TABLE 3 CHARACTERISTICS OF COMMERCIAL AND MILITARY AIR TRANSPORTATION SYSTEMS

System Characteristic	Commercial	Military
Operational Performance Data	Substantial	Uncertain
Demand	Stable	Dynamic
Load Relationships	Independent	Dependent
Delay Tolerance	Hours	Days

Differences Between Commercial and Military Air Transportation Systems

For both systems, performance is typically based on some function of arrival times (travel and service time). We believe that, although the problems are quite similar, there are aspects of the two systems that can affect modeling. These system characteristics include the characteristics of the demand for system capacity, load relationships, delay tolerance, and the availability of operational performance data (Table 3).

With respect to demand, commercial air transport systems are relatively stable within the time frame of practical scheduling. Military demand for system services during operational contingencies is highly dynamic. This contributes to a significant level of prediction uncertainty on a daily and weekly basis. This phenomena is compounded by the fact that, unlike most commercial cargo loads, military loads are typically not independent. By this we mean that the system goal is to have all of a unit's cargo arriving within some specific time frame. Because unit cargos are typically spread over many missions, a delay or schedule change may impact many missions. This is less often the case for commercial systems.

Two additional factors create differences in control activity for commercial and military systems. First, the relatively stable route structures and travel activity for commercial systems supports a relatively stable and substantial source of operational performance data for the system. The unique characteristics of military contingencies contributes to a relatively sparse database for the expected performance of the operational system. This compounds the prediction requirements for the system scheduler. The good news is that unlike commercial customers who measure delay in minutes or hours, realistic military schedules are not particularly sensitive to delays of this duration. For strategic deployment, the system customer is rarely sensitive to delays that do not exceed a day.

Summary

The purpose of this brief discussion was to motivate discussion about differences between the modeling and analysis requirements of alternative transportation modes and of military and commercial travel. Our observation is that air transportation models and analysis will be particularly sensitive to the complex carrier-to-carrier relationships that affect service cost. Differences between military and commercial system goals will likely contribute to different control logic in their schedulers.

Comments Concerning ITS

The concept of Free Flight for commercial air routes has a number of potential implications with respect to these observations. First, to the extent that variation in flight paths produces variation in arrival times for aircraft at airports, it provides a source of uncertainty that can measurably affect system throughput. This effect can be realized either through the direct impact of variation on service-queuing activities at airports, or implicitly through a requirement to incorporate more "slack time" in the schedule to offset the potential impacts of this variability. Either way, this potential source of variability can create a reduction in system throughput. Second, to the extent that one pilot's "planning freedom" is a source of planning uncertainty for other aircraft flight plans, it might provide a source of aircraft-to-aircraft interaction that could cause air traffic models to become more complex in order to produce accurate predictions.

Technology Transfer from Basic Research (N. Glassman)

The Air Force Office of Scientific Research (AFOSR) is the basic research agency for the Air Force—it controls all of the funds spent by the U.S. Air Force on basic research.

During the last several years, however, the distinction between basic and applied research has become blurred as program managers have come under increased pressure to demonstrate results—or in our terminology, transitions. Further, the definition of "transition" has become increasingly restricted to ensure that claimed transitions, which are published yearly, are real.

Philosophy

For the program manager, the challenge is not only to find interesting research that has the potential for application or transition, but to find mechanisms that ensure successful transition. Of course, the easiest method is to require the proposer or principal investigator to specify a transition path in the proposal—that is to require that he make the connection with the Air Force or industry beforehand. This is a difficult requirement for many university researchers, but the specification of such a mechanism definitely is a positive factor in proposal evaluation.

Another successful mechanism involves our close connection to the Air Force laboratories. Many of our topical thrusts are centered at laboratories, with a laboratory researcher doing basic research as part of a larger effort. Then, other research performed by universities or industry can be undertaken with the laboratory as a centerpiece. Because the Air Force laboratories are intimately involved with Air Force applications, securing the cooperation of laboratory scientists and their approval through the proposal review process almost assures an eventual successful transition.

Brokerage

Of course, as a program manager, one task is to broker research. That is, if I receive a theoretical proposal that I want to fund, I can search through the Air Force or industry to find a potential application and take a chance that my insight will prove to be correct. On the other hand, when I come across an interesting applied problem, I can formally or informally solicit proposals related to it. As a result of all of these techniques, and probably some others that I have neglected to mention, I have had several recent successes in the transition game. Let me mention a few of them:

1. Over the years, I have worked fairly closely with the Air Mobility Command. AFOSR provided the command with consulting support when they leased the original KORBX machine, and has helped the command develop models and optimization algorithms to rationalize their transshipment networks. AFOSR is now supporting research on optimization under uncertainty, so-called robust optimization, and I hope to ultimately transition to these models.

2. I have been able to form a consortium of Rice University, IBM, and Boeing that applies nonlinear optimization to a number of problems faced by Boeing. The current one of interest is in the design of helicopter wings to minimize vibration.

3. Although not directly related, research that AFOSR has supported has resulted in new algorithms for multitarget tracking. It improves the performance of Air Force radars by 3dB, without any changes in hardware, and is now being considered for inclusion in new Air Force systems.

In conclusion, the rapid transitioning of results is of crucial importance to the military research community and we are constantly seeking improved transitioning methods.

Technology Transfer from an Airport Operator's Perspective (G.W. Blomme)

An informed environment in which all relevant civilian and military knowledge can be identified, accessed, and shared will effectively facilitate civilian airport safety, security and operations worldwide. This process is the domain of technology transfer—a process that must be improved so that information sharing can be more effectively used to facilitate airport-critical development at minimum cost. Minimizing the costs of security programs, for example, can in turn expedite additional development and generate additional benefits to airport customers.

Let me cite examples. During the past year I have been involved in several safety and security projects that most likely could have been expedited if airport and information systems colleagues and I had ready access to information generated by noncommercial sources such as the FAA's recently established Centers of Excellence and other research institutions as well as declassified military documents. In all likelihood improved airport perimeter security systems and other matters of airside and landside security could directly benefit from knowledge databases already developed by noncommercial sources. Further, time-intensive standard procurement policies of airport operators can be offset to some extent by making more relevant information more readily available. These benefits will only increase in the future as FAA's Centers of Excellence generate more studies, more findings, and more recommendations. The same conceptual thinking that applies to security systems, in regard to facilitated review of research done to date, also applies to control systems and other types of operating support systems.