UNIVERSITY OF VIRGINIA

PASSENGER DEMOGRAPHICS AND SUBJECTIVE RESPONSE TO COMMUTER AIRCRAFT IN THE NORTHEAST

Memorandum Report 403219

Short-Haul Air Transportation Program

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David Noskowitz and Ira D. Jacobson

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Department of Engineering Science and Systems

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INTRODUCTION

This report compares the results of comfort and environmental studies taken in conjunction with the University of Virginia's STOL Program. Data were taken on flights of four different airlines, each flying different aircraft. Two of the lines are classified as commuter airlines flying between relatively close destinations. The aircraft involved are: the De Havilland Twin Otter, a Canadian aircraft; the French Nord 262; the Beechcraft 99 Airliner and the Sikorsky S-61 helicopter, both American.

The De Havilland Twin Otter is a STOL transport powered by two turboprop engines, with a high-wing configuration and nonretractable landing gear. The capacity of this plane is 19 passengers and it has a maximum cruising speed of about 200 mph at 10,000 ft. The Nord 262 is a twin-engined, pressurized light transport. Its wings are in the high-wing configuration and it has a retractable landing gear. The aircraft, powered by two turboprop engines, can carry up to 29 passengers in three-across rows, with two seats on one side of the plane. It has a maximum cruising speed of 233 mph and has a fully-loaded range of 565 miles. The Beech 99 is a twin-turboprop light transport and can be converted to an executive airplane. It is in a low-wing configuration, with a retractable landing gear. The plane carries 15-16 passengers, all with window seats. Normal cruising speed at 12,000 ft is 252 mph, and the range with a full passenger complement is 375 miles. The Sikorsky S-61 version in this study is nonamphibious and has a longer fuselage than the military version. The aircraft has two shaft-turbine engines. The cabin accommodates up to 30 passengers and has a mix of double and single seating along both sides of the

helicopter. The average cruising speed is 140 mph and the maximum range with full fuel is 450 statute miles.†

Passengers on these flights were requested to answer a survey form that dealt with demographic factors (such as age, income, occupation, and sex), flight information (e.g., flying experience, purpose of trip, etc.), and comfort factors (e.g., reactions to aircraft motion, environmental variables, and their overall reaction to the flight). For Airline I, flying the De Havilland Twin Otter, 200 samples were obtained in October 1973. For Airline II, using the Nord 262, 156 questionnaires were collected, also in October 1973. One hundred thirty-three surveys were returned on Airline III, flying the Beech 99, from November 12-15, 1973 and 339 samples were collected from passengers on S-61 helicopters of Airline IV.

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†All data on aircraft from Jane's All the World's Aircraft, 1969-70, JWR Taylor, ed., McGraw Hill Book Co.

DEMOGRAPHIC DATA

With respect to the demographic factors, it is found that the age distributions do not vary widely (Figure 1). The biggest discrepancy is that the maximum in the S-61 distribution falls in the 30-39 year age group, rather than in the 40-49 year age group as do the other three. The income distribution was slightly more varied (Figure 2). With the exception of the Twin Otter flights, the income group of $20,000-$29,000/year occurred most frequently. The Nord 262 flights showed a heavy preponderance in this area, with nearly 50% of its passengers falling into this category. With the exception of the Nord 262 flights, the other three airlines all showed significant peaks or shoulders in the above-$40,000/year group.

Passengers in most of the flights were predominantly male. In the Twin Otter and Beech 99 flights, the ratio of males to females was about 2.5 to 1. In the S-61 study, it was 5.7 to 1, and for the Nord 262, it was 8.5 to 1. In the case of occupations, over half of all passengers on the four airplanes considered themselves to be either in a professional or managerial occupation (Table 1); the average was about 65%. The Beech 99 figure was 56%, and the Nord 262 was 75%. Other notable features were that homemakers constituted a significantly higher fraction of the population on the Twin Otter and Beech 99 flights than on the other two. Also students constituted a significant fraction only on the Beech 99 flights. In conclusion, most of the passengers on these short-haul flights were middle- and upper-level managers, predominantly male, with an income in excess of $20,000.

The flight information obtained is what would have been expected from a population of mostly professional or managerial passengers. In all cases, less than 20% of the passengers on all flights were flying for pleasure (Figure 3). The figure for the Nord 262 flights (10% pleasure) was exceptionally low; 17% was a more typical response. The number of passengers who had flown fewer than four times on the noncommuter aircraft was comparable to the number of new passengers on the commuter aircraft, the response being from 25-35%. Of those passengers on the commuter aircraft, the Beech 99 and the S-61, over 90% had four or more flights on other commercial aircraft,

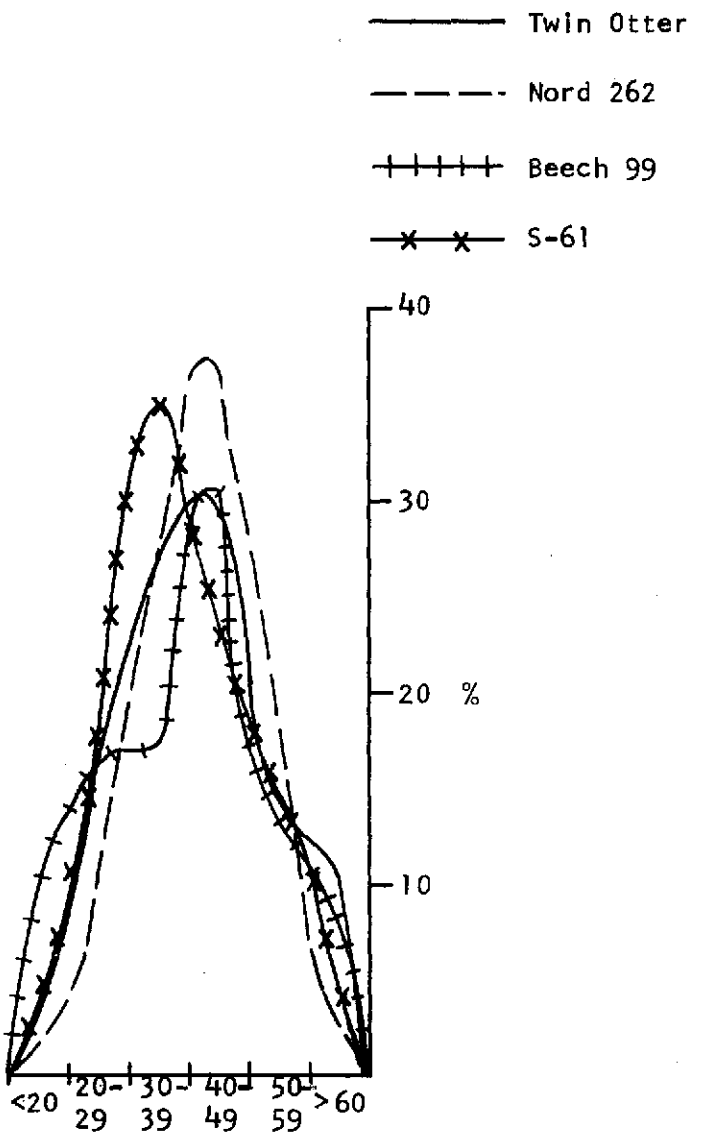

Figure 1. Age Distribution

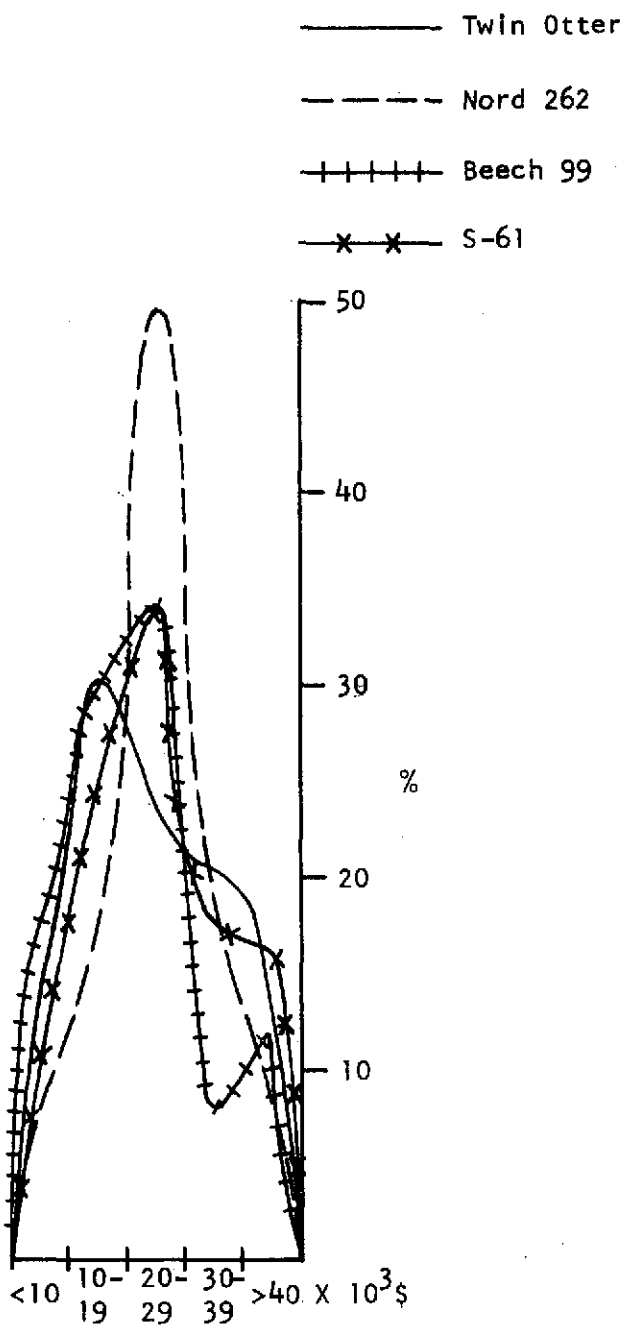

Figure 2. Income Distribution

Table 1. Occupation Distribution by Aircraft Type

Occupation	Airline I Twin Otter	Airline II Nord 262	Airline III Beech 99	Airline IV S-61 Helicopter
Professional	36.8	47.2	33.2	36.5
Manager, Official	31.4	26.8	22.9	29.3
Other	10.6	11.0	8.0	9.9
Homemaker	8.7	2.7	8.7	6.0
Sales	7.7	8.4	14.4	10.7
Student	3.8	1.9	10.4	5.0
Secretary, Clerical	1.5	1.2	1.9	1.7
Craftsman, Mechanic	0.0	0.8	0.8	0.8
Farming, Fishing	0.0	0.0	0.0	0.2

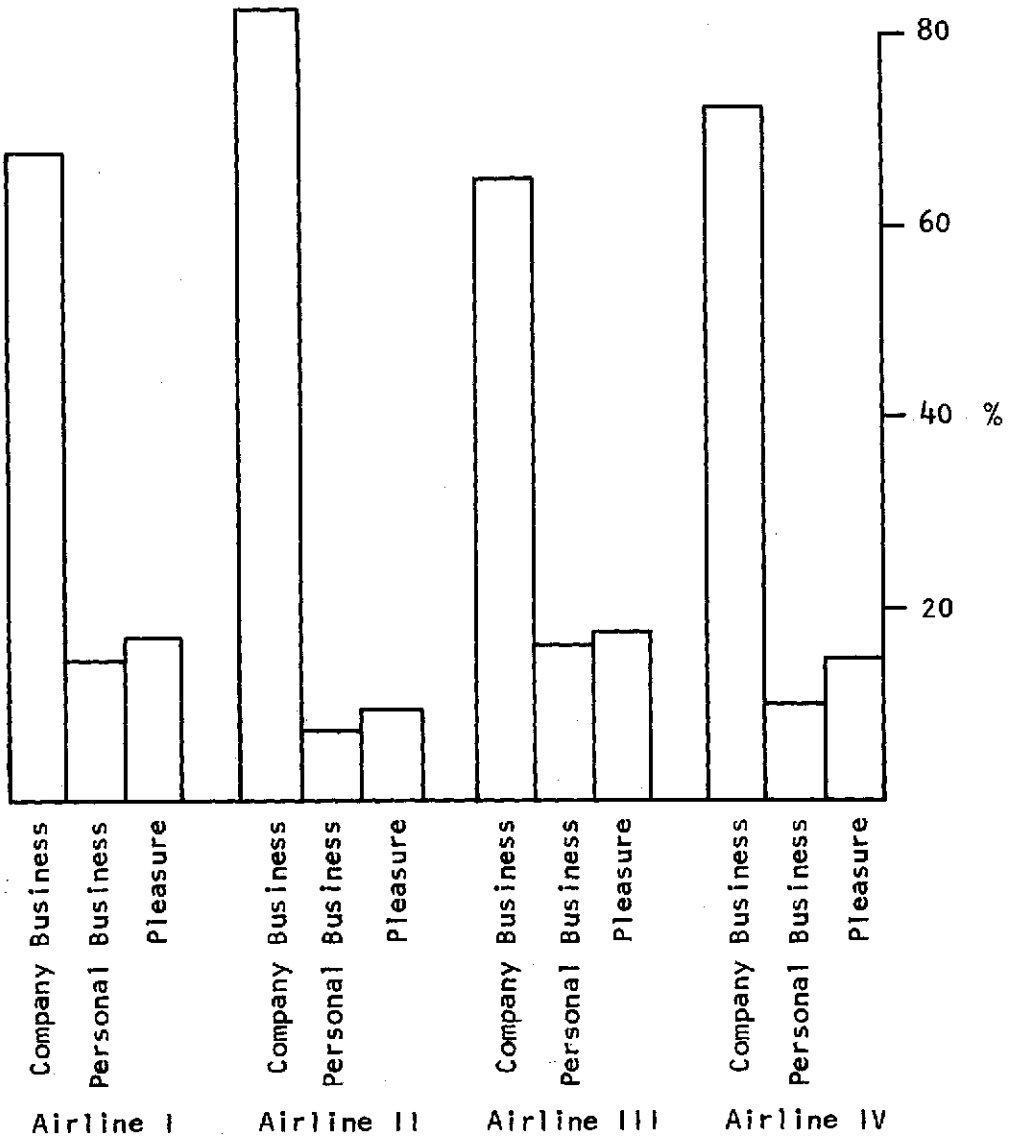

Figure 3. Purpose of Trip

PASSENGER REACTION

Most passengers on these flights either liked flying or were ambivalent about it. The exception to this is that passengers on commuter flights gave generally more favorable responses to the question of how they enjoy flying in other commercial airliners (Table 2). Most passengers felt that they had to fly. Sixty percent had to fly in the case of the Twin Otter and Beech 99 aircraft, 50% for the Nord 262, and 75% for the S-61. Most passengers had not taken airsickness medication, and in all cases, over 90% experienced no airsickness on their flights. Most people on these flights would either be eager for another flight or would take it without hesitation. On the Twin Otter, Nord 262, and Beech 99, this group averaged about 70% of the sampled population. For the S-61, the response was 93%. The rest would experience some hesitation, and in all cases, under 10% said that they would prefer not to fly again or would not fly again (Figure 4).

This data indicates that most of the people on these flights had flown before. Many were experienced travelers. Of the passengers on the commuter flight, better than 90% had extensive experience with flying on the noncommuter commercial airlines. This seems to indicate that the more experienced flyers were more willing to try a small commuter aircraft. Of those sampled, very few actively disliked flying, and very few suffered sufficient discomfort to cause airsickness. It is interesting to note that passengers in the S-61 were very enthusiastic about flying in that aircraft, but it is not known how many of these passengers had flown in a helicopter prior to taking this flight. The novelty of helicopter flying may have something to do with this high response. Another possible factor is the trip duration. The S-61 flight route is restricted to a single metropolitan area, and the longest possible flight is less than 25 miles. It is reasonable to assume that discomfort on a flight increases with time.

Part of a passenger's comfort response is related to the aircraft environment. Among these environmental variables are:

Table 2. Attitude vs. Aircraft Type

Feelings about Flying	Airline I Twin Otter	Airline II Nord 262	Airline III Beech 99 Feeling re: Flying Commuter	Airline III Beech 99 Feeling re: Flying Commercial	Airline V S-61 Helicopter Feeling re: Flying Commuter	Airline V S-61 Helicopter Feeling re: Flying Commercial
Like	45.0	59.5	41.0	73.0	52.0	64.0
No Strong Feeling	44.0	35.0	45.0	24.5	43.0	32.0
Dislike	11.0	5.5	14.0	2.5	5.0	4.0

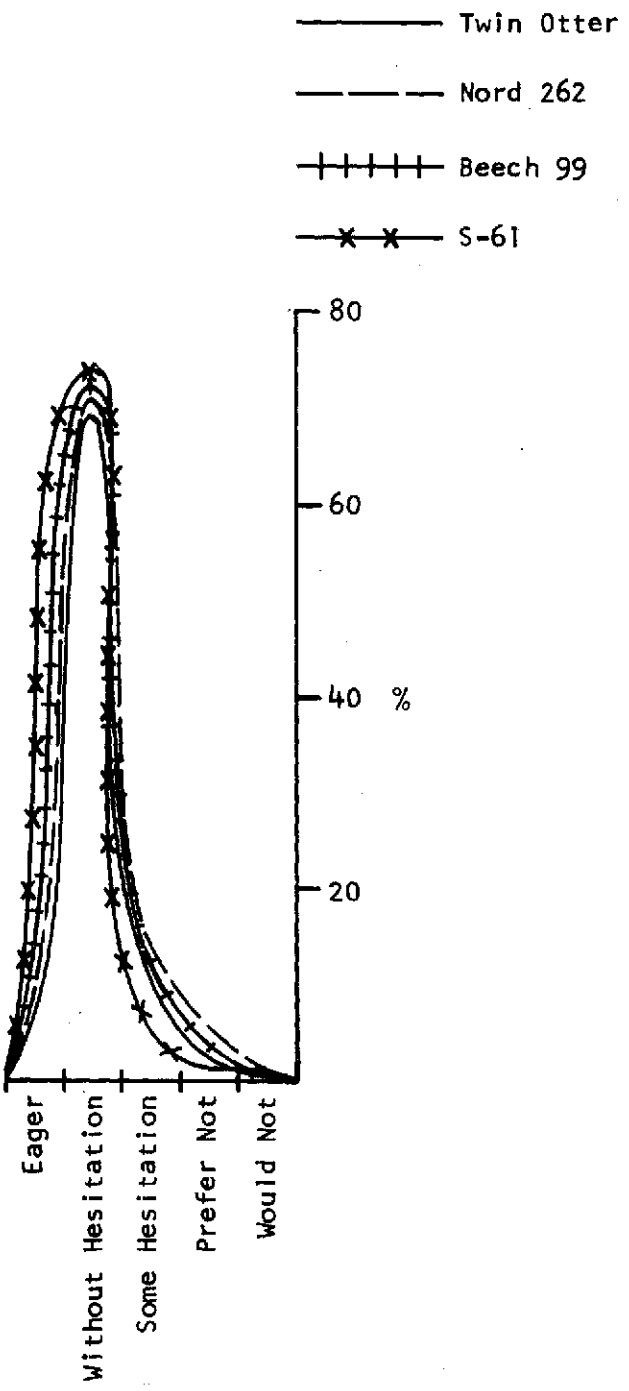

Figure 4. Desire for Another Flight

1. Work space--generally considered inadequate and uncomfortable. The Nord 262 was especially bad; only 19% of the passengers found it not uncomfortable. The S-61 was rated not uncomfortable by 57%, and the others were about 30%.
2. Noise--all the aircraft had virtually the same response, i.e., about 65% found it to be uncomfortable in varying degrees.
3. Up and down motion--superior ratings in the Nord 262, with about 88% not uncomfortable. The S-61 was rated not uncomfortable by 79%, and the others found not uncomfortable by 52%.
4. Tobacco smoke--found not uncomfortable by about 77% in all cases.
5. General Vibration--most people felt uncomfortable with the vibration level.
6. Sudden jolts--most found this not to be a problem, with the S-61 and Nord 262 rated better than the others.
7. Side to side motion--rated not uncomfortable by most people, with the Nord 262 and S-61 rated better than the others.
8. Backward and forward motion--generally found not uncomfortable, again with the Nord 262 and S-61 slightly more comfortable.
9. Lighting--found to be about the same level of comfort in all cases, about 80%.
10. Pressure--found not uncomfortable by only 40% in the Beech 99. The S-61 had the lowest uncomfortable rating, followed by the Nord 262 and Twin Otter. It should be remembered that the Nord 262 is pressurized, and the S-61 flies at low altitudes.
11. Sudden descents--generally not uncomfortable, with the Nord 262 and S-61 somewhat better than the others.
12. Temperature--found about 80% not uncomfortable in all cases.
13. Ventilation--generally rated 79% not uncomfortable, except in the Nord 262 which was 72%.
14. Odors--found to be about 90% not uncomfortable in all cases except the S-61 which had a rating of 79%. This appears to be because the rotor might send the engine exhaust into the helicopter. (See Appendix I for data.)

Another comfort factor is the seat. There are various parameters for determining seat comfort. They are as follows:

1. Leg Room--only the S-61 was found to have enough (72%), the others were all below 40%, and two were below 30%.
2. Seat firmness--most people found the seats firm enough. The Nord 262 was rated sufficiently firm by 74%, the Twin Otter and S-61 were found firm by 90% or more of the passengers, and the Beech 99 was found satisfactorily firm by 82%.
3. Seat width--Nord 262 seats were significantly narrower than the other aircraft resulting in only 1/3 of the passengers being satisfied. The S-61 had the widest seats, being found satisfactory by 61%.
4. Seat shape--generally found satisfactory. The lowest rating was the Nord 262, found satisfactory by 52%.
5. Seat adjustment--found generally unsatisfactory, with the S-61 having the best rating of 57% unsatisfactory. The Nord 262 was the worst with 77% of the passengers finding it uncomfortable. It is important to note that none of these seats had any variability in adjustment, hence the passenger was reacting to the existing adjustment for the seat.

Dimensions of the seats used are shown in Table 3.

The factors of seat quality and environment explain the overall reaction to the flight. The highest rated aircraft, the S-61, was rated about the same in environment as the Nord 262. However, in the case of the Nord 262 the apparent neglect of seat quality in the airplane's design accounts for the fact that a greater percentage of passengers were uncomfortable, in varying degrees, than on any other aircraft in the survey (Figure 5). The validity of this comparison is substantiated by the insignificant differences in the relative importance of system characteristics of passengers on all flights (Figure 6). In other words, passengers on all flights expected the same thing out of them.

Table 3. Approximate Seat Dimensions

	Seat Characteristics					
Aircraft	Width	Depth	Arm Rests	Leg Room	Adjustment	Cushion Type
Twin Otter	16-1/4"	18"	No	9-1/2"	None	Foam
Nord 262	14-3/4"	17-1/2"	Yes	8"	None	Foam
Beech 99	17-1/2"	17-1/2"	No	8"	None	Foam
S-61	19"	18"	Yes	8-1/2-10-1/2"	None	Foam

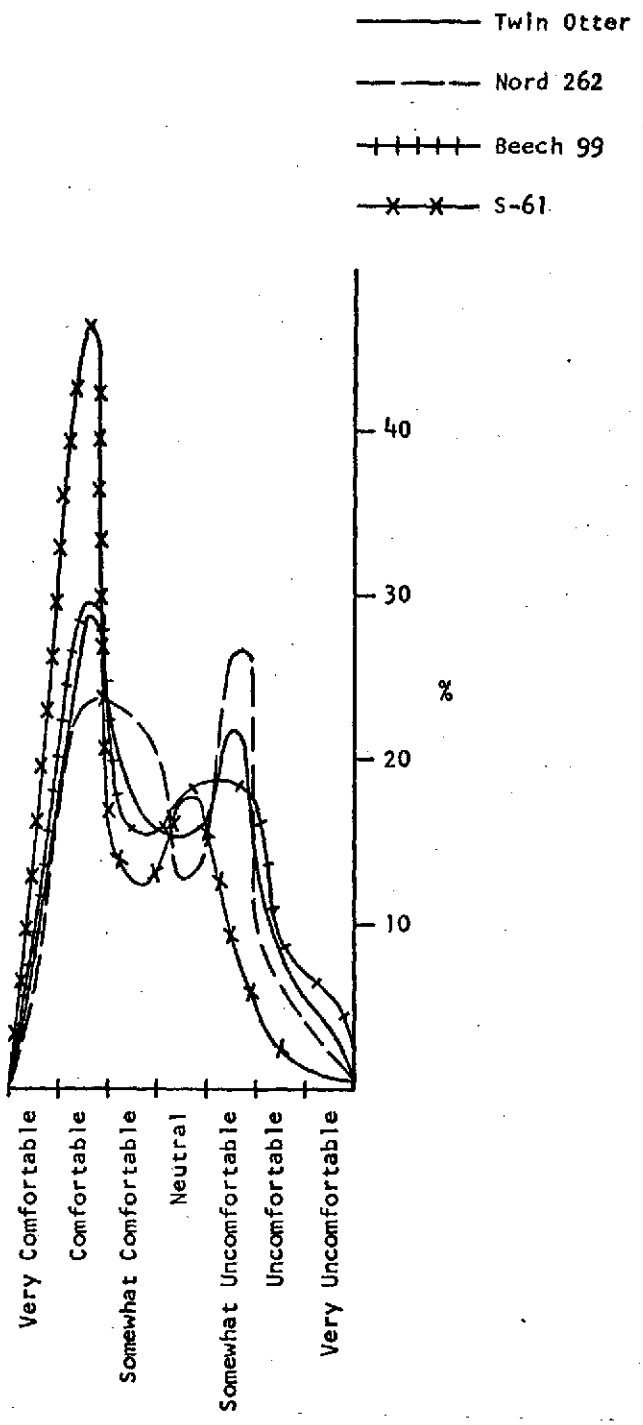

Figure 5. Overall Reaction to Flight

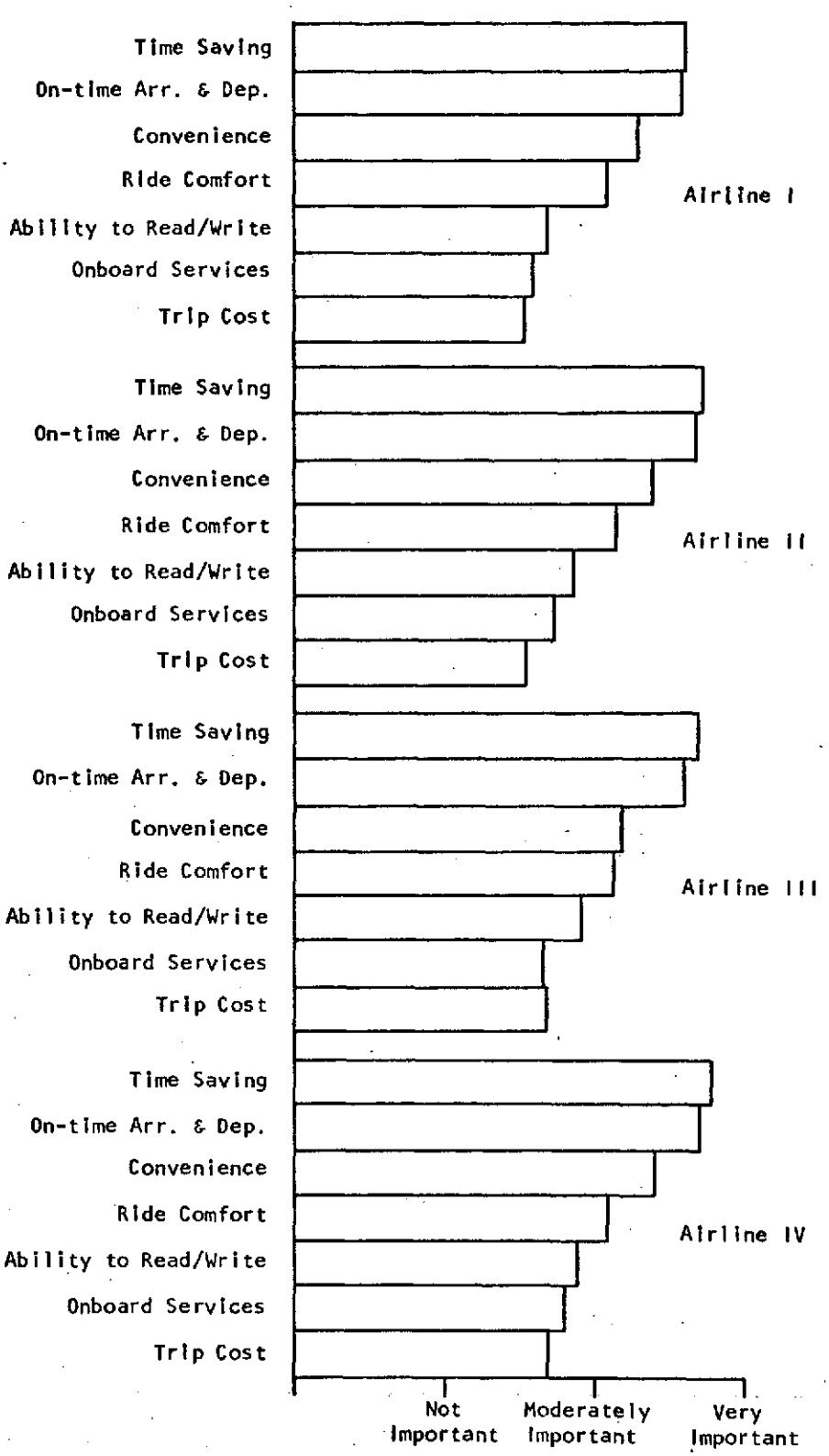

Figure 6. Relative Importance of System Characteristics

CONCLUSIONS

In conclusion, it can be said that in designing an aircraft for commercial use the ride quality and seat quality are very important design parameters. A well-designed aircraft cannot depend on a good ride alone to insure passenger comfort, but has to consider the quality of the seating. A perfect example of this is the Nord 262, which has a good ride, but bad seating.

Appendix I

Comfort Responses to Environmental Variables[†]

	Airline I Twin Otter	Airline II Nord 262	Airline III Beech 99	Airline IV S-61 Helicopter
Workspace				
Very Uncomfortable	66{25	81{22	73{30	43{15
Somewhat Uncomfortable	41	59	43	28
Not Uncomfortable	34	19	27	57
Noise				
Very Uncomfortable	71{16	68{14	60{11	67{12
Somewhat Uncomfortable	55	54	49	55
Not Uncomfortable	29	32	40	33
Up & Down Motion				
Very Uncomfortable	48{12	12{1	48{9	21{2
Somewhat Uncomfortable	36	11	39	19
Not Uncomfortable	52	88	52	79
Tobacco Smoke				
Very Uncomfortable	23{9	30{15	26{9	16{6
Somewhat Uncomfortable	14	15	17	10
Not Uncomfortable	77	70	74	84
General Vibration				
Very Uncomfortable	66{8	54{5	58{11	66{13
Somewhat Uncomfortable	58	49	47	53
Not Uncomfortable	34	46	42	34
Sudden Jolts				
Very Uncomfortable	40{8	13{1	40{4	24{4
Somewhat Uncomfortable	32	12	36	20
Not Uncomfortable	60	87	60	76
Side-to-side Motion				
Very Uncomfortable	36{8	10{1	35{6	17{1
Somewhat Uncomfortable	28	9	29	16
Not Uncomfortable	64	90	65	83
Backward & Forward Motion				
Very Uncomfortable	23{6	8{0	21{5	13{1
Somewhat Uncomfortable	17	8	16	12
Not Uncomfortable	77	92	79	87
Lighting				
Very Uncomfortable	21{6	12{2	21{7	17{3
Somewhat Uncomfortable	15	10	14	14
Not Uncomfortable	79	88	79	83
Pressure				
Very Uncomfortable	38{5	32{4	60{10	26{4
Somewhat Uncomfortable	33	28	50	22
Not Uncomfortable	62	68	40	74

[†]All numbers given in percentages.

Appendix I (Continued)

	Airline I Twin Otter	Airline II Nord 262	Airline III Beech 99	Airline IV S-61 Helicopter
Sudden Descents				
Very Uncomfortable	21	10	25	14
Somewhat Uncomfortable	5 / 16	1 / 9	3 / 22	3 / 11
Not Uncomfortable	79	90	75	86
Temperature				
Very Uncomfortable	18	20	21	22
Somewhat Uncomfortable	2 / 16	3 / 17	2 / 19	2 / 20
Not Uncomfortable	82	80	79	78
Turning				
Very Uncomfortable	10	5	8	9
Somewhat Uncomfortable	2 / 8	1 / 4	1 / 7	1 / 8
Not Uncomfortable	90	95	92	91
Ventilation				
Very Uncomfortable	21	28	21	21
Somewhat Uncomfortable	1 / 20	5 / 23	3 / 18	3 / 18
Not Uncomfortable	79	72	79	79
Odors				
Very Uncomfortable	10	8	12	21
Somewhat Uncomfortable	1 / 9	1 / 7	2 / 10	3 / 18
Not Uncomfortable	90	92	88	79

Appendix II

Seat Characteristics†

	Airline I Twin Otter	Airline II Nord 262	Airline III Beech 99	Airline IV S-61 Helicopter
Leg Room				
Enough	37	27	27	72
Not Enough	63 (42)	73 (44)	73 (39)	28 (21)
Emphatically Not Enough	(21)	(29)	(34)	(7)
Seat Firmness is Satisfactory				
Agree	90	74	82	94
Disagree	10 (9)	26 (19)	18 (13)	6 (4)
Strong Disagreement	(1)	(7)	(5)	(2)
Seat Width Satisfactory				
Agree	42	33	56	61
Disagree	58 (43)	67 (50)	44 (31)	39 (34)
Strong Disagreement	(15)	(17)	(13)	(5)
Seat Shape Satisfactory				
Agree	75	52	69	83
Disagree	25 (20)	48 (35)	31 (24)	17 (14)
Strong Disagreement	(5)	(13)	(7)	(3)
Seat Adjustments Satisfactory				
Agree	33	23	33	43
Disagree	67 (51)	77 (51)	67 (37)	57 (44)
Strongly Disagree	(16)	(26)	(30)	(13)

†All numbers given in percentages.