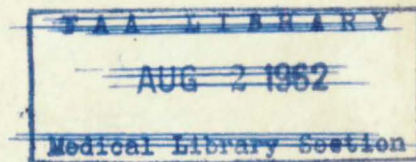


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A HUMAN FACTORS BIBLIOGRAPHY  
ON  
DISPLAY,  
COMMUNICATION,  
CONTROLLER WORKLOAD,  
AIRCREW ACTIVITY,  
AND MAN-MACHINE RELATIONSHIPS



31 January 1962

Contract FAA/BRD-301  
Report #59  
Project AA

1630 PINE STREET  
PHILADELPHIA 3, PA.

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Report #59  
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31 January 1962

Rosa Bernstein  
Wallace H. Wallace

PREPARED

FOR

BY

Aviation Research and Development Service  
Federal Aviation Agency  
Washington 25, D. C.  
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Courtney and Company  
1630 Pine Street  
Philadelphia 3, Pennsylvania

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A HUMAN FACTORS BIBLIOGRAPHY  
ON  
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The purpose of this task was to develop a bibliography covering recent technical literature in selected human factors areas for the Federal Aviation Agency's System Design Team. Some references, although somewhat less recent, were nevertheless included because of their importance. The bibliography should acquaint the team members of the state of the developments in their required areas.

Coverage

The bibliographic areas are as follows:

- a. Display of ATC information and data by radar, filtered radar, scan conversion, etc., and other methods.
- b. Communication studies pertaining or related to Air Traffic Control. (This shall consist essentially of an up-dating of the Bibliography contained in the Convair report "Human Factors Analysis of Voice Communications Practices in Air Traffic Control.")
- c. Studies of controller workload and stress. (This shall consist of an up-dating of work in this area already performed by the contractor and an extension of the area to include studies on stress such as those performed by the Flight Safety Foundation.)
- d. Aircrew activity studies such as Channell, R. C., An Analysis of Pilots' Performance in Multi-Engine Aircraft.

- e. Studies pertinent to the problem of man-machine relationships in the ATC System.

An additional "bibliography of bibliographies" was included which covered the above and related fields. Many of these contain references to older literature.

Before searching the literature, each of the specified areas was more specifically defined. The breakdown of these fields is given in the appendix.

The references in the area of communications supplement the report work done by Convair/Pomona entitled, HUMAN FACTORS ANALYSIS OF VOICE COMMUNICATIONS PRACTICES IN AIR TRAFFIC CONTROL, PART I, June 1960. Included in this report is a comprehensive bibliography which can be found on pages 199-214. In contrast, the general emphasis of the Courtney and Company bibliography is less on the engineering aspects of communications and somewhat more on the human factors level.

When possible, the references given in this bibliography were checked for accuracy by referring to the original source.

#### Sources

The main sources which were used in comparing the bibliography are given below. Whenever a document was uncovered whose title did not indicate that it was clearly relevant, the document was individually checked whenever possible to determine whether it should be included.

A Human Engineering Bibliography (McCollom and Chapanis)

Autonetics Bibliography

Information Requirement Methods as Applied to Development of Displays and Consoles (Havron)

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TABS (ASTIA)

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APPENDIX

## DISPLAY OF ATC INFORMATION

- A. Methods of Studying Displays
- B. Principles of Displays
  - 1. Evaluations of Display
  - 2. Methods of Determining Information Requirements
  - 3. Coding Factors
  - 4. Channel Factors
  - 5. Input/Output Relations
  - 6. Noise
  - 7. Other Factors
- C. Specific Display Techniques and Equipment and Evaluations
  - 1. Plan Position Displays 4.3D
  - 2. Large Scale Displays 5. Color
  - 3. Simulators 6. etc.
- D. Presentation of Symbols and Information--Characteristics and Effects
  - 1. Legibility of Letters, Numbers and Other Symbols
  - 2. Maps, Graphs, Tables
  - 3. Multi-Dimensional Information
  - 4. Specific Types of Information  
(i. e., identity)
- E. Effects of Environment and Presentation Variables
  - 1. Color
  - 2. Phosphor
  - 3. Signal Strength
  - 4. Fading
  - 5. Viewing Angles
  - 6. Ambient Illumination
  - 7. Exposure Time
- F. Other

## COMMUNICATION STUDIES RELATED TO ATC

A. Environmental Effects

1. Ambient Noise
2. Measurement of Ambient Noise Level and its Composition
3. Noise Reduction and Control
4. Aircraft Cockpit Noise (although no detailed search for it since not part of original Convair Bibliography)

B. Effects of Auditory Equipment Components

1. Input Devices--microphones, vibration pickups, etc.
2. Transmission Devices--expanders, filters, clippers, frequency modulators, scramblers, delay lines, etc.
3. Output Devices--includes loudspeaker, earphones, etc.

C. Evaluations of Specific Systems in Speech Communication

1. Telephone and Intercom Systems
2. Radio Systems

D. Basic Data in the Production and Perception of Speech

1. Basic Characteristics of Speech
2. Speech Audiometry and Articulation Testing
3. Speech Masking and Signal to Noise Ratio
4. Speech Distortion and New Communication Techniques--effects of speech intelligibility of clipping, chopping, amplitude modulation, frequency distortion, compression and expansion.
5. Language Design--design of highly audible phrases, phonetic alphabets, mechanized translation, expectations, etc.

E. Training in Speech CommunicationF. Description of Content of Speech in ATC Systems--Communication measurements of Existing Systems

1. Cockpit
2. Ground
3. Air/Ground

COMMUNICATION STUDIES RELATED TO ATC (continued)

G. Considerations in the Design of Semi- and Fully-Automatic ATC  
Communication and Data Link Systems

1. Air/Ground/Air Systems
2. Ground/Ground Systems

## STUDIES OF CONTROLLER WORKLOAD AND STRESS

The outline is approximately as follows, but always only in reference to conditions expected to be encountered by controllers:

- A. Bibliographies
- B. Special Environmental Factors Affecting Performance
  1. Thermal Environments

References to decrements in performance through lack of proper air conditioning, etc.
  2. Noisy environments (mainly others' talking and effects on performance)
  3. Monotonous Environments
- C. Individual Factors, Work Conditions, and Task Characteristics that Affect Behavioral Efficiency
  1. Attention, Alertness, Vigilance
  2. Stress, and Effects of Overloads, in terms of amount of work, speed, complexity, etc.
  3. Fatigue and Behavior Decrement
- D. Activity Analysis of Controllers and Personnel in Related Fields

AIRCREW ACTIVITY STUDIES

- A. Methods of Study
- B. Total Activity Analyses
  - 1. Activities of Individual Aircrew Members
  - 2. Activities of Aircrew Team  
(Emphasize pilot studies)
- C. Partial Activities of Aircrews
  - 1. Visual Processes
  - 2. Communication Processes
  - 3. Motor Activities--Tracking
  - 4. Other

## MAN-MACHINE RELATIONSHIPS

- A. Methodology for Studying Man-Machine Relationships
- B. Man-Machine Integration
1. Allocation of Function in Man-Machine Systems (includes automation and performance, man's strengths and weaknesses as system component)
  2. Theory of Man-Machine Integration
- C. Man Considered as a System Component
1. Overall emphasis is on operator characteristics limiting system performance, e.g., input rates.
    - physical dimensions
    - \*capability for data sensing
    - \*capability for data processing
    - capability for motor activity
    - capability for learning
    - physical and psychological needs
    - sensitivities to social environment
    - coordinated action
    - differences among individuals
    - capability for high loads and stress (see other bibliography)
  2. Team Composition, Crew Behavior and Organization, et al, and Effect on System and Productivity of Group
  3. Characteristics of Man's Performance in Man-Machine Systems
    - Vigilance and Monitoring
    - Information Processing
    - Storage
    - Transfer of Information
    - Decision Making

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\* Emphasized areas

MAN-MACHINE RELATIONSHIPS

D. Machine Factors Affecting Man's Performance

Brief references here to:

1. Design and Workspace Layout
2. Design of Equipment
3. Display Control Relationships

E. Specific System Description Designs, and Evaluations

F. Other