EVALUATION OF THE EFFECTS OF ONE YEAR'S OPERATION OF THE DYNAMIC PREFERENTIAL RUNWAY SYSTEM

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ABSTRACT

The FAA introduced an experimental aircraft operations program at JFK Airport called the Dynamic Preferential Runway System (DPRS) in the summer of 1971. The program is designed to distribute air traffic as equally as possible over the surrounding communities, to limit periods of continuous overflight and to vary the same hours of overflight from day to day. After a full year's operation, an evaluation was made of the system's effectiveness. All of the operation's goals were moderately achieved with the greatest relief in reduced overflight afforded the most heavily impacted areas. Few residents, however, were aware of DPRS or felt that it had greatly reduced annoyance or represented a major effort by the aircraft authorities. Statistical analyses of reported annoyance obtained from two independent surveys in 1969 and 1972 reveal limited reductions in annoyance in 1972, with shifts from reported high annoyance to moderate annoyance.

PREFACE

This report is an attempt to assess the effectiveness of the DPRS operations program. TRACOR developed the operation's statistics for 1972 from computer tape of each aircraft's operation. Dr. Skipton Leonard supervised the computation of comparable operations data for 1969. Thelma Weiner was in charge of the sociological field interviewing and coding activities and Dr. Philip Cheifetz and Joseph Carlino advised on the statistical analyses. Paula Tito and Jean Blansett actually did most of the statistical computations. Dr. William T. Shepherd is the NASA Technical Officer.

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I. Introduction

There are three basic approaches to reducing community aircraft noise exposures. Modifying the design of the aircraft is usually the most effective method of noise control. The development of acoustically treated, more efficient engines in the new wide bodied 747s, L1011s and DC-10s are examples of this method. A second technique is to optimize the way aircraft are operated in the vicinity of airports to reduce unnecessary noise emissions. Preferential runway use, power cut-backs, turns to avoid populated areas, where safety permits, and restrictions on hours of operation, are some of the practices commonly used to modify aircraft operations. The third basic approach is to zone areas near airports for compatible land use, i.e. to limit residential and other development which require relatively quiet environments in high noise exposure zones.

The Dynamic Preferential Runway System (DPRS) is an example of "operations control". It is an experimental system developed in concept by the FAA Eastern Regional office, and was installed at John F. Kennedy International Airport during the summer of 1971. It has continued to operate on an experimental basis for the past three years.

The system computer hardware and logic were developed and installed by the TRACOR Corporation of Austin, Texas. It was designed to accomplish three goals: (1) to distribute the overflight experience as equitably as possible over the surrounding communities, (2) to break up lengthy periods of continuous community exposure to aircraft overflight (dwell), and (3) to avoid overflights during the same hours from day to day.

The design, installation and operation of the current DPRS is described in the TRACOR final report. 1/

Briefly, the DPRS consists of a small computer system which accepts and stores operations data from the Airport tower, and then uses these data to recommend on the basis of calculated estimates of previous and resulting community impact, preferred runways for takeoff and departure. The DPRS is dynamic in operation, and incorporates such diverse inputs as changes in air traffic demand, weather forecasts, time of day, increased public sensitivity on weekends and holidays, size of exposed populations, and persistence of overflights.

In evaluating the meaningfulness and effectiveness of the DPRS, two principal questions will be answered:

1. How effective is the system in actual practice in distributing air traffic among the populated areas and accomplishing the other operations' goals?

2. How perceptible are these changes in operations to the populations living near the airport and what effect do they have on community annoyance?

II. Research Design

A. Ideal Method - The most efficient scientific technique for evaluating the effects of a change in operations, such as the DPRS, is to conduct a "before and after" study. Before the change is instituted, a survey is conducted to measure all the basic acoustic and human response parameters. Then, using identical instruments and procedures, a subsequent study determines the results after the changes are made. Inferences can then be made as to the effects of the experimental changes between the two surveys. Unfortunately, no thorough base line study was made before the DPRS was introduced, so this ideal procedure is not possible.

B. Retrospective Questions - One evaluation technique is to use retrospective questions about the DPRS. As part of its on-going field-laboratory research program, 2/ Columbia University interviewed residents in the spring and fall of 1972 as part of a screening process 3/, to select subjects for its controlled laboratory studies. In the August interviews, a number of questions were added concerning the possible awareness of the residents of the DPRS program and any reactions to it. Towards the end of an hour-long interview, after a series of responses had been recorded about the general environment, perceived local noises and aircraft noise in particular, all persons were asked a number of questions about awareness and reactions to DPRS. The first questions was "As far as you know, during the past year or so, did the aviation people make any changes in the way airplanes fly by here?" If the answer was, "No" or "Don't know", no further direct questions were asked. If the answer was "Yes", then three sub-questions were asked:

1. What changes did they make?
2. Using the "how much scale", could you tell me how much the changes reduced your annoyance with the airplanes?
3. And how much do you feel the aviation people are doing to reduce the noise?

C. Limited Statistical Analyses of Reported Changes in Annoyance between 1969 and 1972 - In 1969 TRACOR, an independent research organization, conducted a survey among a selected number of communities in the vicinity of JFK airport. Some of the questions asked about noise in general and aircraft noise in particular were similar but not identical to those used by Columbia University. This poses a technical problem of comparability of answers, and, as will be described in Appendix A, adjustments were made in the Columbia University responses to make them as comparable as possible to the TRACOR questions. It should be noted, however, that interpretations of statistical comparisons which are made between results of the two studies are limited by the fact that this is not a true "before and after" study, using identical survey measures and procedures. The findings, however, are the best available and tend to be consistent with the direct retrospective questions included above.

III. Findings

A. Effects of DPRS on Noise Exposure - Five measures of noise exposure will be used to evaluate changes between 1969 and 1972 for the eleven communities studied in 1972. (L) Composite Noise Rating (CNR), (2) Number of hours of overflight, (3) Dwell periods of continuous overflight, (4) Average number of hours per dwell, and (5), Number of same hours of dwell within 48 hours.

In general, the DPRS was moderately successful in all three of its program goals: (1) Traffic was more evenly distributed among the areas, with moderate reductions in hours of exposure at Bergen Beach and Howard Beach, the most heavily impacted areas, (2) It reduced the average continuous overflight to about 8 hours or less in all but two of the 11 areas studied. In these two areas, the 1972 average hourly exposure was substantially less than 1969, and (3) The traffic flow was varied to some extent from day to day and for all 11 areas about one-fourth fewer hours of overflight were the same within a 48-hour period.

1. Composite Noise Rating - (CNR) - The CNR computation procedure uses the maximum values of Perceived Noise Level (PNL) for aircraft operations, computed from noise band levels. Repetitive operations are summed on an energy basis (10 log n), and night operations are assigned a value 13dB units higher than day operations.

The CNR for a single class of operation j, defined as those fly-overs which produce a particular noise characteristic at the point in question, is:

$$CNR_j = PNL_j + 10 \log (N_{D_j} + 20N_{N_j}) - 12,$$

where N_{D_j} and N_{N_j} are the number of occurrences during day and night, respectively.

The total exposure at the site results from the operation of various types of aircraft on different flight paths, given by the energy sum of the CNR_j:

$$CNR = 10 \log \sum_j \text{antilog} (CNR_j/10).$$

As Table 1 indicates, the general decline in CNR levels between 1969 and 1972 reflects the combined effects of a drop in air traffic, increased use of quieter 747s and other wide-bodied jets, and the operation of the DPRS. Inwood, Howard Beach, Lawrence, Bergen Beach and Long Beach experienced the biggest declines. Most of the other areas had much smaller changes.

2. Number of Hours of Overflight - This measure is the sum of the hours of overflight that occurs over an area during a period regardless of continuity of exposure. If at least 15% of the arrivals or departures during any hour are using a particular runway, then the areas under the approach or departure paths of that runway are defined as having overflights. This measure of aircraft activity ignores continuous duration, which is reflected in the concept dwell periods. The 15% criterion is used to distinguish between normal, regular runway utilization and special situations where a runway is sometimes utilized only a few times an hour.

Table 2 indicates that the Bergen Beach - Howard Beach flight path still bears the brunt of all air traffic, due to prevailing westerly winds during the summer months. The Howard Beach area reflects primarily departures, while the Bergen Beach area receives both arrivals and departures. The DPRS, however, appears to have redistributed a substantial amount of the air traffic to other areas in 1972. While the average number of hours of overflight over all 11 areas increased from 1969 to 1972, the standard deviation (σ) among the areas decreased about a third, reflecting in part the success of the DPRS in reducing extreme variations in traffic among the different areas.

TABLE 1

COMPARISON OF COMPOSITE NOISE RATINGS (CNR)

1969 - 1972

Area	June-July			Aug. -Sept.		
	1969	1972	Reduction	1969	1972	Reduction
A. Close (1.1 miles)						
Rosedale South	135.7	135.1	0.6	134.1	133.9	0.2
Meadowmere	138.1	136.1	2.0	138.9	137.0	1.9
Inwood	132.6	127.6	5.0	131.7	126.6	5.1
Howard Beach	140.2	136.0	4.2	136.6	135.6	1.0
B. Middle (2.5 miles)						
Rosedale North	125.9	125.3	0.6	124.3	124.0	0.3
Cedarhurst-Woodmere	128.3	125.9	2.4	128.6	127.0	1.6
Lawrence	124.4	119.3	5.1	123.3	118.4	4.9
C. Distant (5.2 miles)						
Bergen Beach	123.0	118.9	4.1	132.4	118.4	14.0
S. Floral Park	114.4	113.6	0.8	112.7	112.3	0.4
Island Park	115.9	114.2	1.7	117.0	115.2	1.8
Long Beach	115.2	110.1	5.1	113.1	109.2	3.9

3. Dwell Periods - A dwell period is defined as a period of continuous overflight of aircraft over a community without at least a three-hour interruption or respite period. After three or more hours of respite, if planes again fly over the area, a new dwell period begins. As Table 2 shows, the DPRS was also moderately successful in distributing the number of dwells among all distance areas. Although traffic, as measured by dwell periods, is generally most frequent over Inwood, Lawrence and Long Beach, the other areas in 1972 received relatively more exposure than in 1969. The overall mean number of June-July dwell periods for all 11 areas studied increased slightly from 65.4 to 67.5 from 1969 to 1972. The standard deviation which measures variations among the 11 areas, however, dropped about a third from 20.7 to 13.6. In the August-September period, the drop in the standard deviation was only about a fourth from 19.6 to 14.5 Constraints of heavy traffic and prevailing winds limit a more even distribution of air traffic.

4. Average Number of Hours per Dwell - Another measure of noise exposure is a combination of the concepts of dwell and hours of exposure. It is the average duration of exposure during a typical dwell period. As Table 4 indicates, with two exceptions, Howard Beach and Bergen Beach, the DPRS managed to hold the average duration per dwell to about eight hours or less. Over the entire summer of 1972, Howard Beach had an average dwell of almost 11 hours, while Bergen Beach experienced an average duration of over 12.5 hours. However, in 1969, without DPRS, these areas had longer average hourly dwells of 13 hours at Howard Beach and 33.5 hours at Bergen Beach, almost three times greater than the 1972 average dwell. These reductions in average hourly dwells were accomplished by DPRS by increasing the dwells over the other areas, thus equalizing exposure.

5. Number of same hours of Dwell within the Preceding 48-hour period - The DPRS is programmed to vary the day to day time periods in which overflights occur over the same area. The assumation is by varying the time periods of exposure, the same activities of a group of residents would not always be affected by the noise exposure and thus, annoyance might be reduced. This measure of the number of hours of dwell which are the same as those in the preceding 48 hours is an indication of failure of one of the DPRS objectives. Table 5 presents these data and, as expected, Howard Beach and Bergen Beach have the largest number of identical hours of overflight. In 1972, however, the number at Bergen Beach was about half the 1969 experience and about 40% less at Howard Beach.

Another measure of success or failure of this objective is presented in Table 6, "Percent of Total Hours of Overflight, which were the same within 48 hours." For the entire summer, all 11 areas in 1972 had one-fourth less exposure of the same hours during a 48-hour period. In the close areas, the reduction was about a fifth, from 61% in 1969 to 48% in 1972. In the middle distance areas, the reduction was only 15%, while in the distant areas the drop was about one-third. It should be noted that Bergen Beach and Howard Beach were also the greatest beneficiaries of this program. In 1969, 90% of the hours of exposure were the same at Bergen Beach, while only 60% were the same in 1972. At Howard Beach, 82% were the same hours in 1969 compared to 56% in 1972. Thus, it can be concluded that DPRS made a substantial improvement in the worst impacted areas.

B. Retrospective Questions - Relatively few residents were aware of the initiation of the new DPRS operations program or even of any general changes in aircraft operations. Consequently, only a very small minority, less than 10%, felt that operations changes were really important, and that their annoyance had been substantially reduced.

TABLE 2

COMPARISON OF NUMBER OF HOURS OF OVERFLIGHT

1969-1972

Area	June - July 1969	June - July 1972	Changes	Aug. - Sept. 1969	Aug. - Sept. 1972	Changes
A. Close (1.1 miles)						
Rosedale South	282	440	+158	216	327	+111
Meadowmere	322	618	+296	489	724	+235
Inwood	390	378	- 12	283	409	+126
Howard Beach	817	773	- 44	952	802	- 50
B. Middle (2.5 miles)						
Rosedale North	282	440	+158	216	327	+111
Cedarhurst-Woodmere	299	411	+112	478	516	+ 38
Lawrence	297	280	- 17	261	275	+ 14
C. Distant (5.2 miles)						
Bergen Beach	1197	912	-285	1217	858	-359
S. Floral Park	282	440	+158	216	327	+111
Island Park	299	411	+112	478	516	+ 38
Long Beach	297	280	- 17	261	275	+ 14
D. Total $\bar{X}$	433	489	+ 56	461	487	+ 26
σ	298	199	- 99	333	216	-117

TABLE 3

COMPARISON OF DWELL PERIODS

1969-1972

Area	June - July 1969	June - July 1972	Changes	Aug. - Sept. 1969	Aug. - Sept. 1972	Changes
A. Close (1.1 miles)						
Rosedale South	57	59	+ 2	39	45	+ 6
Meadowmere	59	84	+ 25	76	79	+ 3
Inwood	106	95	- 11	91	85	- 6
Howard Beach	84	70	- 14	67	78	+ 11
B. Middle (2.5 miles)						
Rosedale North	57	59	+ 2	39	45	+ 6
Cedarhurst-Woodmere	48	51	+ 3	69	61	- 5
Lawrence	83	72	- 11	79	69	- 10
C. Distant (5.2 miles)						
Bergen Beach	37	70	+ 33	39	73	+ 34
S. Floral Park	57	59	+ 2	39	45	+ 6
Island Park	48	51	+ 3	69	61	- 8
Long Beach	83	72	- 11	79	69	- 10
Total $\bar{X}$	65	67	+ 2	62	64	+ 2
σ	21	14	- 7	20	15	- 5

TABLE 4

AVERAGE NUMBER OF HOURS PER DWELL

1969 - 1972

Area	June - July				Aug. - Sept.				June - Sept.			
	1969		1972		1969		1972		1969		1972	
A. Close (1.1 miles)	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Rosedale South	5.38	8.38	7.53	5.76	6.0	7.28	7.27	4.26	5.64	7.92	7.41	5.19
Meadowmere	5.91	7.80	7.36	6.34	6.78	7.62	9.16	8.25	6.41	7.69	8.23	7.41
Inwood	4.09	3.24	3.98	3.22	3.64	3.21	4.81	3.78	3.89	3.23	4.37	3.53
Howard Beach	10.97	14.35	11.04	11.22	16.05	26.27	10.28	10.58	13.23	20.60	10.58	10.92
B. Middle (2.5 miles)												
Rosedale North	5.38	8.38	7.53	5.76	6.0	7.28	7.27	4.26	5.64	7.92	7.41	5.19
Cedarhurst-Woodmere	6.64	8.45	8.06	6.84	7.26	7.74	8.46	6.34	7.01	8.01	8.28	6.61
Lawrence	3.96	2.91	3.89	3.36	3.87	3.01	3.99	3.58	3.92	2.95	3.94	3.48
C. Distant (5.2 miles)												
Bergen Beach	34.35	41.61	13.03	12.21	32.76	46.21	11.75	10.69	33.54	43.75	12.38	11.52
S. Floral Park	5.38	8.38	7.53	5.76	6.0	7.28	7.27	4.26	5.64	7.92	7.41	5.19
Island Park	6.64	8.45	8.06	6.84	7.26	7.74	8.46	6.34	7.01	8.01	8.28	6.61
Long Beach	3.96	2.91	3.89	3.36	3.87	3.01	3.99	3.58	3.92	2.95	3.94	3.48

TABLE 5

NUMBER OF SAME HOURS OF DWELL WITHIN 48 HOURS

1969 - 1972

Area	June - July 1969	June - July 1972	Change	Aug. - Sept. 1969	Aug. - Sept. 1972	Change
A. Close (1.1 miles)						
Rosedale South	105	157	+ 52	56	135	+ 79
Meadowmere	120	297	+177	222	391	+169
Inwood	190	121	- 69	138	158	+ 20
Howard Beach	626	434	-192	820	454	-366
B. Middle (2.5 miles)						
Rosedale North	105	157	+ 52	56	135	+ 79
Cedarhurst-Woodmere	97	167	+ 70	214	200	- 14
Lawrence	146	74	- 72	135	55	- 70
C. Distant (5.2 miles)						
Bergen Beach	1058	562	-496	1109	505	-604
S. Floral Park	105	157	+ 52	56	135	+ 79
Island Park	97	167	+ 70	214	200	- 14
Long Beach	146	74	- 72	135	55	- 80

TABLE 6

PERCENT OF TOTAL HOURS OF OVERFLIGHT WHICH WERE THE SAME WITHIN 48 HOURS

1969 - 1972

Area	June - July 1969	June - July 1972	Aug.-Sept. 1969	Aug.-Sept. 1972	Total June-Sept. 1969	Total June-Sept. 1972
A. Close (1.1 miles)						
Rosedale South	37%	36%	26%	41%	32%	38%
Meadowmere	37	48	45	54	42	51
Inwood	49	32	49	39	49	35
Howard Beach	77	56	86	57	82	56
Total	57%	46%	64%	50%	61%	48%
B. Middle (2.5 miles						
Rosedale North	37%	36%	26%	41%	32%	38%
Cedarhurst-Woodmere	32	41	45	39	40	40
Lawrence	49	26	52	20	50	23
Total	40%	35%	42%	35%	41%	35%
C. Distant (5.2 miles)						
Bergen Beach	88%	62%	91%	59%	90%	60%
S. Floral Park	37	36	26	41	32	38
Island Park	32	41	45	39	40	40
Long Beach	49	26	52	20	50	23
Total	68%	47%	70%	45%	69%	46%
GRAND TOTAL	59%	44%	62%	45%	61%	45%

As Table 7 indicates, less than one out of five respondents said, "yes" to the general question, "As far as you know, during the past year or so, did the aviation people make any changes in the way airplanes fly by here?" Awareness of the DPRS program was not even closely related to the intensity of noise exposure, or closeness of the community to the airport. About 19% of all residents in the close areas (1.1 miles from airport) said they knew of a change, compared to 24% of the residents in distant (5.2 miles) and 17% of the Westbury residents who live 12 miles from the airport on the approach flight path to JFK. Aircraft over Westbury are usually at least at 3000 ft. altitude and fairly quiet. Consequently, Westbury is used as a control area, representative of minimal aircraft exposure.

When the 292 residents who said they felt there had been changes in operations were asked, "What changes did they make?", Most volunteered some type of change in aircraft operations. However, in terms of all residents, since about 80% knew of no changes at all, only 7-20% reported any "changes in operations". Only about 5% appeared to know about the overall DPRS plan and spoke of re-routing of planes; the rest merely observed there were changes in the "number of planes", "type of operation" or "noisiness of planes" flying overhead. Table 8 presents these findings.

The impact of the perceived changes was probed by the following question which was asked the 292 residents who had said there had been changes. "Using the 'how much' scale, could you tell me how much the changes reduced your annoyance with the airplanes?" Table 9, which presents the answers to this question, indicates that most residents reported very little reduction in annoyance. Only 5% of the close residents and 9% of the distant residents felt their annoyance had been reduced by substantial amounts (scores of 3 or 4).

The last retrospective question asked of those who perceived a change in operation was, "And how much do you feel the aviation people are doing to reduce the noise?" The answers which are presented in Table 10, indicate that only about 2-3% of close or middle distance residents felt that a substantial effort is being made (scores 3 or 4), compared to only 6-7% of the less impacted distant and control area residents.

C. <u>Statistical Analyses of Annoyance Responses</u> -

1. <u>Problems of Comparability of Data</u> - As indicated in the introduction, there are no identical human response data for the period prior to DPRS and after its introduction. TRACOR conducted about 1000 interviews in four communities near JFK in 1969. Columbia University questioned almost 1300 different residents in 1972 living in 11 different areas under comparable CNR noise exposure conditions. Different questions, and different measures of response were obtained in the two studies. In order to make some judgement about possible changes in annoyance from 1969 to 1972, the Columbia scales of response were modified, as described in Appendix A, to make them as nearly comparable as possible to the TRACOR data. In all past social surveys of community response to aircraft noise, three of the most important independent variables related to annoyance responses were:

a. a measure of physical exposure such as CNR,
b. attitudes of fear of aircraft crashes, and
c. attitudes of misfeasance by the aviation people

By controlling for these primary variables in 1969 and 1972, changes in the dependent annoyance responses may be judged. It should be noted that when respondents

TABLE 7

REPORTED BELIEF THAT AVIATION PEOPLE MADE CHANGES IN AIRCRAFT OPERATIONS DURING THE PAST YEAR OR SO

Belief	TYPE OF AREA				
	Close	Middle	Distant	Control	Total
	N=508	N=326	N=482	N=259	1575
Made Changes	19%	11%	24%	17%	18%
Not Made Changes	65	75	54	64	64
Don't Know	16	14	22	19	18

TABLE 8

REPORTED KINDS OF CHANGES MADE BY AVIATION PEOPLE

Types of Changes	TYPE OF AREA				
	Close	Middle	Distant	Control	Total
	N=508	N=326	N=482	N=259	N=1575
No Changes Observed	81%	89%	76%	83%	82%
A. Operations					
Some Operations Change	14	7	20	14	14
Re-routed planes	4	1	5	4	3
More flyovers	3	1	3	6	3
Fewer flyovers	7	5	12	4	8
No mention operations	5	4	4	3	4
B. Noise of Planes	5%	3%	5%	4%	4%
Engines noisier	1	2	1	1	1
Engines quieter	4	1	4	3	3
C. Type Operation	2%	1%	1%	*	1%
Take-off and land Used to land only	1	*	0	0	*
Take-off and land Used to take-off only	1	1	1	*	1

* Less 1% response

TABLE 9

REPORTED CHANGES IN ANNOYANCE RESULTING FROM PERCEIVED CHANGES IN AIRCRAFT OPERATIONS

	TYPE OF AREA				
	Close	Middle	Distant	Control	Total
No Change Observed in Operations	N=508 81%	N=326 89%	N=482 76%	N=259 83%	N=1575 82%
Amount of Annoyance Change					
Very Much....4	2	1	3	2	2
3	3	*	6	1	3
2	6	3	5	5	5
1	3	2	4	1	2
Not at all....0	5	5	6	8	6

TABLE 10

REPORTED EFFORT BY AVIATION PEOPLE TO REDUCE NOISE

	TYPE OF AREA				
	Close	Middle	Distant	Control	Total
No Changes Observed in Operations	N=508 81%	N=326 89%	N=482 76%	N=259 83%	N=1575 82%
Amount of Effort					
Very Much....4	1	1	3	3	2
3	2	1	4	3	2
2	5	2	6	6	5
1	6	3	5	2	4
Not at All... 0	5	4	6	3	5

are grouped into these three key independent variables, there are often very few cases (less than 10) available for analysis.

Two types of statistical tests of significance are used in these analyses of differences in annoyance. Chi-square tests are used to judge differences in the distributions of high, medium and low annoyance responses. T-tests of possible differences in average annoyance responses are also used. In order to calculate average annoyance responses, it was necessary to introduce some arbitrary weights to the different annoyance classes of response. Since the TRACOR data did not provide actual scale scores for individual respondents, but only included low, medium and high annoyance classifications of respondents, it was necessary to assign the following arbitrary numerical values to these discrete scale classifications; -1 for low annoyance, 0 for medium and +1 for high annoyance. In view of all of the departures from ideal statistical procedures, interpretations of t-tests of differences between means must be made with caution.

2. Reported Feelings of Fear and Misfeasance - For comparable levels of noise exposure as measured by CNR, both intensity of fear and feelings of misfeasance were substantially lower in 1972 compared to 1969. In light of the problems of comparability between the TRACOR and Columbia data, however, it is difficult to assess the meaningfulness of these findings which are shown in Table 11.

There appears to have been some limited reduction in annoyance from 1969 to 1972, primarily among residents with low and medium fear responses. None of the high fear residents reported statistically significant changes in annoyance in the two periods. The group most consistent in reporting changes were residents with the combination of medium-fear - medium misfeasance attitudes. Most of the changes in annoyance were shifts from High annoyance to Medium annoyance responses. Since the annoyance scales are not identical in 1969 and 1972, these findings must be accepted as indications of change that require more precise verification.

Chi-square tests indicate that annoyance responses for the close and distant area low fear residents were different in 1972, at the p =.01 level of significance. The changes for the middle distance low fear residents were at the p. 05 level of significance. Inspection of Table 12 reveals that the shifts in annoyance between 1972 and 1969 were primarily from high fear to medium fear responses. T-tests of differences between annoyance means indicate that only the close (CNR125+) low fear residents reported a significant drop in average annoyance (p =.01).

Residents in all distance areas with reported medium fear responses had different annoyance distributions in 1972. Chi-square tests reveal statistically significant differences at the p =.01 level. Table 12 indicates that shifts in annoyance were from the extremes (low and high) towards the middle annoyance category. T-tests of average annoyance responses for these medium fear respondents indicate that only the closest residents reported significant differences at the p =.01 level.

3. Reported Annoyance by CNR, Fear and Misfeasance - Table 13 presents Annoyance by CNR, Fear and Misfeasance groups. T-tests of statistical significance were calculated for average annoyance for each comparable group of residents, and the low fear group showed the most changes from 1969 to 1972. The low fear,

TABLE 11

REPORTED FEELINGS OF FEAR AND MISFEASANCE BY CNR

1969 AND 1972

CNR	TRACOR - 1969 109-114.9	TRACOR - 1969 115-124.9	TRACOR - 1969 125+	Columbia - June-July 1972 109.114.9	Columbia - June-July 1972 115-124.9	Columbia - June-July 1972 125+
N=	219	341	198	336	172	749
Low Fear	28%	16%	9%	36%	18%	10%
Medium Fear	25	26	19	41	42	27
High Fear	47	58	72	23	40	63
Low Misfeasance	24%	25	17	13	11	11
Medium Misfeasance	33	37	33	66	75	62
High Misfeasance	43	38	50	21	14	27

TABLE 12

REPORTED ANNOYANCE BY CNR AND FEAR

1969 - 1972

CNR	TRACOR 1969 109-114.9	TRACOR 1969 115-124.9	TRACOR 1969 125+	Columbia 1972 109-114.9	Columbia 1972 115-124.9	Columbia 1972 125+
Low Fear	N=61	N=55	N=17	N=120	N=31	N=75
Low Annoyance	25%	24%	18%	19%	26%	12%
Med. Annoyance	36	40	23	66	64	75
High Annoyance	39	36	59	15	10	13
Med. Fear	N=54	N=90	N=38	N=139	N=73	N=203
Low Annoyance	17%	15%	8%	2%	3%	2%
Med. Annoyance	31	33	8	61	68	46
High Annoyance	52	52	84	37	29	52
High Fear	N=104	N=196	N=143	N=77	N=68	N=471
Low Annoyance	2	4	1	1	1	1
Med. Annoyance	12	13	8	20	24	12
High Annoyance	86	83	91	79	75	87

TABLE 13

REPORTED ANNOYANCE BY CNR, FEAR & MISFEASANCE

1969 - 1972

CNR			TRACOR 1969			Columbia 1972		
			109-114.9	115-124.9	125+	109-114.9	115-124.9	125+
Fear	**Misfeasance**	**Annoyance**	N=23	N=20	N=5	N=26	N=7	N=18
Low	Low	Low	39%	30%	60%	38%	71%	28%
		Medium	30	45	20	58	29	72
		High	31	25	20	4	0	0
	Medium		N=15	N=22	N=7	N=81	N=22	N=47
		Low	33%	27%	0%	14%	14%	6%
		Medium	33	32	29	73	73	77
		High	34	41	71	13	13	17
	High		N=23	N=13	N=5	N=13	N=2	N=10
		Low	4%	8%	0%	15%	0%	0%
		Medium	44	46	20	39	100	70
		High	52	46	80	46	0	20
Medium	Low		N=16	N=29	N=9	N=13	N=9	N=29
		Low	19%	28%	22%	0%	0%	10%
		Medium	50	31	22	85	89	52
		High	31	41	56	15	11	38
	Medium		N=21	N=33	N=9	N=96	N=59	N=147
		Low	14%	9%	0%	1%	3%	0%
		Medium	24	30	0	59	65	48
		High	62	61	100	40	32	52
	High		N=17	N=28	N=20	N=30	N=5	N=27
		Low	18%	7%	5%	3%	0%	0%
		Medium	23	39	5	57	80	30
		High	59	54	90	40	20	70
High	Low		N=13	N=37	N=19	N=5	N=3	N=33
		Low	8%	13%	0%	0%	0%	0%
		Medium	31	22	16	60	33	21
		High	61	65	84	40	67	79
	Medium		N=37	N=72	N=49	N=44	N=48	N=268
		Low	3%	3%	2%	2%	2%	1%
		Medium	11	14	8	14	29	14
		High	86	83	90	84	69	85
	High		N=54	N=87	N=75	N=28	N=17	N=170
		Low	0%	0%	0%	0%	0%	0%
		Medium	7	9	7	21	6	8
		High	93	91	93	79	94	92

medium and high misfeasance groups in the closest CNR 125+ areas reported significantly less annoyance (p =.05) in 1972 compared to 1969. The low fear, low misfeasance residents in the CNR exposure areas of 115-124.9 also showed less annoyance in 1972 (p =.05). None of the high fear respondents reported any significant changes in annoyance and only the medium fear-medium misfeasance group in the closest CNR125+ areas expressed less average annoyance in 1972 (p =.01).

Chi-square tests of the annoyance response distributions indicate the following statistically significant changes:

1. For low fear-low misfeasance respondents, the close and distant residents report significant shifts from low and high annoyance to mostly medium annoyance (p =.05). Responses for the middle distance residents were not different.

2. For low fear-medium misfeasance respondents, all distance groups reported statistically significant changes in annoyance, with patterns similar to those cited above, less high and low annoyance and increases in medium annoyance. Chi-square tests indicated the differences in annoyance of the close respondents was at p =.01 level of significance while the differences for the middle and distant residents was at the p =.05 level.

3. For the low fear-high misfeasance classification of respondents, only the distant residents reported significantly lower annoyance at the p.01 level of significance.

4. For the medium fear respondents, only the medium misfeasance group reported consistently different annoyance responses in all distance groups. The close residents' responses were significantly different at the p =.05 level, while the other distance groups were significantly different at the p =.01 level.

5. For the medium fear-low misfeasance group, only the middle distance residents reported significant annoyance changes at the p =.01 level.

6. For the medium fear-high misfeasance group of respondents, only the most distant residents reported significant shifts in annoyance at the p =.05 level.

7. None of the nine high fear, CNR exposure and misfeasance groups of respondents reported significantly different annoyance responses from 1969 to 1972.

APPENDIX A

PROBLEMS IN COMPARABILITY OF TRACOR AND COLUMBIA UNIVERSITY DATA

1. Composite Noise Rating - CNR. This measure of noise exposure has already been described and the procedures used to calculate the 1969 and 1972 levels are almost identical.

2. Fear - This is defined as a belief that aircraft flying overhead pose a threat to one's safety. The noise connotes an approaching plane and fear is the belief that it may crash into the place where the person is located. In both the TRACOR and Columbia University studies, the Likert summated ratings technique [4/] is used to measure the intensity of a human response. In this process, the separate scores for response categories of a set of questions, all representing a particular dimension or attribute, are summed to form a composite rating. By using a set of questions rather than a single question, greater reliability in the measurement of the dimension or attribute is usually obtained.

In the TRACOR study the following two questions were used to form a scale of fear response.

Question 14. "When you see or hear airplanes overhead, how often do you feel they are flying too low for the safety of residents in the area? (0 = Never, 4 = Very often, possible scores 0-4).

Question 15. "When you see or hear airplanes overhead, how often do you feel there is some danger that they might crash nearby? (o = Never, 4 = Very often; possible scores 0-4).

In the Columbia University study, four questions were used to form a fear scale. With a high coefficient of reliability (Alpha) of .84. The first two questions are new; the last two are very similar to TRACOR's questions:

Question 5B, Item 8. Respondents were asked how much they disliked twelve aspects that apply to living conditions in their community. Each respondent referred to an "opinion thermometer" on which "0" corresponded to "none" and "4" corresponded to "Very Much". In Question 5B, Item 8, respondents rated the dislike of ....

Unsafe low - flying airplanes............

Question 22D. How much does the noise from (item) startle or frighten you? The question was asked for various (5) noise sources. The response to airplane noise was used in the fear scale. Again the response choices ranged from "0" (not at all) to "4" (very much).

Question 27. When you see or hear airplanes fly by, how often do you feel they are flying too low for the safety of the residents around here? Response choices were "0" (not at all) to "4" (very often).

Question 28. And how often do you feel there is some danger that they might crash nearby? Response choices were "0" (not at all) to "4" (very often).

Each respondent's fear score was obtained by summing the responses to each of the four fear items. Since possible responses for each item were 0, 1, 2, 3, 4, the range of fear scores was 0-16.

The TRACOR study had a range in fear scores of 0-8 and divided them so that Low fear was defined as having a score of 0-1 (12%), medium fear 2-4 (25-50%), and high fear 5-8 (62-100%). With four items, the Columbia range in fear scores was 0-16. The three fear categories were made comparable to TRACOR, by establishing the Columbia scale intervals at the extremes equal to the TRACOR distribution as shown below:

	TRACOR Fear Scale		Columbia Fear Scale	
Category	Scale Scores	%	Scale Scores	%
Low	0-1	0-12	0-2	0-12
Medium	2-4	25-50	3-9	19-56
High	5-8	62-100	10-16	62-100

3. Misfeasance - This is defined as the respondent's belief that various agents connected with the propogation of aircraft noise are capable of reducing the noise, but for some insignificant reasons are not doing so. In the TRACOR study, respondents were asked four true-fale questions: Each "yes" was scored "1", and each "No" scored "5".

Q. 42 - Aircraft designers are doing all they can to produce quieter engines.

Q. 45 - Community leaders are doing all they can possibly do to reduce aircraft noise in this city.

Q. 43 - The airport is operated in such a way as to serve the best interests of the entire city.

Q. 46 - Airport authorities are doing all they can possibly do to reduce aircraft noise.

Columbia University used a six item scale with a coefficient of reliability (alpha) of .76. Each item had a response range of 0-4, so the total scores ranged from 0-24. On Question 36, respondents were asked, "Would you say any of these people are in a position to do anything about the aircraft noise around here?

a. The people who run the airlines........
b. The airport officials.................
c. The other government officials.........
d. The pilots............................
e. The designers and makers of airplanes..
f. The community leaders.................

For each "yes" response, a sub-question was asked, "How much do you feel they are actually doing to reduce the noise?, with 0 meaning nothing at all and 4 meaning very much. In calculating the misfeasance score, the order of response is reversed, i.e. 0=4, very misfeasant; 4=0, not misfeasant at all. Achieving comparability between TRACOR and Columbia on this attitude variable is very difficult.

Fortunately, "fear" which is by far more highly correlated to annoyance than misfeasance is also more comparable in the two years. Consequently, less emphasis is placed on the misfeasance variable in these anlyses. The following adjustments in misfeasance scales were made:

	TRACOR Misfeasance Scale		COLUMBIA Misfeasance Scale	
Category	Scale Scores	%	Scale Scores	%
Low	1-4	5-20	0-1	0-4
Medium	5-14	25-70	2-15	8-63
High	15-20	75-1000	16-24	67-100

4. Annoyance - TRACOR used a 9-item scale, while Columbia used an 11-item scale. The coefficient alpha, or measure of reliability for the Columbia scale was .91.

TRACOR asked the following question (25a): I will now read a number of daily activities. Which of these are disturbed by aircraft noise in your own situation here?

1. Eating
2. Sleeping
3. Reading/Concentrating
4. Listening to Records/Tapes
5. Telephone Conversation
6. Relaxing Inside
7. Relaxing Outside
8. Face-to-Face Conversation
9. TV/Radio Reception

Respondents who were disturbed were asked: "How much are you bothered? (0 = none; 4 = very much). Those who were not disturbed at all were assigned a score of "0". Thus, the range in annoyance scores was 0-36.

Columbia University Q.24 was as follows:

"Can you tell me if the noise from airplanes ever (ask each item below)(Do they ever.....)

1. Interfere with your listening to radio or TV?........
2. Make the TV picture flicker?........................
3. Startle or frighten anyone in your family?...........
4. Disturb your family's sleep?........................
5. Make your house rattle or shake?....................
6. Interfere with family's rest or relaxation?..........
7. Interfere with conversation?........................
8. Make you keep your windows shut during the day?......
9. Make you keep your windows shut at night?...........
10. Make you feel tense and edgy?.......................
11. Give you a headache?................................

For each "yes", a subquestion was asked, "And how disturbed or annoyed does this make you feel? (0 = none, 4 = very much).

The comparable TRACOR and Columbia annoyance scale categories are as follows:

	TRACOR Annoyance Scale		Columbia Annoyance Scale	
Category	Scale Scores	%	Scale Scores	%
Low	0	0	0	0
Medium	1-11	3-30	1-15	2-34
High	12-36	33-100	16-44	36-100

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