GENERAL AVIATION TECHNOLOGY ASSESSMENT

Technical Report
National Aeronautics and Space Administration
Grant No. NGR 47-005-202

Technical Report 403905
Short-Haul Air Transportation Program

Submitted by:

Ira D. Jacobson

SCHOOL OF ENGINEERING AND APPLIED SCIENCE

RESEARCH LABORATORIES FOR THE ENGINEERING SCIENCES

UNIVERSITY OF VIRGINIA

CHARLOTTESVILLE, VIRGINIA 22901

Report No. ESS-4039-103-75

October 1975

RESEARCH LABORATORIES FOR THE ENGINEERING SCIENCES

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For information on current programs and capabilities, write to Director, Research Laboratories for the Engineering Sciences, Thornton Hall, University of Virginia, Charlottesville, Virginia 22901.

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GENERAL AVIATION TECHNOLOGY ASSESSMENT

Introduction

The objective of this study was to investigate the existing problem areas in general aviation in order to identify those which can benefit from technological payoffs. The emphasis is placed on acceptance by the pilot/passenger in areas such as performance, safety, handling qualities, ride quality, etc. Inputs were obtained from three sectors: industry; government; and user, although the study was slanted toward the user group. The results of this study, presented here, should only be considered preliminary due to the small sample sizes of the data. Trends are evident however and a general methodology for allocating effort in future programs is proposed.

Objectives

The objectives of the study are shown in Figure 1. These cover the entire spectrum of factors related to general aviation. For this study, as a first iteration of the problem, these objectives are sufficiently specific. However, in later iterations it would be desirable to create more detailed objectives in lower levels of the tree. As can be seen, the overall objective of this study is a subproblem of the more general question of investigating existing problem areas in general aviation.

In order to give some feeling for the complex relationships existing between the various segments of the general aviation system, an interaction matrix was developed (see Figure 2). Furthermore, it is a graphical tool which can be used to point out any interactions which may have been overlooked in the initial analysis. The intensities of the interactions are value judgments based on all available information at the time.

FIGURE 1.

OBJECTIVES TRE

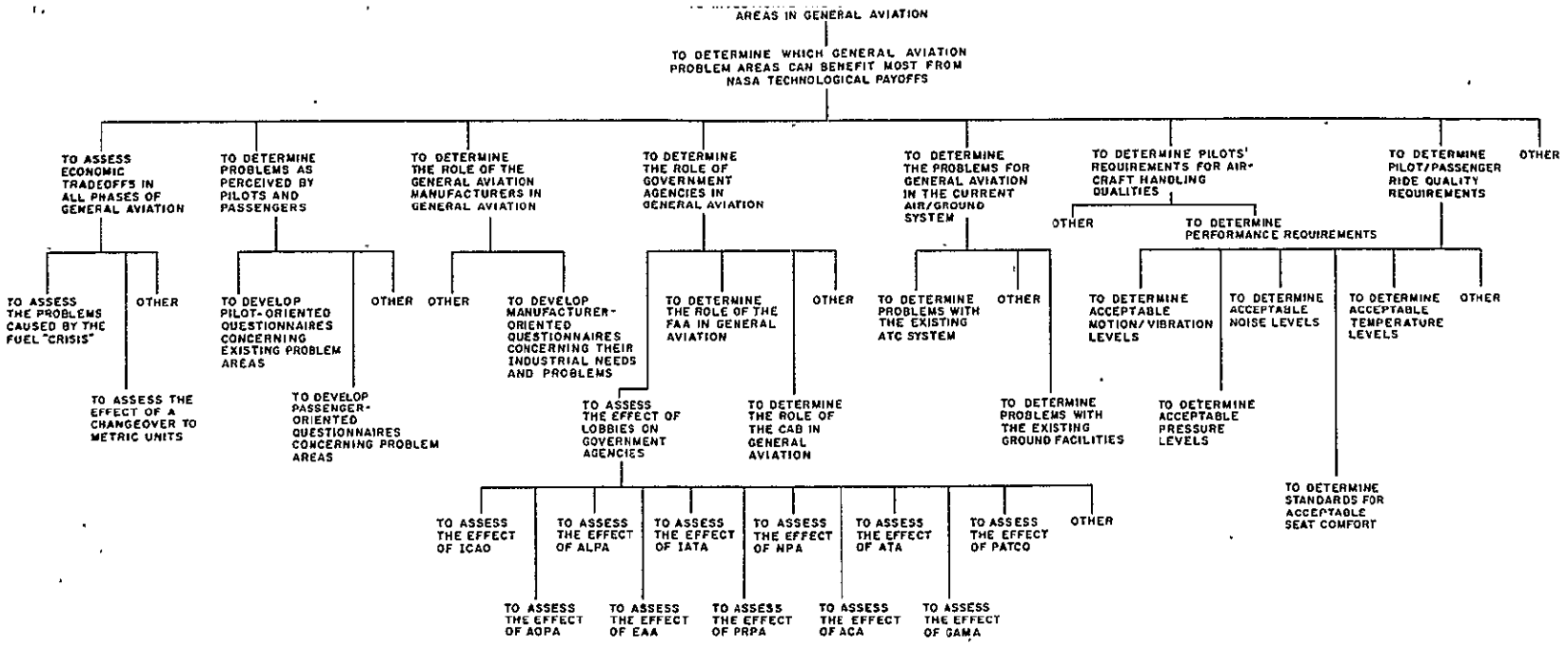
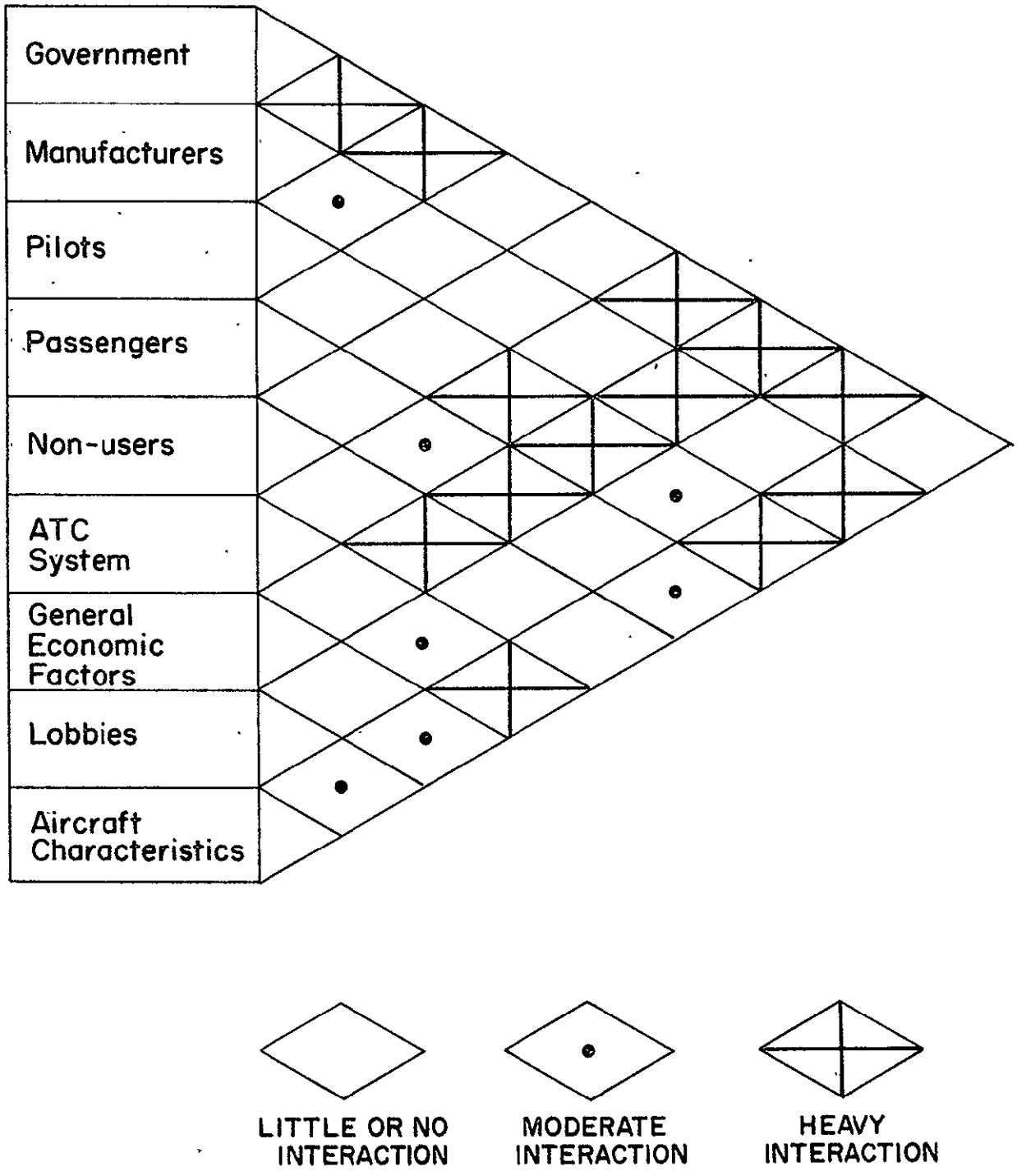


FIGURE 2.

INTERACTION MATRIX



Government/Industry Outlook

In order to obtain the viewpoint of the government and industry sectors, inquiries were made to the government and many special interest groups. A complete record of this correspondence is given in Appendix I. The following is a list of those responding:

AOPA (Aircraft Owners and Pilots Association)
GAMA (General Aviation Manufacturers Association)
Flight Safety Foundation, Inc.
AIA (Aerospace Industries Association of America, Inc.)
The Ninety-Nines, Inc.
EAA (Experimental Aircraft Association)
NPA (National Pilots Association)

DOT (Department of Transportation)
- a. General Aviation Division, Flight Standards Service
- b. Engineering and Development
- c. Information Services

CAB (Civil Aeronautics Board)

U.S. Senators
- Cannon, H. W. (Aviation Subcommittee)
- Goldwater, B. (Aeronautical and Space Sciences Committee)
- Moss, F. E. (Aeronautical and Space Sciences Committee, Chairman)

The correspondence with government officials and special interest groups indicates that there is either very little interest in improving present conditions, or that very few of them feel that they are in a position to provide any input to a study such as this one. The U.S. Senators seemed to be the most knowledgeable and able to make concrete suggestions.

In general, the manufacturer's point of view as expressed by the response from GAMA indicates a general dislike for any research that could lead to new regulations.

The problem areas these groups identified are as follows:

1. Internal noise
2. External noise
3. Control systems that are not automated
4. Aircraft systems which have not been designed with human factors in mind--too many controls, not standardized displays, etc.
5. De-icing and anti-icing systems
6. Stall/spin
7. Proximity warning and collision avoidance systems are insufficient
8. Fuel management
9. Maintenance
10. Engine efficiency/emissions
11. Performance
12. The possible changeover to the metric system
13. The fuel "crisis"
14. Weather information
15. High costs of aircraft
16. Insufficient pilot training
17. Lack of simple and inexpensive pressurization systems
18. High cost of avionics
19. Complexity of the ATC system (air/ground interface)
20. Crash protection
21. Seat comfort/cabin layout
22. Vibrations
23. Certification procedures
24. Possible non-renewal of the Airport and Airway Development Act of 1970
25. Rescue and survival
26. Apparent lack of leadership or representation for pilots and their concerns
27. Complexity and weakness of regulations.

These problem areas fall into one or more of several technologies. These are:

1. Stall/spin prevention
2. Weather information
3. Cockpit displays
4. Aircraft stability augmentors
5. Proximity warning indicators
6. Collision avoidance systems
7. Fully automated control systems
8. Human factors studies to reduce accident rate, including aircraft and ATC
9. Systems design standardization
10. Powerplant reliability and efficiency
11. Noise reduction
12. Ride quality improvements
13. Structural design
14. Standardized and improved regulations
15. Performance improvements
16. Improved crashworthiness
17. Airframe and component de-icers
18. Improved avionics
19. Angle-of-attack indicators
20. Use of plastics to lower aircraft construction costs.

Pilot Outlook

To obtain the opinion of the general aviation pilot, a mail survey was undertaken. The pilots were asked to fill out the questionnaire shown in Figure 3 and encouraged to comment freely. The data has been tabulated in Tables 1 through 9. A total of 140 questionnaires were returned out of 300 mailed. As can be seen, the majority of pilots were highly experienced (i.e., greater than 2000 hours of flight time).

The items that are perceived to be needed, after lower costs, are: (in approximate order of importance, calculated by adding

FIGURE 3.

PILOT QUESTIONNAIRE

This questionnaire is being sent to you as part of a study conducted for NASA by the University of Virginia. The objective of the study is to identify those areas of general aviation where further research is most needed. Your help in this matter may well have an effect on gaining improvements in general aviation technology. While the questions pertain to the entire scope of general aviation, please answer them from the standpoint of your particular flying operations. Your response will be greatly appreciated.

Please check the appropriate box or boxes.

1. What is your total piloting experience?

☐ 200 hours or less ☐ 500-1000 hours ☐ over 2000 hours

☐ 200-500 hours ☐ 1000-2000 hours

2. How many years have you been a pilot?

☐ 2 or less ☐ 5-10 ☐ more than 20

☐ 2-5 ☐ 10-20

3. Approximately how many hours have you flown in the past year?

☐ 50 or less ☐ 100-200 ☐ over 1000

☐ 50-100 ☐ 200-1000

4. What type aircraft do you normally fly?

☐ single engine, fixed gear ☐ multiengine

☐ single engine, retractable gear ☐ jet

5. What pilot certificate do you hold?

☐ Student ☐ Commercial ☐ Military

☐ Private ☐ Airline Transport

6. What other certificates or ratings do you hold?

☐ Flight Instructor ☐ Seaplane ☐ Other_____

☐ Instrument ☐ Helicopter

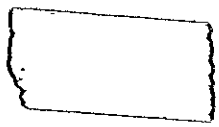
☐ Multiengine ☐ Glider

7. What is your home base?_____

On the following pages, many items are listed concerning general aviation aircraft. We would like to know where you feel the most emphasis should be placed in future research efforts. For each item, please check one box indicating how much emphasis that item should receive. The boxes are numbered from 1 to 5, with 1 meaning very little and 5 meaning very much.

	Very Little				Very Much
8. Performance Considerations	1	2	3	4	5
Greater speed	☐	☐	☐	☐	☐
Greater rate of climb	☐	☐	☐	☐	☐
Higher ceiling	☐	☐	☐	☐	☐
Shorter takeoff distance	☐	☐	☐	☐	☐
Shorter landing distance	☐	☐	☐	☐	☐
More efficient power plant	☐	☐	☐	☐	☐
More load-carrying ability	☐	☐	☐	☐	☐
Greater range	☐	☐	☐	☐	☐
9. Safety Considerations					
Improved stall/spin characteristics	☐	☐	☐	☐	☐
Improved handling qualities	☐	☐	☐	☐	☐
Improved crashworthiness	☐	☐	☐	☐	☐
Improved visibility	☐	☐	☐	☐	☐
More effective procedures to cope with wake turbulence	☐	☐	☐	☐	☐
Improved (and more recent) weather information	☐	☐	☐	☐	☐
Improved air traffic control systems	☐	☐	☐	☐	☐

	Very Little				Very Much
10. Displays and Pilot Aids	1	2	3	4	5
Improved cockpit layout	☐	☐	☐	☐	☐
Standardization of cockpit design	☐	☐	☐	☐	☐
Improved avionics	☐	☐	☐	☐	☐
Improved autopilots	☐	☐	☐	☐	☐
Improved means of primary control (other than conventional stick or wheel and rudder pedals)	☐	☐	☐	☐	☐
Improved weather rader (including adaptability to single-engine aircraft)	☐	☐	☐	☐	☐
Improved airframe deicers	☐	☐	☐	☐	☐
Improved component deicers	☐	☐	☐	☐	☐
11. Comfort					
Quieter	☐	☐	☐	☐	☐
Improved temperature control	☐	☐	☐	☐	☐
Less vibration	☐	☐	☐	☐	☐
Improved seats	☐	☐	☐	☐	☐
Spaciousness	☐	☐	☐	☐	☐
12. Reliability and Economics					
Maintenance (mean time between failures)	☐	☐	☐	☐	☐
Initial costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐



13. New Technology

How important do you feel the following specific devices would be in improving flight operations?

	Very Little 1	2	3	4	Very Much 5
Direct lift control devices (such as spoilers or other devices which do not require rotation of the airplane by elevators)	☐	☐	☐	☐	☐
Stability augmenters (such as wing levelers or similar devices)	☐	☐	☐	☐	☐
Variable stability devices (to alter stability to best suit flight condition)	☐	☐	☐	☐	☐
Angle-of-attack indicators	☐	☐	☐	☐	☐
Traffic proximity warning devices	☐	☐	☐	☐	☐
Ground proximity warning devices	☐	☐	☐	☐	☐

14. How necessary to flight safety do you feel is the present requirement for carrying an ELT (Emergency Locator Transmitter)?

☐ ☐ ☐ ☐ ☐

If you checked the box for "very much" on any of the above questions, we would appreciate any further comments or suggestions you have concerning those items. Also, if you think that this questionnaire omitted any important items, please tell us what they are._____

_____

_____

_____

* * * Optional * * *

Name_____

Address_____

Telephone #_____

RESPONSES TO PILOT QUESTIONNAIRE SHOWN IN FIGURE 3

Table 1

Pilot Experience

200 hours or less	- 14%
200 - 500 hours	- 14
500 - 1000 hours	- 12
1000 - 2000 hours	- 8
over 2000 hours	- 52

Table 2

No. of Years Flying

2 or less	- 10%
2 - 5 years	- 12
5 - 10 years	- 22
10 - 20 years	- 20
more than 20	- 36

Table 3

No. of Hours in Past Year

50 or less	- 24%
50 - 100 hours	- 19
100 - 200 hours	- 11
200 - 1000 hours	- 46
over 1000 hours	- 0

Table 4

Aircraft Type Normally Flown

Single engine, fixed gear	- 42%
Single engine, retractable gear	- 13
Multi-engine	- 44
Jet	- 26
Helicopter	- 3

RESPONSES TO PILOT QUESTIONNAIRE SHOWN IN FIGURE 3

Table 5

Pilot Certificate Held

Student	- 4%
Private	- 34
Commercial	- 26
Airline Transport	- 36
Military	- 8

Table 6

Other Ratings Held

Flight instructor	- 23%
Instrument	- 49
Multi-engine	- 48
Seaplane	- 12
Helicopter	- 6
Glider	- 6
Airframe and powerplant mechanic	- 3
Flight engineer	- 1

RESPONSES TO PILOT QUESTIONNAIRE SHOWN IN FIGURE 3

Table 7

Emphasis Needed in Future Research

	Very Little 1	2	3	4	Very Much 5
a. Performance Considerations					
Greater speed	18	17	36	15	14
Greater rate of climb	7	13	37	23	20
Higher ceiling	20	20	35	12	13
Shorter takeoff distance	8	10	22	29	31
Shorter landing distance	7	12	23	29	29
More efficient powerplant	3	5	13	19	60
More load carrying ability	4	6	29	28	33
Greater range	3	6	24	28	39
b. Safety Considerations					
Improved stall/spin charact.	14	17	28	22	19
Improved handling qualities	9	19	40	19	13
Improved crashworthiness	5	11	22	20	43
Improved visibility	4	11	28	26	31
Procedures for wake turbulence	12	13	27	19	29
Improved weather information	4	5	17	27	47
Improved air traffic control systems	11	11	24	25	29
c. Displays and Pilot Aids					
Improved cockpit layout	8	13	39	22	18
Standardization of cockpit	6	8	23	27	36
Improved avionics	5	1	33	33	28
Improved autopilots	12	15	47	15	11
Improved primary controls	30	25	31	11	3
Improved weather radar	9	13	27	23	28
Improved airframe deicer	9	13	32	26	20
Improved component deicer	9	14	30	27	20

RESPONSES TO PILOT QUESTIONNAIRE SHOWN IN FIGURE 3

Table 7
(Con't.)

	Very Little 1	2	3	4	Very Much 5
d. Comfort					
Quieter	3	2	11	35	49
Improved Temperature Control	9	12	34	25	20
Less Vibration	6	11	33	27	23
Improved Seats	10	14	37	24	15
Spaciousness	12	18	35	21	14
e. Reliability and Economics					
Maintenance (MTFB)	3	2	23	25	47
Initial Costs	1	5	21	20	53
Maintenance Costs	1	0	18	27	54

RESPONSES TO PILOT QUESTIONNAIRE SHOWN IN FIGURE 3

Table 8

Perceived Improvement Achievable in Flight Operations Due to New Technology

	Very Little 1	2	3	4	Very Much 5
Direct Lift Control Devices	16	19	27	21	17
Stability Augmenters	11	26	27	21	25
Variable Stability Devices	8	13	39	23	17
Angle-of-attack Indicators	14	15	23	23	25
Traffic Proximity Warning Devices	7	10	24	22	35
Ground Proximity Warning Devices	13	12	26	19	30

Table 9

Importance of Emergency Locator Transmitter to Flight Safety

Very Little Importance 1	2	3	4	Very much Importance 5
39	9	20	12	20

the percent responses in columns 4 and 5 for each item and rank ordering those exceeding 50%)

1. Quieter
2. More efficient power plant
3. Improved weather information
4. Greater range
5. Improved crashworthiness
6. Standardized cockpit design
7. Improved avionics
8. More load carrying capability
9. Shorter takeoff distance
10. Shorter landing distance
11. Improved visibility
12. Improved air traffic control systems
13. Improved weather radar
14. Less vibration
15. Improved wake turbulence procedures.

These match up with several of the technologies already identified, however it is worth noting that several of the above require improved aerodyanmics, propulsion, and avionics.

In addition to pilots' perceptions of research areas, they were asked to assess some very specific technologies with the view toward improvements in flight operation. Table 8 shows little variation in the importance they place on each of the items shown--all being somewhat important.

Passenger Outlook

A similar study was conducted for passengers of general aviation aircraft through business firms owning this class of craft. The questionnaire used is shown in Figure 4. Due to the small sample size (N = 42), these results should only be considered trends. The rank order of importance of items relating to reasons for flying in general aviation aircraft are:

FIGURE 4.

PASSENGER QUESTIONNAIRE

This questionnaire is being sent to you as part of a study conducted for NASA by the University of Virginia. The objective of the study is to identify those areas of general aviation where further research is most needed. Your help in this matter may well have an effect on gaining improvements in general aviation technology. You need not answer any question that offends you. Thank you.

Please check the appropriate box or boxes.

1. Age _____

2. Sex ☐ M ☐ F

3. Occupation _____

4. Primary purpose of most flights:

   ☐ Business ☐ Personal ☐ Other

5. Are you familiar with the term "general aviation"?

   ☐ Yes ☐ No

6. General aviation as defined by the FAA refers to all aircraft activities not performed by certificated or supplemental air carriers, commercial operators, scheduled air taxi, or military aircraft. Was this your understanding of the term?

   ☐ Yes ☐ No

7. In what category of aircraft do you normally fly?

   ☐ Single-engine airplane ☐ Helicopter

   ☐ Multi-engine propeller airplane ☐ Other (specify) _____

   ☐ Jet

8. If known, in what specific make and model of aircraft do you normally fly?

   _____

9. How frequently do you ride in general aviation aircraft?

   ☐ Several times a week or more ☐ Several times a year

   ☐ Several times a month ☐ Once a year or less

10. In general, with all factors such as time, cost, and convenience being equal, how would you prefer to travel?

☐ Air ☐ Ground transportation

11. Reasons for Flying

How much does each of the following factors contribute to your reasons for riding in general aviation aircraft?

	Very Little 1	2	3	4	Very Much 5
Time saving (can reach destination and return in a minimal amount of time)	☐	☐	☐	☐	☐
Convenience (easier to reach destination considering connections, reservations, etc., involved in other modes of travel)	☐	☐	☐	☐	☐
Safety (feel safer traveling in this way)	☐	☐	☐	☐	☐
Luxury (more privacy, ability to work during trip)	☐	☐	☐	☐	☐
Cost saving	☐	☐	☐	☐	☐
Reliability of service	☐	☐	☐	☐	☐
Other (specify)_____	☐	☐	☐	☐	☐

12. Performance

How much emphasis do you feel should be placed on the following items of performance in the design of future aircraft?

Greater speed	☐	☐	☐	☐	☐
Longer range (without stopping)	☐	☐	☐	☐	☐
Higher altitude capability (to avoid bad weather)	☐	☐	☐	☐	☐
Ability to land at smaller fields (thereby increasing the number of available destinations)	☐	☐	☐	☐	☐
Capacity (relative ease/difficulty of getting a seat)	☐	☐	☐	☐	☐

13. Comfort

How much do you feel general aviation aircraft should be improved in the following areas?

	Very Little 1	2	3	4	Very Much 5
Seating comfort (including width, headroom, legroom, seat spacing, and seat contour)	☐	☐	☐	☐	☐
Cabin noise and vibration	☐	☐	☐	☐	☐
Cabin heating, ventilation, oxygen systems, and pressurization	☐	☐	☐	☐	☐
Smooth riding in turbulent air	☐	☐	☐	☐	☐

14. Safety

How safe do you consider the following:

	Unsafe 1	2	3	4	Very Safe 5
Flying in general aviation aircraft	☐	☐	☐	☐	☐
Flying on scheduled airlines	☐	☐	☐	☐	☐
Traveling in an automobile	☐	☐	☐	☐	☐

How much concern about safety does each of the following factors cause you

	Very Little 1	2	3	4	Very Much 5
Crew's (pilot's) capability	☐	☐	☐	☐	☐
Aircraft's structural and mechanical reliability	☐	☐	☐	☐	☐
Traffic control system reliability	☐	☐	☐	☐	☐
Effects of bad weather	☐	☐	☐	☐	☐

15. If you can't travel by airplane, how do you travel?

☐ Car ☐ Train ☐ Bus

Time savings;
Convenience;
Reliability of service;
Luxury;
Safety;
Cost saving.

Similarly, for future aircraft, the following items were seen to require improvement by the passenger (in approximate order of importance):

Cabin noise and vibration;
Higher altitude capability (to avoid bad weather);
Smooth riding in turbulent air;
Greater speed.

In terms of safety, all items on question 14 were considered important with over 70% indicating a 4 or a 5 to indicate their concern. Only traveling by automobile was considered unsafe.

Safety Statistics

Improved safety is considered to be a very important area on which to focus future research efforts. In order to determine the areas which would most affect safety, the NTSB (National Transportation Safety Board) safety statistics were examined. The ten most frequent causes of fatal accidents and those of non-fatal accidents were taken from the Annual Review of Aircraft Accident Data, U.S. General Aviation, Calendar Year 1972, which was the latest data compiled. Those causes which could be identified with a design characteristic of an aircraft were considered pertinent. All other causes which were strictly a matter of pilot error in judgment, planning, or decision-making were lumped into one other category. These statistics are given in Tables 10 and 11; for fatal and non-fatal accidents, respectively. As can be seen, many of the same problem areas identified previously appear in this list.

Table 10

Ten Most Frequently Cited Causes/Factors of Fatal Accidents

All Operations

Fatal Accidents - 681

10 Most Frequently Cited Causes/Factors	Percentage of Fatal Accidents	Related Technology
Weather - low ceiling	26.87	Weather
Pilot - failed to obtain/ maintain flying speed	22.91	Stall/spin
Pilot - continued VFR flight into adverse weather conditions	21.73	Weather
Weather - fog	18.21	Weather
Terrain - high obstructions	16.15	ATC, weather
Pilot - spatial disorientation	15.42	Display, stability
Pilot - inadequate preflight preparation or planning	14.39	Pilot training
Weather - rain	12.19	Weather
Pilot - exercised poor judgment	8.37	Proximity warning
Miscellaneous - undetermined	7.93	--

Reference: Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1972, p. 13.

Table 11

Ten Most Frequently Cited Causes/Factors
of Nonfatal Accidents

All Operations

Nonfatal Accidents - 3,496

10 Most Frequently Cited Causes/Factors	Percentage of Nonfatal Accidents	Related Technology
Miscellaneous acts, conditions - overload failure	13.93	Structural design
Terrain - high obstructions	12.50	Pilot training
Pilot - inadequate preflight preparation or planning	12.50	Pilot training
Pilot - failed to maintain directional control	11.27	Stability, handling
Pilot - failed to obtain/ maintain flying speed	9.58	Stall/spin
Weather - unfavorable winds conditions	8.92	Weather
Terrain - rough/uneven	8.87	Pilot training
Pilot - improper level off	8.04	Pilot training
Pilot - mismanagement of fuel	7.01	Systems design
Pilot - selected unsuitable terrain	6.89	Pilot training

Reference: Annual Review of Aircraft Accident Data, U.S. General Aviation Calendar Year 1972, p. 14.

Proposed Analysis Technique

In order to arrive at a composite ranking of the technologies identified as being important for future research, all of the above data must be integrated. Figure 5 illustrates a matrix method which can be used to arrive at this composite ranking. Here a matrix of problem areas by technologies is first ranked by each of the groups concerned--government, industry, pilots, and passengers--then weighted according to the relative weight placed on each group's opinions to arrive at a final ranking of technologies. A fifth influence can be added, economics, if desirable, as well as any others deemed important. By placing 1's and 0's in Matrix 3, the rank ordering of each individual group is obtained.

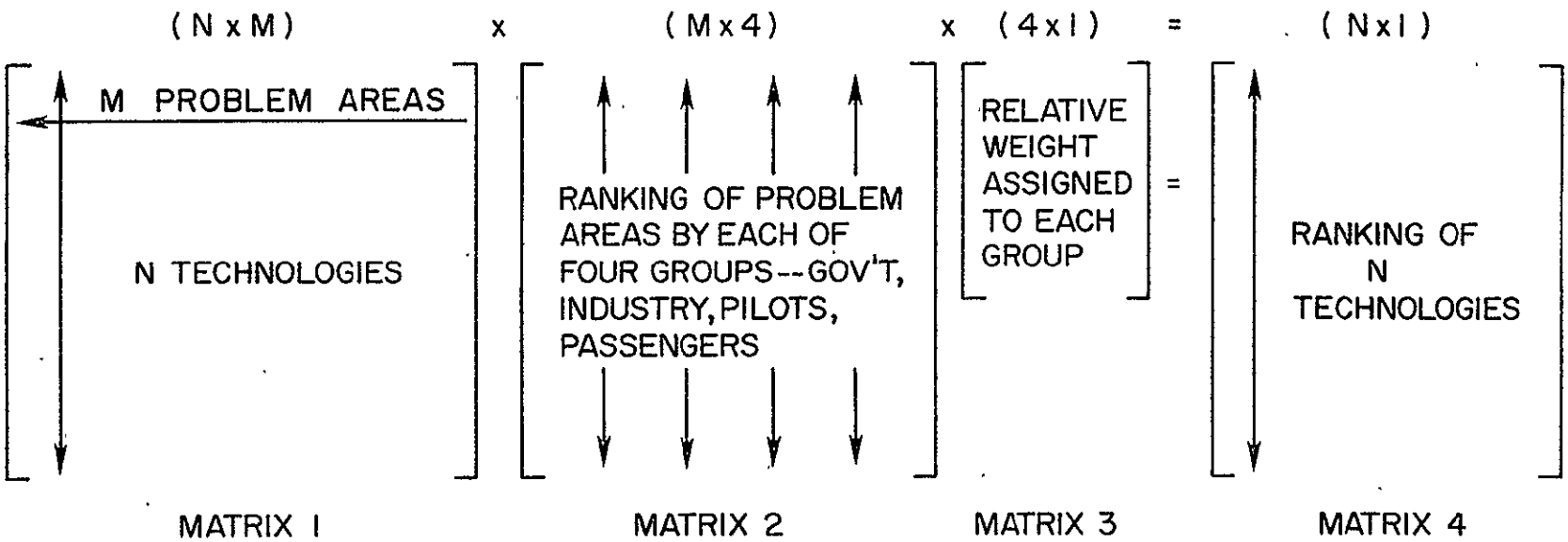
The matrix routine can offer many ways of interpreting the input from correspondence, questionnnaires, etc. The main value of such an analytical tool is that weightings can be varied and matrices expanded as inputs increase. Thus a sensitivity analysis of the results can be done very easily and inexpensively.

Conclusions

Although preliminary in nature, the results of this report indicate definite trends in research areas desired by each of the groups involved in general aviation. A method for integrating these results has been developed, however, due to the limited data base, it has not been exercised. Considerable overlap in technologies needed as identified by each group is evident.

FIGURE 5.

MATRIX RANKING METHOD



APPENDIX I

GENERAL AVIATION CORRESPONDENCE

AIRCRAFT OWNERS AND PILOTS ASSOCIATION/WASHINGTON, D.C. 20014/Tel: (301) 654-0500/cable address: AOPA, Washington, D C.

February 14, 1975

Mr. I. D. Jacobson
Associate Professor
University of Virginia
Charlottesville, Va. 22901

Dear Professor Jacobson:

In response to your letter of February 6th requesting information for a research project concerning general aviation. I am enclosing a statement prepared for hearings by the Committee on Aeronautical and Space Sciences by Robert E. Monroe of our staff which may be of assistance to you in your project.

Cordially,

J. B. Hartranft, Jr.
President

NOTE

Enclosed Statement of Robert E. Monroe, Congressional Liaison, Aircraft Owners and Pilots Association (AOPA) prepared for Hearings by the Committee on Aeronautical and Space Sciences regarding NASA authorization for fiscal year 1974.

Enclosure

JBH/mes

General Aviation Manufacturers Association

Suite 1215
1025 Connecticut Ave , N.W.
Washington, D. C. 20036
(202) 296-8848

20 February 1975

Dr. I. D. Jacobson
Associate Professor
Department of Engineering Science
and Systems
Thornton Hall
University of Virginia
Charlottesville, Virginia 2290

Dear Professor Jacobson:

This is in response to your letter of February 6th concerning your research project to determine major problem areas in general aviation that would benefit most from NASA technological research.

Inasmuch as I serve the General Aviation Manufacturers Association (GAMA) in a consulting capacity, the comments which follow reflect my personal views and are not necessarily those of GAMA. I am enclosing a copy of the prepared testimony on the NASA budget given today by Mr. Edward W. Stimpson, President of GAMA, before a Congressional Committee in which some GAMA views are reflected. I suggest you visit Mr. Stimpson to discuss the matter in more detail prior to reaching any conclusions in your study.

In my own view, the entire list of concerns expressed in your letter is inappropriate for NASA research. NASA has excellent, and perhaps unique, capability to perform aerodynamic and propulsion research and the industry sorely needs the use of their capabilities in these areas. NASA does not need to inquire into areas where it has neither the expertise nor capability to make a significant contribution.

The industry needs basic work in areas that will make general aviation aircraft safer and more efficient. Examples are the GAW wing, stall-spin investigations, icing, noise, emissions, and crash protection. Limited activities are now being, or have been, undertaken in all of these areas but more concentration is needed.

On the other hand, NASA seems to be seeking a role in air traffic control which is now assigned to FAA, worrying about economic trade-offs which are determined in the marketplace and not by

governmental intervention, and the role of manufacturers which will not be affected by any NASA study of their role.

The study of the role of government agencies appears to be self-seeking as those roles are properly determined by Congress.

Research on ride quality requirements and handling quality requirements may or may not be appropriate. If the research is aimed towards producing more basic knowledge in these areas, fine; if the aim is to produce more government regulations, not so good as the FAA has been given that responsibility.

In summary, my view is, since the need for basic aerodynamic and propulsion research is almost limitless and NASA has the responsibility, the facilities and know-how in these areas, NASA should concentrate in these areas rather than seek new responsibilities that are now carried out elsewhere.

Sincerely,

D. D. Thomas

David D. Thomas
Consultant

DDT/pd

Enclosure

NOTE

Enclosed Statement of Edward W. Stimpson, President, General Aviation Manufacturers Association before the Subcommittee on Aviation and Transportation Research and Development, Committee on Science and Technology, U.S. House of Representatives, February 20, 1975.

FLIGHT SAFETY FOUNDATION, INC.

-29-

7 March 1975

Mr. Ira D. Jacobson
Associate Professor
School of Engineering & Applied Science
University of Virginia
Charlottesville, Va. 22901

Dear Mr. Jacobson:

In the August 1970 issue of the Foundation's publication, "Flight Safety Facts & Analysis," a list of the 10 most urgent safety problems was published. Xerox copy is attached. Several months later (November 1971) we printed the Dept. of Transportation's recommendations to improve General Aviation safety. Xerox copy of that also is attached.

In the opinion of many, the so-called most urgent safety problems remain relatively unchanged. However, your study may indicate differently. We'd be interested in your results.

Another report that may be of some help would be that of the Special Subcommittee on Investigations of the House Committee on Interstate and Foreign Commerce. It carries the title "Air Safety: Selected Review of FAA Performance" and is dated January 1975. Perhaps a letter to the House Committee on Interstate & Foreign Commerce, House Office Building, Washington, D.C. 20510, would get you a copy.

Thank you for writing us and please be assured of our desire to be of assistance.

Sincerely,

D. N. Ahnstrom

D. N. AHNSTROM
Vice President Publications
& Referrals

NOTE

Enclosed: 1. DOT's recommendations to improve general aviation safety, September 15, 1971.

2. Flight Safety Facts and Analysis, Flight Safety Foundation, Inc., Vol. 1, No. 1, August 1970.

1800 NORTH KENT STREET
ARLINGTON, VIRGINIA 22209
(703) 528-4100

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

1725 DE SALES STREET, N.W. WASHINGTON D C. 20036 TEL 347-2315

March 12, 1975

Mr. Ira D. Jacobson
Associate Professor
University of Virginia
School of Engineering and Applied
Science
Charlottesville, Virginia 22901

Dear Professor Jacobson:

Thank you for your recent letter requesting information on various aspects of general aviation. I believe the information can be obtained from:

General Aviation Manufacturers Association
1025 Connecticut Avenue, N. W.
Washington, D. C. 20036

The inquiry could be addressed to the attention of Mr. Jerry Boyer, Director of Public Relations for GAMA.

Sincerely,

Gerald J. McAllister
Associate Director for
Publications

GJMcA:elp

The Ninety-Nines, Inc.
International Organization of Women Pilots

INTERNATIONAL HEADQUARTERS
WILL ROGERS WORLD AIRPORT
P. O. BOX 59964
OKLAHOMA CITY, OKLA. 73159

Patricia Z. McEwen
16206 East Central
Wichita, Kansas 67230

March 25, 1975

Professor Jacobson, your letter to Ms. Elizabeth Sewell has been forwarded to me, as her term as president of the Ninety-Nines, Inc. has expired and I am presently serving as president.

The Ninety-Nines, Inc. are not in a position to comment on major problem areas which would benefit most from NASA technological research. However, we do suggest you contact GAMA (General Aviation Manufacturers Association), Suite 1215, 1025 Connecticut Avenue, N.W., Washington, D. C., 20036.

Another source would be AOPA (Aircraft Owners and Pilots Assn.), P. O. Box 5800, Washington, D. C., 20014.

Am sure the above two can be of help to you. Best wishes for success with your project.

Sincerely,

Patricia McEwen, President
The Ninety-Nines, Inc.

PZMc/plc

Ira D. Jacobson, Associate Professor
University of Virginia
School of Engineering and Applied Science
Charlottesville, Virginia 22901

EXPERIMENTAL AIRCRAFT ASSOCIATION

An International Non-Profit Organization Dedicated to the Advancement of Aviation Education, Homebuilt Aircraft and Sport Aviation

OFFICES & AIR EDUCATION MUSEUM: 11311 W FOREST HOME AVE., FRANKLIN, WISCONSIN

Paul Poberezny, President | Ray Scholler, Vice-President | S. H. Schmid, Secretary | Arthur Kilps, Treasurer

PHONE 414 / 425-4860

POST OFFICE BOX 229, HALES CORNERS, WISCONSIN 53130

April 2, 1975

-32-

Mr. Ira D. Jacobson
Associate Professor
University of Virginia
School of Engineering & Applied Science
Charlottesville, VA 22901

Dear Ira:

Thank you very much for the letter of February 25h. We are sorry to be delayed in getting back to you.

Regarding your question of problem areas that would benefit most from NASA technological research. The role of government agencies regarding the technology of flight would be pretty all inclusive as they stay with the aircraft from the type certification, registration, all maintenance all the way through its life. My understanding is they have very little actual engineering to do except on new type certification and on type certification of various products for existing aircraft.

Of course, our category of aircraft are concerned primarily with amateur builts, certificated in the experimental category and which certification has to be renewed annually. The connection our members have with the FAA is in the pre-cover inspection while the aircraft is under construction; the final inspection before flight and in the annual inspections to insu: airworthiness. They do not become involved in the technology of design or construction other than to insure reasonable compliance with aircraft standards.

The Air Traffic Control System most of our members do not use as the aircraft are usually quite simple in design; sporting aircraft designed for sporting use. We do have quite a few members, particularly those in metropolitan areas, who are finding it increasingly difficult to get about in the frame work of the air traffic system due to requirements for radio, transponders, etc.

Regarding pilot/passenger ride-quality requirements, again it appears to be a question of passenger comfort that you are talking about. Most of our members prefer aircraft of a

sporting nature. The majority of them prefer open cockpit flying. Comfort is not very high on their list.

Handling qualities of our light aircraft are that some of them are quite sensitive which is a condition we seek, and our aerobatic pilots are proud of theroll rate of aircraft like the Pitts Special with the roll rate around one hundred and eighty degrees a second at cruising speed.

The role of general aviation manufacturers is generally not of much concern to our members. Many of them do own aircraft. At the present time we are happy to see that many of the manufacturers are playing an active role in restrictive legislation that fuel conservation and, in some cases, demands of the airline transport industry are placing on general aviation.

A source of information that I would suggest for additional information of this type would be Mr. David H. Scott, Suite 915, 1346 Connecticut Ave., Washington, D. C. 20036. Mr. Scott is EAA's representative in Washington. He is an independent free-lance aviation authority on matters such as you are interested in and possibly would be interested in participating with you on solving these problems.

Sincerely,

Ben Owen

Ben Owen
Executive Assistant

m

National Pilots Association

806 15TH STREET, N.W./WASHINGTON, D.C. 20005/TEL: (202) 737-0773

A Member-Controlled Non-Profit Organization For All Pilots

April 7, 1975

-34-

Mr. Hubert Smith
Department of Engineering Sciences & Systems
Thornton Hall
University of Virginia
Charlottesville, Virginia 22901

Dear Mr. Smith:

It was a pleasure talking with you a couple of weeks ago, and it is particularly a pleasure now to send you this sample copy of the just-published April issue of National Pilots Association NEWS. You will note in the center of this that we have a four page tear out brochure, which allows our members to order aeronautical charts through us from the National Ocean Survey with a minimum of fuss and bother. The back page of this four page brochure becomes the outside envelope, acceptable to the Post Office Department.

My suggestion would be that you and your associates plan a similar form, which would permit you to use three full pages for questions and answers (plus, if you needed it, at least the top third of the final page).

Should you decide to take advantage of the opportunity to poll our varigated membership of private, sport, and business pilots, we would also offer to you "editorial support" in the form of either a front page or inside page articles. (We would work together with you on any such article, obviously, and if you found that you wish to include additional explanatory material - above and beyond that for which there was space on the four page tear out form itself - we would of course be willing to give you additional space for such additional explanations, if you needed them.)

By handling your polling process through an insert in our publication, you would of course save a very substantial amount - no envelopes, no stamps, no addressing costs - all of which would be required if you did this "on your own". The National

Pilots Association would expect to receive a fee for handling the distribution of these questionnaires to our membership, but the amount of this fee would be negotiable between us and would, in any case, inevitably be substantially less than the 20¢-25¢ cost per unit, should you decide to mail these questionnaires out individually to pilots.

A final reminder: we would like to schedule this, if we decide jointly to go ahead with the project, in such a way that did not conflict with any other insert material. We would get together, as early as possible, and reserve a certain month's issue for your material.

I look forward to hearing from you, after you and your associates have had an opportunity to review this offer.

Very truly yours,

William H. Ottley
Executive Director

WHO/dp
Enclosure

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20591

FEB 2 5 1975

Mr. I. D. Jacobson
Associate Professor
University of Virginia
School of Engineering and Applied Science
Charlottesville, Virginia 22901

Dear Mr. Jacobson:

Mr. Butterfield has asked me to reply to your letter of February 6 about your general aviation research project.

Our primary concern is, of course, safety. Along with that are the ongoing objectives of reducing accidents and the rate of fatality risk. This would seem to match up with at least two of your research interests, the role of government agencies and, economic tradeoffs. Throughout the give and take of the legislative process, we have found that the legislature is quite responsive to our concern for safety.

You may wish to contact the various aviation trade organizations for other possible sources of information. Some are:

National Air Transportation Associations
1156 Fifteenth Street, N.W.
Washington, D.C. 20005

General Aviation Manufacturers Association
1025 Connecticut Avenue, N.W. - Suite 1215
Washington, D.C. 20036

Aircraft Owners and Pilots Association
P. O. Box 5800
Washington, D.C. 20014

National Business Aircraft Association
401 Pennsylvania Building
Washington, D.C. 20004

We wish you success with your project.

Sincerely,

Bernard A. Geier

BERNARD A. GEIER, Acting Chief
General Aviation Division
Flight Standards Service

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20591

February 28, 1975

Mr. I. D. Jacobson
Associate Professor
University of Virginia
School of Engineering and
Applied Science
Charlottesville, Virginia 22901

Dear Mr. Jacobson:

Your letter of February 6, 1975, addressed to Mr. Rudolph has been referred to this office for reply.

In support of FAA's various responsibilities and particularly those related to operation, maintenance, and improvement of the Nation's air traffic control system; certification of aircraft; and rule-making and regulatory functions, we look to NASA for technical support in the general field of aeronautical research and development. An FAA/NASA Coordinating Committee provides the mechanism for arranging and monitoring mutual support in specific areas of common interest. The enclosed listing of current areas and projects of FAA-NASA coordination and support should provide the basic information which you desire.

If you have a need for further information in any of these areas, I suggest direct contact with the FAA and NASA personnel listed.

Sincerely,

J. W. COCHRAN
Associate Administrator for
Engineering and Development

Enclosure

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20591

FEB 28 1975

Professor I. D. Jacobson
School of Engineering and Applied Science
University of Virginia
Charlottesville, Virginia 22901

Dear Professor Jacobson:

Since the general aviation industry should be given the opportunity to contribute to your study, we suggest you get in touch with appropriate industry representatives whom we shall list for you in a later paragraph. You should also get to know and talk to the inspectors at your nearest GADO, which is located at Byrd Field, in Richmond.

In line with the foregoing, we are enclosing among other relevant material, a copy of our National Aviation System Policy Summary, the latest FAA Historical Chronology, our Annual Report for fiscal year 1973, a draft copy of the as yet unpublished Annual Report for fiscal year 1974, the latest Census of U.S. Aircraft, our latest Statistical Handbook and our latest Survey of General Aviation Activity.

Industry associations that may be able to help are as follows:

1. Aerospace Industries Association
   1725 DeSalles Street N. W.
   Washington, D.C. 20036

2. Air Taxi and Commercial Pilots Association
   Post Office Box 441
   Washington, D.C. 20017

3. Air Transport Association of America
   1709 New York Avenue N. W.
   Washington, D.C. 20006

4. General Aviation Manufacturers Association
   Suite 1215
   1025 Connecticut Avenue N. W.
   Washington, D.C. 20036

2.

5. National Aviation Transport Association
1156 15th Street N. W.
Washington, D.C. 20005

6. National Business Aircraft Association
401 Pennsylvania Avenue N. W.
425 Thirteenth Street N. W.
Washington, D.C. 20004

Sincerely,

for L. J. CHURCHVILLE
Assistant Administrator
Information Services

CIVIL AERONAUTICS BOARD
WASHINGTON, D.C. 20428

IN REPLY REFER TO: B-7

February 24, 1975

I. D. Jacobson
Associate Professor
University of Virginia
School of Engineering and
Applied Science
Charlottesville, Virginia 22901

Dear Professor Jacobson:

Thank you for your letter to the Civil Aeronautics Board seeking information.

Enclosed you will find a synopsis of the CAB. However, the CAB has no jurisidiction over general aviation.

I hope the enclosed material will be helpful to you.

Sincerely,

James O. Hughes
Director
Office of Information

Enclosure

NOTE

Enclosed: Synopsis of Purposes and Provisions of the Federal Aviation Act in Relation to the Civil Aeronautics Board, Revised March 31, 1972.

United States Senate
COMMITTEE ON COMMERCE
WASHINGTON, D.C. 20510

February 24, 1975

I. D. Jacobson, Associate Professor
University of Virginia, School of
Engineering and Applied Science
Thornton Hall
Charlottesville, Virginia 22901

Dear Professor Jacobson:

In regard to your recent letter expressing your interest in general aviation, I would advise you to contact the General Aviation Manufacturers Association here in Washington, which is the leading trade organization representing the industry.

GAMA will be able to provide you factual statistical background concerning the general aviation system. Insofar as my Subcommittee is concerned, the major issue facing us relating to general aviation this year will be renewal of the Airport and Airway Development Act of 1970. As you know, this aviation development program has a large impact on general aviation and general aviation is required, through user charges, to help support the developments which are made. Hearings before my Subcommittee will begin sometime this spring; hopefully by June 1, we will have developed another five year development program. I hope this serves to answer your questions.

Sincerely yours,

Howard W. Cannon

HOWARD W. CANNON, Chairman
Aviation Subcommittee

HWC:rgb

BARRY GOLDWATER
ARIZONA

COMMITTEES:
AERONAUTICAL AND SPACE SCIENCES
ARMED SERVICES
PREPAREDNESS INVESTIGATING SUBCOMMITTEE
TACTICAL AIR POWER SUBCOMMITTEE
NATIONAL STOCKPILE AND NAVAL PETROLEUM RESERVES SUBCOMMITTEE

United States Senate

WASHINGTON, D.C. 20510

February 27, 1975

Professor I. D. Jacobson
Department of Engineering
Science and Systems
University of Virginia
Charlottesville, Virginia 22901

Dear Professor Jacobson:

Thank you for your letter concerning general aviation and the role of NASA technology. The items you mentioned in your letter seem worthy of consideration.

If you have not done so, may I suggest you get in touch with the General Aviation Manufacturers Association. It might be helpful to you to get inputs from industry.

It seems to me there are two major issues concerning general aviation:

First, establishing sensible guidelines for engine emissions;

Second, proving the fuel efficiency of aircraft.

As you may know, NASA is starting programs to increase the fuel efficiency of aircraft in the commerical fleet. Perhaps some of that work would be useful to general aviation.

Sincerely,

Barry Goldwater

Barry Goldwater

United States Senate
COMMITTEE ON
AERONAUTICAL AND SPACE SCIENCES
WASHINGTON, D.C. 20510

March 6, 1975

Dr. I. D. Jacobson
Associate Professor
Department of Engineering Science and Systems
School of Engineering and Applied Science
University of Virginia
Charlottesville, Virginia 22901

Dear Dr. Jacobson:

Thank you for your letter of January 22 concerning areas of general aviation which would benefit from NASA technological research.

I am enclosing a copy of our FY 1975 authorization hearings. Starting on page 402 is a description of the NASA general aviation technology program which our Committee supported. As you will note the primary emphasis has been on safety, efficiency, and utility.

It is hard, in many ways, to separate general aviation from the broader subject of aeronautics technology. The responsibilities of our Committee relate to technical research and development rather than to regulation or government roles and missions.

We are concerned with technological developments which will maintain the role of the United States as a leader in aeronautical science and its applications. We are looking forward to the results of a study NASA is doing on the probable direction of aviation in the years 1985 to 2000. This will help us to determine problems for aviation in the future.

A specific area of interest to our Committee is aircraft fuel efficiency. For your information I am enclosing a copy of a recent letter from Senator Goldwater and myself to Dr. Fletcher asking for a NASA program to develop technology for fuel efficient aircraft.

When you ask about "general aviation lobbies", I assume you mean the generic sense of the term. I don't know of any registered "lobbyists" in the strict sense that have "lobbied" the Committee.

We do have rather infrequent and loose contacts with representatives of GAMA and general aviation manufacturers. The purpose of the contacts tends to be primarily for the staff to obtain technical information quickly, not to discuss issues. I think I can confidently say that representatives of the general aviation industry have seldom, if ever, sought to initiate or carry through legislation of any kind in this Committee.

In fact it would appear that the general aviation manufacturers are not anxious to see NASA involve itself at all in general aviation related technology with the possible exception of work on new airfoils. As far as I can tell, NASA's work on quieter engines, fuel efficiency, electronics devices, crash-worthiness, and other innovations that might be the subject of future regulation by the FAA, is not encouraged by the general aviation industry.

On the other hand NASA has not focused on general aviation problems until the last two or three years. And even now only a relatively small portion of the budget is devoted specifically to general aviation affairs.

The Committee's interest in general aviation for the most part has followed NASA's focus on the subject. I know of only one instance in which the Committee initiated an investigation of a general aviation problem. That occurred several years ago when Senator Anderson, then Chairman of the Committee, learned of an aircraft accident in which no flight plan was available to aid rescuers. Senator Anderson's concern led the FAA to review the requirements on filing flight plans and to stiffen those regulations.

I have some thoughts on areas you might consider in your study:

1. Has the FAA-type certification policy had the effect of stifling the adoption of new technology into general aviation designs? It is my understanding that radical innovations in design require a new type certificate and compliance with all regulations to date, whereas minor improvements can be incorporated into an aircraft under an old type certificate and no new regulations enacted after the date of that certificate will apply. Thus, aircraft manufacturers can avoid many FAR's by avoiding major technological innovations in their design.

2. To what extent, if at all, do the general aviation manufacturers oppose NASA's involvement in their affairs for fear that FAA regulatory action (or legislative action) will follow requiring adoption of NASA's innovations?

3. If such a situation exists at all, does it inhibit communication and cooperation between NASA and the general aviation manufacturers?

4. Should NASA be undertaking research into areas which the industry might avoid for fear of adverse legal and economic consequences, i.e., crash-worthiness, etc.?

Hearings on NASA aviation research and technology will be held on March 11th starting at 9:30 a.m. The hearing is open and you might find it interesting to attend.

Sincerely,

Ted Moss

Frank E. Moss
Chairman

FEM:par

COPY

January 31, 1975

Dr. James C. Fletcher
Administrator
National Aeronautics and Space Administration
Washington, D. C. 20546

Dear Dr. Fletcher:

As you know, the Committee has been reviewing the NASA Aeronautical Research and Technology program in detail. The highly competent support of Mr. Lloyd Jones and his staff in this review has been most helpful.

We were favorably impressed with many of the aeronautical projects aimed at achieving the NASA objective of "the preservation of the role of the United States as a leader in aeronautical science and technology."

In particular, we are impressed with those technology projects which could enable the United States industry to provide a new generation of fuel-efficient commercial aircraft. Technologies have been identified with the potentiality of savings as high as 50 percent by 1985. The value of such technology should not be underestimated since potential benefits include both fuel savings -- perhaps approaching one million barrels of petroleum per day -- and increased international trade.

We feel that NASA, in consultation with industry, should consider establishing a clearly defined goal of demonstrating the technology necessary to make possible a new generation of fuel-efficient aircraft by a stated date. Such aircraft would have the same general operating characteristics as at present, would meet safety and environmental requirements, would be similar in cost, could be flying in the 1980's, and would have a large improvement in fuel efficiency.

COPY

Adopting the type of goal we have in mind would require that you develop the program to achieve it in such a fashion that the technology transfer process is facilitated. The program which NASA develops should specify major milestones, percent of fuel savings to be achieved, and a description of the planned efforts and their cost.

We think it would be most appropriate that your initial response to this suggestion be included in the NASA presentation during the FY 197 authorization hearings. It is our hope that the goal you establish will be one that is both feasible and challenging.

Sincerely,

Barry Goldwater
Ranking Minority Member

Frank E. Moss
Chairman

UNIVERSITY OF VIRGINIA

School of Engineering and Applied Science

The University of Virginia's School of Engineering and Applied Science has an undergraduate enrollment of approximately 1,000 students with a graduate enrollment of 350. There are approximately 120 faculty members, of whom, about 90% hold a doctorate. Excellence in graduate education is aided and supplemented by a research program approximating $3 million per year. This relatively high level of participation in sponsored research is one factor which helps our faculty consistently to maintain high quality graduate education at all degree levels.

As research is an integral part of the educational program, research interests parallel academic specialities. These interests range from the traditional engineering departments of Chemical, Civil, Electrical and Mechanical to include departments of Biomedical Engineering, Engineering Science & Systems, Materials Science, Nuclear Engineering, and Applied Mathematics & Computer Science. In addition to these departmental interests, there are interdepartmental groups in the areas of Automatic Controls and Applied Mechanics. All departments are authorized to offer the doctorate while the Biomedical and Materials Science Departments are graduate degree granting departments only.

The School of Engineering and Applied Science, is an integral part of an outstanding University, which has strong professional Schools of Law, Medicine, and Business Administration. In addition, the College of Arts and Sciences has strong basic science departments in Mathematics, Physics, Chemistry, and other departments relevant to the engineering research program. This not only provides an excellent scholarly climate, but also enhances the school's potential for creating truly interdisciplinary teams in the pursuit of our basic goals of education, research, and public service.

Inside this cover are listed some of the present research activities of the department from which this report originates. For more information on this or other areas, address the department chairman or Dean J. E. Gibson, Commonwealth Professor and Dean, School of Engineering and Applied Science, University of Virginia, Charlottesville, Virginia 22901.