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Brent D. Bowen, Editor

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SORENSEN BEST PAPER AWARD

The *Journal of Air Transportation World Wide* is proud to present the Sorenson Best Paper Award, named in honor of Dr. Frank E. Sorenson. This award gives recognition to the author(s) with the best literary and scholarly contributions to the field of air transportation. The Editor, on the basis of reviewer rankings during the review process, grants the Sorenson Award. The manuscript with the highest overall score is awarded the Sorenson Best Paper Award. This is considered a high recognition in the aviation community.

Dr. Frank E. Sorenson was a pioneer in the field of aviation education since its early beginnings in the 1940s. A renowned educator and prolific writer, Sorenson contributed not only education texts to the field, but also served as a consultant and innovator throughout the expanding realm of aviation education and research.

Dr. Sorenson's aviation impact and potential were recognized early on by the National Aeronautics Association when he received the Frank G. Brewer Trophy in 1946 for the most outstanding contribution to the development of youth in the field of education and training. In 1958, the University Aviation Association honored him with the William A. Wheatley Award in recognition of outstanding contributions to aviation education. These were the first of many awards and citations he would earn on a local and national level as he continued his active involvement in the field of aerospace education up until his death in 1977.

Through his involvement with the University of Nebraska–Lincoln Teachers College, Dr. Sorenson generated some of the earliest teaching materials for aviation education and textbooks for military aviators during World War II. Throughout the course of his career, he contributed over forty articles and publications related to the field of aviation education. His efforts guided the way for extensive aerospace research and scholarship from the grassroots to the global level through his participation in Civil Aeronautics Association, the World Congress on Air Age Education, and UNESCO. He has served as chairman of the Air Force Associations Aerospace Council, the Aerospace Education Forum at the First World Congress of Flight, the U.S. Air Force Air Training Command, the Men in Space book series, and NASA's Aerospace Education Advisory

Committee. As a result of his visionary involvement and development of the Link Foundation, the organization has gone on to provide grants now totaling over a half million dollars a year to support and advance aerospace education and training in aeronautics.

Dr. Sorenson's continuous involvement in aviation education and research laid the groundwork for many of the advancements currently taking place in the industry. His ceaseless research and educational outreach demonstrated how one person can make a difference not just today but well into the future.

Currently, several awards exist that are representative of his achievement in aerospace education and research. These include the Frank E. Sorenson Award for Excellence in Aviation Scholarship, representing the highest scholarly honor in aviation education, presented annually by the University Aviation Association; the Frank E. Sorenson Pioneers in Nebraska Aviation Education Award presented annually by the University of Nebraska at Omaha Aviation Institute, as well as a memorial lecture fund and scholarship fund. A maximum of two award plaques will be given per article to the two lead authors in order of submission. Additional co-authors have the option to receive an award plaque if they agree to pay the cost plus shipping and handling. All plaques must be ordered at the same time or special handling charges will apply.

**Recipients of the
Sorenson Best Paper Award**

2000 Faiba Alamdari and Julian Burrell, *Marketing to Female Business Travellers*, Volume 5, Number 2.

Sorenson Best Paper Award Recipient
QUALITY TRAINING AND LEARNING IN
AVIATION: PROBLEMS OF ALIGNMENT

Phillip J. Moore, Tai Po, New Territories, Hong Kong

Henry R. Lehrer, Rossford, Ohio,

and

Ross A. Telfer, Newcastle, Australia

ABSTRACT

The challenge of producing training programs that lead to quality learning outcomes is ever present in aviation, especially when economic and regulatory pressures are brought into the equation. Previous research by Telfer & Moore (1997) indicates the importance of appropriate alignment of beliefs about learning across all levels of an organization from the managerial level, through the instructor/check and training level, to the pilots and other crew. This paper argues for a central focus on approaches to learning and training that encourage understanding, problem solving and application. Recent research in the area is emphasized as are methods and techniques for enhancing deeper learning.

Phillip J. Moore a Professor and Head of the Department of Educational Psychology, Counselling and Learning Needs for the Hong Kong Institute of Education in Tai Po, New Territories, Hong Kong. He has earned the following degrees from the University of Newcastle, Australia: B.A., B.Ed.Stud., M.Ed. and Ph.D. Moore previously served as an Assoc. Professor, Faculty of Education, The University of Newcastle, Australia. (1991-1999)

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Ross A Telfer is an Emeritus Professor of Aviation at the University of Newcastle, Australia. At time of writing manuscript, he was also Director of Instructional Research and Development Pty. Ltd. His educational credits include: B.A. (University of New South Wales), Dip. Ed. Administration (University of New England), M.Ed. Administration (University of New England), and Ph.D. (University of Newcastle). Telfer previously served as an Associate Professor of Education, then Professor of Aviation at the University of Newcastle, Australia (1976-1994).

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INTRODUCTION

The bean counters will never give us the money to train properly....

How can we provide check and training if we aren't given the funds we need?

Management will not approve the extra hours we need for training....

Why doesn't our management realize that to train properly we need appropriate funding?

Training is the key to an efficient airline: why won't the accountants recognize this?

Sound familiar? The tension between training departments and budgetary control in aviation management is a perennial issue. Reduced to its elements, the conflict is one of quality versus quantity, or effectiveness versus efficiency. A solution argued in this paper is that present approaches to training contribute to the tension and are part of the problem. The common solution to a training problem is to provide more training; unfortunately, it is usually more of the same. The ab initio pilot who flies more and more circuits in order to gain expertise in flaring the aircraft in landing will eventually make it: but at what cost?

The cost extends way beyond the dollars. Think of the soul-destroying repetition for the instructor, the reputation of the training establishment, the self-concept of the trainee, the changing attitude towards further training, and the loss of motivation. The overall cost is massive. Now let us extend this cost structure into an airline, and consider it over an extended period. Training is more than big bucks: it is big costs.

One way of reducing the training costs is to work on the quality of training: which means improving the quality of a trainee's learning. Our recent research, part of an ongoing international study by Moore, Telfer and Smith (1994), Telfer and Moore (1997) and Lehrer, Moore and Telfer (1998), provides insight into how this can be achieved.

BACKGROUND

Our research is concerned with the motives and strategies that learners, instructors, and managers have for learning. As Telfer (1994) notes, the outcomes of training are very much determined by the motivation and strategies of the individual pilot or student, by the instructor or check and training captain's values, skills and knowledge (especially about learning and instruction), and by the nature of the organization or system in which the training occurs. Central to our work are questions such as: Is learning just remembering and being able to repeat the information without understanding? Is learning a sense of challenge? Is learning something that increases anxiety? Is learning about doing well? What do instructors know about learning? Do they see learning in a manner similar to that of their trainees? What do training managers think of learning and instruction?

Before moving to examine these questions in more detail, there is merit in placing the instructional cycle into a context and Biggs and Moore's (1993) 3P Model of Learning provides a useful framework. Their 3Ps refer to Presage, Process and Product factors as they relate to learning. Presage factors are the baggage that pilots, students, instructors and the organization bring to learning. For pilots and students these include age, experience, abilities, personality, and their preferred way of learning. For instructors, their Presage factors include age, experiences, motivations, personalities and their beliefs and views about learning. Organization factors such as the training syllabus, provision of resources and facilities, scheduling, supervision, and the effects of regulatory authorities are part of Presage as well. (We will return to these organizational factors in the concluding section of the paper.)

The second P in the 3P model is Process, the actual processes that occur when a pilot or trainee, and instructor, engage in a particular task or set of tasks. Clearly, the above Presage factors influence how that occurs. The pilot's baggage for learning interacts with that of the instructor and the organization.

The final P is Product, the outcomes of learning. Can the trainee now do what is expected? Can they pass the test? What type of test is it? Typically, outcomes are measured quantitatively (She got 78 percent or he rated at 4/5) and presumably the higher the rating or score the more has been learned or the better the overall performance. Qualitative assessment also is used when judgements are made about the quality of the learning outcome (This response shows a good level of integration and understanding with application to novel problems.) However, it is well recognized that the Product component of the model has the potential to wag both Presage and Process parts of the model. If, for example, the tests are of low level details and facts, then it is likely that after repeated experiences of such tests both trainees and instructors will focus their learning on such details, perhaps to the detriment of understanding and application. So, the 3P Model represents a convenient way of examining learning and instruction, from the perspective of what is brought to the learning situation, what occurs in the learning, and what is assessed. It may be stating the obvious, but if each of these is out of synchrony, then potential problems will arise. Now, to return to the questions posed at the beginning of this section.

For aviation the posing of such questions, and their answers, are important for a number of reasons. Firstly, there is a substantial body of literature that demonstrates the effects of learner approaches to learning on subsequent learning outcomes (Biggs, 1999, 1987; Biggs & Moore, 1993). Individuals who are Surface in orientation (Biggs, 1999, 1987) are primarily motivated to do the least amount of work possible to get through a

course, are sometimes anxious about their learning (and possible failure), and rely extensively upon rote learning or learning things by-heart (without understanding) to pass a test or training program. Individuals who are Deep in orientation are quite different to those who are Surface, because they tend to see learning as a challenge, as something which gives enjoyment through mastering what has to be learned and they employ a range of strategies that ensure that understanding emerges (e.g., taking own notes, summarizing, discussing with others). Biggs (1987) identifies a third approach to learning, the Achieving approach. This approach is characterized by a desire to do well, compete and be organized for learning. Of course, there may be circumstances in which each of these approaches is appropriate but for the most part, understanding should be a priority. (It is very difficult to argue against understanding in aviation when you think of the ways in which the crew handled the well-documented Sioux City accident.)

From typical school, college, and university studies, there is evidence that Surface approaches to learning tend to be harmful and that Deep and Achieving approaches are more beneficial to learning (e.g., Biggs, 1987; Cantwell & Moore, 1998; Drew & Watkins, 1998). Moore and Telfer (1990) replicated these findings in ab initio aviation settings. Indeed, they showed that those who were deeper in their approaches to learning, went solo earlier than those trainees who were not so oriented. Work with experienced pilots by Moore, Telfer and Smith (1994) and Monfries and Moore (1998) illustrates a general propensity of Deep and Achieving in captains and first officers, with Deep scores being higher. Surface approaches to learning were ranked low by experienced pilots but there were differences between pilots from different airlines suggesting both corporate and national cultural effects.

Secondly, there is evidence that students and pilots are influenced by the beliefs of those who instruct them. In school settings, for example, Tang (1993) demonstrated that teacher knowledge influenced students' approaches to learning (they were Deeper with experts) and Richardson, Andes, Tidwell and Lloyd (1991) showed a positive link between teachers' classroom practices and their beliefs about learning. In aviation, Henley's (1995) work amply shows that beliefs about learning influence how instruction is conducted, how feedback is provided, how expectations are established and so on. Her findings are important because, as Biggs (1999) indicates, student approaches to learning are essentially reactions to the teaching/instructional environment.

Thirdly, there is evidence that organizational factors influence learning. It is not difficult to think of examples where the organization makes (or breaks) quality learning. At the simplest level, the allocation of appropriate

resources (say a high fidelity simulator) can influence the quality and effectiveness of learning, as can the time devoted to training. Similarly, there needs to be a corporate sense of commitment to high quality training, compared to just minimally meeting the regulatory requirements (Maurino, 1997). Bent and Fry (1997) reinforce the critical role of appropriate resource investment by the organization when new aircraft are introduced into the fleet.

Fourthly, there is potential problem of lack of congruence or poor alignment across the three levels of student/pilot, instructor, and organization. What if the expectations of the instructors are different from those of the organization? What if the objectives are on understanding but testing is on unrelated facts? What if the pilots are motivated to understand but their instructors focus on surface level matters? Conflicts of perceptions and expectations in learning are not conducive to quality learning (Cohen, 1987). The next section of this paper examines one of these issues specifically, a comparison between pilots and instructors' views on learning, their approaches to learning and instruction.

PILOT AND INSTRUCTOR APPROACHES

We were concerned about the possibilities of different perspectives on learning being taken by pilots and instructors. Do they align or not was the basic question, and a subsidiary question was if they were, were they appropriate in terms of quality learning. We used the constructs of Deep, Surface and Achieving developed by Biggs (1987) and in order to make some comparisons between pilot and instructor beliefs about learning, we compared pilot data previously reported by us (Moore, Telfer & Smith, 1994; Moore, 1995) with some data we gathered from instructors more recently (For initial analyses see Lehrer, Moore & Telfer, 1998).

Firstly, though, a quick look at the pilot data. Three hundred forty-six experienced pilots from five different international carriers and one U.S. institute completed the Pilot Learning Processes Questionnaire (PLPQ), a 30 item six point Likert scaled instrument which identifies Deep, Surface and Achieving approaches to learning. (See Moore, Telfer and Smith (1994) for validity and reliability of the scales.) In general terms, the results showed that pilots had a greater propensity to report Deep approaches to learning (mean scale score of 4.63 on the 1 to 6 scale), than Surface (mean scale score of 2.74) while Achieving perspectives (mean scale score of 3.93) were somewhat in between. The standard deviations for the three scales were in the range 0.42 to 0.59 indicating a reasonable distribution of scores around the means. Not unexpectedly in any analysis of individual differences, there were individuals who scored well above the mean on

individual scales as there were individuals who scored well below the mean for the various scales. In other words, a number of different profiles could be generated from the data with some pilots showing a higher propensity for Surface learning and lower Deep scores and so on.

The data from instructors were gathered from the Pilot Instruction Processes Questionnaire (PIPQ) which we developed (Moore, Lehrer & Telfer, 1997), again using the constructs of Deep, Surface, and Achieving and six point Likert-type items. With responses from over 220 instructors in the U.S., we were able to establish factorial validity for a 15-item version (three factors of Deep, Surface and Achieving) with reliabilities acceptable for a developing scale. Typical items from the revised questionnaire include: "Opportunities are provided to ensure that students really understand what they are being taught" (Deep); "I try to promote an expectation that those I instruct just need to pass" (Surface); and "Competition brings out the best in students" (Achieving). For the instructors, the mean scale score (range 1 to 6) was highest for Deep (4.95 with standard deviation of 0.56), then Achieving (3.70 with standard deviation of 0.61), and lowest mean scale scores for Surface (3.31, standard deviation of 0.69). However, as in the pilot sample, there were differences amongst individuals. For example, for Deep the highest individual scale score was 6.0, the lowest 2.40, the person with a mean of 6 clearly saw learning as being for understanding and instruction should be designed to accommodate that approach. For Surface the corresponding extremes were 5.60 and 1.00. An instructor with high scores like the 5.60 above, shows a strong emphasis towards a minimalistic approach of telling students what is to be learned and passing the test. So, in this sample there were individual instructors whose views and beliefs about instruction and learning were markedly different with others. Some reported instruction as being about developing pilots' understanding while others' perceptions were centered on just passing the examinations, and "how to do" not the "how and why."

COMPARISONS OF PILOTS AND INSTRUCTORS

Direct comparisons can be made between our pilot group and our instructor group on approaches to learning and instruction, although any interpretation needs to be tempered by the fact that the data were gathered from two different groups, that is the instructors were not those who instructed the pilots. (We anticipate conducting a study where the individuals all come from the one organization.)

The general profile across the three sub scales of Deep, Surface, and Achieving shows a similar trend for both pilots and instructors with the highest mean scale scores being for Deep (4.63 pilots, 4.95 instructors), the

lowest for Surface (2.74 pilots, 3.31 instructors) with Achieving in between (3.93 pilots, 3.70 instructors). The largest mean difference is between pilots and instructors on the Surface scale with almost a standard deviation difference suggesting that of the three scales, the Surface one differentiates the two groups most. Instructors seem more concerned than pilots about just passing examinations.

As indicated above, however, there were substantial differences in the profiles of individuals in both the pilot and instructor groups. Several hypothetical examples will help show the potential problems that can arise if there is a lack of appropriate alignment between those who instruct and those who are instructed. There are individuals in our data sets who reflect these profiles.

Pilot A has a profile on the PLPQ of high Deep (mean = 5.70), low Surface (mean = 1.90) and high Achieving (mean = 4.90). Here is a pilot who is very motivated to understand, to be competent and master the materials or tasks to be learned, and wants to do well against other pilots in the course. This pilot has a range of strategies for comprehensive learning while also recognizing there may be a role for Surface learning, but it is not the predominant approach. The predominant approach is Deep/Achieving (Understanding and doing well.).

Pilot B's PLPQ profile shows highest scores for Surface (mean = 4.90), and low scores for both Deep and Achieving (respective means = 2.80 and 2.20). Here is a pilot who is concerned about examinations (anxious), is only willing to do what is required to just get through and not the slightest bit more, and uses rote learning to have the material ready to regurgitate at the test. Pilot B is not so keen to succeed but does recognize to some extent that learning has to do with understanding. However, the dominant feature of the profile is the high Surface approach.

Instructor A's PIPQ profile shows high Deep scores (mean = 5.60), low Surface scores (mean = 1.80) and high Achieving scores (mean = 4.70). Here is an instructor who is keen on pilots gaining understanding through discussion, supplementary materials, and encouragement to study and do independent work. This instructor is not interested in having pilots just pass the test but encourages them to excel, seek perfection, and interact with others. This is a Deep/Achieving oriented instructor.

Instructor B has a PIPQ profile of low Deep (mean = 2.40), moderate Achieving (mean = 3.20) and high Surface (mean = 5.50). This instructor focuses on telling pilots what they need to do to pass the test and only instructs them to do so, nothing more. Little attention is given to understanding and learning for application in other situations. Instructor B is a Surface oriented instructor.

Now consider the consequences of these pilots and instructors working together. Take Pilot A and Instructor A. Clearly their approaches to learning are aligned in that they both are concerned with quality understandings, mastery, competence and overall, doing well against others. It is likely that the outcomes would be quality learning and greater motivation to continue learning due to the intrinsic rewards emerging from satisfaction with learning (and instructing). However, if we take Pilot B and Instructor B, we see that there is alignment (both are Surface oriented) but it is an alignment that the literature indicates will not produce quality outcomes, it is inappropriate. The focus for both will be on doing the minimal amount to pass the tests and while this may be important in itself, there is less likelihood that the learning will be enduring. (You may recall the experience of learning something only to pass a test and then having forgotten it almost immediately after the test was taken.)

The mixed profiles pose other problems due to the tensions of mismatches. What if Instructor B instructs Pilot A? The literature suggests that in this situation it is not likely the instructor will change (Henley, 1995). Pilot A may have to suffer the Surface approach of the instructor and in additional time do those Deep things to keep understanding in the foreground. It is conceivable, however, that if type B instructors consistently instruct pilots like Pilot A, these pilots may revert to Surface level strategies to survive the courses. [Recall our earlier reference to Biggs' (1999) comment that student approaches are reflective of the instructional environment.] Clearly such a reversion would be an undesirable state of affairs. What of the match between Pilot B and Instructor A? Again there is a mismatch but the literature is helpful here as it shows that an individual's approach to learning can be changed for the positive through instructional strategies reflective of the Deep and Achieving approaches (e.g., Moore, 1991). Some of the examples we give in the discussion below help show how deeper approaches can be encouraged by an instructor. What is apparent from these examples is that congruence at the high Deep/Achieving end is likely to produce better quality learning outcomes, problem solving abilities, and greater satisfaction (for pilot and instructor).

DISCUSSION

The lack of appropriate congruence between the approaches of instructors and trainees to training in aviation has major implications for key players: not only the check and training staff, and the pilots being trained, but the management of the organization needing to find the additional funds for over-hours training, and those executives who strive to establish a reputation for a well-managed operation.

Aviation management needs to develop the same acuity and sensitivity that leads an experienced pilot to automatically adjust out-of-sync engines. Understanding, professional judgement and long experience have provided a blueprint of the feel and sound of balanced power. As soon as a lack of synchronization occurs, there is an automatic reaction to correct it. Aviation organizations need to develop the same homeostatic response to differential values in the training department. Trainees and instructors have to be a collaborative team in order to achieved high quality training. Deep and Achieving are the aim points.

Why is such congruency vital? Because aviation organizations are working with adults as trainees, and adults learn in ways which are quite different from those which work with children at school. Many of the key approaches to adult education (or andragogy) cannot be achieved if the instructor lacks a deep and achieving approach or, worse, has only a surface approach (our Instructor B). There are three major training problems which result: *dislocated objectives; an emphasis on instruction rather than learning; and an application of pedagogy (child learning) rather than andragogy.*

Dislocated Objectives

In order to evaluate training in a reliable and valid way, it is necessary to consider the extent to which training objectives are attained. In other words, training departments look to see if there is any gap between what they say they are providing in training, and what trainees actually achieve. The only way to do this is to express objectives in terms of what the trainee has to know and do. These so-called *performance objectives* have to be based in learner terms. Something like: “*At the end of this sortie, the trainee will be able to...*”. What we often see in organizations with a surface approach to training is the objectives expressed in terms of what the instructor will do: “*Teach duties of pilot-flying...*” The key difference is that between instructing and learning. Without learning, there has been no training. Without learning, there will be a need for overflying the training syllabus.

Instruction rather than Learning:

Efficient learning occurs when we are taught what we do not already know. This implies a recognition that adults have different levels of experience and knowledge, which skilled instructors identify through questioning and other forms of testing (eg. Schiewe & Moore, 1997; Telfer, 1994). It costs training dollars when a standard course is presented regardless of trainees’ existing experiences and knowledge. A side effect is that the examples presented in either the training manuals or the instructor’s

presentation will not relate to the trainees' world. Rapport is diminished. The flow-on effects include a reduced likelihood of trainee questions, less awareness of trainee reactions, and an artificially-enhanced view of trainee feedback. This relates, too, to the way in which the overall training program is to be evaluated. To consider this we go to the final consideration: adult learning and its implications for training.

Andragogy, not Pedagogy

Adults are undertaking training to improve their skills and knowledge in application to their job. They need to know why they are learning something, where it applies, and how they expect it to improve their on-the-job performance. They are not simply completing exercises and sorties, exams, subject, tests and topics. Ticking the boxes is a poor substitute for real training. See the link with Deep and Achieving?

It follows that adult training is problem-based not subject-based. How does a surface-oriented training program present it?

This is what you need to know for the test.

It is in the manual...

It is on the video.

Watch the slides and complete the questions.

You need to get 80 percent on the multiple-choice test.

Questions from the instructor will tend to be closed and convergent:

What is the speed for.....?

How many miles out.....?

Quality learning has a crucial place for additional open and divergent questions:

Why does.....?

What would happen if....?

Consider this case study then tell me what you would do and why....?

In summary, instructors and trainees need to:

1. Speak the same language (figuratively as well as literally);
2. Start from where the trainee is;
3. Use the trainee's experiences, past and present;
4. Use questioning as a key activity;
5. Look at the big picture of training, examples from line activities, and applications on the job.

These activities can only occur when the training and testing program, instructors and trainees are in sync.

As noted above, challenges for management also arise from the notions of alignment and congruence. As Telfer (1997) notes, for effective training the dynamics of the organization have to be considered. Managers have control over factors such as resources, personnel, the syllabus, standards, licensing and testing. Their beliefs about learning will undoubtedly impact on each of these factors, where appropriate, and if manager beliefs are different from those of the instructors and pilots, there will be tensions that may reduce instructional and learning effectiveness. If management, for example, views learning of Crew Resource Management (CRM) as something to be done merely to satisfy a regulatory authority, then their commitment is likely to be more of a Surface orientation, the minimal amount of time and resources being made available for both instructors and pilots, cabin crew, maintenance crew etc. Under such conditions, it is not likely that quality instruction and learning will occur. Indeed, we would argue that managers need to be reflective about their beliefs about learning so that organizations can then consider appropriate alignment across all three levels, pilots, instructors and organization. Telfer and Moore (1997) indicate ways in which management can investigate its approaches to learning using the Deep, Surface, and Achieving constructs which have been a consistent theme of this paper.

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UNEQUAL BARGAINING? AUSTRALIA'S AVIATION TRADE RELATIONS WITH THE UNITED STATES

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ABSTRACT

International aviation trade bargaining is distinguished by its use of a formal process of bilateral bargaining based on the reciprocal exchange of rights by states. Australia-United States aviation trade relations are currently without rancour, but this has not always been the case and in the late 1980s and early 1990s, their formal bilateral aviation negotiations were a forum for a bitter conflict between two competing international aviation policies. In seeking to explain the bilateral aviation outcomes between Australia and the United States and how Australia has sought to improve upon these, analytical frameworks derived from international political economy were considered, along with the bilateral bargaining process itself. The paper adopts a modified neorealist model and concludes that to understand how Australia has sought to improve upon these aviation outcomes, neorealist assumptions that relative power capabilities determine outcomes must be qualified by reference to the formal bilateral bargaining process. In particular, Australia's use of this process and its application of certain bargaining tactics within that process remain critical to understanding bilateral outcomes.

For Australia, its economic relations with the United States have been important for almost all of this century, though rarely considered by commentators as important as the security relations. Of these economic relations, Australia's bilateral trade relations have dealt more with merchandise trade than services trade between the two countries though the potential, if not current importance, of Australia-U.S. services trade is beginning to be recognised.¹ See Table 1 for a review of the quantity of service exports and total exports in the 1990s.

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**Table 1. Australia's Services Exports as a Proportion of Total Exports
(Balance of Payments Basis AUD\$m at Current 1997 Prices)**

	<i>Services Exports</i>	<i>Total Exports (Goods & Services)</i>
1990	14,102	66,257
1991	15,085	69,959
1992	16,374	76,396
1993	18,539	82,361
1994	19,935	86,381
1995	22,416	96,600

Source: Yearbook Australia, 1997

Australia's trade relations with the U.S. have not been without their frustrations and U.S. protectionist policies in a number of trade sectors, most notably agriculture, have prompted strident comments by Australia's political leaders. Such comments have not, however, translated across into efforts by Australia to link these trade problems to other aspects of the overall political-economic or even strategic relationship.² The rhetorical flourishes against U.S. policies during the 1990s by Australian ministers from both sides of politics, as well as from prominent industry actors, should not blur the fact that Australia's approach to the U.S. on trade, as on other economic matters, has been generally conservative and predictable.³ Concern at U.S. treatment of Australia's trade interests has been tempered by regard to the U.S.'s uniquely important security role with the current Howard government deliberately enhancing the security aspects of the relationship. The importance given to the security dimension of the relationship together with the disavowal of issue linkage reveals an acknowledgement by Australian policy-makers of the overall weakness in Australia's bargaining power in relation to the U.S.

Against this background, it is all the more surprising that Australia has periodically sought to modify the structural weakness in its aviation trade relations with the U.S. and improve its bilateral trading outcomes. Central to understanding how Australia has sought to improve these sectoral outcomes is an appreciation of the bargaining process through which the two countries have formally traded their aviation rights.⁴ With aviation services trade effectively excluded from the Uruguay Round settlement, the bilateral aviation trade negotiations between Australia and the U.S. remain a more important focus than the multilateral approach taken by each country.

Recent years have seen changes in Australia's approach with efforts made to reform the sector while the U.S. has pursued a policy of promoting greater reform of international aviation through the negotiation of liberal

bilateral agreements. Despite global changes made in the direction of trade liberalisation, international civil aviation still retains overtones of state-based mercantilism with the balance of trading rights between countries still determined by a process of bilateral bargaining based on reciprocity rather than comparative advantage.

ARGUMENT IN BRIEF

In order to explain aviation trade outcomes between Australia and the U.S., reference can be made to the neorealist/neoliberal debate. In particular, neorealism and liberal institutionalism are presented as possible frameworks to explain aviation trade outcomes. The neorealist approach privileges the power-capable resources of states and argues that bilateral outcomes between asymmetrically powerful states will be determined by which state has greater resources.⁵ Liberal institutionalism, on the other hand, argues that in explaining outcomes, account must be taken of the influence of international institutions or regimes.⁶ These institutional arrangements are able to explain the complexity of interdependence; provide the means by which states co-operate with each other; and act to constrain the behaviour of the stronger state and assist the weaker state in securing favourable results. Another related approach, that of modified structural realism,⁷ argues that the co-operation developed by such arrangements comes to be seen as beneficial for states as they pursue their own interests.

This paper presents a modified neorealist explanatory model. This model posits that while neorealism offers the greater insights into Australia-U.S. aviation bargaining outcomes, the formalised bilateral bargaining process transmutes as well as transmits power-capable resources and should be seen as seriously qualifying the assumptions derived from the asymmetry of power relations. While power relations remain important in explaining outcomes, the formalised bilateral bargaining process provides the opportunity for the influence of non-power, or cognitive factors, notably the ideas and perceptions of policy-makers and negotiators. The intervention of this bargaining process relaxes the neorealist assumptions by allowing the weaker state to take advantage of the mutual need for a deal and apply these non-power resources towards an improvement in its outcomes.

Applying this model, the paper contends that the formal bilateral bargaining process, with its emphasis upon deal-making, has allowed weaker states to apply bilateral tactics to extract concessions from stronger states.⁸ In its aviation trade bargaining with the U.S., Australia has made use of three bargaining tactics which have served to improve its outcomes,

albeit each to a limited extent. These have been the withholding of agreement; the assertion of control over important aspects of the negotiations; and the demonstrating of commitment and determination.

NEOREALISM

A neorealist analysis argues that patterns of behaviour between states can be best understood as being derived from the structure of the international system with the state considered a rational actor motivated to apply its own power-capable resources to advance its own self-interest.⁹ As related to the bilateral relations between asymmetrically powerful states, this approach argues that the strong would prevail over the weak as measured by their respective power-capable resources. Domestic factors and non-power considerations are not considered relevant in helping to explain state behaviour. States are concerned more about relative gains and advantage than about absolute gains in their relations with other states and behave accordingly.¹⁰ How much power a state has in relation to its bargaining partners will determine how likely it will be able to satisfy both its demands and its national interests.

The neorealist analysis is useful in helping to explain the asymmetrical bargaining context—the distribution of power capabilities favouring the U.S.¹¹ over Australia—within which these two states trade their aviation rights. However, neorealists seek to explain bargaining outcomes rather than simply the context within which such bargaining occurs. Such an explanation requires that we must be able to show that the relative power capabilities of the stronger state will consistently translate across into favourable bargaining outcomes. This translation of power into favourable outcomes depends, in turn, on the extent to which issues or sectors can be linked. In other words, power fungibility must exist in the sense that the asymmetry of power in one issue or sector can be found, in like measure, in another issue or sector.

As an explanation of Australia-U.S. aviation trade outcomes, neorealism should be able to show that their bilateral bargaining outcomes are determined more by Australia's position within the global political economy, and its relative power-capabilities vis-à-vis the U.S., than by its own actions or bargaining tactics. While the structural relationship may fall short of providing a complete explanation, there are certainly important external sources of influence upon Australia. Officials, for instance, will be influenced by the opportunities and constraints which confront the Australian economy as it engages with the global economy, while industry actors will be affected by the international market as they trade globally.

LIBERAL INSTITUTIONALISM AND MODIFIED STRUCTURAL REALISM

Liberal institutionalism is an international level approach arguing that conventions and expectations (institutions) can be as important as power-capable resources in understanding the relations between states. For the liberal institutionalists,¹² these institutions or regimes¹³ assist in explaining the complexity of interdependence which exists between states and serve as manifestations of the co-operation which states are capable of exhibiting towards each other for common ends.

Regimes are seen as accounting for the regularity of state behaviour¹⁴ and in not necessarily acting in response to the demands of the major trading states¹⁵; and may indeed act to constrain the self-seeking behaviour of major states and operate as mechanisms to structure states' preferences. The ability of such institutional arrangements to constrain state behaviour is enhanced the longer these regimes remain in existence and, over time, they can reveal an important normative dimension.

A modified structural realist approach¹⁶ argues further that co-operation is not only possible but necessary and that patterns of co-operation, once established, tend to persist and come to influence state behaviour. However, while regimes may well act as intervening variables and take on a 'life of their own', it should not be assumed that they necessarily constrain self-interested state behaviour and prevent stronger states from securing favourable outcomes. To test the explanatory power of regimes, political scientist Baldev Raj Nayar has suggested three qualifications to the hypothesis that regimes are necessary.¹⁷ The first of these is that the norms of the regime ought to be genuinely 'interdependence norms' and not simply reflect the international system of states in which the influence of the powerful prevails.¹⁸ Secondly, a regime must be shown to be a constraint on self-interested state behaviour; and thirdly, the regime must be shown to continue in existence despite changes in the balance of power or in national interests, particularly with respect to powerful states.

Therefore, if we take these reservations into account, we are more concerned with a regime's outcomes to assess whether its norms, which may ostensibly encourage interdependence (thereby constraining self-interested state behaviour), do in fact perform that role. The General Agreement on Tariffs and Trade (GATT) and its successor, the World Trade Organization (WTO) has arguably had a moderating effect upon the conduct of bilateral relations in the trading of goods and some services. However, these international institutions, with their advocacy of multilateral liberalisation, have continued to be excluded from considering the important economic issues relating to the conduct of aviation trade. In fact, trade in international air services reverses the usual means by which

the GATT/WTO has liberalised trade in goods with air services being 'prohibited unless specifically allowed' by the various 'freedoms of the air' in the Air Services Agreements (ASAs).¹⁹ Importantly, where the trade in goods and other services are conducted on the basis of the principle of comparative advantage, trade in air services occurs in the expectation of reciprocal benefits being granted between states.

There are two important international organizations that deal with international aviation matters. They are the International Civil Aviation Organization (ICAO), a United Nations agency with a membership of nearly two hundred states, with major safety responsibilities;²⁰ and the International Air Transport Association (IATA), a trade association which undertakes tariff-setting, policing of the industry, and facilitates the necessary financial transfers among airlines.²¹ While useful and relevant in terms of their technical and other functional services, these organizations have been of limited and declining importance in terms of the trading of economic rights.²²

Bearing in mind Nayar's three qualifications on the relevance of regimes, the above organizations do not present themselves as good candidates for explaining aviation trade relations by means of a liberal institutionalist or modified structural realist approach. With the continued importance of the bilateral ASAs, and their formalisation of the notion of reciprocity, the multilateral negotiation of economic rights and responsibilities promoted by the GATT/WTO has not had, and is unlikely to have, much impact in this issue area. While the GATT's Uruguay Round settlement has included a General Agreement on Trade in Services (GATS) which applies to a number of air transport services,²³ GATS' important Annex of Transport Services excluded the application of the multilateral agreement to the trading of traffic rights.

The five-year review of the operation of the Annex undoubtedly encourages those who argue that the WTO and its "generalized principles of conduct"²⁴ such as multilateralism and non-discrimination will, in time, replace the bilateral regulation of air transport services.²⁵ This is, however, highly questionable given that the U.S. and other major aviation powers have used the bilateral means of 'open skies' agreements to pursue their own policies of international aviation liberalisation since the 1970s. As to whether international institutions could act to weaken the structural power of strong states such as the U.S., it is sobering to remember that such institutions have been useful vehicles for powerful states to further their own particular interests. These may have been either for the support of protectionist instruments or towards the liberalisation of trade. There would seem little reason to believe that their application to international air transport services would be any different.²⁶

THE BILATERAL BARGAINING PROCESS

The Chicago Convention of 1944²⁷ failed to come to terms with the fundamental economic issues involved in international civil aviation due to the diametrically opposed positions of the two major participants, the U.S. and the UK. Thus, the bilateral system of regulation established before the Second World War prevailed and was able to develop independently of any multilateral framework. Apart from the first two ‘freedoms of the air’²⁸, the trading of aviation rights has continued to be regulated by means of state-negotiated bilateral air service agreements (ASAs).²⁹ This bilateral bargaining process has served to perpetuate the principle of state sovereignty and generally acted to protect the economic position of ‘national carriers.’³⁰ In essence, these bilaterals will regulate entry usually by identifying the number of carriers, routes and kinds of traffic allowed with such resultant bilateral agreements being usually based on the mercantilist concept of reciprocity. In other words, each bilateral partner has a critical role in determining the size of the total supply of the bilateral market and not just the level of its own output.

The form of trade regulation that this lattice of bilateral accords represents is essentially discriminatory in nature and acts contrary to the multilateral principles of Most Favoured Nation (MFN) and National Treatment and has kept international air transport removed from the GATT/WTO’s liberalization developments.³¹ This does not mean that this bargaining approach cannot facilitate (perhaps even encourage) increasingly liberal economic regulatory arrangements, as evidenced by the series of ‘open skies’ bilaterals³² which the U.S. and others have used as instruments to advance liberalisation.

Both contextual (or systemic) factors and issue-specific capabilities influence the formal bilateral bargaining process that regulates aviation trade.³³ The process has the potential to translate as well as transmit power-capable resources towards certain specific outcomes with the issue or sectorally-specific resources at each state’s disposal being brought to the negotiations and offering opportunities to a weaker state to apply tactics to gain against a stronger partner.³⁴ For instance, it may be that in the process of making a deal, the weaker state will be able to show a determination to gain a certain result (even if that means making other sacrifices) which could force the stronger state to accede so as to reach an overall agreement.

As an intervening variable which may serve to prevent the direct transmission of power-capable resources into sectoral outcomes, the bargaining process has three important features: that both parties realise that there are gains to be made from the agreement; that mutual action is required for an agreement; and that there exists more than one possible

agreement.³⁵ Taken together, these place two asymmetrically powerful states in a more comparable (if not equal) relationship to each other while providing opportunities for the application of issue-specific resources and the use of tactics towards favourable outcomes. Importantly, the process provides a mechanism through which a weaker state can avoid focusing its bilateral bargaining directly upon the policy process of the stronger state, thus making it more difficult for the latter to apply its structural power towards a desired result. Instead, both parties are required to undertake a formal process towards a jointly agreed result.

HISTORY AND BACKGROUND TO AUSTRALIA-U.S. AVIATION BARGAINING

Australia-U.S. aviation trade relations over the postwar period has always been conducted against a background of U.S. dominance in the international aviation market and with the Australian government and its negotiators keeping close attention to the economic welfare of its international carrier, Qantas. For its part, Qantas was expected to pursue commercial objectives that were compatible with national ones.

As with most aviation bilateral negotiations, the major issues in contention between the U.S. and Australia were the levels of capacity on the specified contested routes—the South Pacific and North Pacific routes (see Table 2)—and the extent of access to each other's domestic market. While market access disputes have been decided to the U.S.' advantage due to its large domestic passenger market, disputes in Australia-U.S. bargaining over route capacity have been resolved through the negotiation process.

Each country has changed its approach to negotiating aviation rights with the other, as a result of variations in its own international aviation policy. Since the Second World War, the U.S. has consistently called for a more liberal, less regulatory regime and this was further promoted after its own 1978 domestic deregulation.³⁶ Concerned that this ideas-driven policy was not delivering satisfactory results for U.S. commercial aviation interests, the Reagan administration implemented a 'trading rights' policy that effectively meant the U.S. would no longer seek to promote global deregulation through bilateral negotiations. Rather the U.S. became more interested in promoting liberalization by trading access to the lucrative U.S. domestic market in return for greater liberalization from its negotiating partners.³⁷ Thus, liberalization came to be used as part of a mercantilist approach to advance U.S. carrier interests as well as more generally furthering global liberalization.

Table 2. Capacity Negotiated and Utilised Under Australia's ASAs with the U.S. (International Air Passenger Transport, as of February 1, 1998)

<i>Capacity (per week) – South Pacific route</i>		
	<i>Australia</i>	<i>United States</i>
Entitlement:	Market driven	Market driven
Utilised:	28 x B747 (10,020 seats excluding seats leased to American, British, Canadian airlines)	21 x B747 & 519 codeshare seats
Unutilised:	New carrier may commence operations at any time with up to 4 services – (conditions apply)	As for Aust.
<i>Capacity (per week) – North Pacific route</i>		
	<i>Australia</i>	<i>United States</i>
Entitlement:	3 frequencies with any aircraft type; maximum of 2 carriers	As for Aust.
Utilised:	Nil	Nil
Unutilised:	3 frequencies with any aircraft type; maximum of 2 carriers	As for Aust.
<i>Capacity (per week) – Guam route</i>		
	<i>Australia</i>	<i>United States</i>
Entitlement:	4 DC10	As for Aust.
Utilised:	Nil	Nil
Unutilised:	4 DC10 (conditions apply)	As for Aust.

Source: Productivity Commission, Draft Report on International Air Services, June 1998.

With little to be gained in terms of market access in Australia, the U.S. has not sought to offer Australia its more liberal 'open skies' agreement, though these agreements do, in fact, reveal similar restrictions to those faced by Australian negotiators.³⁸ The U.S. pro-competitive 'trading rights' negotiating policy, as applied to its bargaining with Australia, has been export-oriented. The focus of the U.S.'s bargaining approach has been upon improving U.S. market share on international routes and this was pursued vigorously in its negotiations with Australia in 1988 and 1993.³⁹

The changes in U.S. policy represent a curious mixture of ideas and interests and reveal a somewhat ambiguous approach to the formal process of bilateral bargaining. On the one hand, the U.S. has been concerned that such negotiations have constituted an impediment or trade barrier to both the liberalization and expansion of international aviation services. On the other, it has recognized the gains made by U.S. carriers from these negotiations and the valuable role they have performed in advancing the liberalization of international aviation. Given its economic strength, the U.S. prefers to negotiate agreements bilaterally on most trade issues despite its rhetoric in support of the periodic multilateral negotiations. Evidence of this preference in the aviation sector can be found in the U.S.'s lukewarm approach to the inclusion of aviation services within the Uruguay Round settlement of the GATT.⁴⁰

Until the late 1980s, Australian policy was based on the singular designation of Qantas as the international carrier; the separation of international and domestic aviation sectors; and the government ownership of airlines in both the domestic and international sectors. In negotiating with the U.S., Australia had adopted a pre-deterministic approach to the setting of capacity that was restrictive and highly regulatory and designed to keep U.S. demands for capacity increases in check. Australia was resistant to any increase in U.S. access to the Australian market without equivalent U.S. market access for Qantas.

Negotiating with the U.S., with its dominant market position and promotion of aviation liberalisation, had always constituted a form of pressure upon Australia for a change in policy. However, when the policy changes did come in the late 1980s and early 1990s, it was for domestic economic reasons rather than as the result of external influences. The Hawke and Keating governments' policy changes were a direct response to a perceived need to bring the aviation sector into the mainstream of national economic policy-making and make aviation policy-making subject to the same impulses as most other sectors.⁴¹ In 1989, the government changed its negotiating policy to become a "...more hard-headed economic approach...and fuller analysis of where to capture the economic and other benefits for Australia...[and]...what is in it for Australia as a whole will be the dominant consideration".⁴² Importantly, this represented the beginning of a new approach aiming for a 'balance of overall benefits', an approach which was more accommodating of the pressure for liberalisation coming from the U.S. and elsewhere. (For a summary of points or gateways available, see Tables 3 and 4).

This change was followed with a more substantial policy change in 1992 when the then Prime Minister Paul Keating announced, as part of a general economic statement,⁴³ a program of accelerated reform of the Australian

Table 3. Points Available to Australia and the United States on the South Pacific Route as Negotiated in ASAs (International Air Passenger Transport, as at February 1, 1998)

Australia

Australia via New Zealand, New Caledonia, Fiji, American Samoa, Canton Island, French Polynesia, Mexico, Canada to the gateway points of Honolulu, San Francisco, Los Angeles, New York and three points to be selected by the government of Australia and to an additional eight points (which may be changed from time to time) in the U.S. only via one or more of the specified and/or selected gateway points and beyond to Canada, Mexico, the UK, and Europe and beyond.

United States

a) United States (excluding Guam and the Commonwealth of the Northern Mariana Islands) via Canton Island, French Polynesia, Fiji, New Caledonia and New Zealand to Sydney, Melbourne, Darwin, Perth, Brisbane, Cairns and another point to be selected by the Government of the U.S. and beyond to New Zealand, Southeast Asia, South Asia, Africa, Europe (including the UK) and beyond.

b) An additional eight points in Australia may be served only via any one or more of the specified and/or selected gateway points in Australia set forth in sub-paragraph (a). These eight one-stop points may be changed at any time.

Source: Productivity Commission, *Draft Report on International Air Services*, June 1998.

Table 4. Points Available to Australia and the United States on the North Pacific and Guam Routes as Negotiated in ASAs (International Air Passenger Transport, as at February 1, 1998)

Australia

Australia via any two points in Asia (including Hong Kong, Japan, Korea and Taipei and may be changed from time to time) to any three points in the United States to be chosen from Honolulu, Los Angeles, San Francisco, New York and one other point selected by the Government of Australia.

Guam and the Commonwealth of the Northern Mariana Islands:

Australia to Guam and the Commonwealth of the Northern Mariana Islands and beyond to any two points to be chosen from Tokyo, Nagoya, Fukuoka, Seoul, Taipei, Beijing, and one additional point to be specified (the beyond points may be changed from time to time).

United States

United States (excluding Guam and the Commonwealth of the Northern Mariana Islands) via Canada, Japan, Southeast Asia including the Republic of the Philippines to any two points in Australia chosen from Sydney, Melbourne, Brisbane, Cairns.

Guam and the Commonwealth of the Northern Mariana Islands:

Guam and the Commonwealth of the Northern Mariana Islands to any two points to be chosen from Sydney, Melbourne, Perth, Darwin, Brisbane, Cairns or a point to be selected by the Government of the U.S.

Source: Productivity Commission, *Draft Report on International Air Services*, June 1998.

aviation industry.⁴⁴ These reforms also signalled the government's gradual withdrawal from the exercise of direct control in international aviation policy-making. An International Air Services Commission (IASC) was created to determine the allocation of international aviation capacity and route entitlements among Australia's airlines. However, despite this deregulation, the Australian government's direct involvement in the determination of aviation outcomes has been guaranteed by its continuing dominance in bilateral negotiations. For instance, the Commission's ability to allocate capacity and route entitlements remains dependent upon the outcome of government-to-government bilateral negotiations.⁴⁵

Whether or not the changes have been sufficient to meet the government's objectives remains in doubt while it is difficult to gauge the economic effect of those changes that have been implemented, despite the growth in Australian international air traffic over the 1990s.⁴⁶ With Australia's unilateral move to increase capacity and to provide for multiple designation, its negotiating approach became one of taking a broader economic view. This view took note of the needs of all interests, including those in the tourist industry, the regions, industry and business, consumer groups, as well as the Australian carriers. This new policy aimed to 'balance overall benefits' rather than remain strictly based upon bilateral reciprocity. While generally more liberal, it reflected the dual, and often conflicting, aims of the government: to protect Qantas' position and its potential to earn export revenue while also promoting new Australasian entrants into the market.⁴⁷

Australia's approach to dealing with the U.S. changed accordingly and from the early 1990s, as evidenced by their 1993 negotiations over the North Pacific route,⁴⁸ Australia sought to negotiate enhanced route and capacity entitlements ahead of demand. The move towards deregulation (though less so than in the U.S.) and greater liberalisation has meant the Australian government has refashioned its role as being independent of any Australian carriers-no longer are Qantas' interests to be paramount. Despite the policy changes, Australia continues to see the bilateral negotiation of aviation rights as extremely important: it is both the avenue through which international liberalisation will occur; and the means by which it can advance its carriers' interests in any such liberalisation.

AUSTRALIA'S AVIATION BARGAINING WITH THE U.S.

In contrast to other bilateral trade sectors (notably agricultural trade), much of the heat has gone out of the aviation bargaining between Australia and the U.S. This has been because capacity has been liberalised and, importantly, because no U.S. carrier appears interested in pursuing

entrance or expansion into the Pacific routes to Australia. This has not always been the case and as recent as the late 1980s and early 1990s, difficulties between the two parties had to be resolved by means of the bilateral bargaining process.⁴⁹ The determination of capacity has traditionally been at the heart of Australia's ASAs.⁵⁰ Along with Australia's concern over route entitlements and access to gateways in its bargaining partner's country, Australia saw the tight regulation of capacity entitlements as a means of containing the liberalising advances of strong aviation countries such as the U.S. What caused Australia to accede to automatic capacity increases in its negotiations with the U.S. was the belief amongst senior ministers and officials, that liberalisation together with the restructuring and deregulation of the aviation industry, would enhance its commercial returns.⁵¹ Yet, the move towards liberalisation was not without mercantilist or regulatory overtones and the Australia-U.S. ASAs have continued to constrain unilateral capacity increases while disallowing cabotage rights.

While Australia's liberalizing impulses have served to accommodate most of U.S. carrier demands from the mid-1990s onwards, the more interesting story is how Australia used the bargaining process to apply certain tactics to address the U.S.'s structural power in this sector. It is not claimed that these tactics are peculiar to this sector but that the formal aviation bargaining process made their application possible. The first of these tactics has been Australia's preparedness to walk away from an agreement. Australia applied this tactic in 1987 when it terminated the then existing bilateral memorandum. Australia correctly saw the U.S. to be just as keen as Australia to reach an acceptable agreement and just as likely to incur costs (notwithstanding the possibility of gains) from the inability of the parties to reach an agreement.⁵²

Even if an agreement with Australia failed to be completely satisfactory, the U.S. would see some value in it for high costs would attach to the alternative no-agreement result. An agreement would serve to regulate the aviation rights between the two countries plus holds value for the U.S. in being a potential (if not an immediately realisable) vehicle for increased liberalisation of international aviation. The regulatory nature of this bilateral bargaining process is also useful to the U.S. in providing stability while conforming with its preference to negotiate bilaterally rather than multilaterally. Of related importance is the recognition by both parties of the iterative nature of the negotiating process. With or without an agreement, both the U.S. and Australia know that they will need to deal again with each other in order to trade aviation rights and that reaching a satisfactory agreement can significantly reduce future conflict in this sector.

Another tactic applied by Australia in its aviation trade bargaining with the U.S. has been the assertion of a level of control over the nature of the negotiations and their subsequent agreement. The joint need for an agreement places the two states in a more equal bargaining relationship and provides opportunities for the weaker state to project its own agenda and interests. Each player has mixed motives (a mutually agreeable result while advancing the position of its carriers) while both have common and competing interests (aviation liberalization but also a greater share of traffic rights). In such a relationship, there is some room for a weaker party to ensure that its interests are taken into account in the final settlement.⁵³ Australia achieved this in its negotiations with the U.S. in the late 1980s and early 1990s through being able to maintain a regulatory approach to the determining of capacity, despite the U.S.'s desire to achieve an open-ended capacity agreement.⁵⁴

For Australia, another bargaining tactic has been a preparedness to show determination or commitment in its bargaining, especially if it desired the inclusion of provisions objected to by the Americans. A committed approach to its bilateral bargaining has been used to help overcome Australia's relative economic weakness. While changes in Australia's negotiating policy have been towards providing greater liberalisation of the airways, its negotiators have indicated to the U.S. that any expansion of capacity is likely to be unacceptable if it means that Qantas or another Australasian carrier will have a reduced market share. However, in the 1993 Northwest airlines dispute, the Australian government showed ambivalence in its attempts to control capacity so as to maintain Qantas' market share on the North Pacific route. In acquiescing to increased capacity by Northwest Airlines, it appeared to have 'painted itself into a corner' as it agreed to remove capacity limits.⁵⁵

In its negotiations with the U.S., Australia had also sought to trade, as far as possible, U.S. access to the Australian aviation market for greater access to the U.S. market. The enduring effectiveness of this strategy has been questioned with one senior Qantas official seeing it significantly reduced by the mid-1990s, with Australia having virtually opened up the whole of its aviation market to U.S. carriers. U.S. access to the Australian aviation market may have been traded away to either assist in the liberalisation of Australia's aviation market; promote other economic interests such as inbound tourism or; simply to reciprocate for increased access to the U.S. market. Regardless of causation, there remain few existing concessions that Australia could now make for increased benefits from its bargaining with the U.S.

The 1992 U.S. Open Skies policy,⁵⁶ promoting liberal ASAs as it does, is more restrictive than others (such as that of New Zealand). It neither

grants cabotage to foreign carriers nor gives foreign carriers the right to increase their ownership of U.S. carriers beyond a maximum of 25 percent of airline voting stock. The pursuit of these more liberal 'open skies' arrangements, particularly since 1995, has resulted in the U.S. signing over 30 such agreements with countries from around the globe.⁵⁷ Until very recently, the U.S. did not consider that Australia embraced liberalisation to the same extent and had not sought to sign such an agreement with it.

In mid 1999, the Australian government, in seeking to balance the costs and benefits of the bilateral negotiating system while promoting liberalisation, responded positively to the recommendation of its Productivity Commission that Australia should seek to "negotiate reciprocal open skies agreements with like minded countries."⁵⁸ Importantly, Australia gave itself an escape clause by stating that such agreements would only be made if they were in the 'national interest'. In effect, Australia was announcing that it would seek its own restrictive version of 'open skies' agreements which, like that of the U.S., do not grant cabotage to foreign carriers (except New Zealand) and limit foreign ownership of Australia's international carriers.⁵⁹

Against this background and that of subtle U.S. pressure provided through the negotiation of other 'open skies' agreements, it should come as little surprise to learn that Australia and the U.S. entered into an open skies agreement on cargo in late 1999.⁶⁰ This agreement removes restrictions on all-cargo air services between and beyond the two countries but, more importantly, the talks included an undertaking by both parties that they would meet again early the following year to discuss removing all restrictions on passenger services between the two countries.⁶¹ Agreement has yet to be reached. With 'unlimited' capacity agreements now covering Australia-U.S. aviation trade in the important Pacific routes and less demand by U.S. carriers for those route entitlements, the principal restriction on U.S. access to Australia, being the carrying of passengers on Australian domestic routes, may well be the focus of imminent talks. However, as a 1999 government decision indicates, restriction may still be the order of the day as this remains an area where Australian carriers, Ansett Australia and Qantas, continue to exercise influence.⁶² The overall result is that while bilateral negotiations no longer contain the previous rancour, they offer little hope of Australia seeing much, if any, progress, in terms of market access to the U.S. The time looks ripe for Australia to consider whether an 'open skies' agreement with the U.S. may provide the improved access that is otherwise unavailable.

CONCLUDING COMMENTS

This paper has sought to apply a modified neorealist analytical model which has called for the neorealist explanation of Australia-U.S. aviation relations to be qualified by an understanding of the dynamics of the bilateral bargaining relationship. In so doing, the paper sets out to show how Australia attempted to modify the structural weakness in its aviation trade relations with the U.S. so as to improve its economic outcomes. Neorealism is considered more useful than liberal institutionalism in explaining Australia-U.S. aviation trade outcomes with relative power-capabilities proving a good indicator of likely results while also explaining the international context within which Australia-U.S. bargaining is conducted. Liberal institutionalism, manifested by international regimes, have, on the other hand, had little impact in determining the nature of these trade relations, as evidenced by the exemption of aviation from the Uruguay Round settlement of the GATT/WTO.

Where the neorealist explanation is found wanting is in explaining this particular sectoral relationship and the dynamics of the bilateral bargaining upon which the trading of rights depends. In contrast to other trading sectors, Australia and the U.S. have stood in not only a more competitive but also a more equal bargaining relationship. Each has sought increases in capacity and improvements in route entitlements while bargaining access to its own domestic market. This has meant that the bargaining process, mainly though not exclusively conducted through formal bilateral negotiations, has been capable of taking on a dynamic of its own, largely independent of the respective power-capable positions of the states. As such, the bargaining process may provide opportunities for a weaker state to exploit towards an improvement in outcomes.

In seeking to exploit such opportunities, Australia sought to apply certain tactics through the bilateral bargaining process: the withholding of agreement; the assertion of control over important aspects of the negotiations; and the demonstration of commitment and determination. The effectiveness of Australia's prosecution of these tactics has also been influenced by cognitive factors such as ideas and the perceptions and belief systems of policy-makers and negotiators. Australia's adoption of a more liberal approach in the 1990s has acted, importantly, as a form of self-denial from the application of a restrictive capacity mechanism. On the other hand, Australian negotiators' perceptions of the U.S.'s need for an agreement (or perhaps the cost of not reaching an agreement) in the late 1980s, enabled Australia to retain an element of control over the conduct of the negotiations during this period. As with Australia, the bilateral bargaining process requires that the U.S. bargains (possibly even making

concessions) and does not simply rely upon the application of its greater power-capable resources to secure desired outcomes.

Encouraged by U.S. carriers, the U.S. government has used the regulatory nature of the bilateral bargaining process to both maximise the benefits to U.S. carriers while also promoting the liberalisation of global aviation. The major exception to this liberalising policy has, of course, been access to the U.S. market. The export competitiveness of U.S. carriers has been emphasised with the U.S. domestic market used as a lever to gain U.S. carriers' access to other markets. For Australia, it has made liberalising concessions so as to gain favourable access to the U.S. market. Gaining such access has proved, however, to be increasingly difficult given that Australia has little left to concede which the U.S. either wants or needs. U.S. liberalising moves have become more acceptable to Australia as the 1990s progressed. This has been largely due to Australian policy changes that sought to position Australia so as to derive greater returns from its international aviation activities. International developments (including domestic U.S. deregulation and liberalisation as well as a new U.S. international negotiating policy) have been influential. However, domestic influences have been more important with the government seeing the removal of the protection traditionally given to Qantas as part of a more assertive policy to promote travel, trade and tourism: a policy shift consistent with its broader economic reform agenda. This new policy framework is not without its problems for the Australian government as it seeks to reconcile the desire to maximise export revenue received from increased travel and tourism to Australia while ensuring Australasian carriers maintain, if not increase, their market shares.

The liberalisation of the international aviation market obviously offers a mixed picture for relatively weak traders such as Australia. The U.S. has most certainly used liberalisation to serve nationalistic and mercantilist ends. Australia too has come to view aviation liberalisation as a means of providing a boost to its balance of payments. In respect of its aviation relations with the U.S., Australia has been keen to promote a translation of ideas of free trade and liberalisation across into a policy of liberalisation of the U.S. domestic market. However, it has remained concerned that global liberalisation of aviation may allow those with a comparative advantage in international aviation to dominate the marketplace. Australia's pursuit of a more liberal policy has resulted in virtually unlimited capacity for U.S. carriers on Pacific routes. Yet, the recent withholding of cabotage from U.S. carriers (and others) reveals continuing shades of mercantilism in Australian policy and ongoing concerns about the complete liberalisation of the Australian aviation market.

Recent developments have shown Australia unable to use the bilateral negotiating process to successfully check the pressures of U.S. carriers on Pacific routes or gain greater access to the U.S. market. This helps to explain why Australia is now beginning to consider the possibility of an 'open skies' agreement with the U.S. on passenger traffic. However, in focusing upon episodes of tension in Australia-U.S. aviation relations, this study has shown how Australia, as the weaker state, has been able to apply specific tactics towards modifying results that would otherwise have favoured the U.S. Even in the possible future context of an 'open skies' negotiation, the provision of the above opportunities for the weaker state means that formal bilateral talks remain the best possibility for Australia to seek to improve upon those outcomes normally expected from such a case of unequal bargaining.

ENDNOTES

1. As Table 1 shows, the proportion of services exports to total exports has gradually increased over the 1990s. Transportation services have constituted just under a third of total services exports during this period.

2. The 'flashing' of the security card in the early 1990s, and its hasty withdrawal by the then Trade Minister over frustration with certain U.S. trade policies illustrated the delicate manner in which Australia has approached the U.S.: John Lyons, "Cook retreats from warning over U.S. ties" in *The Weekend Australian*. June 12-13 (1993), p. 4.

3. J.D.B. Miller captured the essence of this when he commented that it has been "derivative, cautious, capitalist, bourgeois and anti-revolutionary": "Reflections on Australian Foreign Policy" in P. J. Boyce, and J. R. Angel, (eds.), *Diplomacy in the Marketplace. Australia in World Affairs 1981-90* (Melbourne, Longman Cheshire, 1992) p. 117.

4. The 1944 Chicago Convention established the current bilateral regulatory framework for international air transport and while privileging state sovereignty, posed the continuing problem of how states could avoid being dominated by others without resorting to protectionism. For a discussion, see Ruwantissa I.R. Abeyratne, "Would Competition in Commercial Aviation Ever Fit Into the World Trade Organization?" *Journal of Air Law and Commerce*, Volume 61 No. 4 (May-June 1996), pp. 793-857.

5. Kenneth Waltz, "Realist Thought and Neo-Realist theory", *Journal of International Affairs*, Vol. 44 No. 1, (Spring 1990), pp. 21-37.

6. Donald J. Puchala and Raymond F. Hopkins, "International Regimes: lessons from Inductive Analysis" in Stephen D. Krasner (ed.), *International Regimes* (Ithaca, Cornell, 1983), pp. 61-91.

7. Robert O. Keohane, *After Hegemony* (Princeton, New Jersey, Princeton, 1984).

8. Habeeb considers weaker states may gain in negotiations through showing a level of commitment, a range of alternatives and/or a degree of control over the negotiations: William Mark Habeeb, *Power and Tactics in International Negotiation: How Weak Nations Bargain with Strong Nations* (Baltimore, Johns Hopkins, 1988), p. 130. Zartman sees weaker powers exercising procedural power in the negotiations through provoking an encounter; influencing

the agenda of negotiations and; importantly, using their 'power to agree' to resolve a dispute to their liking: I. William Zartman, *The Politics of Trade Negotiations Between Africa and the EEC: The Weak Confront the Strong* (Princeton, New Jersey, Princeton, 1971), pp. 227–8.

9. See for example, Kenneth Waltz, "Realist Thought and Neo-Realist Theory", *Journal of International Affairs* Vol. 44 No.1, (1990), p. 34.

10. Michael Mastanduno, "Do Relative Gains matter? America's Response to Japanese Industrial Policy" in David A. Baldwin (ed.) *Neorealism and Neoliberalism: The Contemporary Debate* (New York, Columbia, 1993) p. 255.

11. Susan Strange has argued that structural power (the power to shape or determine the structure of the global political economy) is more important than relational power (the power of one party to determine the surrounding structure of the relationship): *States and Markets* (London, Pinter, 1988) p. 26.

12. See for example, Donald J. Puchala and Raymond F. Hopkins, "International Regimes: Lessons from Inductive Analysis" in Stephen D. Krasner (ed.), *International Regimes* (Ithaca, Cornell, 1983), pp. 61–91.

13. Krasner's definition of a regime has been accepted by most scholars regardless of theoretical allegiance: sets of implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge: Stephen Krasner (ed), *International Regimes*, (Ithaca, Cornell, 1983) p. 2.

14. Donald J. Puchala and Raymond F. Hopkins, "International Regimes: Lessons from Inductive Analysis", p. 63.

15. Oran R. Young, *International Cooperation: Building Regimes for Natural Resources and the Environment* (Ithaca, Cornell, 1989), p. 64.

16. See for example, Robert O. Keohane, *International Institutions and State Power*. (Boulder, Westview, 1989) and *After Hegemony* (Princeton, New Jersey, Princeton, 1984).

17. Baldev Raj Nayar, "Regimes, power, and international aviation", *International Organization*, 49, 1, Winter 1995, p. 144.

18. Nayar has borrowed the language of Jock Finlayson and Mark Zacher: "The GATT and the Regulation of Trade Barriers: Regime Dynamics and Functions" in Stephen Krasner (ed), *International Regimes*, (Ithaca, Cornell, 1983) pp. 273–314 at p. 277.

19. Productivity Commission, *International Air Services*, Draft Report (Melbourne, June 1998), p. xxi.

20. For a discussion of the history and role of ICAO, see Ruwantissa I. R. Abeyratne, "Would Competition in Commercial Aviation Ever Fit Into the World Trade Organization?" pp. 808–816.

21. Nayar, "Regimes, power, and international aviation", p. 145.

22. For instance, IATA's traditional price setting role has declined over time.

23. These are computer reservations systems in air transport; the selling and marketing of air transport services; and aircraft maintenance.

24. As Ruggie argues, multilateralism is not just about coordinating national policies in groups of three or more states but in specifying certain conduct without reference to each state's particular interests: John Gerard Ruggie, "Multilateralism: the Anatomy of an

Institution” in John Gerard Ruggie (ed), *Multilateralism Matters* (New York, Columbia, 1993) p. 14.

25. For a discussion, see Ruwantissa I. R. Abeyratne, “Would Competition in Commercial Aviation Ever Fit Into the World Trade Organization?” pp. 832–843.

26. See, for example, Vicki L. Golich, “Alternative Paths to Competitiveness: US Trade Policies in International Transport Services and Commercial Class Aircraft Manufacturing” in David A. Rapkin and William P. Avery (eds.), *National Competitiveness in a Global Economy*, (Boulder, Lynne Rienner, 1995), pp. 179–198.

27. The Chicago Convention, the first international civil aviation conference recognising the commercial as well as military significance of civil aviation, could not agree between the contending U.S. (more laissez-faire) and UK (some government intervention) approaches to structuring a regime. While creating an international body, ICAO, the conference made its operation subject to the principle of national sovereignty over airspace.

28. The first freedom is the right to fly over another nation without landing, while the second freedom is the right to land for purely technical reasons.

29. The other five freedoms form the basis upon which states negotiate their capacity rights. These are the right of an airline of one country to carry traffic from its country to another; the right of an airline of one country to carry traffic from another country to its own country; the right to carry traffic between two other countries providing the flight originates or terminates in its own country; the right to carry traffic between two other countries via its own country; and the right to operate flights between two other countries without the flight originating or terminating in its own country.

30. For a discussion, see Vicki L. Golich, “Liberalizing International Air Transport Services” in Dennis J. Gayle and Jonathon N. Goodrich (eds.), *Privatization and Deregulation in Global Perspective* (New York, Quorum Books, 1990), p. 163.

31. Eugene Sochor, *The Politics of International Aviation* (Houndmills, Basingstoke, Macmillan, 1991), p. 216.

32. Even a strongly liberal Australian government agency, in a recent draft report, has acknowledged that liberalisation is both available and preferable through the existing bilateral system: Productivity Commission, *International Air Services*, Draft Report.

33. Issue-specific resources are derived from domestically based factors in each party.

34. William Mark Habeeb, *Power and Tactics in International Negotiation How Weak Nations Bargain with Strong Nations* (Baltimore, Johns Hopkins, 1988), pp. 130–131.

35. Christer Jonsson, *International Aviation and the Politics of Regime Change* (London, St. Martin’s, 1987), p. 61.

36. Importantly, with the U.S. Airline Deregulation Act of 1978 came the end of the regulatory role of the Civil Aviation Board (CAB); U.S. airlines developing hub-and-spoke operations on domestic routes; new pricing strategies; computerized reservation systems (CRS); and the frequent flyer programs: Daniel M. Kasper, *Deregulation and Globalization: Liberalizing International Trade in Air Services* (Washington D.C., American Enterprise Institute, 1988) p. 29.

37. Each bilateral relationship was assessed by negotiators in terms of “the totality of U.S. transportation interests in any particular relationship”: John W. Fischer, *Airlines Under Deregulation at Mid-Decade: Trends and Policy Implications*. CRS Report No. 86–67 E (Washington D.C.: CRS, 1986), p. 16.

38. 'Open skies' agreements do not, however, include cabotage rights, have not relaxed the limits on foreign ownership of U.S. carriers, while also not allowing foreign carriers to establish within the U.S.

39. Interviews with U.S. Department of State officials, 1989 and 1996.

40. Interviews with officials of the U.S. Trade Representative. However, these same officials saw some "doing business" issues, such as baggage handling and catering, being usefully dealt with in a multilateral agreement.

41. The Hawke government's policy change is revealed in Transport Minister Willis' Statement of June 1989: Hansard, House of Representatives, Ministerial Statement, *International Aviation: Maximising the Benefits* (June 15, 1989), p. 3539; while that of its successor appears in Bob Collins, *Australian Aviation: Towards the 21st Century*. A Policy Statement by the Minister for Shipping and Aviation, February 27, 1992.

42. Ministerial Statement, *International Aviation: Maximising the Benefits*.

43. Hon. P.J. Keating, *One Nation*, February 26, (Canberra, AGPS, 1992).

44. These reforms included the removal of the international/domestic divide between Australian carriers; facilitation of the privatization of Qantas; the re-negotiation of bilateral air service agreements to secure multiple designation agreements; and a pro-competitive approach to enhance route and capacity arrangements.

45. For instance, the Australian Department of Transport has the power, by virtue of each bilaterally negotiated agreement, to grant a temporary permission for a designated Australasian airline to operate on a particular route.

46. These outstanding changes include the privatisation program and the establishment of the multiple designation regime for Australasian (including New Zealand) carriers: Productivity Commission, *International Air Services*, Draft Report, p. 60.

47. This partly explains the staggered nature of the liberalization with international routes being made available to Australasian carriers (other than Qantas) on a piece-meal basis as relevant bilateral negotiations were concluded. This made it more difficult for new entrants, such as Ansett, to acquire sufficient capacity to make their proposed services viable.

48. While Australia considered Northwest Airlines had an insufficient proportion of through passengers on its New York-Osaka-Sydney route, in the negotiations, Australia withdrew in the face of a tough U.S. stance. Northwest Airlines gained a 6-month extension despite little evidence of a guarantee to build up its through passenger numbers: Ian Thomas, "Air truce as Australia backs down", *The Australian Financial Review*, June 18, 1993, p. 4.

49. Interviews with U.S. and Australian transport officials.

50. The other important issues found in most of Australia's ASAs are the substantial ownership and control of the airlines by a country's nationals; the restriction of cabotage; the restriction of market access; and the government's approval of tariffs.

51. Interviews with Australian government officials. See also statements in 1992 by Prime Minister Keating, *One Nation*, and Minister Collins, *Australian Aviation: Towards the 21st Century*.

52. Interviews with former negotiators in the U.S. Department of State and the Australian Department of Transport.

53. For a useful discussion, though on a different sector, see Helen Milner, "The Interaction of Domestic and International Politics: the Anglo-American Oil Negotiations and the International Civil Aviation Negotiations 1943-47" in Peter B. Evans, Harold K. Jacobson & Robert D. Putnam (eds.), *Double-Edged Diplomacy* (Berkeley, University of California Press, 1993), p. 225.

54. Interviews with U.S. Department of State and Department of Transportation officials. For a policy overview, see Jeffrey N. Shane, "The U.S. Perspective on the International Air Transport Regulatory Environment", Speech to the Air Canada/AMDA Conference, Montreal, May 27, 1987.

55. These particular negotiations saw Australia concerned to be seen to be promoting market access, thus allowing a U.S. carrier to develop new markets on particular Pacific routes despite any reciprocal benefit for an Australian airline.

56. The U.S. 'Open Skies' policy includes open entry on all routes between the bilateral partners; unrestricted rights to operate between any international gateways in both countries; unrestricted capacity, frequency and aircraft on all routes; flexibility in setting fares within certain guidelines; open code-sharing opportunities; non-discriminatory computer reservation systems; and optional 7th freedom all-cargo rights: Fact Sheet, Office of Aviation Negotiations, Bureau of Economic and Business Affairs, U.S. Department of State, "Open Skies Agreements", March 1, 2000. <http://www.state.gov/www/issues/economic/tra/>

57. Productivity Commission, *International Air Services*, Final Report (Melbourne, June 1999), p. 57.

58. Productivity Commission, *International Air Services*, Final Report, p. 229.

59. Media Release, Joint Statement of the Australian Minister for Transport and Regional Services and The Treasurer, "International Air Services", June 3, 1999, http://www.dot.gov.au/media/anders/archive/1999/jun_99/a79_99.htm

60. A more liberalised cargo agreement does not impinge on sovereignty in the same way as such an agreement in respect of air passenger transport. It would also be seen as encouraging mutually beneficial commerce and, importantly, be a sign of generally more liberalised bilateral trade in aviation services.

61. U.S. Department of State. Press Statement by James P. Rubin, "U.S. and Australia Agree on Open Skies for Cargo", Office of the Spokesman, December 15, 1999. <http://secretary.state.gov/www/briefings/statements/>

62. Steve Creedy, "Airports open to foreign airlines" in *The Australian*, June 1, 1999, page 3. The significance of the decision is much diminished by the fact that the unlimited access to airports which it grants to foreign carriers does not include the most important gateways of Sydney, Melbourne, Brisbane and Perth.

INTEGRATING SAFETY IN THE AVIATION SYSTEM: INTERDEPARTMENTAL TRAINING FOR PILOTS AND MAINTENANCE TECHNICIANS

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ABSTRACT

The study of human factors has had a decisive impact on the aviation industry. However, the entire aviation system often is not considered in researching, training, and evaluating human factors issues especially with regard to safety. In both conceptual and practical terms, we argue for the proactive management of human error from both an *individual* and *organizational* systems perspective. The results of a multidisciplinary research project incorporating survey data from professional pilots and maintenance technicians and an exploratory study integrating students from relevant disciplines are reported. Survey findings suggest that latent safety errors may occur during the maintenance discrepancy reporting process because pilots and maintenance technicians do not effectively interact with one another. The importance of interdepartmental or cross-disciplinary training for decreasing these errors and increasing safety is discussed as a primary implication.

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In the current aviation environment there is a strong emphasis on human factors issues in the improvement of aviation safety (Harle, 1994). Too often, however, this emphasis has not encompassed the entire aviation system in researching, training, and evaluating human factors practices. Traditionally, the study of aviation human factors has focused on understanding the mechanisms of *individual* human error so that measures to minimize the possibility of error could be devised. More recently, an alternative approach has been proposed that emphasizes the proactive management of human error from an *organizational* systems perspective (Maurino, Reason, Johnston, & Lee, 1995). Graham and Kuenzi (1997) also suggest a systems approach of combining methods to analyze human error. In addition to a reduction in risk of future errors, another positive by-product of this approach is increased communication between the various departments or career fields of the company (e.g., maintenance, flights operations, in-flight, and ground operations). This article argues for the adoption of a systems perspective in both conceptual and practical terms. It begins with a review of traditional human factors literature and discusses a contemporary shift toward systems thinking about error management. This viewpoint became the foundation for a multidisciplinary research project that addressed maintenance discrepancy reporting and incorporated survey data from pilots and maintenance technicians representing five industry segments and an exploratory study integrating students from relevant disciplines. Although somewhat limited by sample size and survey design, the implications of this study recommend interdepartmental training as a way to decrease errors and increase safety in the aviation system.

TRADITIONAL HUMAN FACTORS RESEARCH

Historically, the study of human factors and the application of related research findings have not encompassed the entire aviation system (Federal Aviation Administration, 2000). The goal of traditional human factors research has been to minimize human error in order to maximize system performance (Proctor & Van Zandt, 1994). Consequently, early research was based upon the popular, although incomplete, notion that aircraft accidents were attributable to individual pilot error thus affixing blame by inferring that human fallibility promoted poor decision making (Hawkins, 1987). While this seemed to appease public sensibilities (and bolster media sales), little was accomplished to evaluate root causes of mishaps or find ways of improving the system. In the early years of accident investigation, there was a tendency to cite blame primarily with the pilot (or air traffic controller) who was directly involved in the accident (Hawkins, 1987, p. 31; National Transportation Safety Board, 1987). The emphasis on pilot

tasks overshadowed consideration of more mundane, lower-profile tasks such as airplane maintenance and passenger service. By narrowly focusing human factors research, training, and practice on the highest profile members of the intricate aviation system, the important interconnections of other key members and groups were virtually ignored.

SHIFT FROM INDIVIDUAL TO ORGANIZATIONAL SYSTEMS PERSPECTIVE

More recently, however, accident investigation has expanded its approach to consider the organization more broadly including the events leading up to the accident. In other words, what organizational factors (i.e., latent errors) led the individual to perform in such a way that his or her actions led to an accident (i.e., active error)? A major challenge to accident investigators is the analysis of factors that may have caused a chain of events reverberating all the way through the organization to the individual. Thus, a theoretical framework of error management must be general enough to encompass the organizational system and yet specific enough to be applicable to past and future accidents (Drury, Wenner, & Murthy, 1997; Maurino, et al., 1995).

Reason (1996) describes errors of two kinds. *Active errors* are those errors that are felt almost immediately. *Latent errors* are those errors that remain dormant for a long period of time but may surface much later, sometimes having significant consequences. It is easier for accident investigators to find the active errors while it is much more difficult to identify latent errors that may have occurred months or even years earlier. All levels of the aviation system contain complex levels of latent deficiencies. It is critical that aviation human factors specialists look beyond the individual to the larger organizational systems that affect the way individuals make decisions.

As in most bureaucracies, major decisions in the aviation environment are often made at the higher management levels (Parsons, 1951; Weber, 1947). These decisions affect all other levels of operation in the organization including personnel decisions, types of aircraft, software and manuals purchased, operating rules for flight crews and ground workers, safety requirements, and communication structures between departments (Westrum, 1996). Separated by time, space, or organizational linkages, these decision makers define the working environment that will strongly impact employee performance. Therefore, it is imperative that the broader issues of organizational contexts and interdepartmental issues be examined for their impact on the behavior of front-line employees (e.g., pilots and maintenance technicians).

As human factors models have evolved through aircraft accident and incident analysis, different segments of the industry have been added in a somewhat piecemeal fashion. Crew Resource Management (CRM) training emerged as a way to begin correcting some of the previous shortcomings. Pilot—aircraft, pilot—pilot, pilot—air traffic controller, and now pilot—automated aircraft interfaces have been developed (Edwards & Edwards, 1990; Hawkins, 1987; Helmreich, Merritt, & Willhelm, 1999). Federal Aviation Administration (1998) Advisory Circular 120-51C suggested that other groups, besides pilots, also be included in company training. These groups could include air traffic controllers, maintenance personnel, passenger service agents, mid-level and upper-level managers, airport operations, and special crisis teams (Bradley, 1995; Ewell & Chidester, 1996). Increasingly, many airlines subsume CRM training within general human factors and safety training. Arguably, emerging human factors research and training *have* reduced errors even though they have narrowly focused on *individual* roles rather than the *organizational* interconnections that occur between these individuals. By shifting to an organizational systems framework of error management, both conceptually and practically, an even greater impact on safety may result (Graham & Kuenzi, 1997; Maurino et al., 1995).

With this concept in mind, Purdue University researchers were interested in learning whether interdepartmental/interdisciplinary interaction among aviation personnel could positively influence working relationships and impact safety. To address this question, faculty and students from relevant disciplines worked together on a research project designed to survey pilots and maintenance technicians from various aviation organizations about their policies and practices for maintenance discrepancy reporting. In addition, students involved in the research project were surveyed about their perceptions of the importance and effectiveness of working with students from other disciplines to learn and complete a task.

METHOD

Survey Development: Interdisciplinary Student Research Teams

Graduate and undergraduate students from the disciplines of aviation technology, aviation flight, aviation administration, communication, and industrial organizational psychology were recruited for this study through professors in these departments and by word-of-mouth. Each student was assigned to one of five research teams. Each research team worked with a different type of aviation organization including regional, general aviation, corporate, and military operations. The research teams were comprised of

students representing each discipline. A faculty member from one of the disciplines provided oversight for each research team. The goal of the research team was to work on the development of a survey both independently as a team and interdependently with the other research teams and with industry professionals. The goal of the survey was to solicit the opinions of professional pilots and maintenance technicians about the effectiveness of the procedures used in communicating maintenance discrepancy information in pilot write-ups or pilot squawks.

Industry Survey

Development of the industry survey of maintenance discrepancy reporting policies and practices occurred in four phases. First, each research team developed potential survey questions. Second, collaboration occurred across teams and with faculty to construct a preliminary survey that integrated the ideas of each research team. Third, industry representatives from each type of aviation organization were contacted for assistance. In addition, each research team visited at least one aviation organization and interviewed members of that organization to solicit feedback on the preliminary survey. These industry representatives and organizations were chosen by convenience based on prior contacts with or proximity to the university. After discussions with industry professionals, some questions were deleted, added, or modified. Fourth, the entire research team met to integrate the findings from the organizational interviews and finalize the survey.

Two versions of the survey were developed; one for pilots (see Appendix A) and one for maintenance technicians (see Appendix B). Virtually the same questions appeared on both surveys. The survey contained 23 questions, measured on a 7-point Likert scale, and a *not applicable/don't know* option. For example, one question posed the statement "Current methods of maintenance discrepancy reporting need improvement" and asked respondents to indicate their response to this statement with 1 being *strongly disagree*, 4 being *somewhat agree*, and 7 being *strongly agree*. In addition, open-ended and closed-ended questions were asked to gather demographics and information about company training and procedures in maintenance discrepancy reporting. For example, a close-ended, yes or no, question asked, "A class including both pilots and mechanics, based on communication and/or crew resource management, would be beneficial to the work environment?" Respondents were then asked in an open-ended fashion "Why or why not?" Blank lines were provided to write in their own words a rationale for their responses.

A comprehensive list of aviation organizations was generated including regional airlines, general aviation, corporate arrangements, and military

operations. A total of 1,250 surveys were distributed to a random sample of pilots and maintenance technicians from the organization list either by mail or personal delivery. Two hundred twenty-two pilots and maintenance technicians completed and returned the survey for a response rate of 18 percent. The respondents represented 55 organizations. Pilots filled out 129 (58.1 percent) surveys and 93 (41.9 percent) surveys were filled out by maintenance technicians. This sample of responses was considered representative of aviation industry pilots and maintenance technicians because the individuals who completed this survey were randomly chosen.

Interdisciplinary Student Research Team Survey

Students participating in the research project were surveyed at the beginning (i.e., pre-test) and conclusion (i.e., post-test) of the research project (see Appendix C). A total of 50 pre-test and post-test student surveys were collected. Due to attrition, not all students who participated in the research project completed both surveys. These surveys contained 29 questions. Open-ended and close-ended response formats were used to collect demographic information, perceptions about students from other disciplines, and perceptions about working on the research project. On the pre-test and post-test, respondents were asked to indicate their perceptions of the various positions associated with aviation and represented on the student research teams (i.e., maintenance technician, pilot, communication specialist, aviation management). Issues addressed included “thinks like me,” “status different from mine” and “background similar to mine.” The response set was a 7-point Likert scale format with 1 indicating a *strongly disagree* response and 7 indicating a *strongly agree* response. On the post-test, respondents also were asked to indicate their general level of satisfaction with participating in the research project with 1 being *very dissatisfied* and 7 being *very satisfied*. In addition, they were asked about the advantages and disadvantages of working on the research project in an open-ended, free-response format.

RESULTS

Analysis of the survey results for pilots, maintenance technicians, and students provided insight into the question of whether interdepartmental/interdisciplinary interaction among aviation personnel would positively influence working relationships and impact safety. The results of the industry survey regarding maintenance discrepancy reporting are presented first, followed by the results of the interdisciplinary student research team survey.

Industry Survey

The industry survey was designed to assess current industry policies for reporting airplane maintenance discrepancies and inquired about respondents' perceptions of training regarding these policies. First, participants were queried about organizational policy for reporting airplane maintenance discrepancies between pilots and maintenance technicians. Respondents were given a number of choices (e.g., written logbook entry, face-to-face reporting, etc.) and an "other" option with blank lines to write in other policies. Most respondents reported that their organization's "policy for reporting maintenance discrepancies from pilots was a written logbook entry" (n=202, 91 percent) and/or an "electronic logbook entry" (n=33, 15 percent). Often, this policy included "face-to-face reporting" (n=130, 58.6 percent) which was the second most frequently reported policy.

Second, it was important to determine whether respondents thought their organization's policy was consistently followed and was considered effective. While both pilots (n=129, M=6.00) and maintenance technicians (n=93, M=5.97) thought their policy was consistently followed and was minimally effective (pilots n=128, M=5.88, maintenance technicians n=93, M=5.78), both groups saw several flaws in their organization's maintenance discrepancy reporting system. Of the 136 respondents to the open-ended question "Which part(s) of your company's policy for reporting maintenance discrepancies from pilots does not work well?," 43 (31.6 percent) wrote that the face-to-face aspect of the policy was not working well. Sixty-three respondents (46.3 percent) wrote that some aspect of the written or electronic logbook entries was problematic (e.g., lack of detail in write-up, not writing up discrepancy, ACARS codes are vague). There were no significant differences in the responses reported by pilots and maintenance technicians.

Third, it would be helpful to know if those using the maintenance discrepancy reporting system thought it needed to be improved. Both pilots and maintenance technicians (n=220) *somewhat agreed* that their organization's current method of maintenance discrepancy reporting needed improvement (M=3.72). Again, there were no significant differences in pilots' (n=128, M=3.69) and maintenance technicians' (n=92, M=3.76) responses to this question.

Finally, it was essential to examine the training pilots and maintenance technicians received regarding maintenance discrepancy reporting. To address the training issue, respondents were asked if they thought the "training/instruction regarding the entire maintenance reporting system" had been adequate. Together, pilots and maintenance technicians reported

that their training had been *somewhat adequate* (n=228, M=4.73). There was no significant difference in pilots' (n=128; M=4.77) and maintenance technicians' (n=90, M=4.68) response to this question.

Further, respondents were asked if they thought that a "standardized debriefing or interview process, to supplement the written data, would help minimize miscommunication during maintenance discrepancy reporting." Pilots and maintenance technicians agreed with this statement (n=218, M=5.23). There was no significant difference in pilots' (n=126, M=5.25) and maintenance technicians' (n=92, M=5.21) responses.

Finally, to address their concern and interest in training, respondents were asked if they thought that "a class including both pilots and maintenance technicians, based on communication and/or crew resource management, would be beneficial." Of the 216 pilots and maintenance technicians who responded to this question, 179 (82.9 percent) thought that training integrating both groups would be beneficial. Thirty-seven respondents (17.1 percent) did not think joint training would be beneficial. Again, there was not a significant difference in the number of pilots or maintenance technicians who responded either in the affirmative or negative to this question. However, there was a significant difference in the overall number of pilots and maintenance technicians who thought interdepartmental training would be beneficial (n=218, $p < .05$).

Also, as noted in Table 1 and Table 2, there were a number of significant correlations between the policy and training issues of interest in this study. For both pilots and maintenance technicians, there was a significant positive correlation between their perceptions of the effectiveness of communication between the two groups and their perception of effectiveness of the maintenance discrepancy reporting policy. That is, increased perception of the effectiveness of communication was related to an increase in their perception of the effectiveness of the policy.

There was a significant positive correlation between their perceptions of whether the policy regarding maintenance discrepancy reporting was being followed and whether it was an effective policy and their perceptions of the adequacy of organizational training about maintenance discrepancy reporting. In other words, as their perceptions about policy adherence increased, there was a corresponding increase in their perceptions regarding policy effectiveness.

Significant negative, or inverse correlations were found between pilots and maintenance technicians perceptions of whether or not the policy was being followed and was effective and whether they perceived that the maintenance reporting system needed to be improved. That is, as perceptions that the policy was being followed and was effective increased,

Table 1. Correlation between perceptions of maintenance discrepancy reporting policy effectiveness and compliance and training issues for pilots

	<i>Follow Policy</i>	<i>Effective Policy</i>
Effective Communication	.401**	.419**
Adequate Training	.347**	.440**
System Needs Improvement	-.293**	-.470**

n=129

** $p < .01$; * $p < .05$ **Table 2. Correlation between perceptions of maintenance discrepancy reporting policy effectiveness and compliance and training issues for maintenance technicians**

	<i>Follow Policy</i>	<i>Effective Policy</i>
Effective Communication	.153	.509**
Adequate Training	.495**	.449**
System Needs Improvement	-.239*	-.382**

n=93

** $p < .01$; * $p < .05$

there was an associated decrease in their perceptions that the maintenance reporting system needed improvement.

The only correlation that was not consistently significant across the pilot and maintenance technician groups was between their perceptions of the effectiveness of communication and whether the policy was being followed. While there was a significant positive correlation between these perceptions for pilots, the relationship for maintenance technicians was not significant. In other words, as pilots' perceptions of the effectiveness of the communication between pilots and maintenance technicians increased, there was a related increase in their perceptions that the maintenance discrepancy reporting policy was being followed. For maintenance technicians, this relationship was not statistically significant.

Interdisciplinary Student Research Team Survey

After working together on the interdisciplinary research project there appeared to be some marked differences in student perceptions of students from other disciplines. Due to the small sample size (n=50; 30 pre-test, 20 post-test), only descriptive statistics are reported for the student survey and these statistics should be interpreted with caution. On the post-test, students generally perceived themselves as more similar to students from the other disciplines in their thinking (pre-test n=30, M=4.90, post-test n=20, M=5.06), behavior (pre-test n=30, M=3.83, post-test n=20, M=3.90), and social class (pre-test n=30, M=3.76, post-test n=20 M=4.0). The only area

on the post-test that students perceived themselves as more different from one another after working together was in their background (pre-test n=30, M=4.43, post-test n=20, M=4.23).

After collaborating on the research project, all students were able to quickly list the responsibilities and tasks of students from the other disciplines. On the pre-test (n=30), for example, many students (n=27) had to leave one or more responses blank when asked to list the responsibilities and tasks involved in a typical day of students studying in the other disciplines. On the post-test (n=21), however, significantly fewer students (n=3) were unable to list any responsibilities or tasks of students from the other disciplines.

By having students catalog, in their own words, the advantages and disadvantages of participation in the research project, insight was also gained into students' (n=21) perceptions of training together on interdisciplinary teams. The most common advantage noted by the students was "learning to work with other disciplines" (n=10). Some students (n=7) also cited the "experiential nature of the project" as an advantage. The only advantage noted more often (n=8) was "making contacts/networking within industry." The most often cited disadvantage of working on the project was the unexpected amount of time the project involved (n=7).

Overall, on a scale of 1 (*very dissatisfied*) to 7 (*very satisfied*), students (n=21) reported a mean satisfaction level of 5.52 after participating in the research project. And one-third of the students (n=7) reported that satisfaction with their choice of major went up as a result of working on the project because they were exposed to industry and had an opportunity to apply the skills they had learned in school. The other two-thirds (n=14) of the students reported that their satisfaction with their major stayed the same after working on the project. None of the students reported that their satisfaction with their major decreased after working on the project.

IMPLICATIONS

This research has both conceptual and practical implications. The aviation industry representatives who completed the survey confirmed suspicions that during maintenance discrepancy reporting the potential for latent safety errors exists because pilots and maintenance technicians do not effectively interact with one another about maintenance problems on the airplane. Additionally, respondents, who themselves are members of a problematic organizational system, were asked to offer practical, proactive solutions for addressing inherent safety issues within that system. Results of both the industry survey and the interdisciplinary student research team survey suggest some viable training implications that may aid in decreasing errors and improving aviation safety.

For pilots and maintenance technicians who perceived problems in their current maintenance discrepancy reporting policy, it was agreed that organizational training may not have been adequate and that interdepartmental training may be beneficial. In fact, the reasons suggested by pilots and maintenance technicians for why an integrated training course on maintenance discrepancy reporting would be beneficial matched the reported advantages of working on an interdisciplinary research project reported by the students. The following paired reasons serve as examples. “Job awareness” was a reason reported by pilots and maintenance technicians and “awareness of the others’ job” was reported by students. The need to “break down the wall of mistrust/conflict/close-mindedness” between the professions was reported by the pilots and maintenance technicians and “get to know students I wouldn’t otherwise associate with” was reported by students. Students reported the importance of “experiential learning” and pilots and maintenance technicians reported “need more hands-on systems knowledge.” Many pilots, maintenance technicians, and students noted that “stressing the importance of good communication” is achieved through integrated interactions. Also, some pilots and maintenance technicians thought that a joint class would help reinforce the joint goal of “striving toward being safe and on time.” Based on the comments and suggestions provided by pilots, maintenance technicians, and students, it seems evident that integrating interdepartmental training may be a viable approach toward decreasing errors. Interestingly, many pilots, maintenance technicians, and students cited the same major obstacles to organized interdepartmental interaction or training—time and scheduling. Overcoming these and other logistical obstacles are necessary considerations in the development of organizational systems training.

Additionally, the experience and responses of students who worked on this research project seem to confirm the significance of interdisciplinary training for increasing systems awareness and decreasing human errors. Thus, the results of this study have implications for both academia and industry. Involving students in research projects that provide them with hands-on access to industry representatives better prepares them to be active, contributing members of the aviation industry upon graduation. The gap between book knowledge and knowledge gained through direct experience within industry is lessened through such applied research strategies. Moreover, the interdisciplinary nature of this research project serves as a simulation of the type of situations students are likely to experience should industry heed the results of this research and train employees to work directly with relevant colleagues from other departments or career fields (e.g., pilots and maintenance technicians in the resolution of airplane maintenance discrepancies). Being part of realistic

simulations like this allows students to make mistakes in a safe learning environment yet promotes transferring these experiences to the actual aviation environment where the ramifications of similar errors could be much more harmful.

For industry, the interdisciplinary student research teams point to an effective way to integrate career fields through an applied training project. For example, by working together on reducing the potential for latent and active human errors, pilots and maintenance technicians may better realize and understand the importance of integrated systems thinking and interaction in the reporting of maintenance discrepancies.

LIMITATIONS

Although this study provides some important implications for improving existing training and safety systems, it is not without limitations. Two main limitations were evident. First, the approach to developing the questions and distributing the surveys may have influenced potential and actual respondents. For example, the wording of the questions may have skewed responses in a particular direction or discouraged recipients from filling out the survey. Future research is needed to test the reliability and validity of a larger pool of survey questions regarding the maintenance discrepancy reporting process and the involvement of interdisciplinary work team members. This may improve both the sample size and the generalizability of the responses. Second, more consistent follow-up measures could have increased the response rate.

CONCLUSION

Despite the limitations of this research project, the necessary evolution of human factors theory, research, and practice were manifest in this study. At the grassroots level, professional pilots, maintenance technicians, and aviation students are recognizing the need for training that transcends traditional departmental boundaries in favor of integrating individuals across the organizational system. This approach to CRM represents a paradigm shift in ways of thinking about and designing training. Training developed within this perspective would emphasize ongoing, interdepartmental, face-to-face, experiential interaction to insure that skills learned readily translate to the daily work environment. Further, the findings of this study promote interdisciplinary training as a way to decrease both latent and active safety errors in the maintenance discrepancy reporting process. The primary aviation industry goals of safety and on-time flights are team goals not individual or department-specific goals. Clearly, training that addresses these objectives needs to be sufficiently integrated across departments and career fields to be maximally effective.

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APPENDIX A
INDUSTRY SURVEY OF PILOTS

Thank you for taking the time to fill out this survey. Please answer the following questions as completely as you can. There are no right or wrong answers. Your answers will be kept strictly confidential.

1. Company you work for: _____
2. Number of years with the company: _____
3. How satisfied are you with your job?

1	2	3	4	5	6
very					very
unsatisfied					satisfied
- 3a. Number of years as a pilot: _____.
4. Total flight time: _____
5. Do you have any military experience? Yes No Years: _____ Rank: _____
6. What type (s) of aircraft do you fly: _____
7. Licenses or certificates you currently hold (check all that apply):

<input type="checkbox"/> Airframe	<input type="checkbox"/> Powerplant	<input type="checkbox"/> FCC
<input type="checkbox"/> Private	<input type="checkbox"/> Commercial	<input type="checkbox"/> Airline Transport Pilot
<input type="checkbox"/> other: _____		
8. Type ratings: _____
9. Highest level of education completed:

<input type="checkbox"/> High School	<input type="checkbox"/> Trade School	<input type="checkbox"/> Some College	<input type="checkbox"/> College	<input type="checkbox"/> Graduate Degree
<input type="checkbox"/> other: _____				
10. Age: under 25 26-35 36-45 46-55 56+
11. Gender: Male Female
12. Annual Salary:

<input type="checkbox"/> \$25,000 or less	<input type="checkbox"/> \$26,000-50,000	<input type="checkbox"/> \$51,000-75,000
<input type="checkbox"/> \$76,000-100,000	<input type="checkbox"/> more than \$100,000	
13. What is your company's policy for communicating maintenance discrepancies?
(check all that apply)

<input type="checkbox"/> written logbook entry	<input type="checkbox"/> electronic logbook entry	<input type="checkbox"/> phone	<input type="checkbox"/> don't have a policy
<input type="checkbox"/> face-to-face reporting	<input type="checkbox"/> other verbal reporting	<input type="checkbox"/> radio	<input type="checkbox"/> don't know
<input type="checkbox"/> other: _____			
14. Please indicate how consistently the above policy is followed.

1	2	3	4	5	6
never					always

29. As a pilot, do you feel you are **VIEWED** by mechanics as **MENTALLY**:
- | | | | | | | |
|-----------------------|---|---|--------------------|---|---|-----------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| inferior
to pilots | | | equal
to pilots | | | superior
to pilots |
30. As a pilot, do you feel you are **VIEWED** by mechanics as **TECHNICALLY**:
- | | | | | | | |
|-----------------------|---|---|--------------------|---|---|-----------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| inferior
to pilots | | | equal
to pilots | | | superior
to pilots |
31. After a flight, how **WILLING** are **MECHANICS** to talk about maintenance problems?
- | | | | | | |
|-----------------|---|---|---|---|-------------------|
| 6 | 5 | 4 | 3 | 2 | 1 |
| very
willing | | | | | very
unwilling |
32. After a flight, how **WILLING** are **PILOTS** to talk about maintenance problems?
- | | | | | | |
|-------------------|---|---|---|---|-----------------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| very
unwilling | | | | | very
willing |
33. After a flight, how **AVAILABLE** are **PILOTS** to talk about maintenance problems?
- | | | | | | |
|------------------|---|---|---|---|-------------------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| not
available | | | | | very
available |
34. After a flight, how **AVAILABLE** are **MECHANICS** to talk about maintenance problems?
- | | | | | | |
|-------------------|---|---|---|---|------------------|
| 6 | 5 | 4 | 3 | 2 | 1 |
| very
available | | | | | not
available |
35. How would you rate your understanding of the entire maintenance reporting system?
- | | | | | | |
|----------------------------|---|---|---|---|---------------------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| do not fully
understand | | | | | fully
understand |
36. Do you think that the training/instruction about the entire maintenance reporting system has been:
- | | | | | | |
|--------------------|---|---|---|---|------------------|
| 1 | 2 | 3 | 4 | 5 | 6 |
| very
inadequate | | | | | very
adequate |
37. To what extent do you think a mechanic knows YOUR job?
- | | | | | | |
|-----------------------|---|---|---|---|---------------------------|
| 6 | 5 | 4 | 3 | 2 | 1 |
| very
knowledgeable | | | | | not very
knowledgeable |
38. I think of mechanics as colleagues. Yes No

39. A class including both pilots and mechanics, based on communication and/or crew resource management, would be beneficial to the work environment: Yes No
Why or why not? _____
-

40. Current methods of maintenance discrepancy reporting need improvement.

1	2	3	4	5	6
strongly disagree					strongly agree

41. What percentage of the time do you think miscommunication between pilots and mechanics is a problem in maintenance write-ups? (circle one)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

42. Maintenance write-ups are **NOT** important.

1	2	3	4	5	6
strongly disagree					strongly agree

43. Regarding maintenance discrepancy reporting, the application of a standardized debriefing or interview process, to supplement the written data, would help minimize miscommunication.

1	2	3	4	5	6
strongly disagree					strongly agree

Thank you for your cooperation in filling out this survey—you have made an important contribution to aviation research!

**APPENDIX B
INDUSTRY SURVEY OF AVIATION
MAINTENANCE TECHNICIANS**

Thank you for taking the time to fill out this survey. Please answer the following questions as completely as you can. There are no right or wrong answers. Your answers will be kept strictly confidential.

1. Company you work for: _____
2. Number of years with the company: _____
3. How satisfied are you with your job?

1	2	3	4	5	6
very					very
unsatisfied					satisfied
- 3a. Number of years as a mechanic: _____.
4. Do you have any military experience? Yes No Years: _____ Rank: _____
5. What type (s) of aircraft do you work on: _____
6. Licenses or certificates you currently hold (check all that apply):

<input type="checkbox"/> Airframe	<input type="checkbox"/> Powerplant	<input type="checkbox"/> FCC
<input type="checkbox"/> Private	<input type="checkbox"/> Commercial	<input type="checkbox"/> Airline Transport Pilot
<input type="checkbox"/> other: _____		
7. Type ratings: _____
8. Total flight time: _____
9. Highest level of education completed:

<input type="checkbox"/> High School	<input type="checkbox"/> Trade School	<input type="checkbox"/> Some College	<input type="checkbox"/> College	<input type="checkbox"/> Graduate Degree
<input type="checkbox"/> other: _____				
10. Age: under 25 26-35 36-45 46-55 56+
11. Gender: Male Female
12. Annual Salary:

<input type="checkbox"/> \$25,000 or less	<input type="checkbox"/> \$26,000-50,000	<input type="checkbox"/> \$51,000-75,000
<input type="checkbox"/> \$76,000-100,000	<input type="checkbox"/> more than \$100,000	
13. What is your company's policy for communicating maintenance discrepancies? (check all that apply)

<input type="checkbox"/> written logbook entry	<input type="checkbox"/> electronic logbook entry	<input type="checkbox"/> phone	<input type="checkbox"/> don't have a policy
<input type="checkbox"/> face-to-face reporting	<input type="checkbox"/> other verbal reporting	<input type="checkbox"/> radio	<input type="checkbox"/> don't know
<input type="checkbox"/> other: _____			
14. Please indicate how consistently the above policy is followed.

1	2	3	4	5	6
never					always

15. How would you rate the effectiveness of your company's current method of reporting maintenance discrepancies?

6	5	4	3	2	1
very effective					very ineffective

16. Which parts of your company's policy for reporting maintenance discrepancies **WORK WELL**?

17. Which parts of your company's policy for reporting maintenance discrepancies **DO NOT** work well?

18. In your opinion, how effectively do mechanics and pilots communicate with each other?

1	2	3	4	5	6
very ineffectively					very effectively

19. How frequently do the following interfere with communication between mechanics and pilots?

	never					always
Acronyms	1	2	3	4	5	6
Technical language	1	2	3	4	5	6
Accessibility to one another	1	2	3	4	5	6
Time constraints	1	2	3	4	5	6
Legibility	1	2	3	4	5	6
Error in write-up	1	2	3	4	5	6
Detail of write-up	1	2	3	4	5	6
Electronic information transfer (for example: ACARS)	1	2	3	4	5	6

20. How often do pilots and mechanics communicate using the following forms of communication:

	very often					very seldom
Written	6	5	4	3	2	1
Face-to-face	6	5	4	3	2	1
Electronic information transfer (for example: ACARS)	6	5	4	3	2	1
Phone	6	5	4	3	2	1
Radio	6	5	4	3	2	1
Other: _____	6	5	4	3	2	1

21. With regard to the reporting of maintenance discrepancies, how effective are the following forms of communication:

	very ineffective			very effective		
Written	1	2	3	4	5	6
Face-to-face	1	2	3	4	5	6
Electronic information transfer (for example: ACARS)	1	2	3	4	5	6
Phone	1	2	3	4	5	6
Radio	1	2	3	4	5	6
Other: _____	1	2	3	4	5	6

22. How helpful are maintenance write-ups in the following areas:

	not helpful			very helpful		
Hydraulics	1	2	3	4	5	6
Pneumatics	1	2	3	4	5	6
Electrical	1	2	3	4	5	6
Avionics	1	2	3	4	5	6
Powerplants	1	2	3	4	5	6
Airframe	1	2	3	4	5	6
Flight controls	1	2	3	4	5	6
Other: _____	1	2	3	4	5	6

23. It is easier to communicate with a pilot who is:

Male Female No preference

24. In general, I get better write-ups from:

Males Females No preference

25. Generally, it is easier to communicate with a pilot who is:

Older than I am Younger than I am The same age as I am No preference

26. Do you agree that communication barriers are created by age differences?

1 2 3 4 5 6
strongly disagree strongly agree

27. As a mechanic, do you feel you are **MENTALLY**:

1 2 3 4 5 6 7
inferior to pilots equal to pilots superior to pilots

28. As a mechanic, do you feel you are **TECHNICALLY**:

7 6 5 4 3 2 1
superior to pilots equal to pilots inferior to pilots

29. As a mechanic, do you feel you are **VIEWED** by pilots as **MENTALLY**:

1	2	3	4	5	6	7
inferior to pilots			equal to pilots			superior to pilots

30. As a mechanic, do you feel you are **VIEWED** by pilots as **TECHNICALLY**:

1	2	3	4	5	6	7
inferior to pilots			equal to pilots			superior to pilots

31. After a flight, how **WILLING** are **PILOTS** to talk about maintenance problems?

6	5	4	3	2	1
very willing					very unwilling

32. After a flight, how **WILLING** are **MECHANICS** to talk about maintenance problems?

1	2	3	4	5	6
very unwilling					very willing

33. After a flight, how **AVAILABLE** are **PILOTS** to talk about maintenance problems?

1	2	3	4	5	6
not available					very available

34. After a flight, how **AVAILABLE** are **MECHANICS** to talk about maintenance problems?

6	5	4	3	2	1
very available					not available

35. How would you rate your understanding of the entire maintenance reporting system?

1	2	3	4	5	6
do not fully understand					fully understand

36. Do you think that the training/instruction about the entire maintenance reporting system has been:

1	2	3	4	5	6
very inadequate					very inadequate

37. To what extent do you think a pilot knows YOUR job?

6	5	4	3	2	1
very knowledgeable					not very knowledgeable

38. I think of pilots as colleagues. Yes No

39. A class including both pilots and mechanics, based on communication and/or crew resource management, would be beneficial to the work environment: Yes No
Why or why not? _____

40. Current methods of maintenance discrepancy reporting need improvement.

1 2 3 4 5 6
strongly strongly
disagree agree

41. What percentage of the time do you think miscommunication between pilots and mechanics is a problem in maintenance write-ups? (circle one)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

42. Maintenance write-ups are **NOT** important.

1 2 3 4 5 6
strongly strongly
disagree agree

43. Regarding maintenance discrepancy reporting, the application of a standardized debriefing or interview process, to supplement the written data, would help minimize miscommunication.

1 2 3 4 5 6
strongly strongly
disagree agree

Thank you for your cooperation in filling out this survey—you have made an important contribution to aviation research!

APPENDIX C
INTERDISCIPLINARY STUDENT RESEARCH TEAM SURVEY

Post-Test Perceptions Survey

THANK YOU for taking a few minutes to reply to this follow-up survey. There are no right or wrong answers; we are interested in your most truthful response to the questions and issues. Your answers will be kept strictly confidential.

1. Age _____
2. Gender _____ male _____ female
3. What year in school are you? _____ Freshman _____ Sophomore
_____ Junior _____ Senior
4. Circle the number that corresponds with your current level of satisfaction with your major.
Very Dissatisfied 1 2 3 4 5 6 7 Very Satisfied
5. Since beginning work on this research project, what has happened to your level of satisfaction with your major? (check one)
_____ Gone Up _____ Stayed the Same _____ Gone Down

If your satisfaction with your major has changed, what occurred to influence the change?
6. Describe your background or experience in aviation maintenance (i.e., courses taken, internships, work experience).

Do you have an A & P certificate? _____
7. Describe your background or experience in aviation flight operations (i.e., courses taken, internships, work experience).

Ratings and Certificates? _____
Total Flight Hours? _____
8. Describe your background or experience in aviation management (i.e., courses taken, internships, work experience).

9. Describe your background or experience in communication such as; public relations, customer service (i.e., courses taken, internships, work experience).

10. Describe any training you have received on how to write-up airplane maintenance discrepancies.

11. Have you ever written or read an airplane maintenance discrepancy report? _____
 If yes,
 What was your general impression of the report(s)?

12. Did you also speak to the maintenance technician or pilot about the discrepancy?
 If yes,
 What was your general impression of this interaction?

On the scales below, please indicate your feelings about the various jobs associated with aviation. Circle the number that best represents your feelings. Numbers "1" and "7" indicate a strong feeling. Numbers "3" and "5" indicate a weak feeling. Number "4" indicates you are undecided or don't know. Please work quickly. Remember, there are no right or wrong answers.

	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
13.	Doesn't think like me								Thinks like me
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	
	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
14.	From social class similar to mine								From social class different from mine
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	
	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
15.	Behaves like me								Doesn't behave like me
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	

	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
16.	Economic situation is different from mine								Economic situation is like mine
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	
	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
17.	Similar to me								Different from me
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	
	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
18.	Status like mine								Status different from mine
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	
	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
19.	Unlike me								Like me
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	
	Aviation Mechanics	1	2	3	4	5	6	7	
	Pilots	1	2	3	4	5	6	7	
20.	Background different from mine								Background similar to mine
	Communication Spec.	1	2	3	4	5	6	7	
	Aviation Management	1	2	3	4	5	6	7	

Based on your general knowledge and the information you have gained by working on this project, answer the following questions in your own words.

21. List the *responsibilities* of:

an aviation maintenance technician.

a communication specialist.

a pilot.

aviation management.

22. What is involved in the *typical day* of:

a *communication specialist*?

aviation management?

a *pilot*?

an *aviation maintenance technician*?

23. What do you think is *most important* to:

an *aviation maintenance technician*?

a *communication specialist*?

a *pilot*?

aviation management?

24. How does aviation management's work *differ* from your work in the aviation environment?

How does an *aviation maintenance technician's* work differ from your work in the aviation environment?

How does a *communication specialist's* work *differ* from your work in the aviation environment?

25. What *kind of training* do you think *aviation management* receives?

What *kind of training* do you think *aviation maintenance technicians* receive?

What *kind of training* do you think *communication specialists* receive?

26. Are you aware of any *nicknames/terms/phrases* that are used in reference to each of the following groups? If so, please write the nickname/term/phrase and explain what it means.

aviation maintenance technicians

What does it mean to use this *nickname/term/phrase*?

pilots

What does it mean to use this *nickname/term/phrase*?

aviation management

What does it mean to use this *nickname/term/phrase*?

communication specialist

What does it mean to use this *nickname/term/phrase*?

27. List below the **pros** and **cons** of working on this aviation research project.

Pros

Cons

28. Circle the number that corresponds with your overall level of satisfaction with this research project.

Very Dissatisfied 1 2 3 4 5 6 7 **Very Satisfied**

Thank you, again, for completing this survey and being involved in this research project!!

OPTIMIZING AIRSPACE SYSTEM CAPACITY THROUGH A SMALL AIRCRAFT TRANSPORTATION SYSTEM: AN ANALYSIS OF ECONOMIC AND OPERATIONAL CONSIDERATIONS

**Scott E. Tarry
and
Brent D. Bowen
Omaha, Nebraska**

ABSTRACT

America's air transport system is currently faced with two equally important dilemmas. First, congestion and delays associated with the overburdened hub and spoke system will continue to worsen unless dramatic changes are made in the way air transportation services are provided. Second, many communities and various regions of the country have not benefited from the air transport system, which tends to focus its attention on major population centers. An emerging solution to both problems is a Small Aircraft Transportation System (SATS), which will utilize a new generation of advanced small aircraft to provide air transport services to those citizens who are poorly served by the hub and spoke system and those citizens who are not served at all. Using new innovations in navigation, communication, and propulsion technologies, these aircraft will enable users to safely and reliably access the over 5,000 general aviation landing facilities around the United States. A small aircraft transportation system holds the potential to revolutionize the way Americans travel and to greatly enhance the use of air transport as an economic development tool in rural and isolated communities across the nation.

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INTRODUCTION

For all the benefits of the hub and spoke system that evolved in the United States after deregulation and throughout the world as air carriers recognized the system's efficiencies, there are some serious social and economic implications for communities unable to take full advantage of the system. Small, rural, and otherwise isolated communities struggle to maintain air service as air carriers pursue their rational commercial interests and concentrate their activities in larger markets and strategically defined route networks. With changes in the way society and the economy function, air service has become even more important for future growth and development.

This paper examines the plight of small and rural communities in the U.S. and briefly examines some of the current policies for alleviating the negative impact of the hub and spoke system. Finding these political solutions lacking for a variety of reasons, the paper examines the Small Aircraft Transportation System (SATS) as a technological solution emerging from cooperative work between government, industry, and academia. An important point about this solution is that it does not argue for the elimination of the hub and spoke system for long haul air carrier operations. In fact, SATS should alleviate some of the pressure on capacity-constrained hub airports by optimizing the use of non-hub and general aviation airports. Moreover, SATS promises to bring reliable cost-effective air service to communities that have been marginalized by the hub and spoke system without altering the way in which air carriers conduct their business. The needs of rural and isolated communities can be addressed without political arm-twisting or "re-regulation" of the airlines. These needs can be addressed without costly subsidization of regional carriers who would otherwise not serve these low-demand communities. SATS offers a rare opportunity for government and industry to work together to efficiently meet the political and social needs of the nation's small communities and rural areas.

The balance of the paper examines the need for SATS through an analysis of recent trends in air transport, the economy, and society more generally. The discussion focuses on the inherent problems of the hub and spoke system, the emergence of the information or digital economy, and important social and demographic trends that will determine the demand for transportation services in the future. Once the problem is defined, the paper explores conventional political solutions and examines the difficulties associated with such efforts. The paper then details the SATS concept and examines the potential for SATS to improve air transport services in small and rural communities in the U.S. Finally, the paper

assesses the exportability of SATS to other parts of the world where alternatives to hub and spoke are attractive and in other places where any form of reliable and efficient air transport services would be welcomed.

HUB AND SPOKE

The hub and spoke system that emerged following regulatory reform of the airline industry in the U.S. has been a double-edged sword for the industry and the nation. Hub and spoke provides efficiencies that are unavailable in point-to-point and other route network systems (Hanlon, 1996; Gialoretto, 1988). The ability of carriers to consolidate operations, better coordinate vast route networks, and control hub airports has benefited both the carriers and the communities that host hub airports (Button, Lall, Stough & Trice, 1999). Unfortunately, hub and spoke is not without its problems and these problems are becoming increasingly clear. Hub airports throughout the U.S. are rapidly reaching capacity. According to the National Civil Aviation Review Commission (NCARC, 1997) the nation's aviation system is quickly heading towards gridlock (NCARC, see also Long et al., 1999 and Donohue, 1999). In 1999, approximately 680 million passengers boarded airplanes in this country (USDOT, 2000). The capacity for our hub-and-spoke system is estimated at one billion boardings, and at the forecasted growth rate in the United States we will reach that capacity somewhere between 2005 and 2010 (FAA, 1998). By 2020, the demand for boardings will approach 1.5 billion if enough additional capacity can be developed in time (NCARC, 1997).

“Traffic data and trends indicate that adding just a few minutes of delay to each airline flight in the United States will bring the aviation system to gridlock with dramatic negative impacts on the economy” (NCARC, p. I-2). It can cost \$1 billion to build a single new runway and as much as \$10 billion to build a new airport. With an average lead-time of ten years between conception and construction, it is unlikely that we will be able to generate the infrastructure needed to keep pace with demand (U.S. GAO, 1997).

Some improvements include possibly squeezing the maximum capacity from what we already have through annual maintenance, better management, increased use of intelligent transportation innovations, and cost-effective improvements in capacity (Hansen, 2000). Even if it were politically and socially possible to augment the current system through 24-hour operations, the use of super jumbo jets, more regional jets, free flight, aggressively reducing aircraft separation requirements, and completing the few new runways currently planned, the system would still be overwhelmed. The problem, however, is that even many of these solutions are not practical in the current or foreseeable future.

The concept of 24-hour operations ignores both the demands of the consumer for convenient flight schedules and the demands of airport communities for quiet evenings. The use of super jumbos will depend on the commercial strategies of air carriers and the willingness and ability of airports to make necessary infrastructure improvements to handle these enormous aircraft. More regional jets might help, but only if these smaller aircraft begin to avoid hubs and fly more point-to-point routes. Free flight and reduced separation will allow for more efficient use of airspace, but both require technological developments and cultural changes within the air traffic control community that are slow in coming (see Aviation Foundation, 1996). Moreover, even if airspace issues can be addressed successfully, problems remain on the ground where aircraft interface with other parts of the intermodal system. Unfortunately, the prospect of new runways and new airports diminishes in the face of huge costs, environmental concerns, and intransigence by air carriers who loudly voice their fears about bearing the brunt of the costs.

More importantly, though, for the purposes of this analysis, squeezing these improvements out of hub and spoke would not adequately address the long-term needs of air transport or the specific needs of the communities that are ignored by the present system. The system needs a solution that both helps to alleviate the current and future pressure on system capacity and brings air transport services directly to more areas of the country.

Current efforts to address the latter issue are problematic because they rely on government to restructure the market to provide air transport services to communities that are not served in the hub and spoke system. While there is demand for air transport in these communities, the demand is not sufficient to attract the attention of air carriers who are seeking to maximize revenues with traditional business plans (USDOT, 1998a). Regional jets are unlikely to serve the interests of these communities since these aircraft are larger and require infrastructure that is often unavailable. As hubs get more crowded, pressure will increase to utilize larger aircraft and fewer flights. This is the case in San Francisco, where the airport has requested that United Airlines fly fewer regional or commuter aircraft into the busy airport.

Since the air carriers are continuing to move away from small communities, political leaders have taken initiatives to preserve or enhance air transport services through legislation. Since deregulation some small communities have relied on the Essential Air Service program to preserve their air service (USDOT, 1998b). This subsidy program uses tax dollars to subsidize air transport services to communities with load factors that are too low to attract purely commercial service. According to the U.S. Department of Transportation, the EAS will cost over \$30 million this year

and provides twice a day turbo-prop service between 77 small communities and hub airports. Unfortunately, preserving air services in this manner is costly and not necessarily effective in meeting the real needs of the community. More recently, some states have embarked on their own efforts to secure or enhance air transport services. Maryland is initiating a subsidy program to enhance air service between a number of small airports and Baltimore Washington International (Maryland DOT, 2000). New York has also embarked on a subsidy program that will, according to the schemes' proponents, deliver badly needed air services to rural and small communities in the state (State Budget, 2000).

In the end, such schemes are problematic. On a financial level, the services provided are expensive. The operation of 19-seat aircraft on routes that only provide 25 percent load factors is an obvious waste of money. Unfortunately, the way the air carrier industry is structured, both commercially and in terms of regulations, these aircraft are typically the smallest equipment that can be used. The use of such aircraft raises additional concerns such as passenger perceptions about small propeller-driven aircraft. Passengers may forego flights on these aircraft even if the service is provided because of unpleasant experiences on such aircraft or perceptions about safety and comfort. These aircraft are also more prone to cancellation due to weather than their larger jet counterparts. Travelers who rely on the small aircraft to take them to a hub to make connections to flights on major airlines discover that the regional leg of their journey is often the most unreliable. A delay or cancellation at the regional airport can completely disrupt an itinerary. Taken together, perceptions about safety, reliability, and comfort work against the regional carrier. Potential passengers will avoid the service by driving or foregoing their trips, a phenomenon known as leakage.

DEMOGRAPHIC AND SOCIAL CHANGE

The current limitations of the hub and spoke system will be exacerbated by two trends in modern American society. First, demographic trends suggest that more Americans will move away from metropolitan areas and into rural communities (Johnson and Beale, 1998). Second, early indications from the information age suggest that time and travel speed will be motivating factors for personal and consumer decisions (Schafer and Victor, 1997). Taken together, these trends describe a population whose needs are unlikely to be met by the current hub and spoke system. More travelers will live away from metropolitan areas and hub airports. These same travelers will be acutely interested in reducing travel times and having reliable access to a variety of new destinations.

THIRD MIGRATION WAVE

America's 'first migration wave' from rural communities to the cities can be traced back to the era of Andrew Jackson in the 1820s. In total population, however, rural America still continued to grow, but at a much slower pace than urban America. The growth that remained in our rural communities was almost exclusively due to the fact that rural women bore enough children to offset rural deaths and out-migrations of families to the cities.

The 'second migration wave' from the cities to the suburbs is closely associated with the affordability of the automobile and with the baby boom that followed World War II. While the swelling of metropolitan areas and the growth of suburbs defined American life for the first seven decades of the 20th century, a new trend might define the next seven decades. Recent information indicates that "What the United States experienced between 1970 and 1996—and is continuing to experience, according to recently released Census Bureau data—is population de-concentration. People are gradually moving away from larger, more densely settled places toward lightly settled areas" (Johnson & Beale, 1998, p. 18). Economic and technological change is allowing many Americans to choose where they want to live.

This third migration wave or 'in-migration' from the suburbs to rural and remote communities is driven by economic, social, and technologic forces. The requirement for large numbers of blue-collar workers reporting to nearby factories has been greatly reduced in the Information Age. Human/intellectual capital is displacing the role that physical capital played in the industrial age. The rise in information technology has made rural areas much less isolated, at least in terms of communications and information, than they were at the height of the industrial age. The paradoxical result of this latest wave of migration is that as the information age frees people to move away from urban and suburban areas, it also forces them to consider time more carefully. The speed of commerce and information increases, but the speed of travel remains stagnant or even declines as capacity limits are met in both surface and air transport sectors.

MEETING THE TRANSPORT NEEDS OF THE NEW ECONOMY

We will soon see an inevitable clash between a population that is becoming more dispersed and concerned about door-to-door travel speeds and an air transport infrastructure that is rapidly approaching saturation. For the variety of reasons mentioned earlier traditional solutions are unlikely to be of much lasting help. A new approach to transportation and a new framework for cooperation between industry and government is

required. Old ways of doing business will only produce expensive half-measures, such as publicly subsidized turbo-prop air service, which fail to provide the desired levels of service at an acceptable cost.

This new approach will build on newly developed aircraft technologies and existing infrastructure. The key, however, is that the technology will allow for dramatic increases in usable airport and airspace capacity. While scheduled commercial air service is provided to consumers at a mere 400 airports in the United States, general aviation can provide services to over 5,000 public facilities and as many as 18,000 landing facilities if private airports are included (GAMA, 1999). Studies show that over 90 percent of the U.S. population lives within 30 minutes of a public-use general aviation airport (Holmes, 2000). The existing general aviation airport infrastructure represents a vast, underutilized capacity for the nation. By expanding all-weather access to the nation's existing public-use airports, the National Airspace System capacity (measured in annual seat-departures) could be increased by a factor of ten compared to the existing commercial hub and spoke system. This increased accessibility and throughput of a more fully utilized infrastructure would contribute substantially to the National Airspace System safety, cost, and efficiency.

Building on the success of the NASA led Advanced General Aviation Transport Experiment (AGATE) consortium and the General Aviation Propulsion program, the NASA-led National General Aviation Roadmap (Holmes, 1999) establishes a framework for coordinating public and private sector investments leading to development of a national Small Aircraft Transportation System (SATS). The Roadmap goal is to cut inter-city travel time in half in 10 years at a total system cost that is competitive with Interstate highway travel.

The Small Aircraft Transportation System, in conjunction with the existing network of general aviation airports, holds the potential to provide the nation with a transportation innovation that relieves current pressures on our ground and air systems, land use, and environment (Whitehead, 1997). SATS will be a safe travel alternative, freeing people and products from transportation system delays and creating access to more communities in less time. Virtually every small community in the nation will have the potential to be served by SATS.

WHAT IS SATS?

The Small Aircraft Transportation System grows out of the successful collaboration of industry and government to improve general aviation technologies through the AGATE consortium. NASA officials and industry representatives recognize that new technologies could dramatically change the face of general aviation and move small aircraft from the domain of the

hobbyist or aviation enthusiast to the domain of the cost-conscious, safety-minded traveler. These technologies include improved avionics, more reliable and efficient power plants, improved flight management equipment, and enhanced information technologies. The current three-pronged SATS effort seeks to develop small aircraft and related technologies that are:

1. Capable of flight in near all-weather conditions,
2. Suitable for high-density operations; and
3. Built with the techniques and processes adopted from the automotive sector.

In each case, the goal is to produce an air vehicle that is safe, reliable, and cost-competitive. More importantly perhaps, the emphasis is on the vehicle and will not rely on expensive or extensive infrastructure improvements, such as longer runways, increased land-use, or elaborate ground-based communications, navigation, or surveillance systems. Table 1 outlines the technical components of the SATS concept. The first three items are the focus of the current program, while other technologies will be developed or integrated as the program evolves.

Table 1. Technical Components of the Small Aircraft Transportation System

-
- Virtual Visual Meteorological Conditions (VMC), which includes virtually autonomous vehicles, human aided automation, virtual terminal procedures, integrated vehicle and air traffic services automation, control de-coupling, and envelope protection.
 - High Density Operations, which includes client-client-based separation and sequencing in non-radar airspace, and non-interfering approaches at Class B airports.
 - Automotive Synergies, which include affordable manufacturing of vehicles through the use of thermoplastics, aluminum, composites, and integrated airframe design and manufacturing processes.
 - Airborne Internet, which includes satellite-based communications-navigation-surveillance in all airspace.
 - Ultra-propulsion, which includes non-hydrocarbon and heat engine options, low-noise/emissions, and low maintenance engines.
 - Smart Airports, which include airport database for remote sensing and monitoring of airport, runway, and weather conditions.
 - Wireless Cockpit, which include open architecture systems, through-the-window displays, and software-enabled controls.
 - Cyber-tutor and Internet-based training, which includes both embedded and onboard training and expert systems.
 - Extremely slow take-off and landing, which includes configuration aerodynamics for slow and vertical operations as well as roadability of vehicle.
-

SATS will begin with a 5-year focused program effort to prove that “SATS works.” While NASA works to show that the technologies integrated into SATS aircraft will work to dramatically change the way Americans think about air travel, other stakeholders, especially the states will explore social, economic, and environmental impacts. Current plans call for a multi-state demonstration of SATS in 2005.

WHAT SATS CAN DO FOR RURAL AND SMALL COMMUNITIES

SATS has the potential to solve the problem of access to safe, reliable, and affordable air transport. Rural and small communities that suffer from inadequate or nonexistent air service can reap the benefits of SATS without the considerable expense typically associated with airport infrastructure development. SATS does not rely on new or expanded runways or prohibitively expensive instrument landing systems. Communities therefore can avoid the risk associated with a “build it and they will come strategy.” Such a strategy is fraught with problems since commercial air carriers are unlikely to make service decisions based solely on the quality of the landing facilities. Adequate infrastructure is a necessary, but not sufficient, requirement for attracting commercial air service in the current market. Fortunately, SATS will allow small communities to reap the benefits of reliable air service without having to provide costly infrastructure up-grades or the load factors expected by commercial airlines.

SATS can effectively lower the barriers to quality air transport services. Currently planned aircraft, such as the Eclipse and the Safire are exciting precursors to SATS aircraft. These small jets will be the first shots in the battle to revolutionize personal transportation. Powered by innovative engines and guided by the latest flight management technologies, the Eclipse and the Safire will make on-demand, point-to-point air travel price competitive with current coach travel, which entails all the downsides of the hub and spoke system. The Eclipse, for example, is a six seat pressurized jet aircraft with projected operating costs of less than \$.50 per airplane mile (Eclipse Aviation, 2000). Further technological advances and the automotive synergies that are a primary goal of the SATS program will further drive costs down and eventually extend the reach of such air service to small, remote landing facilities with even the most minimal level of infrastructure.

Such technological advances will address the problems posed earlier in this paper. With the hub and spoke system reaching saturation and time becoming the most precious commodity in our information-oriented society, travelers will demand fast, efficient, and reliable transportation

tailored to their needs in terms of schedules and destinations. While some conventional airlines may recognize this market and seek to address its demands with smaller regional jets, truly small and remote communities will still lack the infrastructure and the load factors necessary to attract adequate air service. Those communities will not be able to participate fully in the global economy unless those air service needs are met. An attractive solution to this problem is the Small Aircraft Transportation System described in this paper.

IS SATS EXPORTABLE?

This paper has focused almost entirely on the problems and prospects for air transport in the U.S. One can easily imagine, though, that the SATS concept offers considerable hope for other countries facing air transport dilemmas. Although not similar in all regards, the congestion at major U.S. airports is mirrored at Europe's major airports. While enhancing its already exceptional rail service might be an attractive means for reducing air transport congestion, rail is still governed by fixed schedules to hub cities. As time becomes a more important criterion to savvy travelers in Europe, the SATS concept might become an attractive option.

More likely, however, is that SATS will have appeal in nations with widely dispersed, small communities that need air service but do not receive it without substantial government subsidy for conventional air carrier service. As is the case in the U.S., such service rarely meets the needs of the traveler and requires the government to spend scarce resources on a service that is inadequate. Such inadequate service, as in the U.S., achieves a political goal but too often does not satisfy more important social and economic goals. Nations such as Australia, Canada, Brazil, Russia, and various other nations throughout South America and Africa would be good candidates for SATS since they tend to have limited and unreliable air transport services for their small, rural communities. SATS aircraft could provide access to areas previously without service because of the lack of adequate landing facilities for all but the smallest, most antiquated aircraft. SATS aircraft could effectively serve these communities with reliable, safe, and efficient services without the need for substantial state subsidy or a constant stream of revenue passengers as required in the air carrier business.

The impact on economic development is obvious. Investors will be able to develop new production facilities in areas previously eliminated from practical consideration because of the lack of air service. New investment and the subsequent development of infrastructure in remote communities might ease the pressure of migration to urban areas taking place in

developing countries. These communities will also benefit from the timely and cost-effective provision of social services. The social and economic development potential of SATS is exciting and worth serious consideration by investors, policy makers, and those interested in spreading the wealth of opportunity the global economy offers.

CONCLUSION

SATS is a concept that proposes a technological solution to a number of critical transportation and economic development problems. It is certainly not a cure-all since it will not likely prevent the gridlock forecasted for the hub and spoke system. The demand for conventional air transport services will continue to grow as the economy grows and the result will be a system saturated to the point where the needs of many travelers are no longer met. SATS is also not a panacea for every small community that lacks adequate air service. SATS is not a promise to provide air service as an entitlement. It does, however, offer a much better means for providing access to reliable and efficient air transport than the current system, within which air carriers focus on large markets and within which government subsidies seem to waste scarce resources subsidizing services that fail to meet most travelers' needs. SATS can reduce the need for substantial infrastructure investment and reduce the demand threshold for attracting reliable air transport services. In the end, SATS promises to be a paradigm shift that will make air transport an even more useful tool for business and leisure.

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BARGAINING FOR OPEN SKIES

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ABSTRACT

In this paper we analyze the bargaining problem between countries when negotiating bilateral air service agreements. To do so, we use the methods of bargaining and game theory. We give special attention to the case where a liberal minded country is trying to convince a less liberal country to agree to bilateral open skies, and the liberal country might also unilaterally open up its market. The following analysis is positive in the sense that the results help explain and predict the outcome of negotiations under different payoffs and structures of the bargaining process. They are normative in the sense that adequate manipulation of the bargaining conditions can ensure a desired outcome.

INTRODUCTION

The purpose of this paper is to systematically analyze the bargaining problem between countries when negotiating bilateral air service agreements. We will give special attention to the case where a liberal minded country is trying to convince a less liberal country to agree to bilateral open skies, and the liberal country might also unilaterally open up its market. The following analysis is positive in the sense that the results help explain and predict the outcome of negotiations under different payoffs and structures of the bargaining process. They are normative in the sense that adequate manipulation of the bargaining conditions can ensure a desired outcome.

The basis for all air service agreements is the Chicago Convention, which entered into force on 4 April 1947. It establishes the principle that each state has complete and exclusive sovereignty over the airspace above its territory. Thus all international air transport is subject to authorization, which is accomplished through a system of some 3000 bilateral (and very few regional) agreements. The classic bilateral air service agreement of the

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Bermuda 1 type includes detailed provisions for market access, capacity and tariffs.

Although recent air service agreements tend to be more liberal in some or all of these aspects (see for example World Trade Organization, 1998, and Morrell, 1998), many still fail to completely deregulate markets. Recognizing that further deregulation provides scope for more trade in airline services and thus more gains in trade, some countries have been pushing towards bilateral open skies agreements. For example, the U.S. has signed open skies air service agreements with 42 countries and is pressing further (Oum, 2000).

Other countries may adopt a less liberal attitude towards air services. First, for some reason a country may take the position that further deregulation does not enhance national welfare (Forsyth, 2000). Second, even if total national welfare is enhanced, distributional effects might be undesirable. Third, even if redistribution is socially acceptable, it might come at the expense of special interest groups. These organized few (i.e., airlines, airports, labor unions) may secure rents from the government at the expense of the unorganized many (i.e., consumers) by lobbying against deregulation.¹ Fourth, a country might speculate that hiding its true (liberal) preferences will provide an opportunity to free ride on the deregulation of foreign markets while keeping the domestic market shut. Considering this, it is not too surprising that negotiations towards more liberal bilateral air service agreements are in many cases stagnant.²

Another option for a liberal country (*A*) then is the unilateral opening of its home market to a less liberal country (*B*). For example the Australian government has decided to offer foreign international airlines unrestricted access to all of Australia's international airports except Sydney, Melbourne, Brisbane, and Perth (Australia's Commonwealth Department of Transport and Regional Services, 1999). The Canadian Transport Minister in response to the domestic dominance of Air Canada/Canadian Airlines announced that "if over a period of 18 months, a couple of years, competition doesn't come forward, then we'll invite foreign carriers in" (Air Transport World, June 2000, p. 9).

¹For example, on February 10, 2000, the CAPA, an association of U.S. airline pilot unions, addressed the U.S. Department of Transportation in an open letter, stating that they were unalterably opposed to the exchange of cabotage rights.

²The following examples provide some anecdotal evidence. In 1998 and 1999 Germany approached 10 countries where prospects for bilateral open skies seemed promising. By February 2000, negotiations hit a deadlock in all but one case. David Marchkick, the chief United States negotiator in aviation rights talks with the United Kingdom, recently resigned as an expression of his frustration of the slow pace of talks over open skies (London Financial Times, October 9, 1999).

But a unilateral opening may imply that country *A* further discourages country *B* to accept a liberal bilateral agreement, as the reward from such an agreement, the opening of *A*'s market, already pertains to *B*: the “carrot” has been fed to *B* in form of a unilateral opening and *A*'s feed bag is empty.

In the next section, we formalize these notions into different bargaining processes and present equilibrium results that depend on countries' preferences, information sets and the structure of bargaining. Policy implications and further conclusions follow in the final section.

THE MODEL

Consider the bargaining problem between a liberal country *A* and a less liberal country *B*.³ Air traffic between *A* and *B* is regulated by a restrictive air service agreement. Denote the payoff to *A* (*B*) under agreement *i* by α_i (β_i). If *A* and *B* do not negotiate or if they fail to reach an agreement, we normalize payoffs to $(\alpha_0, \beta_0) = (0, 0)$ per period, representing the status quo or the threat point.

Country *A* may decide to unilaterally open up its market (*A* and *B* “agree” on “1”), resulting in total discounted payoffs of (α_1, β_1) at the time of market opening. Unilateral opening might encompass full market access for *B* to, from, and beyond country *A*, cabotage within *A*, etc. whereas country *A*'s traffic rights with *B* remain restricted. Countries *A* and *B* may also agree on “2”, bilateral open skies (or at least a higher degree of deregulation than under the existing agreement), resulting in discounted payoffs of (α_2, β_2) at the time of agreement.

Note that payoffs are the additional rents that deregulation provides and β_2 is the carrot. We will restrict analysis to these three distinct cases although one might argue that actual bargaining might also cover other degrees of deregulation.

Both *A* and *B* are fully rational in the sense that they bargain to maximize expected payoffs, any bounded rationality, problems of special interest groups, etc., then are captured in the payoffs. We will assume that both unilateral and bilateral deregulation improve total welfare of the two countries:⁴

$$\alpha_2 + \beta_2 \geq 0 \text{ and } \alpha_1 + \beta_1 \geq 0. \quad (1)$$

³The analysis does not change if *A* is a deregulated region that has given a mandate to negotiate on behalf of the whole region.

⁴From the general theorem of the second best it follows that a small departure from the first best (unilateral open skies) need not be better than a large one (bilateral regulation). Thus it need not be the case that $\alpha_2 + \beta_2 \geq \alpha_1 + \beta_1$.

By assumption A is liberal which implies $\alpha_2 \geq 0$, α_1 .⁵ Hence payoffs for A can take two forms:

A^w : $\alpha_2 > \alpha_1 > 0$, in this case we will say that A is **weak** (for reasons that will later become apparent). Denote a weak A by A^w .

A^s : $\alpha_2 > 0 > \alpha_1$, in this case we will say that A is **strong**, denoted by A^s .

The strict inequalities rule out indifference between the alternatives and thus simplify the following arguments.

If country B values bilateral deregulation higher than both unilateral opening on behalf of A and the status quo ($\beta_2 > \beta_1, 0$) then A and B have common interests and will agree on bilateral open skies. Furthermore, $\beta_1 < 0$ cannot be part of B 's payoff because unilateral open skies give B all opportunities it has under the status quo, plus some more. Thus we are left with two different possible payoff structures for B :

B^w : $\beta_1 > \beta_2 > 0$, in this case we will say that B is **weak**. Denote a weak B by B^w .

B^s : $\beta_1 > 0 > \beta_2$, in this case we will say that B is **strong**, denoted by B^s . Country B is strong if the carrot is small.

In all models, countries A and B cannot make binding agreements or commitments apart from those explicitly mentioned ("1" and "2", so far). In particular, they cannot agree on side payments, that is they cannot arrange payoffs $(\alpha_i - \Delta, \beta_i + \Delta)$, and they cannot (credibly) ex ante commit to make unilateral restrictions that are not rational ex post.

In what follows, we will analyze various sequential structures of bargaining between different types of A and B by applying the according equilibrium concepts. We employ a strategic approach, which embodies a detailed description of the bargaining procedure, because it is especially suitable to model and analyze negotiations between governments or states on an international level (Holler and Illing, 1990, p. 241).

In contrast to the strategic approach, the axiomatic approach relies on desirable properties that the outcome of a bargaining problem should comply with. Due to the leeway involved in defining desirable properties, there are numerous axiomatic solution concepts. In the case of two possible agreements, two axioms (Selten's axioms) suffice to establish the most commonly applied Nash solution (Harsanyi, 1987):

1. Monotonicity. Starting with a symmetrical game ($\alpha_1 = \beta_2$ and $\alpha_2 = \beta_1$) and increasing one or both payoffs of an agreement will make this agreement the solution of the new game.

⁵Any other preference ordering would be trivial, anyway: $\alpha_1 \geq 0$, α_2 implies that A opens unilaterally and $0 \geq \alpha_1$, α_2 implies that A realizes the threat point.

2. Linear Invariance. The outcome will not change under an order-preserving linear transformation of utilities.

Assume that both countries are weak. Then under monotonicity and linear invariance, the solution to our bargaining problem is unilateral opening of A^w if $\alpha_1\beta_1 > \alpha_2\beta_2$ holds, and bilateral open skies if $\alpha_2\beta_2 > \alpha_1\beta_1$ holds. In the following sections, we will apply the strategic approach.

Bargaining with Complete Information and a Finite Horizon

One-shot Bargaining

Denote a bargaining process over T periods between parties i and j where i moves first in period T (the last period) by $\Gamma_T(i, j)$. Now consider $\Gamma_1(B, A)$, the case of a one-shot bargaining process where first B makes an offer and then A either accepts or rejects.⁶ Every aspect of the bargaining process is common knowledge, that is A and B know the structure of the bargaining process and each others payoffs, and they know that they know, and so on.

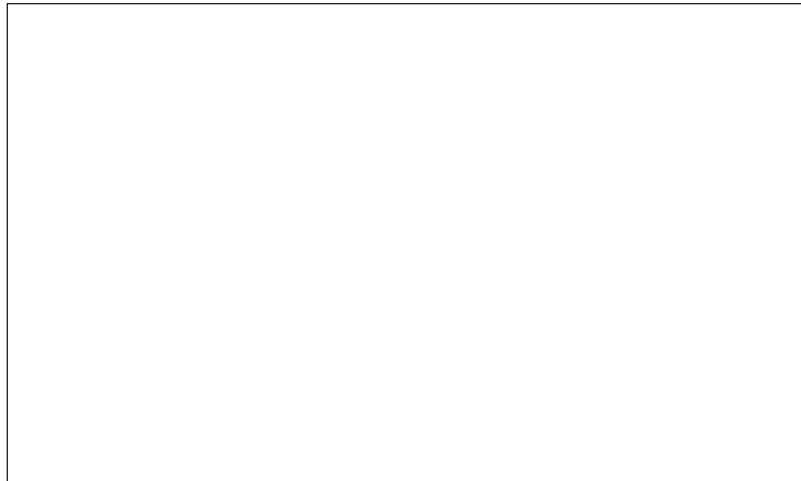


Figure 1: One-shot Bargaining Process $\Gamma_1(B, A)$.

Figure 1 depicts the extensive form of $\Gamma_1(B, A)$ where dominated strategies are eliminated: neither B^w nor B^s ever offer “0” because both can secure at least those payoffs by offering “1”, and neither A^w nor A^s ever reject offer “2”. By backward induction we obtain the subgame-perfect

⁶ B offering unilateral opening of country A may be interpreted as B not offering anything.

equilibria, that is the Nash equilibria that do not involve noncredible threats. The payoffs of $\Gamma_1(B, A)$ then are as in Table 1 (the according strategies are straightforward).

Table 1: Payoffs of $\Gamma_1(B, A)$

	A^s	A^w
B^s	(0, 0)	(α_1, β_1)
B^w	(α_2, β_2)	(α_1, β_1)

If country A is of type A^w , the result of the bargaining process will always be unilateral opening of A^w because A^w cannot credibly threaten not to open unilaterally if B offers “1”, and B knows this. This absence of a credible threat ($\alpha_1 > 0$) makes A^w weak.

If A is strong it credibly threatens not to open up if offered “1” ($0 > \alpha_1$) and then equilibrium depends on the type of B : B^w will offer “2”, because bilateral opening offers a higher reward than the status quo ($\beta_2 > 0$) and A^s will accept. In contrast, B^s will not offer “2” ($0 > \beta_2$) and A^s will not open up its market when offered “1”. Both realize their threat point because it is individually rational not to agree to the unfavorable agreement. In this case neither country is at its bliss point, and even in the absence of side payments there is room for improvement on both sides.

Proposition 1 (Pareto-improving Lottery). If both countries are strong and risk neutral and any deregulation improves total welfare, then there exists a Pareto-improving lottery.

Proof. Let L denote a lottery where unilateral open skies are drawn with probability p and bilateral open skies with probability $(1 - p)$. If A^s is risk neutral, it will accept L if and only if $p\alpha_1 + (1 - p)\alpha_2 \geq 0$ or, rearranging,

$$p \leq \frac{\alpha_2}{\alpha_2 - \alpha_1} \equiv p_A, \text{ where } 0 < p_A < 1. \quad (2)$$

Risk neutral B^s will offer L if and only if $p\beta_1 + (1 - p)\beta_2 \geq 0$ or, rearranging,

$$p \geq \frac{\beta_2}{\beta_2 - \beta_1} \equiv p_B, \text{ where } 0 < p_B < 1. \quad (3)$$

Lottery L will be offered and accepted if and only if $p_B \leq p \leq p_A$. Now assume that no such lottery exists which implies $p_B > p_A$. Applying Equation 2 and Equation 3 and rearranging yields

$$\alpha_1\beta_2 > \alpha_2\beta_1. \quad (4)$$

Deregulation improves welfare: $\alpha_2 + \beta_2 \geq 0$ and $\alpha_1 + \beta_1 \geq 0$. This can be rearranged to $\alpha_2 \geq -\beta_2$ and $\beta_1 \geq -\alpha_1$, and combining the two yields $\alpha_2\beta_1 \geq \alpha_1\beta_2$, contradicting (4) and thus the assumption. ■



Figure 2: Payoffs With and Without Lottery.

Figure 2 illustrates Proposition 1. If A^s and B^s could enter a binding agreement to conduct a lottery L with $p_B \leq p \leq p_A$, both could secure a higher expected payoff because the lottery convexifies the payoff possibilities. This lottery may for example come in the form of third party arbitration where the probabilities of ruling in favor of any outcome are as described above.⁷

Now consider $\Gamma_1(A, B)$, that is A makes an offer and B accepts or rejects. The equilibrium payoffs of $\Gamma_1(A, B)$ are identical with those of $\Gamma_1(B, A)$

⁷Note that at this point we are introducing further possibilities of binding agreements, changing the nature of the bargaining process from noncooperative to cooperative.

except if both players are weak, where $\Gamma_1(A, B)$ results in bilateral open skies (see Table 2).

Table 2: Payoffs of $\Gamma_1(A, B)$

	A^s	A^w
B^s	(0, 0)	(α_1, β_1)
B^w	(α_2, β_2)	(α_2, β_2)

The reason is that if both countries are weak, any agreement (“1” or “2”) makes both parties better off than no agreement (“0”), and the first mover in the only and thus last round of bargaining chooses the agreement serving him best. Hence the country preparing the last offer has bargaining leverage because it can credibly commit.

Repeated Bargaining

Repeated Bargaining with a Single Country

Now consider the case of $T > 1$ rounds of bargaining between A and B , and suppose that countries discount future payoffs by a factor of $\rho \in (0, 1)$ per period. If an agreement is reached, bargaining is stopped and each player gets the according payoff. Again, every aspect of the bargaining protocol is common knowledge, including the maximum number of bargaining rounds T and who moves first in each period.

Proposition 2. If countries do not discount future payoffs, then only the last round of bargaining determines equilibrium. Formally, $\Gamma_T(i, j)$ has the same equilibrium payoffs as $\Gamma_1(i, j)$.

Proof. Suppose A^w and B^w are bargaining and B^w prepares the offer in period T , A^w then either accepts or rejects. As T is the last period, the parties face a one-shot situation as in Figure 1. Thus B^w will offer “1” and A^w will accept, resulting in payoffs of (α_1, β_1) , see Table 1.

First suppose that A^w is entitled to make an offer in period $T-1$. B^w will only accept offers “ i ” that yield a payoff of $\beta_i \geq \beta_1$, otherwise B would wait another period and realize profits β_1 in period T . Hence B^w would reject offer “2” and A^w will offer “1”, which B^w accepts.

Next suppose that B^w is entitled to make an offer in period $T-1$. A^w accepts any offer “ i ” resulting in a payoff of $\alpha_i \geq \alpha_1$, otherwise it would

prefer to wait until period T and realize α_1 . But here B^w will realize its bliss point by offering “1”, which A^w accepts.

So no matter who makes an offer in period $T-1$, the bargaining will result in payoffs (α_1, β_1) . Now we may repeat the same argument for period $T-2$, and so forth up to period 1. Whoever makes an offer in the first period will offer “1” and the other country will accept.

All other cases can be shown in a similar manner. ■

The intuition behind Proposition 2 is as follows: if up to period $T-1$ no agreement has been reached, the resulting bargaining situation is as in the one-shot setting. As time is not costly, any side can credibly threaten to wait for the last round to secure the payoffs of the one-shot bargaining game, thus no other outcome can be an equilibrium. Actual agreement may be reached in any round of bargaining. The equilibrium is invariant with respect to the order in which offers are made up to and including round $T-1$. Hence the country preparing the offer in round T has the full bargaining power.

Now we are concerned with the equilibria if countries do discount future payoffs.

Proposition 3. If at least one country is strong, then Proposition 2 also holds if countries discount future payoffs ($\rho < 1$)

Proof. Consider $\Gamma_T(A^s, B^w)$ and $\Gamma_T(B^w, A^s)$. In round T , parties will agree on “2”, no matter who moves first (see Tables 1 and 2). Now assume that A^s moves first in round $T-1$: B^w will accept any offer “ i ” that provides payoff $\beta_i \geq \rho\beta_2$, therefore A^s will offer “2” and B^w will accept. If B^w moves first in period $T-1$, A^s will accept any offer “ i ” with $\alpha_i \geq \rho\alpha_2$. Because of $\rho > 0$ and $\alpha_2 > 0$ this implies $\alpha_i > 0$. As $\alpha_1 < 0$ holds for A^s , offer “1” will be rejected. Because B is weak, $\beta_2 > \beta_0$ holds and B will offer “2”. So in $T-1$, parties will agree on “2”, no matter who moves first. This argument can be repeated for $T-2$ and so forth up to period 1.

All other cases can be shown in a similar manner. ■

Proposition 3 indicates that if a strong and a weak country bargain, the strong country will always be able to enforce its first best outcome, because the alternative agreement is worse than the status quo. Consequently, two strong countries will always realize the threat point. Delay is costly and hence if parties agree, they will do so in the first round and bargaining is terminated immediately, “...from an economic point of view, the bargaining process is efficient (no resources are lost in delay)” (Osborne and Rubinstein, 1990, p. 50).

Proposition 4. If both countries are weak, then the equilibrium depends on the structure of bargaining in the first and in the last round and on the relative sizes of payoffs.

The resulting equilibria under all possible bargaining situations are summarized in Figure 3 (not to be confused with an extensive form game). If both countries are weak, discounting may change the equilibrium outcome. If the discounted first best is worse than the second best, then a party will agree to a proposal of the second best, even if it could secure the first best in the next round.

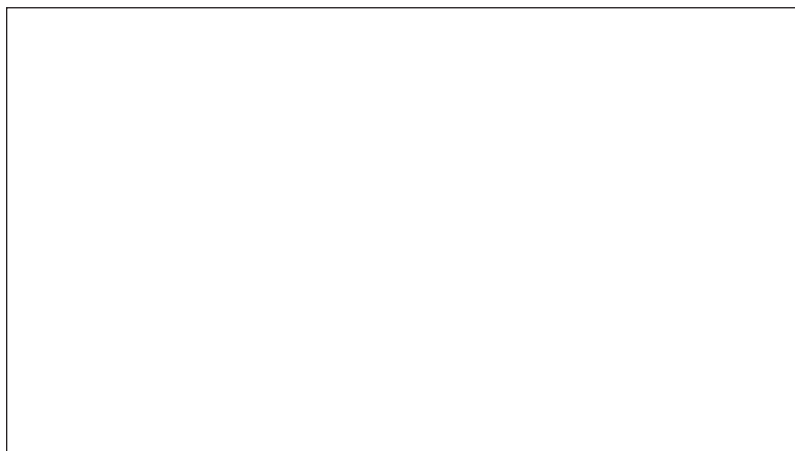


Figure 3: Equilibria of $\Gamma_T(A^w, B^w)$ and $\Gamma_T(B^w, A^w)$.

Here too, equilibrium is always reached in the first round. The equilibria depend on the relative sizes of the payoffs, the discount factor, and which country prepares the offer in the last and in the first round, although the first round only matters if both countries do not care too much about getting the second best instead of the first best.

To clarify the workings behind Proposition 4, we will present the induction process for the case where A^w offers in T , $\alpha_1 > \rho\alpha_2$ and $\beta_2 < \rho\beta_1$, which results in unilateral open skies (“1”).

In period T , A^w offers “2” and B^w accepts. First assume that A^w offers in $T-1$. Country B^w accepts any offer “ i ” where $\beta_i \geq \rho\beta_2$. Hence A^w will offer “2” and B^w will accept. This argument can be repeated leading to equilibrium “2” if A^w always offers (displayed as a separate branch in Figure 3).

Let period $T-k$, $1 \leq k < T$, be the last period where B^w offers. By the above induction process we know that in period $T-k+1$, A^w offers “2” and B accepts. So in period $T-k$, A^w will accept any offer “ i ” such that $\alpha_i \geq \rho\alpha_2$. By assumption, $\alpha_1 > \rho\alpha_2$ and hence B^w will offer “1” and A^w will accept.

Turn to period $T - k - 1$. A^w will accept any offer “ i ” where $\alpha_i \geq \rho\alpha_1$. So should B^w offer in $T - k - 1$ then it will offer “1” and A^w will accept. On the other hand, B^w would accept any offer such that $\beta_i \geq \rho\beta_1$. But, by assumption, $\beta_2 < \rho\beta_1$ and thus B^w would reject “2”. Then A^w offers “1” and B^w accepts. This argument can be repeated for all periods $T - k - 2$ to 1, and the equilibrium agreement is “1”. So to change the equilibrium from “2” (in the case where A^w prepares all offers) to “1”, it is sufficient that B^w has the chance to make a single offer in any period, given $\alpha_1 > \rho\alpha_2$ and $\beta_2 < \rho\beta_1$.

The bargaining situation Γ_T is akin to Selten’s chain-store game (Selten, 1978). Take the case where both countries are weak, $\beta_2 < \rho\beta_1$, and B^w moves first in the last period. Country A^w might be tempted to reject unilateral open skies in the first rounds (or, if A^w moves first, it might be tempted to offer bilateral open skies) to convince B^w that it is playing tough and will not accept unilateral opening. But in the last period, there is no reason for A^w to convince B^w that it is playing tough anymore, indeed it would be irrational not to open up unilaterally as this would imply a loss of $\alpha_1 > 0$. But if the outcome of period T does not depend on anything that has happened before, why should A^w bother playing tough in $T-1$? Neither does it generate any immediate payoff nor is it profitable in the future, that is period T . So A^w will not play tough in $T-1$. This argument can be repeated and the logic of backward induction is incorruptible: A^w will not play tough and will open unilaterally in the first round; there is no scope for reputation building.

Bargaining with Different Countries

Now take Γ_T and modify it such that there are T different less liberal countries B_i , and country A engages in a one-shot bargaining process with B_i in period i .

The argument for reputation building on behalf of A then seems even stronger. Consider the case where all countries are weak and B_i^w moves first in period i . As B_i^w is only bargaining once, it cannot recoup the losses it incurs if A^w rejects offer “1”. So if A^w has rejected offer “1” for, say, k periods, then B_{k+1}^w , who observes this, might be convinced that A^w will again reject if offered “1”, which in turn would imply that B_{k+1}^w offers “2”. But this reputation effect does not withstand scrutiny, as the above backward induction argument demonstrates.

Instead, the unique subgame-perfect equilibrium consists of the realization of the one-shot equilibrium in each period. Introducing a slight uncertainty on the side of the B_i^w about the nature of A (A^w or A^s) does give room for reputation building, as will become apparent later.

Bargaining with an Infinite Horizon

So far we have assumed that the total number of periods of bargaining is bounded and common knowledge. In this setting, the last period is especially important as it confers bargaining leverage due to the solution concept of backward induction. Because in many practical settings there is no fixed last period of bargaining, it is desirable to overcome this artificiality. Therefore we are now concerned with the results if the countries believe that bargaining will only stop after an agreement has been reached and otherwise continue indeterminately, that is $T \rightarrow \infty$. In addition, we will relax the notion of a detailed bargaining protocol, instead each country can make an offer or react to an offer in each period.

Assume that $\rho \in (0, 1)$; time is strictly valuable. If one of the countries is strong and the other is weak, the weak country can at no time expect the other side to agree on the weak country's first best alternative. Hence the best the weak country can achieve is its second best, which is the strong country's first best. Knowing this, the cost of delay lets the weak country offer or agree to its second best in the first period. If both countries are strong, they will never agree because any agreement is to the disadvantage of one side compared to doing nothing.

The more interesting case arises if both countries are weak such that both unilateral and bilateral open skies benefit both parties. Assume that at the beginning of each period, any of the two parties may concede and accept the first choice of the other party. Assume that payoffs are symmetric: $\alpha_1 = \beta_2 = \pi^0$ and $\alpha_2 = \beta_1 = \pi^+$.⁸

If neither of the countries concedes in period t the bargaining continues in period $t+1$ and payoffs for period t are $(\alpha_0, \beta_0) = (0, 0)$. If country A^w concedes in period t and unilaterally opens its market then bargaining stops and payoffs are $(\alpha_1, \beta_1) = (\pi^0, \pi^+)$. Similarly, if country B^w concedes in period t and agrees to a liberal bilateral agreement then bargaining stops and payoffs are $(\alpha_2, \beta_2) = (\pi^+, \pi^0)$. If both countries concede in the same period then payoffs are $(0, 0)$.

This is a discrete-time war of attrition, and the costs of not conceding are the delayed benefits of deregulation. A pure-strategy Nash equilibrium consists of A^w 's strategy to never concede and of B^w 's strategy to immediately concede, for another one just swap names.

Of more interest, there is a unique symmetric equilibrium in mixed strategies. Denote by p the constant probability that one country concedes

⁸A mixed-strategy Nash equilibrium has the unpleasant property that the equilibrium strategy of a country only depends on the payoffs of the other country and not on its own payoffs. This counterintuitive property is circumvented by equalizing payoffs.

given that the other has not yet conceded. Denote the expected discounted value of a country's payoff if it continues bargaining by V_{con} . Then with a probability of p (which is the probability that the other country surrenders) the payoff is large (π^+) and with a probability of $1 - p$ (the probability that the other country continues bargaining) the payoff is the discounted expected value of the next period:

$$V_{con} = p\pi^+ + (1 - p)\rho V_{con}. \quad (5)$$

On the other hand, surrendering yields π^0 :

$$V_{sur} = \pi^0. \quad (6)$$

In a mixed-strategy equilibrium the payoffs of continuing and surrendering have to be equal, and from Equation 5 and Equation 6 we get

$$p^* = \frac{1 - \rho}{\pi^+ / \pi^0 - \rho}. \quad (7)$$

The strategies of each player to concede with probability p^* in period t if the other player has not surrendered before t then form a subgame-perfect Nash equilibrium (see Fudenberg and Tirole, 1991, p. 120).

Equation 7 reveals some interesting comparative static results of equilibrium behavior. As impatience of the countries grows (ρ runs from 1 to 0) the probability of surrendering increases (p^* runs from 0 to π^0/π^+). So if time is not costly, nobody will ever concede. If on the other hand delay is so costly that next period's payoffs are worthless, then countries will concede with probability $\pi^0/\pi^+ < 1$.

As the additional benefits from winning grow (π^+/π^0 runs from 1 to $+\infty$) the probability of surrendering decreases (p^* runs from 1 to 0). Countries fight longer if the prize is big. The expected bargaining time may be calculated by interpreting t as time. Then each country surrenders according to a Poisson process with parameter p^* and the probability of a country still bargaining at time t , given that the other country still bargains, is $\exp(-p^*t)$. As these probabilities are independent as long as bargaining continues, the probability that the bargaining is still in progress at time t is $\exp(-2p^*t)$, which yields expected bargaining time of $1/(2p^*)$ with variance $1/(2p^*)^2$.

Although continuing to bargain does not induce any direct monetary costs on the countries, there are opportunity costs for postponing a mutually favorable agreement. As in equilibrium both continuing and surrendering yield the same expected payoff, it follows that all additional rents above π^0 are dissipated by delaying agreement so long until the expected discounted payoff equals π^0 . Note that the postponement of an

agreement has no socially valuable by-product, thus dissipation is socially wasteful.

Bargaining with Incomplete Information

So far we have assumed that all aspects of bargaining are common knowledge and deterministic. But incomplete information and/or randomness may come in many modes. Country *A* may not know Country *B*'s payoffs, or vice versa, or both. Countries might be unsure about their own payoffs, especially of those in the distant future. There could be uncertainty about the duration of the bargaining process or about the exact structure of the game. Payoffs might be random, for example they may depend on the mix of business and tourist passengers, which in turn depends on the weather, or payoffs may depend on the outcome of the next election.

Most of these extensions are beyond the scope of this paper, instead we focus on the case of incomplete information which permits reputation building on behalf of *A*. The following analysis is a simple application of results established by the seminal work of Kreps and Wilson (1982) and Milgrom and Roberts (1982) on the building of reputation under incomplete information.

Under complete information, the logic of backward induction precluded the building of a reputation on behalf of *A*, motivating the chainstore-paradox. Now take another look at the bargaining process between country *A* and *T* different weak countries B_t^w .⁹ Countries *A* and B_t^w engage in a one-shot bargaining process of type $\Gamma_1(B_t^w, A)$ in period $t \in \{1, \dots, T\}$.¹⁰ Countries maximize discounted payoffs.

The main innovation is uncertainty on behalf of the B_t^w concerning the type of country *A* they are bargaining with: they initially assess the probability δ that *A* is strong with payoffs $\alpha_2^s > 0 > \alpha_1^s$ and probability $(1 - \delta)$ that *A* is weak with payoffs $\alpha_2^w > \alpha_1^w > 0$. Country *A* on the other hand knows its type and also knows that *B* is weak. Denote this game by $\Gamma_T(B_t^w, A^\delta)$.

Assume that payoffs are symmetric in the sense that the gains from improving from second best to first best in relation to the gains from improving from the worst to the second best are identical for A^s and A^w :

⁹If the countries B_t are strong there is no need for reputation building on behalf of *A*. Country B_t^s never offers "2" because it is dominated by offering "1" ($\beta_2 < 0$).

¹⁰The results do not change if *A* repeatedly bargains with a single country *B*, as long as the agreements are only valid for the period in which they have been made.

$$a \equiv \frac{\alpha_2^w - \alpha_1^w}{\alpha_1^w} = -\frac{\alpha_2^s}{\alpha_1^s}, \quad (8)$$

where $a > 0$ follows from the assumptions regarding payoffs. Let

$$b \equiv \frac{\beta_1 - \beta_2}{\beta_1}, \quad (9)$$

where a large b coincides with a small carrot. As B is weak it holds true that $0 < b < 1$. Now a positive affine transformation of payoffs does not change the bargaining game between A and B_t^w and yields the bargaining process of a single period as depicted in Figure 4.

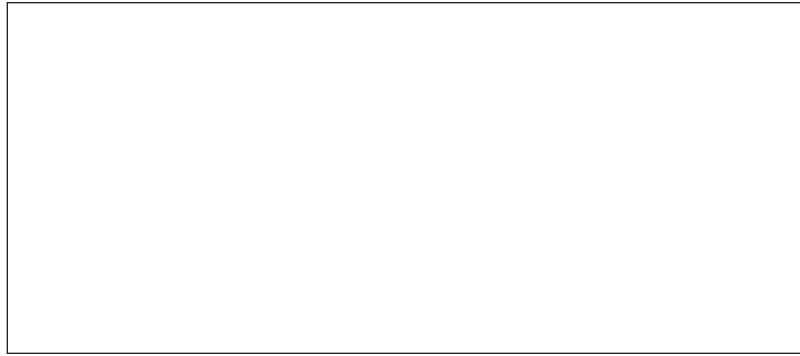


Figure 4. Bargaining Process with One-Sided Uncertainty

All parties can observe all moves and countries B_t^w update their belief about A each period by Bayesian learning. Denote by p_t the probability assessed by country B_t^w that A is strong. Then p_t is a sufficient statistic for the history of play up to date t , and choices in period t only depend on p^t and for A on B_t^w 's offer.

First turn to the case where $a > 1$, that is A gains more from getting the first best instead of the second best than it loses if it gets the worst instead of the second best. Assume further that A does not discount, $\rho = 1$. Then the following beliefs and strategies form a sequential equilibrium of $\Gamma_T(B_t^w, A^\delta)$ which under some weak conditions is unique (Kreps and Wilson, 1982, p. 264).¹¹

¹¹A Bayesian equilibrium satisfies the fixed-point condition that strategies are optimal given beliefs and beliefs are obtained from strategies by Bayesian learning. A sequential equilibrium puts further restrictions on the consistency of beliefs off the equilibrium path (see Fudenberg and Tirole, 1991).

Equilibrium Beliefs

1. If B_{t-1}^w offers “2” then $p_t := p_{t-1}$.
2. If B_{t-1}^w offers “1”, A rejects and $p_{t-1} > 0$ then $p_t := \max\{b^{T-t+1}, p_{t-1}\}$.
3. If B_{t-1}^w offers “1” and A accepts or $p_{t-1} = 0$ then $p_t := 0$.

Equilibrium Strategy of A

1. A^s and A^w always accept “2”.
2. A^s always rejects “1”.
3. If A^w is offered “1” at stage t , then the response depends on t and p_t :
 - (a) If $t < T$ and $p_t \geq b^{T-t}$ then reject.
 - (b) If $t < T$ and $p_t < b^{T-t}$ then reject with probability $\frac{(1-b^{T-t})p_t}{(1-p_t)b^{T-t}}$, accept with complementary probability.
 - (c) If $t = T$ then accept.

Equilibrium Strategy of B_t^w

1. If $p_t > b^{T-t+1}$ then offer “2”.
2. If $p_t < b^{T-t+1}$ then offer “1”.
3. If $p_t = b^{T-t+1}$ then offer “2” with probability $1/a$.

Equilibrium beliefs are formed as follows: if A is offered bilateral open skies then nothing is learned about A because both A^s and A^w always accept. If A opens up unilaterally for a single country B^w , it is established in all following negotiation rounds that A is weak because a strong A always rejects offer “1”. If A rejects unilateral open skies then the probability of A being strong is adjusted upward. Late rejections of “1” allow for higher probabilities of A being strong as the benefits of reputation building for A^w fade towards the end of bargaining.

This in turn explains why it is an equilibrium strategy of A^w to accept offers “1” towards the end that it would have rejected earlier. Country B_t^w on the other hand offers bilateral open skies if it assesses a small probability of A being strong or if there are only few rounds of bargaining left.

Let $k(\delta) = \sup\{t: \delta < b^{T-t+1}\}$. For $t < k(\delta)$, country A will never accept unilateral open skies and B_t^w will offer bilateral opening. In period $t = k(\delta)$, there is a non-vanishing probability that a weak A would accept unilateral opening, but this probability is too small for B_t^w to offer accordingly. In periods $t > k(\delta)$, B_t^w may offer “1” and A^w may accept. It is remarkable that in periods 1 to $k(\delta)$, the less liberal countries do not test A with offer “1” because they know that A would reject to build its reputation.

If the initial belief that A is strong is large (δ large), then there will be a prolonged period where A is not tested. The same holds if the carrot is large (b small). This fact is depicted in Figure 5 for the case where A bargains with 10 different weak countries. If T is sufficiently large, even a very small initial assessment that A is strong leads to bilateral open skies in the first periods.

Figure 5. Number of Rounds where A is not Tested in $\Gamma_{10}(B_t^w, A^\delta)$.

Extensions

So far we have assumed that $a > 1$ and $\rho = 1$. The main characteristics of equilibrium do not change for $0 < a \leq 1$ or for discounting on behalf of A at a rate of $\rho > 1/(1 + a)$ or, equivalently, $\rho > \alpha_1^w / \alpha_2^w$. Equilibrium behavior may get more complicated towards the end.

If on the other hand $\rho \leq \alpha_1^w / \alpha_2^w$ holds, then the character of equilibrium does change: country A^w will accept the first offer “1” and B_t^w will offer “1”

if $p_t < b$, “2” if $p_t > b$. Building its reputation by not opening unilaterally then does not pay off for A because a bilateral agreement in round $t + 1$ is worth less than a unilateral opening in round t .

Another possible extension is the introduction of two-sided uncertainty so that neither country is sure about the payoff structure or type of the other side. Kreps and Wilson in their original work do consider two-sided reputation formation, and they find that the resulting game is very similar to a war of attrition game. More recently, Abreu and Gul (2000) consider a model of two-sided incomplete information, two-sided offers, and multiple types, where players bargain over a “pie” of fixed size. The resulting equilibrium has a war of attrition structure and the bargaining outcome is independent of the bargaining protocol.¹² So, as long as both sides have an interest in building reputation and uncertainty is two-sided, the war of attrition seems to be a natural outcome.

CONCLUSION

In the preceding analysis we have presented different bargaining procedures pertaining to the problem of negotiating bilateral air service agreements and we have deduced the according equilibria. The former analysis is of course by no means complete: we have concentrated on the case of two countries and two possible agreements. Extending the analysis to regional air service agreements and thus multilateral bargaining is easy in the case of Nash’s axiomatic approach, as it extends unchanged to multilateral situations. In the case of the strategic approach, the exact rules and the procedure of bargaining determine the outcome, and equilibria need not be unique.¹³ Furthermore, we have ignored any transaction costs associated with bargaining. Despite these shortcomings, we believe that the above analysis provides some guidance for a structured positive analysis.

Now we are concerned with policy implications. Countries may exert influence on the bargaining situation via two levers: payoffs on the one hand and the structure of bargaining on the other. So far we have assumed that both are exogenous, but in many cases there is room for manipulation. The following discussion is informal, a rigorous treatment would have to incorporate the decisions with respect to bargaining structure and payoff manipulation into the structure of the game tree.

¹²Abreu and Gul (2000) also provide a detailed discussion of the related literature.

¹³Krishna and Serrano (1996) consider the case where n players bargain over a pie of fixed size. Under their bargaining procedure, the equilibrium agreement approximates the n -player Nash solution if players are patient. Under different bargaining procedures this need not be the case.

Assume that we are to advise country A and that our concern is total welfare. Assume further that total welfare is highest if bilateral open skies are agreed on so that our interests are also A 's (otherwise we would advise B). Depending on the other conditions, the following advice may be in order:

1. If country B is strong, make it weak. One way to do this is to sweeten bilateral open skies, such that $\beta_2 > \beta_0$. For example, one might grant route traffic royalties or bundle air service negotiations with non-aviation quid pro quos which are in the interest of B . Another way of making B weak is to spoil the status quo and thus achieve $\beta_2 > \beta_0$. This may be accomplished if country A sets standards (e.g. technical) that are costly to achieve for B .¹⁴
2. If country A is weak, get strong (get $\alpha_0 > \alpha_1$). Country A may try to make unilateral open skies costly to achieve, for example by passing according legislation, by making public statements and by mobilizing special interest groups. This gives credibility to the threat of not opening up unilaterally if B fails to approve to bilateral open skies.
3. If country A is weak, appear strong. Emphasizing that one is very happy with the status quo and considers unilateral opening as harmful may plant a seed of doubt regarding the true nature of A into some B . As we have seen before, even a very small initial assessment of A being strong can be sufficient for A to build a reputation.
4. Choose the right order of bargaining partners. First, signing open skies agreements with like-minded countries may be convenient, but it may also seriously deteriorate the bargaining position vis-à-vis less liberal countries. If only few agreements have been signed so far, there is a much stronger case for A to build a reputation and the less liberal countries, knowing this, may be more prone to agree on bilateral open skies at this stage.
5. Choose the right intervals of bargaining. By changing the time between bargaining rounds, A can influence the discount factor and hence the equilibrium outcome if both players are weak. For example take the case where $\alpha_1 = 9$, $\alpha_2 = 10$, $\beta_1 = 10$ and $\beta_2 = 5$. Both countries discount at 6.38 percent per year. Now take the game $\Gamma_T(A^w, B^w)$. If

¹⁴For example, the Dutch Government supposedly threatened to withhold payments to NATO until the U.S. granted some concessions to KLM (Hanlon, 1996, p. 80).

bargaining takes place every second year, then we get $\rho = 0,8836$. It follows that $\alpha_1 > \rho\alpha_2$ and $\beta_2 < \rho\beta_1$, resulting in unilateral opening of A in equilibrium. If bargaining takes place every year, we get $\rho = 0,94$. Then it holds that $\alpha_1 < \rho\alpha_2$, resulting in bilateral open skies in equilibrium.

6. Avoid wars of attrition. As these wars soak up all of the additional rents, they are in nobody's interest. So in the case of complete information, try to fix an end date of bargaining. In the case of two-sided uncertainty, employ an economic adviser to reduce uncertainty about payoffs and types of players.

Although there are many reasons for less liberal countries to reject bilateral open skies, there are nearly as many means to fabricate the bargaining protocol and to manipulate payoffs. The above analysis provides guidance how and to what extent payoffs have to be corrected and how bargaining should be structured to achieve a socially desirable outcome.

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AVIATION SYSTEM SAFETY AND PILOT RISK PERCEPTION: IMPLICATIONS FOR ENHANCING DECISION-MAKING SKILLS

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ABSTRACT

This research explores risk perception in a defined population of flight instructors and the implications of these views for flight training. Flight instructors and students engaged in collegiate aviation flight training were interviewed for this qualitative study. Thirty-three percent of the instructors interviewed reported that flying is not a risky activity. This is important because research identifies risk perception as one factor influencing instructional choices. These choices can then impact the subsequent decision-making processes of flight students. Facilitating pilot decision-making through the use of an appropriate type of learning that incorporates the modeling of consensually validated cognitive procedures and risk management processes is discussed.

Issues of safety are of paramount importance in the field of aviation. The Federal Aviation Administration's *Safer Skies* initiative (1998), for instance, is a primary vehicle for addressing issues of safety. One goal of this initiative is to achieve "a significant reduction of general aviation accidents and fatalities" (p. 1). To accomplish this goal for general aviation, the initiative suggests an emphasis on pilot decision-making as well as loss of control, weather, controlled flight into terrain, survivability, and runway incursions.

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Flathers, Giffin, and Rockwell (1982) studied decision-making behavior of pilots facing a deviation from a planned flight. They found that differences in decision-making related to several factors, including grade of pilot certificate, the amount and type of initial and recurrent training, and the type of flying most commonly done. In this study, they found that pilot training affected subsequent decision-making and suggested that “A closer examination of the training and certification process is in order” to improve pilot decision-making (Flathers et. al., 1982, p. 963). O’Hare and Roscoe (1990) also state that “Most national and international aviation organizations are increasingly accepting the position that flight training, particularly in general aviation, is a problem” (pp. 61–62). They continue that to increase safety, more attention needs to be paid to the judgmental education of professional pilots in addition to the traditional emphasis on training in skills and procedures.

What is the best way to teach good pilot decision-making skills? One way, suggested by Bandura (1986), is by using strategies which take into account the amount of risk involved with aviation. A study by Green (1998) suggests that instructional choices can be influenced by the degree to which flight instructors perceive an activity as high-risk. The instructional choices made by the flight instructors can then impact subsequent decision-making processes of their students. This research explores factors that affect risk perceptions, the perceptions of risk identified in a defined population of flight instructors, and the implications of these views on aviation training.

BACKGROUND

Risk Perception

It is obviously important to understand those factors which influence the practitioner’s perception of risk and to determine whether prevailing attitudes among flight instructors identify the activity as being high-risk in nature. High-risk is defined for these purposes as the potential in an activity for loss of life or limb, litigation, loss of reputation, and/or expenditures of large amounts of money if a pitfall or in-flight problem is mishandled.

Thompson (1993) explores risk perception. She proposed that principles of realism, optimism, and flexibility affect the amount of personal control experienced and the adaptiveness of naturally occurring perceptions of control. She stated that: “In considering how people judge the control available to them, it appears that people often have optimistic estimates of their control that focus on what they can influence, downplay the areas where control would be difficult, and overestimate the likelihood of their influence being successful” (Thompson, 1983, p. 89). Thompson also states that even when people do not feel they can exert primary control, they

maintain perceived control by trusting in the ability of others to help them (secondary control). Reliance by a pilot on ATC to avoid weather or other problems is an example of this. Thompson stated in explaining “bounded flexibility” that: “Many people seem to overestimate their potential for influence, but judgments of personal control are also responsive to objective limits and subjectively perceived constraints on an individual’s influence” (Thompson, 1983, p. 89). Boundaries are thus provided to these individual perceptions.

Wickens (1992) states that “people’s perception of risk seems to be guided by the availability of examples of the risky event in long-term memory” (p. 294). He cites the work of Slovic, Fischhoff, and Lichtenstein (1981) that reports certain risks are considerably overestimated while others are greatly underestimated by people and that “perceived risks are directly correlated with the amount of publicity that the varying hazards receive in the media” (p. 294). Wickens also reports that personal experience plays a role in availability and the estimated risks of an activity decreases for people who have had accident-free experience with an activity (Karnes, Leonard, and Rachwal, 1986 cited in Wickens, 1992, p. 294). Personal experiences may be misleading, however. Pilots with no personal encounters with “pitfalls” in training or in flight may therefore not consider either aviation in general or a specific task to be a risky activity.

Slovic (1987) states that “those who promote and regulate health and safety need to understand the ways in which people think about and respond to risk” (p. 280) and that this information can be used to direct educational efforts. Douglas and Wildavsky (1982) cited in Slovic (1987) assert that “people, acting within social groups, downplay certain risks and emphasize others as a means of maintaining and controlling the group” (p. 281). Slovic (1987) states that “when experts judge risk, their responses correlate highly with technical estimates of annual fatalities” (p. 283) but that “expert’s judgments appear to be prone to many of the same biases as those of the general public” (p. 281). He reports that lay people may have differing evaluations of the risk of an activity because of the use of a different definition of risk that may include, for instance, catastrophic potential. Slovic (1987) exemplifies this variation in a table that quantifies the perceived risk by different groups for 30 activities. General aviation is ranked as the seventh riskiest activity by the League of Women Voters, and is ranked twelfth riskiest of the listed activities by aviation experts.

Risk in General Aviation

Accident analyses indicates that “during the four years 1989–1992, 1226 instructional airplanes were involved in 1218 crashes included in the National Transportation Safety Board files. The casualties included 250

deaths, 128 serious injuries, and 270 minor injuries” (Baker, Lamb, Li, and Dodd, 1996, p. ix). For the six years 1991–1996 the Nall report (1997, p. 3) reports a total of 10,811 U.S. General Aviation accidents. These included 1,906 fatal accidents with 4,065 fatalities. Aviation is a high-risk activity.

The Nall Report (1997) states that just because there are risks in an activity it does not mean that harm is inevitable. The Nall report also states, however, that pilots cannot afford to ignore the risks involved in aviation simply because they are inherent in the activity. The goal is to “gain knowledge about the risks and take proactive steps to control them” (Nall Report, 1997, p. 2). The first step is acknowledging the risk in aviation and then enhancing decision-making skills in order to manage them effectively. This research explored how flight instructors perceive risk in general aviation.

METHODOLOGY

This paper presents qualitative data collected from private and instrument flight instructors and students teaching and learning in collegiate aviation programs. The data presented here are those used in previous research (Green, 1998) addressing learning through flight simulation. Dimensional sampling (Arnold, 1970) was used to identify participants in the study. According to Arnold, dimensional sampling involves three steps. In the first step, the universe to which you eventually want to generalize is explicitly delineated. In the second step, what appear to be the most important dimensions along which the members of this universe vary and develop are spelled out. A typology is also developed that includes the various combinations of values of these dimensions. In step three, this typology is used as a sampling frame for selecting a small number of cases from the universe.

This type of sampling allows a researcher to avoid limitations that would be experienced in either a single-case study or a large-number approach to a topic. This sampling technique seeks to minimize systemic variance and maximize potential diversity.

Systemic variance in this study was minimized by selecting potential respondents only from the population of those using flight/aviation training device (F/ATD's) as part of a college or university based flight program. This is one segment of the general aviation community flight training community. A survey by the University Aviation Association (1991) found that training devices were in use in this segment of the aviation community.

Diversity was maximized by identifying the following four dimensions for sampling purposes:

1. The type of certification F/ATD training was used for: The two types of certifications addressed in this dimension were
 - (a) Private Pilot Certification; and
 - (b) Instrument Pilot Certification.
2. The type of instructor qualifications: Types of instructor certification addressed were
 - (a) Certificated Flight Instructors (CFI's); and
 - (b) Certificated Instrument Flight Instructors (CFII's).
3. The type of simulation technology:
 - (a) Flight training devices; and
 - (b) Personal Computer-Based Aviation Training Devices
4. The type of higher education institution:
 - (a) University;
 - (b) College; and
 - (c) Community College

The qualitative, exploratory principle of saturation was used to determine the actual number of interviews and observations (Merriam, 1988). According to the principle of saturation the time to stop collecting further data from observations or interviews is when additional data is unlikely to differ from what has already been obtained because the last few observations or interviews have contributed little or no new information.

Individual interviews of flight instructors and students were conducted both in person and by telephone. A total of 25 interviews were conducted with the following types of persons: Certificated Flight Instructors; Certificated Instrument Flight Instructors; primary flight students; and instrument flight students. The distribution of field interviews according to type of institution is presented in Table 1. The distribution of field interviews according to type of interviewee is shown in Table 2.

Table 1. Distribution of Field Interviews According to Type of Institution

<i>Type of institution</i>	<i>Number of institutions in which interviewing was conducted</i>	<i>Number of interviews</i>
Universities	5	23
Colleges	1	1
Community Colleges	1	1
Total	7	25

Table 2. Table Distribution of Field Interviews According to Type of Interviewee

<i>Type of interviewees</i>	<i>Number of interviews</i>
Instrument instructors (CFII)	12
Primary instructors (CFI)	3
Instrument students	6
Primary students	4
Total	25

Nine of the fifteen instructors interviewed (CFI and CFII) were from the same university based program. These nine instructors were also observed giving instruction in a training device. The students who were involved in these observations were also interviewed. In other words, each student interviewee was explicitly linked to one of the nine instructors in this subset and was also the subject of observation. In one case, two observations were performed of one instructor and both students observed were then also interviewed. This resulted in a total of ten student interviews and observations. All of the students interviewed had been exposed to the influences of at least two instructors (ground and flight).

Using instructor interviews and student interviews from one academic program resulted, through purposive sampling, in the inclusion of instructors with different experience levels and maximum diversity. Since the object of the research was not to explore diversity solely within the tradition of one flight program (Ruesch, 1975, pp. 49-57), other schools were chosen through systematic selection from a listing of college-based aviation flight programs (UAA, 1991). The department heads of these schools then nominated an individual to take part in the research.

RESULTS

In response to an interview question, 73 percent of flight instructors initially indicated that they do not consider flying a risky activity. When the question was reframed pointing out specific potential flight hazards, the percentage indicating that they did not consider flying to be risky declined, although 33 percent of the instructors still maintained that flying is not a risky activity.

Do You Consider Flying to Be a Risky Activity?

Interviewees seemed strongly partisan to seeing flying either as safe or risky. Students and instructor responses both included strong denials that flying was risky. Overall, the majority of respondents (68 percent) indicated flying was not risky; that it was safe (Table 3). Among instructors, 73 percent reported that flying was not risky (that it was safe). Included in

Table 3. Summary of Responses: Do You Consider Flying to Be a Risky Activity?

	<i>Risky</i>	<i>Safe</i>	<i>Total</i>
Instructors	4 (27%)	11 (73%)	15
Students	4 (40%)	6 (60%)	10
Total	8 (32%)	17 (68%)	25

this 73 percent figure are 17 percent (2) who stated that risk depended solely on pilot actions (see Appendix A). Among students, 60 percent indicated that flying was not risky (see Appendix B).

Engaging in this type of risk denial can result in an instructional design process that completely bypasses the need to address pitfall management. Risk denial allows practitioners to view flight as merely the implementation of technical procedures that, if done correctly, eliminate the potential for risk and downplay the role of good pilot judgement. This question turned out to be essential in helping the researcher understand the interviewee's frames of reference pertaining to their view of the aviation environment.

Leaving the interview at this level, however, was not found to be sufficient. Using the "funnel sequence" (Cannell and Kahn, 1968) helped interviewees reconsider their way of explaining their view of safety and risk in aviation. According to Cannell & Kahn (1968): "Within a subject area, the sequence of questions should be such as to lead the respondent meaningfully through the process of exploration. Often this can be done by means of the 'funnel sequence,' which proceeds from the broadest and most open of questions to the most specific" (p. 571). The question was reframed and asked again.

Can Loss of Life or Limb, Litigation, Loss of Reputation, and/or Expenditure of Large Amounts of Money Result if You Mishandle a Pitfall or Encounter Untoward Events? If Yes, Please Give an Example

With the reframing of this question 33 percent of the instructors still insisted flying is not a risky activity (see Appendix C). The majority of overall respondents (72 percent) did agree that these forms of risk were possible (Table 4). Among flight instructors there was 67 percent agreement and among students (see Appendix D) there was 80 percent agreement that these risks could occur. The flight instructors and students who initially indicated that they considered flying risky were included in the "Yes" category of this answer.

Pitfalls that were identified by interviewees included engine problems, wind shear, mechanical problems, and pilot error such as mistuning navigation radios and misreading altimeters. One instructor mentioned the

Table 4. Summary of Responses: Can Loss of Life or Limb, Litigation, Loss of Reputation, and/or Expenditure of Large Amounts of Money Result if You Mishandle a Pitfall or Encounter Untoward Events? If Yes, Please Give an Example

	<i>Yes</i>	<i>No</i>	<i>Total</i>
Instructors	10 (67%)	5 (33%)	15
Students	8 (80%)	2 (20%)	10
Totals	18 (72%)	7 (28%)	25

American Airlines accident in Cali, Colombia as an example of a risk resulting from mistuning a navigation radio and related a similar error made by his student.

There is defensiveness to the responses of those who exhibit radical denial of risk, almost protective of aviation, refuting the traditional view of aviation as a daredevil activity. One person said that aviation only appeared risky to people outside the profession. While aviation may not be a “daredevil” activity, it is not realistic to deny all risk.

DISCUSSION

Whether instructors recognize risk in aviation cannot be overestimated when considering the type of learning that is appropriate for an activity. According to Bandura (1986) any type of learning: autonomous; guided inquiry; reception (all described by Ausabel, Novak, and Hanesian, 1978); or social-cognitive (Bandura, 1986) is appropriate for low risk endeavors. When an activity is safe there are no adverse consequences to implementing any type of learning.

If aviation is viewed as primarily a high-risk activity (the potential exists for loss of life or limb, litigation, loss of reputation, and/or expenditures of large amounts of money if a pitfall is mishandled) then instructors need to operate with the understanding that any form of trial-and-error learning is contra-indicated because of the potentially catastrophic consequences. Bandura (1986) states that

one does not teach children to swim, adolescents to drive automobiles, and novice medical students to perform surgery by having them discover the requisite behavior from the consequences of their successes and failures. The more costly and hazardous the possible mistakes, the heavier must be the reliance on observational learning from competent exemplars.... (p. 20)

Bandura characterizes risk as a condition that precludes the use of autonomous learning or guided inquiry, both of which have a self-directed component. A method of learning which allows socialization to the “gold standards” of the field (acceptable routines that have been constructed and consensually validated by a profession to handle specific types of situations) is appropriate under these conditions.

Cognitive apprenticeship was developed by Collins, Brown, & Newman (1989). It is a form of social-cognitive learning which has as been operationalized for use in socializing learners to proficient practice in high-risk professions (Brandt, Farmer, & Buckmaster, 1993; Farmer, Buckmaster & LeGrand, 1992). Cognitive apprenticeship starts with a type of situation and models an acceptable way of performing that has been constructed and consensually validated by the field. The purpose is to socialize learners to a cadre of people in the same occupation and to have them proficiently deal with types of problems using procedures that are accepted by a particular field of practice. Table 5 outlines the five phases of cognitive apprenticeship. Integral to cognitive apprenticeship is the explicit inclusion of validated risk management processes

IMPLICATIONS

The challenge before us is to increase aviation safety through the improvement of pilot judgement and decision-making. It is recognized that even highly experienced and well trained commercial flight crews sometimes make decisions when dealing with unplanned events that in retrospect are nearly inexplicable. The accident analysis for AA Flight 965 near Cali Columbia (Aeronautical Civil of the Republic of Columbia, 1996) is a case in point. This accident was a controlled flight into terrain caused primarily by a change of course, based on guidance from a mistuned radio, that was made without first verifying the effect on flight path. The accident report states in part that “although the accident flight crew articulated misgivings several times during the approach, neither pilot displayed the objectivity necessary to recognize that they had lost situation awareness,” the descent was not discontinued, and a climb was not initiated in time to avoid terrain. The analysis notes that one explanation of the crew’s actions is that “the guidance given in the in the airline reference guide and in training did not have sufficient impact to be recalled in times of high stress and workload,” and that the crew “did not recognize the hazards the airline had warned them about” (pp. 36–37).

This research demonstrates that pilot attitude toward risk and risk management strategies are established quite early in flight training. The first step to risk management is the recognition of risk. Fully a third of the flight instructors interviewed did not recognize the risk inherent in aviation, assuming competence in routine procedures will suffice in achieving an accident-free career. The emphasis on criterion-referenced performance standards i.e., maintenance of +/-100 feet in maneuvers, in the FAA Practical Test Standards may contribute to this view. The pilots of AA 965, in terms of “bounded flexibility,” displayed an optimistic estimate of their

ability to complete the approach, downplayed the areas where control would be difficult, and overestimated the likelihood of their influence being successful.

This research also suggests that pilot decision-making can be facilitated through the use of an appropriate type of learning that incorporates the modeling of consensually validated cognitive procedures and risk management processes. Not just content, but how that content is taught in the early stages of pilot training, can have important implications for the development of risk management strategies in pilots. The accident analysis of AA 965 states that the pilots were not able to apply what they had learned simply from reading or hearing about the approach conditions. The robustness of cognitive apprenticeship for aviation instruction is validated

Table 5. Phases of Cognitive Apprenticeship

<i>Phase</i>	<i>Role of Learner</i>	<i>Role of Model</i>	<i>Key Concepts</i>
Phase I	Observes performance of activity, not merely the subskills. Develops mental model or schema of what the real thing looks like.	Models an acceptable procedure. Model states aloud: principles underlying the procedure; tricks that make it work; and identifies pitfalls likely to be incurred and how to handle them.	Articulation Domain specific heuristics Situated knowledge Schema
Phase II	Approximate doing the real thing and articulate its essence. Reflect on the model's performance. Use self-monitoring and self-correction	Provide coaching to the learner. Provide support when needed.	Scaffolding Coaching
Phase III	Continue to approximate the real thing. Work individually or in groups.	Decrease scaffolding and coaching	Fading
Phase IV	Practice doing the real thing on his/her own. Do so within specified limits acceptable to profession and society.	Provide assistance only when requested.	Self-directed learning
Phase V	Discuss the generalizability of what has been learned	Explain the generalizability of what has been learned and provides an advance organizer.	Generalizability

Note: By J.A. Farmer, 1996. Adapted with permission of the author.

in that it either includes or addresses all seven important training factors identified by Wickens (1992). These factors are: (a) practice and overlearning; (b) elaborative rehearsal; (c) reducing concurrent task load; (4) error prevention; (5) adaptive training; (6) part-task training; and (7) knowledge of results.

In training competent pilots we must teach not only for the overwhelming majority of flight time that is routine but also for those instances that distinguish aviation as a high-risk endeavor. The learner must be able to do routines but also handle problems in ways that work for the individual pilot and are appropriate under the circumstances while being in compliance with the regulations, rules, procedures, and principles of aviation. The training to achieve this, which will impact pilots throughout their careers, needs to be incorporated in the early stages of flight training. If and how we adapt our educational practices to enhance pilot decision-making will have important implications for aviation safety in the future.

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APPENDIX A

Instructor Responses: Do You Consider Flying to Be a Risky Activity?

- “I don't consider flying risky if you know what you are doing.”
- “I don't feel every day I go up and take my life in my hands.”
- “I don't consider it any riskier than any other activity. I risk my life when I wake up and get out of bed.”
- “No, not at all risky.”
- “I don't consider flying to be adversely risky. If you are riding a bike there is risk”
- “I don't think flying is risky.”
- “I never feel like flying is risky.”
- “It is no riskier than boating.”
- “I don't feel like it is risky, but I am so used to it I might as well be getting in my car.”
- “I guess it depends. If I were to do something stupid like fly in icing conditions it would be risky. Most of the time I feel I am in control of the situation, whether I am flying by myself or with a student.”
- “Yes, I do consider flying risky, but I also deliver pizzas and I find that driving to have the same risk level.”

APPENDIX B**Student Responses: Do You Consider Flying to Be a Risky Activity?**

“I think flying is very safe.”

“I consider driving a car more risky than flying.”

“There is less risk than most activities.”

“There is not too much risk.”

“No I do not consider it risky.”

“No (it’s not risky) because technology has advanced. The main concern of everyone while flying is having an engine failure. And the technology that new engines use today is so far advanced that engine failures are very rare. Almost every other risk you can prevent yourself.”

“I do consider it risky but no more so than driving.”

“I’m not sure it’s risky but it is scary.”

“From what I have heard, it is risky.”

“In a way I think it is. It’s riskier than many other occupations but it is also risky being a police officer. (In aviation) not only is your life in danger, but you are putting in so much money and if you fail a class there are additional costs. So you have to take it more seriously. We really have a lot of responsibility. In that respect, I think it is a pretty dangerous occupation, but if you have developed a how-to-be-responsible attitude you can avoid a lot of the hazards.”

APPENDIX C

Instructor Responses: Can Loss of Life or Limb, Litigation, Loss of Reputation, and/or Expenditure of Large Amounts of Money Result if You Mishandle a Pitfall or Encounter Untoward Events?

“I don’t agree with that statement.”

“(This definition) doesn’t change my answer. I don’t find aviation risky. If you’re riding a bicycle there’s always a potential for catastrophe.”

“No, bad luck is created by people and if you have competent people that lessens the potential risk factor.”

“My answer stays the same, no, aviation is not risky.”

“No, mechanical problems and engine failures could be risky, but if you know how to take care of (them) I don’t consider them very risky.”

“I have enough confidence in myself and my students (to prevent) risks.”

“If you are looking at one mistake and there goes my ticket then I would definitely consider it higher risk.”

“The potential is always there.”

“I think so. I agree with that.”

“Most certainly.”

APPENDIX D

Student Responses: Can Loss of Life or Limb, Litigation, Loss of Reputation, and/or Expenditure of Large Amounts of Money Result if You Mishandle a Pitfall or Encounter Untoward Events?

“I think most of the risk comes at the point where the accident chain is advancing and the pilot doesn’t realize it, something goes wrong, and the risk all of a sudden just explodes.”

“Considering that most flights are very safe, there are few that crash, it really doesn’t change my mind (aviation is safe). Only a very small percentage have problems.”

“It has more risk than other things you could be doing but there’s a lot of things that are more risky, like being a police officer. So I think the chances are better that those things aren’t going to happen.”

BOOK REVIEW

Millbrooke, A.M. (1999). *Aviation History*. Englewood, CO: Jeppesen Sanderson. Pp. 612. ISBN 0-88487-235-1. \$68.00, hardcover.

Reviewed by Nanette M. Scarpellini, Omaha, Nebraska

Aviation History delivers an entertaining account and perspective on international aviation history. This book is an excellent resource to students, educators, and aviation enthusiasts. In reviewing this book, the principal criteria included content, organization, and reference sources. While editing errors and organizational incongruities plague some of the latter chapters, many of the shortcomings of this first edition will likely be alleviated by later editions. These problems are only a minor distraction to the story being told.

Starting with the first unmanned hot air balloon flight in 1783 through the announcement of the X Prize that will be awarded to the first non-government sponsored manned spacecraft, the author shows the detailed progression of international aviation and aerospace technology. The reader is taken on a journey through the world of aviation and receives first-hand accounts from the inventors and dreamers who made it possible. The tone of the book reflects a learned appreciation for the marvel of aviation as illustrated by a quote from the 1759 aviation-related novel *Rasselas*, by Samuel Johnson which explains flight in this fashion: “So fishes have water, in which yet beasts can swim by nature, and men by art. He that can swim needs not despair to fly: to swim is to fly in a grosser fluid, and to fly is to swim in a subtler” (2-5).

The author, Anne Marie Millbrooke, is a proven historian and author specializing in science and technology with an emphasis on aviation history. In addition to acting as a historian for such organizations as the National Park Service, National Aeronautics and Space Administration,

Nanette Scarpellini is a graduate research assistant in the NASA Space Grant College and Fellowship program for the University of Nebraska at Omaha Aviation Institute and the managing editor for the *Journal of Air Transportation World Wide*. Ms. Scarpellini is pursuing a Master of Public Administration degree with an Aviation Administration concentration. In addition, she has a Bachelor's degree in Journalism and Psychology with an Advertising concentration from The Ohio State University and a Certificate of Organizational Development and Training from New York University. Ms. Scarpellini's research focuses on various aspects of aeronautical education and distance learning. She holds a Private Pilot Certificate and is pursuing of additional ratings.

she has also managed the Archive and Historical Center at United Technologies Corporation and been a Research Collaborator with the National Air and Space Museum. Her educational accomplishments include earning her doctoral degree from the University of Pennsylvania as well as her pilot certificate. Millbrooke's multi-faceted background establishes her in a strategic position to gather and assemble key pieces of aviation history that span the globe.

The organization of *Aviation History* allows the reader to easily follow the evolution of aviation. The book is divided into ten chapters. Opening with early aviation of the 18th century, the book progresses through the Wright Brothers, early flight, World War I, peacetime aviation, the Golden Age of Charles Lindbergh and aviation firsts, World War II, the Cold War, space age aviation, and finally modern aerospace through 1999 with glimpses of the 21st century and beyond. The appendices conclude with a listing of aviation firsts and space flights, as well as a copy of the Wright U.S. Patent. While it is impossible to explore thoroughly all topics, the detailed bibliography provides sources for obtaining more information.

The construction of the book lends itself well to a study of different time periods in history. Each chapter is broken down into four sections, which typically fit logically into the topic of the chapter. All chapters are composed of the following defining parts. The Summary of Events for the time period under review leads into the introduction and the chapter goals. Within the text of the chapter, are an assortment of breakout boxes that either describe an historic event, provide historical evidence to support aviation theories, or relate bibliographical information about individuals who were propitious in shaping aviation history. Unfortunately, the stories that intrigue can also confuse a reader when they are so numerous as to distort the flow of the text. The chapter is completed by a thorough bibliography, study questions reviewing the material covered, and a timeline augmented by providing events not directly associated with aviation. The book is well-referenced making skillful use of first-person sources.

The orderliness of the book conforms to an academic curriculum. While the chapters create neatly parceled packages, certain areas seem forced to conform to the ten-chapter plan. For instance, Chapter 9: Space Age Aviation feels oddly burdened by the last third of the chapter which focuses on fighter aircraft and various wars from Vietnam to the U.S. invasion of Granada as well as a final section completely on private and general aviation. These subjects can be better covered by creating another chapter or by parceling them into both earlier and later sections. Overall, a detailed story of the advancement of aviation is shown in readable and entertaining style.

Millbrooke presents a broad analysis of aviation history that focuses on developments worldwide as opposed to the many history books that single out achievements of the United States. *Aviation History* offers an objective view of aviation developments and illustrates the interactive nature of the industry. War spurred many of aviation's most significant advances with countries openly borrowing new procedures and operations from enemy progress in the field to create the most effective fighting fleet. "Nationalistic pride in aviation went beyond the romance and fads of aviation, to national identity and claims of distinctiveness and superiority...Legends grew around the British S.E. (scout experimental made by the Royal Aircraft Factory), the French Spad, and the German Fokker" (4-4).

Each chapter is filled with pictures and colorful quotes from people of that era. These firsthand accounts provide deeper insight into what, in some history books, is just a listing of factual information. When the "Red Baron" Manfred von Richthofen describes his victory over British ace Lanoe Hawker on November 23, 1916, the day comes alive. "I was on patrol that day and observed three Englishmen who had nothing else in mind than to hunt. I noticed how they ogled me, and since I felt ready for battle, I let them come..." (in Richthofen's *The Red Baron*, 4-29).

The author supplies an in-depth analysis of various aspects of aviation often glossed over in aviation books. Some of the areas explored include the development of aerial photography, air-to-ground communication with early wireless radio equipment, and airmail expansion beyond the United States. Antoine de Saint-Exupery flew a *la Ligne* mail route between France and Spain that sometimes crossed hostile territory. A flight on February 1927 he recounts in the following fashion in a letter to his mother. "The trip went well, aside from a breakdown and the plane crashing into the desert" (Schiff. 1994 in 5-41). As evidenced by the stories recounted throughout the volume, early pilots were part mechanic, part inventor and part adventurer in order to survive.

Aviation History is a collection of significant events in aviation accented by the people who made it happen and correlated with world affairs. The book's use of color and vivid stories helps to make the advancements come to life as something more than significant events on a timeline. While at times the stories may clutter the page, they also breathe life into what is considered by many to be a dull subject. The author's enthusiasm for the topic is obvious throughout. More thorough proofreading could help alleviate some of the confusion that is caused by typos and a few mislabeled illustrations. The credibility of the content does not suffer due to these obvious errors which will likely be corrected in the next edition.

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