

Workshop on the Concept of the

**NATIONAL AVIATION OPERATIONAL
MONITORING SERVICE
(NAOMS)**

May 11, 1999



WELCOME AND NAOMS INTRODUCTION

Linda Connell
NASA Project Manager, Level III



Background

- **White House Commission on Aviation Safety and Security (Gore Commission)**
 - Called for 80% reduction in fatal accidents in 10 years
 - Encouraged NASA to actively participate
- **In 1998, NASA initiated a multi-year aviation safety program to support the Commission goal**
- **Focused Aviation Safety Program (AvSP)**
 - Formally begins FY00
- **NASA Aviation Operations Systems (AOS)**
 - Has supported ramp up activities in FY98 and FY99



AvSP Organization

Aviation Safety Program

Aviation Safety Program Office

Mike Lewis, Director

George Finelli, Dep Dir

Cynthia Null, Dep Dir (ARC)

Frank Jones, Asst Tech Mgmt

Jai Shin, Dep Dir (LeRC)

Connie Smith, Secretary

James Yamanaka, Dep Dir (DFRC)

Level 1
Program

1.1
Technical Integration
Vince Schultz (LaRC)

1.2
Program Integration
Mike Basehore (FAA)
Carrie Walker (LaRC)
Mike Durham (LaRC)

Level 2
Elements

2.1
Aviation System
Monitoring &
Modeling
Yuri Gawdiak
(ARC)

2.2
System-Wide
Accident
Prevention
Dave Foyle
(ARC)

2.3
Single Aircraft
Accident
Prevention
John White
(LaRC)

2.4
Weather Accident
Prevention
Ron Colantonio
(LeRC)

2.5
Accident
Mitigation
Doug Rohn
(LeRC)

- System Monitoring
- Data Sharing
- Data Analysis

- Human Error Modeling
- Maintenance Human Factors
- Training

- Health Management & Flt Crit Sys Design
- Precision Approach & Landing Info
- Control Upset Mgmt
- Engine Containment
- Flight Integration

- Wx Info Distribution & Presentation
- Synthetic Vision Display
- Turbulence Detection & Mitigation

- Systems Approach to Crashworthiness
- Fire Prevention

Level 3
Projects



NASA Aviation Safety Program Opportunities and Challenges

- **Opportunity:** to intensify national efforts to maintain our nations outstanding aviation safety record
- **Challenge:** to maintain this record as traffic grows in coming years

We need to be able to accurately measure progress towards the goal stated by the Gore Commission

Measurement Objectives



- **Better, more comprehensive numbers to**
 - Measure progress towards the safety improvement goal
- **Better and more rapid feedback on technological and procedural change**
 - Measure the effects of AvSP and related technologies as they are introduced to the aviation system
- **Escape from event-driven safety policy**
 - The accident *du jour* response syndrome
 - By giving policy makers a more secure sense of the safety state of the national aviation system
- **Create a data-driven basis for safety decisions**



Desired Measurement Characteristics

- **System-wide**
- **Operationally focused**
- **Timely**
- **Reliable**
- **Valid**
- **Flexible**
- **User accepted**



Existing Capabilities

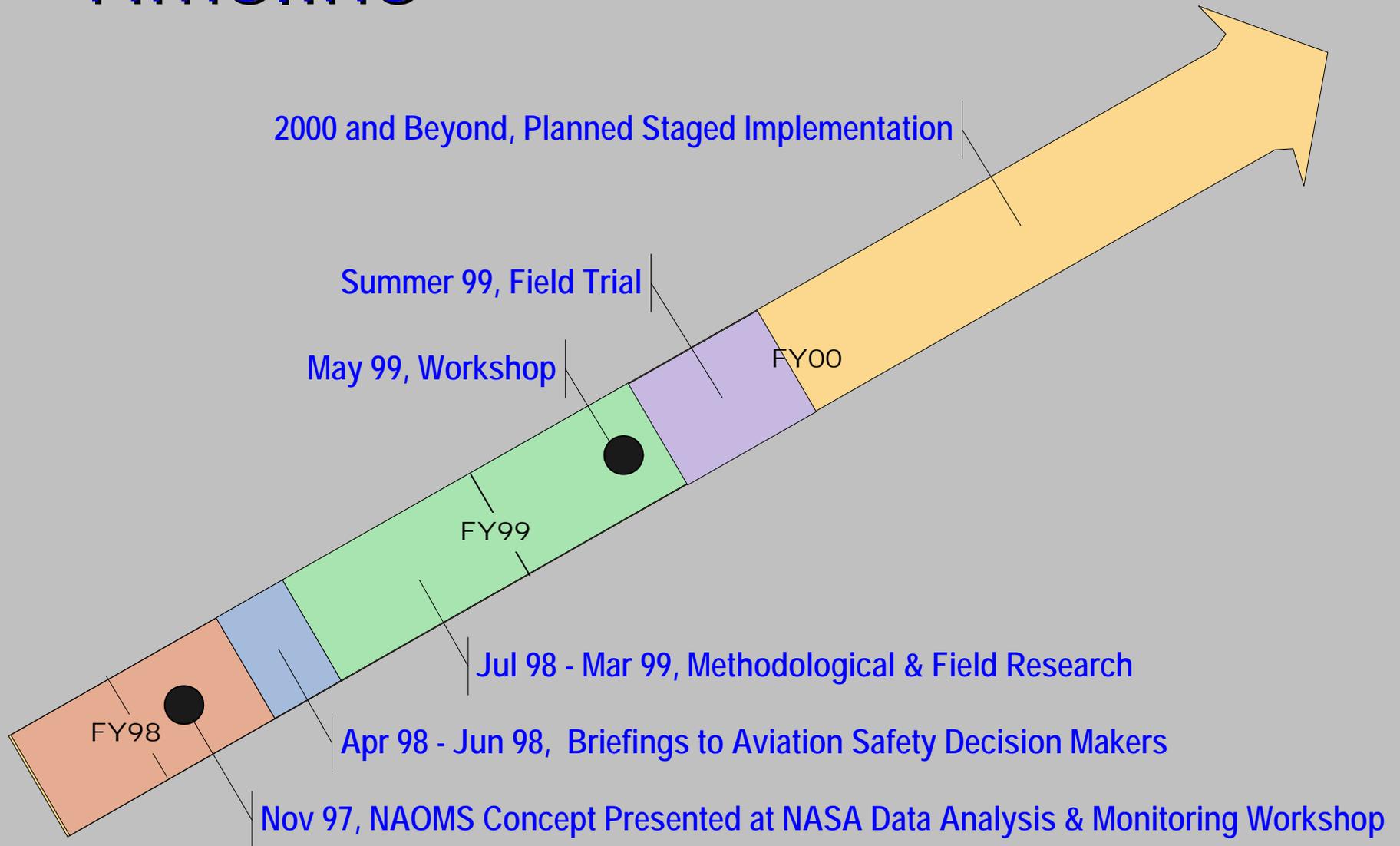
- **A number of valuable publicly available data collection programs already exist**
 - SDR / OpError / AIDS
 - ASRS
 - NTSB database
 - And others
- **These data collection efforts satisfy many needs**
- **But they do not provide**
 - An adequate top down view of long-term NAS safety trends
 - An effective means of measuring the impacts of new aviation technologies and procedures



Proposed Benefit

Create a new capability that will track aviation safety trends while monitoring the impacts of technological and procedural changes to the aviation system

NAOMS Development Timeline





Workshop Goals

- **Further discuss NAOMS concept**
- **Describe work accomplished to date**
- **Describe planned field trial**
- **Discuss issues of data sensitivity and use**
 - Confidentiality, FOIA, legal issues, etc.
- **Solicit comments**

Roadmap for Remainder of the Morning

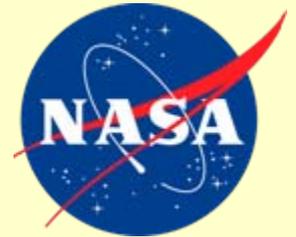


- Loren Rosenthal will outline the NAOMS concept
- Bob Dodd will describe the NAOMS research & development plan and the work accomplished to date
- Jon Krosnick will discuss key methodological issues related to NAOMS data gathering and analysis
- Joan Cwi will describe the planned next steps in the NAOMS development effort
- Linda Connell will summarize the presentations and set the stage for work group discussions

NAOMS CONCEPT AND RATIONALE

Loren Rosenthal
Battelle Project Manager

NAOMS Will Generate . . .



**Statistically valid estimates of the
actual rates of safety events and
related experiences occurring
in the NAS**



NAOMS Approach

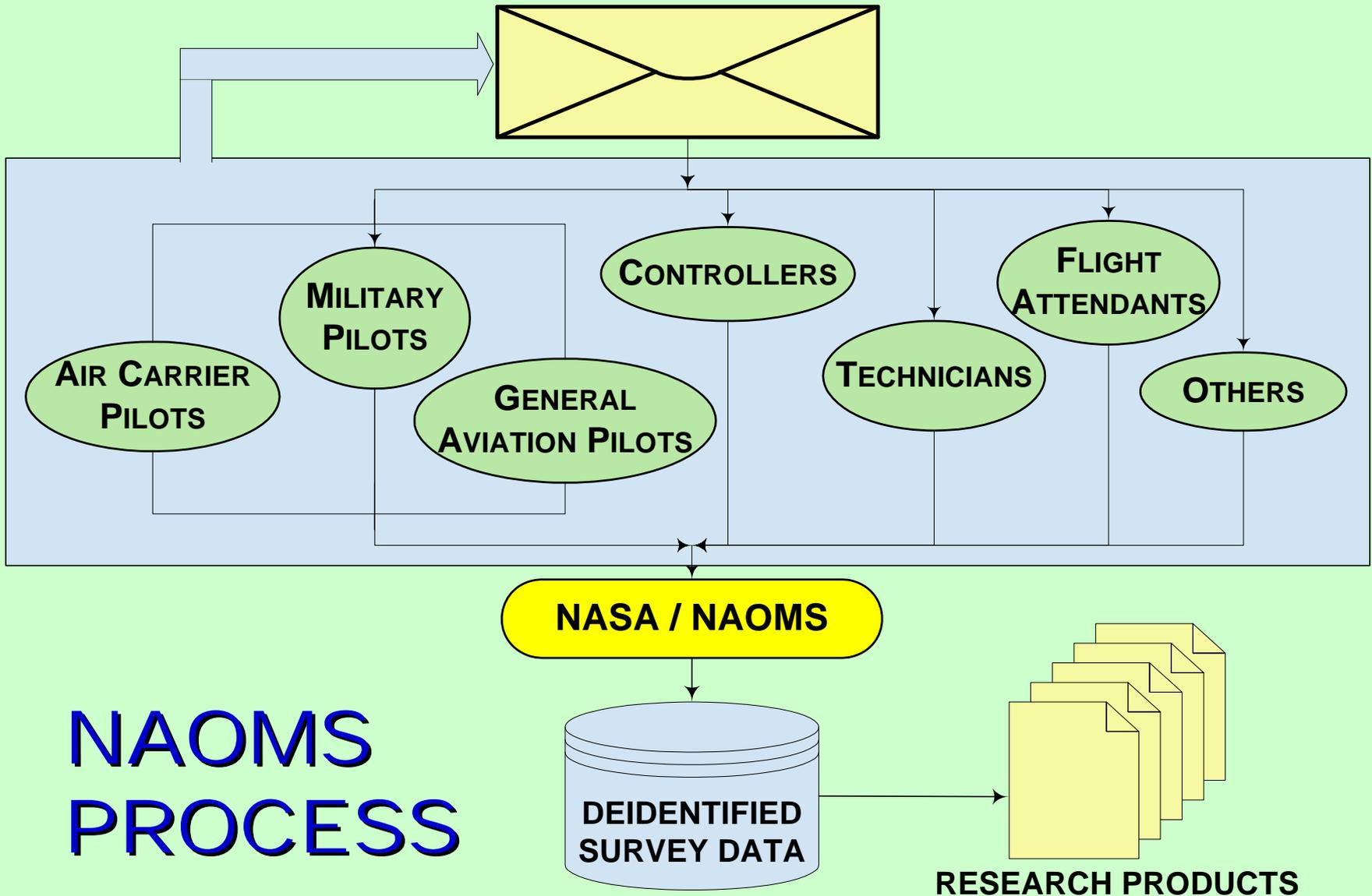
- **Regularly survey pilots, controllers, mechanics, flight attendants and others who operate the national aviation system (NAS)**
 - View the national aviation system through their eyes
- **Achieve scientific integrity by using well crafted survey instruments and carefully designed statistical sampling methods**

Why NAOMS Chose the Survey Method



- **Proven in other venues**
 - Public health
 - Public policy
 - Market research
- **Scientific and representative**
- **Capable of addressing human performance issues**
- **Timely data collection**
- **Well-developed methodologies**

SURVEY FORM, PHONE CALL, OR FACE-TO-FACE INTERVIEW QUESTIONS
DEVELOPED BY NASA IN CONSULTATION WITH AVIATION COMMUNITY



**NAOMS
PROCESS**

RESEARCH PRODUCTS



Participant Confidentiality is Assured

- **NAOMS will work with and through participating organizations**
- **It will have no means of tracing a survey response to the individual who provided it**



NAOMS Will Collect Data on

Participant Experiences involving . . .

★ **Aviation Operations**

- Flight hours / legs
- Time on control position
- Other pertinent measures

🕒 **Safety Events**

- A standard set of benchmark incidents

🕒 **New Technologies and Procedures**

- First-hand experiences
- Continuously refocused in response to changing needs



NAOMS Products

■ EXPECTED OUTPUTS

- Summarized aviation operational experience data
- Statistically reliable estimates of incident rates
- Near real-time feedback on impacts of new technology and procedures
- Structured NAOMS data sets

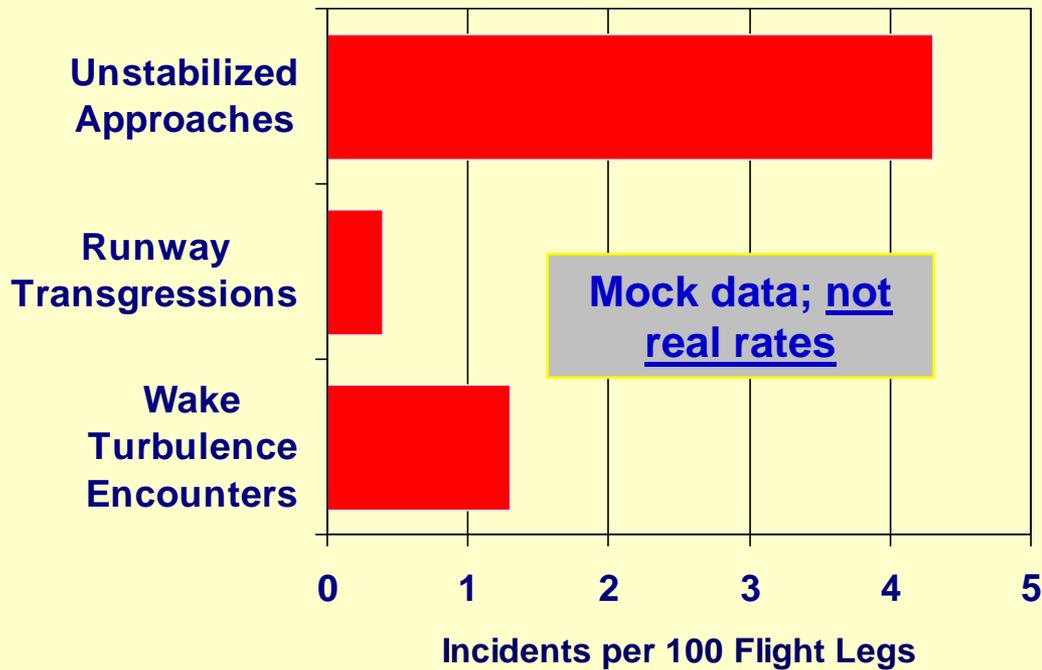
■ PRODUCT CONSUMERS

- Decision makers (government and industry)
- Safety professionals and research organizations

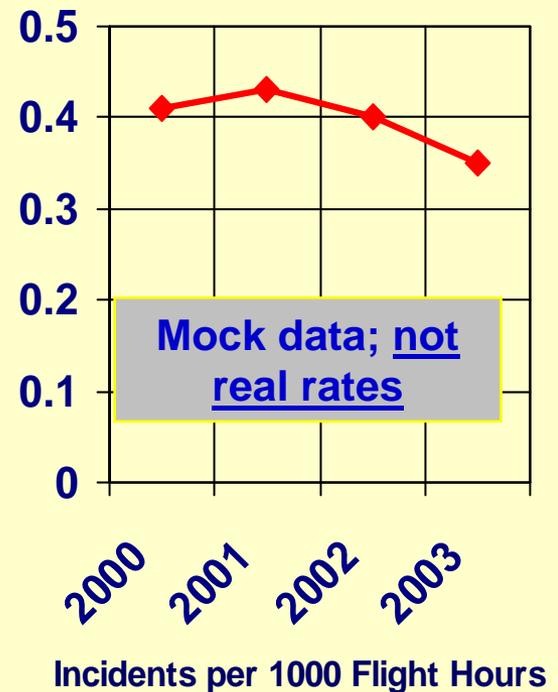


Examples of Possible NAOMS Safety Outputs

SAFETY EVENTS (CY 2001)



CRITICAL GROUND CONFLICTS (CY 2000-03)





Development Team

Under Battelle Support Service Contract to NASA

- Loren Rosenthal Program Manager
- Robert Dodd Sc.D. Principal Investigator
- Jon Krosnick Ph.D. Survey Methodologist
- Joan Cwi Ph.D. Survey Application
- R. Iachan Ph.D. Statistician
- Mike Silver M.S. Survey Methodologist
- Mike Jobanek M.S. Aviation Safety Analyst

NAOMS PROJECT ACTIVITIES

Robert Dodd
Principal Investigator



Plan of Action

- **Feasibility Assessment (FY 98 - FY 99)**
 - Methodological issues
 - Estimation of sample size requirements
 - Enlisting support of aviation community
- **Field Trial FY 99**
- **Planned Implementation (FY 00 - FY 03)**
 - Staged implementation beginning with air carrier pilots
 - Regular monthly surveys
 - Then, other aviation constituencies

Feasibility Assessment



- **Background Research**
 - Literature Review
 - Participant group profiles
- **Field Research**
 - Focus Groups
 - Follow-up Activities
- **Survey Instrument Development**
 - Drafts Developed, Reviewed Internally
 - Field Trial (next step)

Background Research (completed)



- **Literature review**
 - Aviation surveys
 - Current data systems and their use
 - Current aviation safety initiatives
- **Collected group profiles on aviation operational personnel**
- **Briefed various organizations and solicited comments**

Field Research (completed)



- **Conducted multiple focus groups**
 - Obtained extensive listing of safety experiences
 - Solicited input on their likely response to a NAOMS survey
- **Conducted evaluation of respondents'**
 - Ability to recall events
 - Method of categorizing events
 - Input on safety event listing

Survey Field Trial



- **Conducted after input from workshop**
 - Early summer 99
- **Assessment of the survey instrument and procedures**
 - Limited to air carrier pilots
- **Various modes will be tested**
 - Telephone
 - Mail
 - Face-to-face
- **Survey will be modified incrementally**
 - As a consequence of test feedback

Analysis of Field Trial Results (Fall '99)



- **Focus will be on methodology**
 - Response rates
 - by mode
 - by survey design
 - Feedback on survey from respondents
- **Projection on feasibility of a fully operational system**
 - Cost estimate
 - Sample size estimate

SURVEY METHODOLOGY

Jon Krosnick

Survey Research Methodologist

Benefits of the Survey Approach to Data Gathering



- Human-centered
- Quantitative
- Stable
- Comprehensive
- Statistically accurate
- Flexible (versatile, topical)
- Well developed methods

Users of Survey Research



- **Federal, State, and Local Government**
- **Academia**
- **Federal and State Courts**
- **Consumer Research**

Examples of Continuing Surveys



- American National Election Studies (CPS) 1948 -
- Annual Housing Surveys (Census Bureau) 1973 -
- Consumer Attitudes and Behavior (SRC) 1953 -
- Consumer Expenditure Surveys (Census Bureau) 1968 -
- Health and Nutrition Examination Surveys (NCHS) 1959 -
- National Health Interview Surveys (NCHS) 1970 -
- Panel Study of Income Dynamics (SRC) 1968 -
- Survey of Income and Program Participation (Census) 1984 -

Things You Can Measure



- Attitudes
- Preferences
- Beliefs about the state of the world
- Predictions about the future
- Past behavioral experiences or events

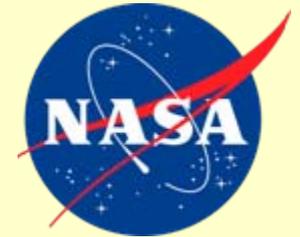
NAOMS will be almost exclusively concerned with measuring actual experiences

Things You Can Learn



- Frequency of occurrences
- Changes over time
- Similarities and differences among groups

Trade-offs Among Data Collection Methods



	Mail	Telephone	In-Person
Response Rate	○	●	●
Following Instructions	○	●	●
Sense of Confidentiality	●	○	●
Honesty	●	○	●
Satisficing	○	●	●
Costs	●	●	○

Key: ● Excellent ● Good ○ Fair



Mail Mode

- Tends to have lowest response rates
- Overall completion poor
- Evidence suggests less respondent bias on sensitive questions
- Easy to demonstrate answers are confidential
- Inexpensive



Telephone Mode

- High response rates with scheduled interview
- Evidence suggest stronger respondent bias on sensitive questions
- Harder to demonstrate confidentiality
- Inexpensive



In-Person Mode

- High response rate achievable
- Good completion rates with scheduled interviews
- Evidence suggest less respondent bias on sensitive questions
- Easy to demonstrate answers are confidential
- Highest cost



Memory Organization

- **People Recall Information in Different Ways**
 - Time sequence
 - Relative Importance
 - Et Cetera
- **Surveys Most Effective When The Questions Match Respondents Natural Memory Organization**
- **Research Approach**
 - Review literature
 - Scenario sorting experiment

Scenario Sorting Exercise



- Pilots were asked to read, sort, and group 96 scenarios
- Examples:
 - While starting engines for a flight from Boston/Logan (BOS) to Baltimore (BWI), a crew experienced a passenger-initiated aircraft evacuation. A passenger yelled "fire" during engine start. Frightened passengers opened over-wing hatches and aft exits and began exiting the aircraft. Several passengers were injured.
 - At cruise altitude on a flight from Chicago O'Hare (ORD) to Kansas City (MCI), the engine driven hydraulic pump on # 1 engine failed. The appropriate malfunction checklist was accomplished and the aircraft landed without incident. There were no injuries.

Results of Sorting Experiment



- **Incidents Appeared to Be Organized in Memory Along Three Dimensions**
 - Descriptive aspects of the event (what happened)
 - Flight phase in which event occurred (when it happened)
 - Underlying causal factors (why it happened)
- **A Hybrid Organization Structure Emerged**
 - That drew upon the above three considerations



Hybrid Memory Recall Organization

Category Name	Criteria for Inclusion
Airborne Conflicts	Any conflicts with other aircraft or objects in the air
Ground Incidents	Runway or taxiway transgressions and ground conflicts with other aircraft or vehicles
Spatial Deviations	Altitude or track deviations that do not result in a conflict
Equipment Problems	Any airframe, engine, or system problem
Wake Turbulence	Wake turbulence
Weather	Weather including clear air turbulence
Passenger Incidents	Any passenger-caused problems
Miscellaneous Human Performance Problems	Any flight crew, ATC, or maintenance problem that does not fit into the above categories



Recall Period

- **Memories Fade Over Time**
 - Important memories fade more slowly
- **Understanding recall is critical to survey design**
 - Participants should not be asked to recall things from too far in the past
- **Routine events remembered accurately for at least one week**
 - This is supported by literature and simple recall exercises
- **But we are less confident about how long more serious events can be remembered**
 - We know that more serious events will be remembered longer
 - This will be a subject of investigation over the next few months



Survey Benefits

- **Surveys have been used to shape national policy for many decades**
- **This use is extensive in areas such as public health policy and economics**
- **Aviation safety is a natural topic for survey data collection**
- **Survey methods are mature and well understood**
- **Best results are achieved with careful design and high response rates**

PLANNED FIELD TRIAL

Joan Cwi

Director, Survey Operations, Battelle CPHRE

Field Trial Team Credentials



- **Data collection will be handled by Battelle Center for Public Health Research and Evaluation (CPHRE)**
- **Has been in operation for 20 years**
- **Manages approximately 60 data gathering activities per year**
- **Many of these efforts are highly sensitive**
 - Physician practice habits
 - Sensitive health topics
- **Data confidentiality has never been compromised**

Field Trial Summer 99



■ Purpose of the trial

- Refine the draft survey instrument
- Address methodological issues
 - Response rates by mode
 - Costs of survey application
 - Data quality and completeness

■ Process

- Iterative
- Multiple small random samples



Field Trial Summer 99 (cont.)

- **Standard Questions**

- Flight experience
- Safety Event experiences

- **Topical Questions**

- Experiences with LAHSO operations (one example)

- **Length**

- Designed for 30 minute completion time or less

Draft

NATIONAL AVIATION OPERATIONAL MONITORING SERVICE



Air Carrier Pilot Test Survey 1

The National Aviation Operational Monitoring Service (NAOMS) is a NASA project. Its purpose is to acquire statistically accurate counts of key safety incidents, and other unwanted events, that are occurring in the national aviation system. NAOMS surveys will also be used to measure the effects of new technologies and procedures when they are introduced to the national aviation system. NAOMS data will be used to track long-term trends in aviation safety and to provide valuable inputs to the decision makers who shape the national aviation safety agenda.

NASA would like to take this opportunity to thank you for your willingness to participate in this effort. The information you provide will be combined with that submitted by others in your group, analyzed carefully, and then presented in a summary format to the

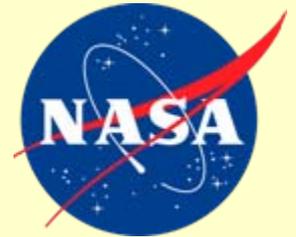


Standard Questions Operating Experience

Intended to . . .

- **Approximate risk exposure**
- **Provide the denominator for safety event rate calculations**
- **For pilots in the field trial**
 - Total flight hours flown
 - Total flight legs flown
 - By aircraft weight class

Standard Questions Safety Events



Derived from . . .

- Focus group input
- Findings from field work
- Information derived from literature review
- Expert opinion

SAFETY EVENTS

Previous 12 MONTHS

(Please describe the safety events that you have personally experienced in the previous 12 months. Some events may fall into more than one of the categories listed below. If so, please list these events in all of the pertinent categories.)

During the past 12 months, a <u>commercial air transport aircraft in which I served as a pilot, second officer, or other flight crewmember</u>:	Number of Occurrences
Spatial Deviation	
Failed to adhere to a land-and-hold-short restriction and entered an active intersecting runway	
Entered a "hot" MOA, ADIZ, or other active special use airspace without authorization	
Aircraft Equipment Problems	
Experienced an engine fire, severe engine damage, or engine separation	
Experienced any aircraft equipment problem that necessitated a return to land or diversion	
Experienced smoke or fire in the cabin, cockpit, or cargo hold	
Actual or Potential Loss of Control	
Experienced a stall or related event that caused a loss of 500 feet altitude or more	
Overran the end of a runway or went off the edge of a runway or taxiway	
Experienced an uncommanded flight control movement that caused loss of aircraft control	
Experienced airframe icing that caused the unwanted loss of 500 feet of altitude or more	
Encountered wake turbulence that induced 45 or more degrees of roll	
Encountered a windshear or microburst that required an emergency escape maneuver	
Took-off with the flight control surfaces, trim, or engine settings improperly configured	

Draft

Draft

CONTRIBUTING FACTORS

In your opinion, what were the factors that caused or contributed to the occurrence of any of these events (please circle all that apply)?

<u>Problematic performance on the part of a</u>				
Flight Crew	Controller	Mechanic	Dispatcher	Other ground personnel
Flight Attendant	Passenger	Other person		
<u>Policy or procedural problems on the part of</u>				
FAA policy	An air carrier	Airport authority	Contract-Maintenance provider	Airframe manufacturer
Engine manufacturer		Avionics or system manufacturer	Other organization	Ground-Support provider
<u>Aircraft design problems involving</u>				
Airframe	Engines	Avionics	Hydraulics Air Conditioning and Pressurization System	
Electrical	Pneumatics	Fuel System	Other subsystem or component	
<u>ATC and weather system design problems relating to</u>				
Radar	Weather data distribution		FANS flight plan processing radio communication	
VOR / VORTAC	LORAN	GPS	HF Communications	ASOS
Other navigational aid	NOTAM Distribution		ATC / Data Link / ACARS Printouts	
<u>Condition of airports</u>				
Ongoing Construction	Taxiway Signage/Markings		Airport Lighting Animal Control	
Runway Markings	FOD or Debris Clearance		Snowplowing	

POSITIVE FACTORS

In your opinion, what kept any of these safety incidents from becoming more serious events or even an accident (please circle all that apply)?

Vigilance and / or timely effective intervention by a:

Flight Crew Controller Mechanic Dispatcher Other ground personnel Flight Attendant
Passenger Other person

Drawing upon past operational experience or training in the following areas:

Emergency procedures Recovery from unusual aircraft attitudes Aerobatics Severe weather encounters
CRM Military flight operations

Aircraft Equipment Redundancy or Reliability, specifically:

Airframe Engines Avionics Hydraulics Air Conditioning and Pressurization System
Electrical Pneumatics Fuel System Other subsystem or component

An effective alerting device, namely:

GPWS TCAS Altitude Alert Stick Shaker Other Stall Warning Device
ATC Low Altitude Alert Other Aircraft Warning Systems

Active intervention by an automated aircraft control system, namely:

Stall Barrier System New Generation "Flight Envelope" Protection

Error tolerances that are intrinsic to, or built into, the aviation system ("Forgiving Factors")

ATC standard separation distances The "big sky"



Special Questions Focus Topics

For the field trial . . .

■ Topic Selection

- Land and Hold Short Operations (LAHSO) was chosen as one test topic because of its high current profile

■ Question Formulation

- ALPA / FAA task force materials
- Approach and landing, Joint Safety Analysis Team (JSAT)
- ASRS incident reports
- Expert opinion

FOCUS QUESTIONS

Our focus this month is on Land and Hold Short Operations (LAHSO) that you have personally experienced during the preceding 30 days. Please limit your responses to descriptions of your own experiences.

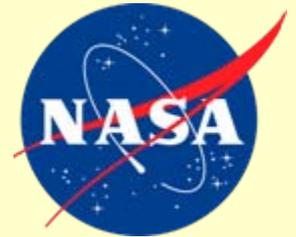
1. Does your company permit LAHSO?	Yes	No
2. Have you been trained on LAHSO?	Yes	No
3. Have you conducted a LAHSO operation during the last 30 days?	Yes	No
Please answer questions 4 through 25 only if your answer was "YES" to all of the above		
4. How many LAHSO landings have you flown during the last 30 days?	(number)	
5. Does your company have policies that restrict the acceptance of LAHSO clearances?	Yes	No
6. Do you know how to get info on effective rwy length after receiving a LAHSO clearance?	Yes	No
7. Have you felt pressured by ATC to accept LAHSO clearances?	Always Rarely	Sometimes Never
8. Have you turned down LAHSO clearances?	Always Rarely	Usually Never
9. Have you declined takeoff clearances because of landing LAHSO aircraft?	Always Rarely	Usually Never
10. Have you accepted LAHSO clearances when you had doubts about your aircraft's ability to successfully comply with their requirements?	Always Rarely	Usually Never
11. Have weather conditions been appropriate for the LAHSO clearances?	Always Rarely	Usually Never
12. Have the LAHSO clearances been issued during wet runway operations?	Always Rarely	Usually Never



How Will the Survey Instrument be Administered?

- **Mailed, Self-Administered:** May send postcard back indicating questionnaire returned, but no identifiers on returned questionnaire
- **Telephone, Scheduled:** Interviewer will mark pilot/ATCs electronic record as completed, but questionnaire will not be linked to anyone
- **In-Person, Scheduled:** Interviewer will have pilot/ATC place unmarked completed interview into postage-paid envelope for respondent to mail

All recorded responses will be held in strict confidence



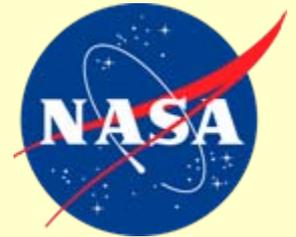
Workshop participants are encouraged to provide input and feedback on the test survey instrument, or the data collection process, either during the course of this workshop or afterwards by mail or e-mail.

PRESENTATION SUMMARY

Linda Connell

NASA Project Manager, Level III

Labor and Industry Participation is Essential



- **To achieve needed participation**
 - Including high response rates
- **To ensure that focus questions relate to high value topics**
- **To apply the NAOMS outputs to operational decision making**
 - Technology development
 - Policies
 - Procedures



Protected Identities

- Identities of all participating persons will be protected either anonymously or confidentially
- There will be no systematic gathering of information that identifies organizations
 - Air carriers
 - Equipment manufacturers
 - Airport / ATC locations
- However, technology focus questions may occasionally reference such organizations



How Focus Questions Will be Formulated

- **Input will be sought from many sources**
 - Technology developers
 - Labor
 - Industry
 - Government agencies
- **NASA will formulate the questions**
 - What questions are included
 - How they are worded
 - Using best scientific methods



Confidentiality / Anonymity

■ PERSONAL IDENTITIES

- All NAOMS data collection will be anonymous or confidential
- No personal names will be recorded with any response
- NASA guarantees these protections

■ ORGANIZATIONAL IDENTITIES

- Information that tends to identify organizations will be collected only when essential to evaluating a technology/procedure impact
- Free-form comments about organizations (e.g., air carriers) will be de-identified in accordance with ASRS policies and procedures



FOIA

- **NAOMS analytic products are intended for open use by the aviation community**
 - Summary reports and related outputs
 - Structured, fully de-identified data sets
- **NAOMS products will be subject to FOIA**
 - Once they are in a finished state
- **NAOMS will not seek publicity**
 - But must respond to media requests as required by FOIA



Discovery

- **Virtually all aviation safety data are subject to discovery**
 - Regardless of who collects it
 - Or, how it is collected
- **NAOMS data will be subject to discovery**
 - But, they will not contain any personal names
 - Will have little if any legal weight

SUMMARY

WORK GROUP GUIDANCE

Linda Connell

Work Group Discussions



- **GENERAL OBSERVATIONS AND REACTIONS**
- **SPECIFIC QUESTIONS**
 - Do you have specific suggestions regarding the conduct of the field trial?
 - Could you suggest ways of improving the proposed data collection process? The survey instrument?
 - Have we adequately addressed issues surrounding data sensitivity and use?

Work Group Discussions (cont.)



■ SPECIFIC QUESTIONS (cont.)

- What can we do to maximize participation and response in the field trial and beyond?
- How might we formalize industry, government, and professional organization participation in continuing NAOMS development? Would an advisory panel be appropriate?
- How should we report back on the results of the field trial to workshop participants?