in numerous conference proceedings.

James L. Thomas (Ph.D., University of Mississippi) is currently an associate professor of marketing at Jacksonville State University. His research has appeared in such publications as the *Journal of Retailing, Business Ethics Quarterly, Journal of Nonprofit and Public Sector Marketing,* and the *Journal of Marketing Theory & Practice.* He has also published papers in several national and regional conference proceedings.

Laura A. Cobb (MBA, Auburn University) is a cost specialist in the market research and technology department of Blue Cross and Blue Shield of Alabama. Her research interests are in finance and transportation. She has been published in both national and regional conference proceedings.

INTRODUCTION

On rare occasions, revolutionary products will enter an existing market and offer a design so unique as to create a new product classification. Much like the change in the computer industry brought about by the introduction of the personal computer or the change in the phone industry brought about by the advent of the cellular phone, many experts in the aviation industry feel that the very light jet (VLJ), known by some as the microjet (Seidenman, 2004), will also have a ground-breaking effect on the air travel equation. These aircraft will have five to six passenger seats, weigh less than 10,000 pounds, and be able to operate safely from airports with runways as short as 3,000 feet. Initial data indicates that these aircraft will offer jet utility and performance and will be able to operate at lower costs relative to traditional jets (Asker, 2005). Industry insiders predict that VLJs will bring about dramatic changes for air travelers, aircraft operators, and providers of aircraft support services. The president of the National Business Aircraft Association (NBAA) predicts a new era of business travel will begin with the introduction of the VLJ (Morrison, 2005).

On July 27, 2006, the Federal Aviation Administration (FAA) granted provisional certification to Eclipse Aviation and its Eclipse 500 (FAA, 2006), the first of fourteen manufacturers seeking certification of twin- and single-jet designs, ranging from the traditional Cessna Aircraft Company to the nontraditional Honda Motor Company (Haines, 2005; Lunsford, 2004; VLJ Magazine, 2007). In support of the aircraft, the NBAA, based on its knowledge of the users and manufacturers of these aircraft, has developed and released pilot training guidelines that many predict will become a baseline for VLJ insurance coverage, a service necessary for aircraft financing (NBAA, 2005; Trautvetter, 2005b). In a related article, Asker (2005) reviewed recent VLJ sales data and noted that aviation industry analysts have predicted hundreds of cities could be transformed by low-cost air taxi service through the introduction of VLJs. Ells (2005) noted that travelers are becoming more aware of the utility and economy of airport-to-airport direct travel and affordable VLJs will provide a big boost to this market. Support for these predictions can be found in a recent report of a Teal Group study. This study concluded that business jet service is expected to grow because unlike air carriers operating from larger airports, business jets can serve smaller cities and offer less hijack threat and less security hassle (Solon, 2005).

Studies conducted by organizations or by manufacturers are routinely referenced, and positive forecasts for future growth in the VLJ market are commonly cited in today's literature (Seidenman, 2004; Trautvetter, 2005a). The depth and completeness of these studies are not publicly available, however, and no common VLJ market information exists for all stakeholders. For example, the question of sales demand for VLJ aircraft is a basic inquiry for manufacturers entering this market. When looking at published research, Trautvetter (2005a) found wide-ranging estimates of VLJ demand with Rolls-Royce predicting 8,000 deliveries by 2023, Inflight Management Development Centre forecasting sales of 847 aircraft by 2013, and the FAA forecasting demand for 4,500 aircraft by 2016. Market data from manufacturers is equally confusing with a sales forecast of from 5,000 to 10,000 VLJs by 2014 (Seidenman, 2004).

INSURANCE, TRAINING, AND REGULATORY ISSUES

Predicting the availability of services in support of VLJ operation is important. Olcott (2004) reviewed the emerging VLJ market and discussed how best to train pilots, gain acceptance by the professional flying community and the FAA, and overcome the problem of insurability of owner-pilots. In reviewing some of these same concerns, Trautvetter (2005a) suggested that because of FAA scrutiny and NBAA training guidelines, insurance costs for VLJ aircraft could be less than turboprop single-engine aircraft. The *NBAA Training Guidelines for Single Pilot Operation of Very Light Jets and Technically Advanced Aircraft* was completed in January 2005 and included guidelines for initial candidate evaluation, pre-training study, manufacturer's training, post rating training, initial operating experience, and annual recurrent training. The guidelines cover four levels of training and suggest level of training should be based on experience. For example, a pilot transitioning from the left seat of a jet aircraft is classified in category 1 and would receive 25 hours of operating experience while a less experienced single-engine pilot would be classified in category 4 and would receive 100 hours of operating experience. Intermediate level single- and twin-engine turboprop cabin-class experience would require 35 hours for category 2 training and 50 hours for category 3 training. Cessna Aircraft Company and Adam Aircraft Company have predicted anywhere from 14,000 to 20,000 twin-engine and turboprop aircraft owners as potential customers to move up to a VLJ (Trautvetter, 2005b). Similar guidelines for dual or mentor instruction are evident for the leading manufacturers (Eclipse, 2007; Sierra, 2007).

In a presentation at the Latin American Business Aviation Event, Stine (2005) noted many common misconceptions about the availability of insurance for owner-flown VLJs. In his summary, he stated that VLJ certification will follow predictable past models, most insurance underwriters are studying coverage guidelines, and some companies have already announced VLJ coverage based on proficiency and specific training requirements. In a more recent review of the state of the aircraft insurance industry, Chappell (2006) concluded that VLJs would be insurable and premiums would be based on aircraft quality; pilot skill and experience; and transition training programs. He also concluded that the jet single-pilot operation would be insured at higher liability limits accompanied by higher premiums.

Government support for these aircraft is also critical to success. In his review of government support initiatives, Stine (2005) found several positive examples. He noted that the FAA had provided additional resources for VLJ aircraft certification and revisions were being considered to key Federal Aviation Regulations to allow Part 23 certification for single-pilot Part 135 operations. He also found the FAA was supporting the development of FAA Industry Training Standard for Technically Advanced Aircraft. He concluded that once certified and in service, VLJs are more likely to use smaller general aviation airports and thus would not add to congestion at larger airports. This logic should be supported by most air-taxi operators seeking efficiency, profitability, and point-to-point customer travel needs.

Reviewing the good and bad aspects of VLJ operations, Webster (2006) offered his expert commentary to the International Risk Management Institute. In his review he considered the range of pilot skills, aircraft use, and owner-pilot background. He concluded faster aircraft could be safer aircraft if pilots are properly trained and the new aircraft type is given respect.

RESEARCH METHODOLOGY

This study was undertaken to provide the data needed to answer some of these questions about the VLJ market. The data was gathered by means of a self-administered questionnaire delivered electronically via the Internet. The mailing list for the study was an opt-in list of magazine subscribers to *Business & Commercial Aviation.* The questionnaire consisted of a section designed to measure the use of air service by respondents' organizations, a section designed to assess perceptions and expected use of VLJ aircraft, and a demographic section to measure business characteristics.

PRELIMINARY RESULTS

While the response rate for the study is disappointing (160 respondents or 3.18%), the sample achieved does appear to be representative of the target population. The validity of the sample may be indicated by two factors. First, those organizations that operate their own passenger aircraft stressed the importance of the availability of resources for such travel to a statically greater extent than organizations that do not operate their own aircraft. Second, and even more revealing regarding the nature of the sample, those that operate their own aircraft were statistically more likely to use VLJs for trips under 500 miles than organizations that do not operate their own aircraft. In other words, the sample appears to consist primarily of organizations that comprise the target market for VLJs.

Furthermore, in summarizing significant positive responses (Table 1), we observed that the majority of the organizations represented in the sample, 59.4%, use air services often (multiple flights per week) or extensively (multiple flights per day) and the vast majority of firms operate their own passenger aircraft (72.5%). Additionally, 78.8% of the respondents occupy middle managers or higher positions in their firms. Even more importantly, 73.8% identify themselves as either a strong influencer or the main decision maker for the buying center of the organization. Not surprisingly, most company trips are comprised of management personnel, 40.6%, or a mixture of different personnel, 53.8% (Table 2). Finally, the majority of respondents appear to work for large businesses in that 60.1% reported annual organizational revenues of more than $6,000,000 and employment of an average of 4,536 organizational employees (Tables 3 and 4).

Table 1. Use of Air Service

		Yes (N=160)	Percent
1.	Does your organization use air services multiple times/day?	39	24.4%
2.	Does your organization use air services multiple times/week?	56	35.0%
3.	Does your organization operate its own passenger aircraft?	116	72.5%
4.	Percent of flights using commercial air carriers?	147	91.9%
5.	Do you prefer jet aircraft over turboprop aircraft?	118	73.8%
6.	Percent of your flights involving 6 or fewer personnel?	141	88.1%
7.	Percent of your flights involving 4 or fewer personnel?	127	79.4%
8.	Are you in a key managerial position in your firm?	126	78.8%
9.	Are you a strong influencer or buying center decision maker?	118	73.8%

Table 2. Type of Personnel that Uses Passenger Air Services

	Number	Percent
No one	3	1.9%
Primarily upper management	53	33.1%
Primarily middle management	9	5.6%
Primarily line management	3	1.9%
Sales Representatives	5	3.1%
Other Personnel	1	0.6%
A mixture of different personnel	86	53.8%
Total	**160**	**100.0**

Table 3. Considerations before a Very Light Jet Purchase

	Min	Max	Mean	Std. Dev
To be considered effective, how many hours per year should very light jet aircraft be used?	2	1,008	343	205
To be considered effective, how many trips (flights) per year should the very light jet be used?	1	600	109	105
Number of locations your organization operates	1	1,000	32	123
Number of employees in your organization	1	80,000	4,536	12,771
Number of college educated employees in your organization	0	30,000	570	3,122

Of key interest are the results regarding the number of personnel using air services and the likelihood the use of air services will increase with the introduction of VLJs. Understanding that VLJs can accommodate up to six passengers, respondents were asked how many organizational personnel typically board the same flight. Of the sample, 88.1% reported that normally six or fewer of their personnel fly on the same flight (Table 1). With a normal seating capacity of six to seven (Seidenman, 2004) and with manufacturers targeting air-taxi operators and owner-pilots, VLJs appear to be well suited to address these organizations' air service needs.

Table 4. Annual Gross Sales/Revenues for Respondent Organizations

	Frequency	Percent Responding
Less than $500,000	19	8.1
$500,000-$1,000,000	12	6.3
$1,000,001-$6,000,000	23	12.5
$6,000,001-$10,000,000	10	8.8
Over $10,000,000	69	51.3
Missing (did not answer)	27	13.1
Total	**160**	**100.0**

The respondents indicated a strong preference for flying on jets as opposed to turboprop aircraft, 73.8% (Table 1). They also indicated they would expect to fly these aircraft an average of 343 flight hours/year and operate an average of 109 flights per year (Table 3). The respondents also were asked how likely their use of air services would increase once VLJs are introduced. Of the sample, 53.8% indicated either "perhaps would increase" or "absolutely would increase," and 8.7% of the sample was unsure (Table 5). Thus, the potential market for VLJs seems quite strong, as a large percentage of air service clients may be likely to switch to them once they are introduced. Looking at the classifications of the respondents' organizations (Table 6), we observe that services represent the largest respondent group, 37.5%, followed by manufacturing, 24.4%, with transportation being the largest single respondent group, 20%. Most organizations had less than 10 different personnel using air services, or 45.7%; however, 23.1% said that over 100 different personnel used air services annually (Table 7).

Table 5. Increase in Use of Passenger Air Services Due to Availability of Very Light Jet

	Frequency	Percent
Yes, absolutely	31	19.4
Perhaps	55	34.4
No	60	37.5
Don't know/unsure	14	8.7
Total	**160**	**100.0**

Table 6. Industrial Classification of Respondent Organizations

	Frequency	Percent
Manufacturing (industrial)	19	11.9
Manufacturing (technological)	12	7.5
Manufacturing (consumer)	8	5.0
Finance/Real Estate/Insurance	27	16.9
Merchandising/Retail-services	4	2.5
Other services	29	18.1
Government	7	4.4
Utilities	2	1.3
Transportation	32	20.0
Construction/Engineering	8	5.0
Communication	7	4.4
Other	2	1.3
Missing (did not answer)	3	1.9
Total	160	100.0

Table 7. Annual Number of Personnel Using Air Service

	Frequency	Percent Responding
None	2	1.3
1-5	55	34.4
6-10	16	10.0
11-25	18	11.2
26-50	18	11.2
51-75	7	4.4
76-100	6	3.8
Over 100	37	23.1
Missing	1	0.6
Total	**160**	**100**

The respondents were asked to rate VLJ use on a scale of 1 to 5 with 1 being least important and 5 being most important. Of interest we found that VLJ use was considered important for short trips up to 500 miles and longer trips over 500 miles. Operation with a single pilot was not considered to be a handicap by prospective VLJ users. Most believe that VLJ use would open up new markets but were very concerned about the availability of ground transportation, fuel, and food services at smaller airports (Table 8).

Table 8. Importance of Very Light Jets and Other Services at Airports

	Mean	Std. Dev.
How important are VLJs on trips up to 500 miles	3.03	1.048
How important are VLJs on trips over 500 miles?	3.53	1.062
VLJs will open access to new markets.	2.88	1.356
How important is VLJ operation with single-pilot option?	2.16	1.284
How important are ground travel assets at smaller airports?	4.15	0.793
How important is jet fuel availability at smaller airports?	4.31	0.730
How important is food service at smaller airports?	3.09	0.983
Scale: 1 = least important and 5 = most important		

VLJ = Very Light Jets

In order to further assess the impact that VLJs may have on the market, an examination of factors that were likely to impact the likelihood of increasing air service use due to VLJs was conducted. Regression analysis (see Table 9) revealed that two factors significantly influence increased use. Specifically, the fact that VLJs allow access to previously inaccessible markets, as well as the importance of the availability of food service at small airports, increased the likelihood of increased air service usage. This finding is encouraging in that regarding the marketability of these aircraft, potential customers of VLJs already recognize the prime benefit that VLJs offer their businesses: reaching more of their own customers more easily.

Table 9. Likelihood That Very Light Jets Will Increase Air Service Use

Variables	Beta	t	ρ
VLJs Allow Access to Previously Inaccessible Markets	.576	6.292	.000
Importance of Food Service for Aircraft at Small Airports	.191	2.082	.041
Adjusted R2=.346; F(76 d.f.) = 21.669, p = .000			

VLJ = Very Light Jet

CONCLUSIONS

VLJs will soon be available in quantity and will offer budget-minded business travelers a new substitute for traditional airline and executive jet service. Today, fifteen manufacturers are posed to capture part of this new market. Stone (2003) refers to them as a "new generation of aviation entrepreneurs" (p. 60). VLJ supporters seem to view the use of these aircraft as an economical way to save time by avoiding the congestion associated with large airports; they believe this convenience will open up new customer markets. According to Stine (2005), the argument of some that thousands of VLJs will create their own type of airspace congestion will probably not occur. By design, VLJs can operate from most of the 5000 public use airports in the U.S. while the airlines currently use only 429 (Industry Facts, 2004). Also, of those used by the airlines, only 30 airports are centers for terminal area class B airspace control, and only a minority of this group experiences most of the recorded flight delays annually (Avoiddelays.com, 2007). VLJs by design and due to projected point-to-point use will avoid most of these airports and the approach and departure corridor congestion and delay associated with these airports.

The respondents of this survey seem to represent a good sample of the market for VLJ ownership and air-taxi use. The majority said they are likely to use VLJs when available. A majority seemed to prefer jets and already operate their own aircraft. The fact that almost 90% of the respondents' business trips involve six or fewer people makes the VLJ a strong candidate for these organizations. Not all of the initial manufacturers will survive the market shakeout, and concerns over support services at smaller airports will have to be addressed if the jets are to reach their full potential.

FUTURE RESEARCH

This study focused on describing the prospective operators of VLJ aircraft. Future market research should focus on those stakeholders impacted by the use of this new aircraft type. Specifically, future research should examine the impact of VLJs on airports, maintenance operations, and food service operations, to name a few. In other words, stakeholders need an understanding of how air support services should adapt to meet the needs of VLJ users. Such an examination will provide VLJ manufacturers with a clearer understanding of the true market and impact of these aircraft.

Additional research should focus upon those factors that will drive demand for VLJs. For instance, a better understanding of the needs of air service customers is required, in addition to the psychographic factors (such as trust in the product and/or manufacturer) that may influence customers' demand for these aircraft. With this understanding, VLJ manufacturers will be better positioned to properly market this new product, and air support providers will gain an increased ability to fulfill adequately the new requirements generated by the introduction of these new jets.

REFERENCES

Asker, J. R., (2005). 'Air taxis' Wild card in very light jet sales. Retrieved July 27, 2005, from http://aviationnow.ecnext.com/comsite5/bin/comsite5.pl?page=aw

Avoiddelays.com (2007). Most delayed airports for departures. Retrieved March 24, 2007 from http://www.avoiddelays.com/worst-offenders/most-delayed-departure.

Chappell, T., (2006). Your insurance renewal should be a pleasant one. Retrieved February 20, 2007 from http://www.aviationinsurance.com/articles/mcfg06yirspo0406a.doc

Eclipse (2007). VLJ insurance guidelines. Retrieved February 20, 2007 from http://www.eclipseaviation.com/index.php?option=com_newsroom

Ells, S. W., (2005). The upcoming introduction of affordable very light jets (VLJs). Retrieved July 3, 2005, from http://www.aopa.org/members/files/pilot/2005/state_infrastructure

FAA clearing the way for mini jets. (2006, July 27). Retrieved July 31, 2006 from www.cnn.com/2006/TECH/biztech/07/27/little.jets.ap/index.html

Haines, T., (2005). HondaJet behind the curtain. *AOPA Pilot*, 48(8), 70-77.

Industry Facts (2004). General aviation manufacturers association (GAMA). Retrieved February 20, 2004 from http://www.gama.nero/aboutGAMA/industryfacts.php

Lunsford, J. L., (2004, February 9). Bigger Planes, Smaller Planes, Parked Planes. *Wall Street Journal,* R4.

Morrison, M., (2005). Bolen makes business case. *Flight International,* 167(13), 24.

NBAA (2005). NBAA training guidelines for single pilot operation of very light jets and technically advanced aircraft. Retrieved February 15, 2007 from http://web.nbaa.org/public/ops/safety/vlj

Olcott, J. W., (2004). Is there a jet in your future? *AOPA Pilot*, 47(1), 89-94.

Seidenman, P., (2004). Jet dream. *Flight International*, 166(4), 62-65.

Sierra (2007). VLJ insurance guidelines. Retrieved February 20, 2007 from http://www.sijet.com/vlj_fivePointProgram_insurance_premium

Solon, D., (2005, May 18). Little company planes become a big business: Business Aviation. *International Herald Tribune*, 19.

Stine, B., (2005). The emerging very light jet market. *Proceedings of the Latin American Business Aviation Event LABACE 2005,* Retrieved February 15, 2007 from http://www.labace.aero/archives/2005/presentations/20050402vlj

Stone, B., (2003, October 6). A taxicab at 30,000 feet. *Newsweek,* 142(14), 60.

Trautvetter, C. (2005a). 2006: The year of the very light jet. *Aviation International News*, Retrieved August 17, 2005, from http://www.ainonline.com/issues/04_05/04_05_vlj_62.html

Trautvetter, C., (2005b). The VLJs will no doubt be popular, but don't count turboprop singles out yet. Retrieved August 17, 2005, from http://www.ainonline.com/issues/06_05/06_05_vlj_20.html

Very Light Jet Magazine (2007). Twin and single engine VLJs. Retrieved February 20, 2007 from http://www.verylightjetmagazine.com/index.php

Webster, A., (2006). Private aviation: The VLJ arrival. Retrieved February 20, 2007 from http://www.irmi.com/irmicom/expert/articles/2006/webster05.aspx

University of Nebraska at Omaha Aviation Institute

Submission Guidelines

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Book Reviews

Books chosen for review by the *Journal of Air Transportation* will focus on areas of interest to its readership. These subjects include topics related to aviation and/or space transportation, both technical and non-technical. An article should be written in a concise and sufficiently non-technical language to be intelligible to both aeronautics generalists and to specialists in other fields.

Individuals wishing to nominate a book for review or who are interested in reviewing books for *JAT* should notify the editor at the below address. Also, authors or publishers wishing to have a book considered for assessment should send a review copy to this address:

Aviation Institute / JAT
University of Nebraska at Omaha
6001 Dodge Street
Omaha, NE 68182-0508 U.S.A.
E-mail other correspondence concerning reviews to journal@unomaha.edu

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Review Procedures

Book reviews should present both a summary and critical evaluation of significant investigations and provide suggestions for further inquiry. A good review will include both a subjective and an objective account of the work. Provide proof to substantiate your position.

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Criteria

In reviewing the book, include a combination of the following elements:
personal impression
analysis of objective
presentation interpretative capability
a generalization of main statements
subject orientation
overall valuation

Articles accepted for publication will not undergo the standard JAT blind review process, but will be reviewed by the editorial staff for relevance and compliance with the following criteria:
Does the book present a topic of interest to readers of JAT?
Does the review portray a clear idea of the contents of the book?
Does the review depict a fair and accurate presentation of the book?
Does the review maintain a balance between content and critique?
Does the submission fit within the specified format and length requirement?

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Format

All review articles must be submitted in electronic format on an IBM formatted 3.5 diskette and must be in a standard word-processing format such as WordPerfect or Microsoft Word.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Author Description

Reviews should include a brief description of the author's institutional affiliation, highest degree earned, and areas of research/teaching interest.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Bibliographic Citation

Every review article should begin by citing the book(s) to be reviewed with full bibliographic information including author(s), copyright date, full title, place of publication, publisher, number of pages, ISBN number, and price if available in U.S. dollars.

The following are examples of bibliographic citation:
Kern, T. (1997). Redefining airmanship. New York: Mc-Graw-Hill. Pp. xi + 463. ISBN 0- 07-034284-9. U.S. $29.95 hard cover.
Findlay, C., Sien, C.L., & Singh, K (Eds.). (1997). Asia Pacific air transport: Challenges and policy reforms. Singapore: Institute of Southeast Asian Studies. Pp. xix + 208. ISBN 981-230-002-3. U.S. $39.90 soft cover.
Horonjeff, R., & McKelvey, F.X. (1994). Planning and design of airports (4th Ed.). New York: McGraw-Hill. Pp. x + 829. ISBN 0-07-045345-4. U.S. $54.95 hard cover.
Length

Review articles should be between 750-1500 words. Reviews outside these limits may be considered at the Editor’s discretion. Comparative reviews of two books may be somewhat longer, but should not exceed 3000 words. Comparative reviews of more than two books are discouraged.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Editorial Policy

Reviews appearing in the JAT represent the opinions of the reviewer and are not necessarily those of the editorial staff. Reviewers should have some authority or experience in the subject area. Reviews may contain positive or negative evaluations of the book. Negative remarks should be objective, precise, and expressed in a constructive, respectful manner. Vague or unsubstantiated criticism may be offensive to an author and generally fails to persuade a reader. Inflammatory remarks will not be accepted.

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Solicited Reviews

The maximum time allowed for completing a solicited review will be four weeks. If a reviewer is unable to meet this deadline, please inform the editor of a new date for completion or return the book so another reviewer can be contacted. For reviewers living outside the U.S.A., reviews may be returned via e-mail.

Conflict of Interest

Reviews written by the book's author(s), publisher, distributor, or by colleagues at the same institution or organization will not be considered. Also, duplicate reviews (previously published) will not be accepted. All authors of book reviews are required to include with their submission the following statement signed and dated. I, author's name, do not have any commercial interest in the main topic of the book under review, nor am I associated with a company or other organization with commercial interest in the main topic of the book.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Sample Book Review

Sample Book Review

In order to view the sample book review you will need Adobe Acrobat Reader. If you do not have a copy you may download if for free by clicking here.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Manuscripts and Call for Papers

JAT GUIDELINES FOR MANUSCRIPT SUBMISSION INSTRUCTIONS TO AUTHORS

Authors wishing to submit original manuscripts for consideration should send two double-space paper copies and one electronic copy either via email at journal@unomaha.edu or on an IBM compatible three and one-half inch diskette to the following address:

Aviation Institute/JAT
University of Nebraska at Omaha
Allwine Hall 422
6001 Dodge Street
Omaha, NE 68182-0508
U.S.A.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Format

All papers must be written in the English language. Use a 12 point font and allow for a 1" margin on all sides. Double-space all material including quotations, the abstract, notes, and references. All figures and tables should be on a separate page at the end of the text. Include the figure name and filename on the bottom of the page. Please proofread all article submissions for punctuation, spelling, and format errors.

The cover page should include the title of the manuscript, the author's name(s), shipping and email addresses, telephone number, and a short biographical statement summarizing the author's education and current affiliation. Please note the primary contact person. The second page should contain an abstract of the manuscript. The abstract should include a concise description of the contents of the paper, the research method used, and the results. Abstracts should generally be kept to about 100 words.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Figures and Tables

Figures and tables should appear at the end of the paper with each item on a separate page. Indicate in the text the approximate location where each figure and table should be placed. Figures, tables, and the text should each be saved as separate files. Do not embed tables and figures in the text files. Include the appropriate file name at the bottom of the page for each figure and table. Figures and tables must be camera-ready, printed in black ink only and must fit with in a 4 inch by 7 inch area.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Reference Style

Due to the international participation, rigid referencing style criteria are not mandated. Acceptable reference styles of the author's country will apply. For the U.S.A., the most recent edition of the American Psychological Association (APA) Manual of Style is preferred. Ensure all references are cited and all citations are referenced.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Review Process

A rigorous double-blind review will be conducted by the *JAT* Panel of Reviewers. Additionally, a member of the Editorial board will conduct a third review. If revisions are necessary, the editor will determine when a revised manuscript is in compliance with reviewer recommendations. Authors must make revisions to original documents and resubmit them to *JAT* on disk in Word or Word Perfect format. All revisions must be completed within two weeks after return to the author. Manuscripts must be original, not previously published, nor under consideration for another journal while undergoing review by the *JAT*.

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68

Exit

Additional Information

Additional information is available on the *JAT* web site at **http://jat.unomaha.edu** or by contacting the *JAT* directly at 402-554-3424 or **journal@unomaha.edu**

Return

ISSN: 1544-6980
Library of Congress: HE9761.1.J68