AIRCREW TASK SURVEYS: SELECTION CRITERIA FOR LOW-COST TRAINING TECHNOLOGY APPLICATIONS

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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235-5601
This paper documents the first phase of a research and development effort to obtain opinion data from Air Force operational aircrews to support the selection of training tasks as candidates for the development of several high-technology, low-cost, part-task trainer demonstrations. The overall goal of the effort is to develop and combine scientifically derived, advanced part-task training methods with state-of-the-art training technology. Several surveys of aircrews who fly tanker, transport, or bomber type aircraft were conducted to elicit their opinions regarding training issues which bear on the matching of task characteristics with low-cost training technology. Survey results provide a general guide to the selection of appropriate tasks for further analysis.
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This publication is primarily a working paper. It is published solely to document work performed.
SUMMARY

Selected members of the tanker, transport and bomber aircrew community of the Air Force were surveyed to obtain their opinions relative to several training issues which appear to bear on the application of low-cost training devices to support the training of aircrews on specific, mission-related tasks performed in the aircraft. This investigation is the initial phase of an effort to develop, validate, and demonstrate the application of advanced part-task training methods and technology for aircrew training. Results from the surveys were used to identify classes of tasks for further analysis which will ultimately lead to development of prototype part-task trainer demonstrations.
PREFACE

This effort represents a portion of the research and development (R&D) program of the Air Force Human Resources Laboratory for Technical Planning Objective 3, the thrust of which is Aircrew Training Effectiveness. The general objective of this thrust is to identify and demonstrate cost effectiveness in training Air Force/aircrew members. More specifically, the effort was part of the R&D conducted under the Aircrew Training Effectiveness subthrust, which has as its goal the provision of a technology base for improving the effectiveness and efficiency of training combat aircrews. The present effort was conducted as a part of Work Unit 1123-25-01, Special Function Trainer Technology. The research was accomplished in cooperation with the Military Airlift Command (MAC) and Strategic Air Command (SAC) in accordance with terms of Memoranda of Agreement with the two organizations specifying the accomplishment of aircrew surveys to identify part-task training R&D requirements. The author acknowledges the cooperation and support of this effort by individuals within both commands. Specifically acknowledged is the assistance of Lt Col Joe Burch, and Mr. Don Barkley, HQ MAC/DOT; Major Irving Boswell and Major Terry Matthews, 93 BMW/DOS (SAC); and Mr. Charles Hamilton, AFMPC/YPS. These individuals made substantial contributions to the development and administration of the survey instruments used in this effort.
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I. INTRODUCTION

This paper documents the first phase of a research and development (R&D) effort to support improved training of Air Force aircrews. The objective of this first phase of the effort was to survey operational aircrews in order to obtain relevant data about the tasks they perform during aircraft missions. The surveys described in this paper provide initial evidence to support the selection of training tasks for the development of several high-technology, low-cost part-task trainer demonstrations. The overall goal of the effort is to demonstrate state-of-the-art hardware/software configurations as vehicles for advanced, scientifically valid part-task training.

The surveys were designed to elicit aircrew member opinions regarding training issues which bear on the matching of task characteristics with training technology, particularly low-cost technology. These issues are: (a) adequacy of training provided in current programs for specific tasks; (b) relative difficulty of tasks; (c) level of training device cost/complexity required to support training for tasks; and (d) appropriateness of high-technology, low-cost alternatives to support training for tasks.

In this report, for purposes of orderly exposition, a more comprehensive discussion of the utilization of survey data, and their implications, will be deferred until after the surveys themselves have been fully described.

Approach to Surveys

The development and administration of the aircrew task surveys was a cooperative effort between the Air Force Human Resources Laboratory, Operations Training Division (AFHRL/OT), and the user commands (Military Airlift Command (MAC) and Strategic Air Command (SAC)). Decisions concerning which aircraft missions/tasks to include in the surveys, the design of questionnaire content, aircrew sampling requirements and provisions, survey administration, data analysis and reporting of results were reached jointly between AFHRL/OT and users. Authorization to conduct surveys within the Air Force was obtained from the Air Force Military Personnel Center (AFMPC, YP).

Aircraft Types

The scope of the surveys was based on obtaining a reasonable cross-section of the range and types of tasks performed during aircrew missions. In the first phase, which was limited to tanker, transport, bomber (TTB) aircraft, the following aircraft were selected for general representativeness, with the concurrence of HQ SAC, Deputy Commander, Operations Training (DOT) and HQ MAC CDT, respectively: C-5A and KC-135 SAC; C-130 and C-141 MAC. It was also determined jointly that each aircrew position for each aircraft would be included in the surveys.

Aircrew Mission Task Lists

Development of the questionnaires began by obtaining task listings for each aircrew position for each of the aircraft selected. These lists were obtained from SAC and MAC as official master task lists. Because of space limitations in the questionnaire, the tasks comprising the mission
were described generally rather than in detail. Task listings in the questionnaires comprised
the entire mission, but each task listed subsumed a considerable number of subtasks which were
not specifically listed. Tasks were listed chronologically as accomplished during the mission.

**Aircrew Sampling**

The objective of sampling was to obtain reasonable representativeness of opinions of the
aircrew member population by aircraft type. However, for purposes of administrative control and
in order to expedite data collection, the most efficient method was for HQ MAC/DOT and HQ SAC/DOT
to administer surveys via lines of authority to operational wings and training squadrons. In
order to obtain representativeness, the distribution of questionnaires was balanced across wings
and squadrons. A goal of a minimum 20% sample of aircrews for each aircraft and each aircrew
position was attempted for each of the surveys.

**Design of Surveys**

The intent of the survey was to elicit an opinion from each aircrew member relative to each
of the major tasks performed during the mission. In the questionnaire, the respondent was
required to answer four questions about each task listed. Each question was constructed to
assess a selection factor judged by researchers as important in determining the relative
appropriateness of tasks as candidates for part-task training research. In the format of the
questionnaire, these questions appear on page 3, opposite a listing of the mission tasks for each
aircrew position. A copy of the questionnaire for the 3-52 radar navigator/navigator position is
included in Appendix A. This questionnaire is typical of those used for all aircraft types and
crew positions surveyed. In each case, the respondent was asked to rate factors relative to
tasks by placing a numbered response (corresponding to rating scales provided with the questions
on page 3) in the appropriate column and row for each task listed on page 2. For example,
Question A, which asks the crew member to rate the adequacy of training provided for the task,
has a response scale ranging from 1 (very inadequate) to 5 (very adequate). The questionnaire
was formatted such that when the respondent had answered Questions A, B, C, and D for all tasks
which comprise his/her mission, a composite picture of opinions in terms of the four task
selection factors would emerge on page 2.

**Task Selection Factors**

The selection factors, as represented in Questions A through D, were generally in an
ascending order of specificity and pointed toward assessing the appropriateness/utility of
special function trainers (SFTs) to support training for tasks. An SFT was defined in Question C
as a microcomputer-based desk top trainer. The rationale underlying each of the questions was as
follows:

Question A asked the respondent to rate the adequacy of training for each task in the current
training program, on a 1 to 5 response scale. The intent was to assess how well the aircrew
member perceived he/she had been trained to perform each task. The purpose was to identify tasks
for which improved training appears warranted.

Question B addressed the relative difficulty of tasks, defined as amount of training time
required by the crew member to learn to perform the task relative to other tasks in the mission.
The scale ranged from 1 (much less than average [amount of time]) to 5 (much more than average).
Tasks judged more difficult would be more likely to be selected as candidates for part-task
training.
Question C asked the respondent to estimate the minimum level of training media required to support training for the task. It assumed the respondent was familiar with the training capabilities of each of the devices/methods listed as options. The options, listed from highest to lowest in terms of cost, ranged from 1 (aircraft) to 8 (workbooks, regs, study guides, texts, etc.). The intent was to determine if the tasks were appropriate for the general area of part-task training. As a general rule, if the task was judged to be supportable at levels 5 through 8, it was considered a potentially selectable training task.

Question D asked for an estimate of how useful an SFT (defined in Question C) would be for training any part of the task. The scale ranged from 1 (not useful at all) to 5 (very useful). The question was designed to elicit specific consideration of the "new technology" option. It assumed that aircrew members were well enough aware of microcomputer-based technology to form opinions of its potential for training.

Implications of Responses

None of the factors taken singly could provide a sufficient basis for selecting candidate tasks. However, taken collectively, these data provide an opinion "profile" on each task in order to identify and prioritize tasks for further analysis.

Open-Ended Response Items

Page 4 of each questionnaire contained five open-ended questions to be answered at the option of the respondent. The purpose of these questions was to provide an opportunity for aircrew members to express opinions about the training program independently from task-specific questions. The method used to classify these responses is described later in this paper.

Coordination of Questionnaire Content/Format

The format and content of all questionnaires were essentially the same except for the tasks listed on page 2, which were specific to each crew position and aircraft. Draft questionnaires were forwarded to HQ MAC/DOTR and HQ SAC/DOTP for examination and revision by subject-matter experts. Following concurrence on format and content, each questionnaire was forwarded to AFMPC/YP for approval and authorization to be used as a survey instrument. The surveys were assigned an AFMPC control number which appeared on the cover of the questionnaires. Questionnaires were then reproduced in quantity and forwarded to MAC and SAC for administration.

II. METHOD

Survey Administration

The administration of each survey was accomplished by either HQ MAC/DOTR or HQ SAC/DOTP, as appropriate. Two hundred fifty copies of each questionnaire were distributed among units within the operational wings of these MAJCOMs. An attempt was made to distribute questionnaires in a balanced fashion across units. Survey control officers were assigned at each participating unit to distribute, control, and collect questionnaires. Typically, 5 to 7 days were allowed for the respondent to complete the questionnaire and return it to the unit control officer. All questionnaires were collected by HQ MAC/DOTR or HQ SAC/DOTP and returned to AFHRL/DT for data analysis.
**Data Analysis**

Data from each of the surveys were computer analyzed and tabulated to show the spread of responses across the scale for each of the questions (A – D) for each aircrew member position and aircraft. An example of one such table is shown in Table 1.

| A. How do you rate the adequacy of training for this task in the current B-52 program? |
|---------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|
| very inadequate | neither adequate | very adequate |
| inadequate | nor inadequate | adequate | 5 |
| 1 | 2 | 3 | 4 | 5 |
| Mission tasks | 1 | 2 | 3 | 4 | 5 | M | SD |
| 1 | 1.0 | 4.0 | 6.1 | 60.6 | 28.3 | 4.11 | .77 |
| 2 | 1.0 | 1.0 | 5.1 | 59.2 | 33.7 | 4.23 | .69 |
| 3 | 3.0 | 3.0 | 11.1 | 50.5 | 32.3 | 4.06 | .81 |
| 4 | 1.0 | 2.0 | 3.1 | 60.2 | 33.7 | 4.23 | .70 |
| 5 | 2.0 | 4.1 | 3.1 | 60.2 | 30.6 | 4.13 | .82 |
| 6 | 2.0 | 3.1 | 3.1 | 60.2 | 31.6 | 4.16 | .80 |
| 7 | 7.1 | 20.4 | 18.4 | 36.7 | 17.3 | 3.37 | 1.20 |
| 8 | 1.0 | 4.1 | 12.4 | 55.7 | 26.8 | 4.03 | .81 |
| 9 | 2.0 | 7.1 | 15.3 | 57.1 | 18.4 | 3.83 | .89 |
| 10 | 9.3 | 8.2 | 19.6 | 44.3 | 18.6 | 3.55 | 1.16 |
| 11 | 2.0 | 4.1 | 5.1 | 61.2 | 27.6 | 4.08 | .82 |
| 12 | 1.0 | 2.0 | 6.1 | 63.3 | 27.6 | 4.14 | .70 |
| 13 | 2.0 | 2.0 | 7.1 | 58.2 | 30.6 | 4.16 | .88 |
| 14 | 3.1 | 3.1 | 8.2 | 55.1 | 30.6 | 4.07 | .89 |
| 15 | 2.0 | 9.2 | 11.2 | 59.2 | 18.4 | 3.83 | .91 |
| 16 | 1.0 | 1.0 | 12.2 | 61.2 | 24.5 | 4.07 | .71 |
| 17 | 1.0 | 1.0 | 10.2 | 63.3 | 24.5 | 4.09 | .69 |
| 18 | 11.9 | 18.3 | 20.4 | 33.3 | 16.1 | 3.24 | 1.25 |
| 19 | 11.3 | 18.6 | 25.8 | 36.1 | 8.2 | 3.15 | 1.18 |
| 20 | 11.2 | 18.4 | 26.5 | 33.7 | 10.2 | 3.18 | 1.23 |
| 21 | 1.0 | 2.0 | 6.1 | 68.4 | 22.4 | 4.09 | .67 |
| 22 | 1.0 | 1.0 | 4.1 | 71.1 | 22.7 | 4.13 | .62 |
| 23 | 1.0 | 2.1 | 6.2 | 63.9 | 26.8 | 4.13 | .70 |

The table shows the percentage of B-52 radar navigator/navigators who selected each point on the response scale of Question A for each listed task. In addition, a mean rating for each task is provided. By inspecting the data table, tasks can be ranked according to the perceived adequacy of training. As indicated in Table 1, task 19 was the task for which training was perceived to be least adequate, followed by tasks 20 and 18.

For each questionnaire, only those tasks were identified and ranked for which the percentage of ratings most clearly indicated relevance for selection. The same process was repeated for Questions B, C, and D to obtain task rankings. For nearly all tables, it was necessary to rank
no more than 5 or 6 tasks, due to the spread of response data. Following the ranking of tasks according to this method, a composite of the rankings was constructed by ranking tasks across the four questions, as shown in Table 2, which provides a clear picture of the relationships among the ranked (prioritized) tasks. Obviously, of most interest would be clustering of the rankings of factors on specific tasks; and tasks for which two or more factors ranked highly were of interest as candidates for selection. For the radar navigator/navigator tasks, clustering of rankings appears for tasks 18, 19, and 20, which ranked first, second, or third on all four criteria. Task 19 ranked first on Questions A, C, and D and second on B. Task 20 ranked second on A, C, and D and third on B. Task 18 ranked third on A, C, and D and first on B. Other tasks on the table showed no substantial clustering effects.

Table 2. Results of Rankings of B-52 Radar Navigator/Navigator Tasks According to Relevance of Responses to Four Selection Factors (Questions A, B, C, and D)

<table>
<thead>
<tr>
<th>B-52 Tasks: Radar Navigator/Navigator</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perform aircraft preflight/documents/check aircraft equipment</td>
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<tr>
<td>2. Perform before exterior inspection</td>
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<td>3. Perform exterior inspection/check condition bomb bay</td>
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<td>4. Perform interior inspection</td>
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<td>5. Perform after engine start procedures</td>
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<td>6. Perform before takeoff procedures</td>
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<td>7. Perform minimum interval takeoff, formation flying and enroute cell</td>
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<td>8. Perform inflight terrain avoidance functional check</td>
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<td>9. Perform air refueling rendezvous procedures</td>
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<td>10. Perform coded switch sequence enabling procedures</td>
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<td>11. Complete weapons preparation for release checklist</td>
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<td>12. Perform before initial point checklist</td>
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<td>13. Perform synchronous bomb run</td>
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<td>14. Perform missile launch</td>
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<td>15. Complete short/retained weapons nuclear checklist</td>
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<td>16. Perform climb after low level checklist</td>
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<td>17. Perform withdrawal checklist</td>
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<td>18. Perform emergency/abnormal offensive avionics station procedures</td>
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<tr>
<td>19. Analyze/resolve abnormal/unsafe weapons status indications</td>
<td>1</td>
<td>2</td>
<td>1</td>
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<tr>
<td>20. Analyze/resolve weapons release malfunctions</td>
<td>2</td>
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<td>21. Perform before descent checklist</td>
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<td>22. Perform descent and before landing checklist</td>
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<tr>
<td>23. Perform after landing status</td>
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The same process was carried out across all questionnaire data for all surveys. For purposes of simplification, the results of this analysis are summarized below by aircraft and squadron member position. The number and percentage of individuals who completed and returned questionnaires distributed are indicated for each.
III. RESULTS

Task Selection

As a result of the analysis described above, the following tasks were identified (and prioritized) as candidates for further consideration and analysis:

C-141 Aircraft

Pilot/Copilot (N = 137, 54%)

1. Compute takeoff, climb, and cruise data
2. Prepare for air refueling procedure
3. Operate navigation system
4. Operate pneumatic system
5. Operate hydraulic system

Navigator (N = 73, 29%)

1. Perform airdrop calculations
2. Perform inflight fuel management
3. Operate inertial navigation system
4. Operate station-keeping equipment
5. Operate communications system
6. Operate aircraft system
7. Interpret pilot instruments

Flight Engineer (N = 121, 48%)

1. Perform special/all-weather procedures
2. Perform airdrop mission procedures
3. Perform communication/navigation equipment operations
4. Operate fuel savings advisory system
5. Operate electrical systems operations
6. Perform weight and balance procedures

Loadmaster (N = 102, 41%)

1. Perform radio operations
2. Operate airdrop equipment
3. Perform gear malfunction requirements
4. Compute DD Form 365-4, A Weight and Balance Clearance Form I—Transport
5. Compute roller load limitations

C-130 Aircraft

Pilot/Copilot (N = 179, 66%)

1. Compute takeoff and landing, climb, cruise and descent data
2. Perform mission planning/preparation
3. Operate airdrop equipment
4. Operate station-keeping equipment
Navigator (N = 105, 42%)

1. Fix aircraft position using pressure pattern methods
2. Fix aircraft position using celestial methods
3. Maintain inflight log and chart
4. Compute MAC Form 512, The Computed Air Release Point, data for all load types
5. Interpret pilot's horizontal situation indicator

Flight Engineer (N = 105, 42%)

1. Verify weight and balance data
2. Perform special and all-weather operations
3. Compute takeoff and landing, climb, cruise, and descent performance data

Loadmaster (N = 107, 43%)

1. Determine winch capabilities
2. Computer cargo load shoring requirements
3. Determine load placement
4. Compute weight and balance data
5. Compute extraction system limitations
6. Determine personnel airdrop equipment requirements

B-52 Aircraft

Pilot/Copilot (N = 104, 42%)

1. Perform before-leaving aircraft checklist/procedures
2. Perform calibration procedures
3. Perform after-landing checklist/procedures
4. Perform before-lineup procedures

Radar Navigator/Navigator (N = 99, 40%)

1. Analyze/resolve abnormal, unsafe weapons status indications
2. Analyze/resolve weapons release malfunctions
3. Perform emergency/abnormal offensive avionics station procedures

Electronic Warfare Officer (N = 93, 37%)

1. Perform defensive procedures
2. Perform penetration duties
3. Perform low-altitude procedures

Support (N = 76, 30%)

1. Perform fire control system checkout procedures
2. Perform strainge-field training procedures
3. Perform fighter intercept exercise procedures
**KC-135 Aircraft**

**Pilot/Copilot (N = 171, 68%)**
1. Compute takeoff, climb, and cruise data
2. Compute penetration descent/approach/landing data
3. Perform system malfunction analysis procedures
4. Perform emergency war order mission preparation

**Navigator (N = 132, 53%)**
1. Perform celestial navigation
2. Perform system malfunction and analysis procedures
3. Operate with abnormal equipment
4. Perform air refueling procedures

**Boom Operator (N = 152, 68%)**
1. Perform weight/balance calculations
2. Perform celestial navigation procedures

---

**Data for Open-Ended Response Items**

The open-ended questions on page 4 of each questionnaire provided the opportunity for aircrew members to express personal opinions about the training program, exclusive of the task-specific training data on pages 2 and 3. In order to tabulate these comments, researchers developed a pool of response-coded categories and prepared short phrase descriptors for each category. Phrase descriptors were reviewed to ensure that the list of descriptors adequately summarized the range and content of the written responses across each aircraft aircrew position. In some cases, several behavioral scientists were used to verify the adequacy of the descriptors. Researchers then re-read each questionnaire and coded the written responses using the validated response categories. The coded responses were then input to a computer and tabulated. The results for each were unique. The tabulated results are contained in Appendix B.

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**IV. DISCUSSION**

**Application of Current Findings**

As discussed earlier, each of the tasks listed in the questionnaires represents a considerable variety of subtasks comprised of various behavioral elements. Not only does each task subsume a large number of subtasks but, in turn, each subtask may be comprised of numerous elements representing diverse behavioral components.

No attempt has been made at the present level of analysis to assess the behavioral dimensions of tasks nor to subdivide them into subtasks or elements. More detailed analysis must await intervention of the user as to the sophistication and priorities of tasks selected in the event of the present aircraft operation data. Once final task selection is made, a detailed analysis will ensue, including the following: a) subdivision of tasks into operationally oriented subtasks, b) division of subtasks into behavioral elements; c) determination of primary loadings of tasks on behavioral dimensions such as perceptual, cognitive, and psychomotor components, and ...
determination of which subtasks and/or behavioral elements can be most effectively supported through the application of SFT technology/methodology. This effort will encompass in-depth behavioral analysis and development of an SFT of advanced hardware/software design for each MAJCOM user. The trainers will be developed jointly with the MAJCOM, which will be involved throughout all phases of development. Software features will include real-time simulation of tasks or part-tasks, performance measurement in the form of feedback and scoring, guidance to the student (tutorial courseware), and instructor-controlled training scenarios. Hardware will be configured with capabilities for advanced computer graphics, videodisc, student responding modes, and other peripheral devices to support specific behavioral requirements. Trainers developed under this effort will be used initially as technology demonstrations. They will be validated first in an experimental environment in which selected part-task strategies will be manipulated to optimize training effectiveness. Final validation of trainer prototypes will be accomplished in the operational training environment in cooperation with the appropriate MAJCOM; once validated, the trainers will be turned over to the command for follow-on applications.

**Task Selection Outcomes**

Four task selection factors were represented in the questionnaires. As described previously, the loadings on these factors were used to select tasks for further discussion and analysis in dialogue with the appropriate MAJCOM. Examination of the selection factors showed the most pronounced loading or clustering occurred on several navigator and electronic warfare officer tasks. Clustering of factors was much less pronounced for pilot, copilot, and flight engineer tasks in general and for B-52 gunner and KC-135 boom operator tasks in particular. Pilot opinions strongly favored the use of aircraft or simulators for training most tasks listed in the questionnaires. Tasks performed by navigators and/or electronic warfare officers were considered generally more suited to the capabilities of SFTs because of the requirements for information display, and task interaction, and the perceptual and cognitive aspects involving computations, manipulation of instruments, and similar operations.

Examination of the nature of each of the selected tasks reveals some fairly obvious correspondence between requirements for training and the capabilities of SFTs.

**Special Function Trainer (SFT)**

The SFT represents a level of training device technology which bridges the gap between academics (including computer-assisted instruction [CAI]) and flight simulators. The SFT is built around a specific, real-time task, with emphasis on engaging the student in the task at the earliest point possible in the training program. SFT capabilities include: (a) providing the essential fidelity dimensions (real time as required) of the task; (b) providing effective guidance, practice, and feedback to the student; (c) permitting self-assessment of proficiency on the task as part of the feedback process; and (d) providing necessary student records and training management resources. The SFT's task-centralized approach affords wide latitude to the training manager in incorporating the system within the program. For example, in SFT can be used as an adjunct to an existing CAI program. Also, the SFT hardware configuration may accommodate a variety of training tasks through multiple software packages.

**Training Power of the System**

The specific characteristics which constitute the training power of the SFT are: (a) real-time simulation of the task and thus, (b) an abundance of time on task for each student to achieve proficiency prior to flight simulator and/or aircraft phases of training, and (c) direct
assessment of student achievement through performance-scoring software. The latter characteristic is essential for the learner, to assess his/her own rate and level of performance, and for the training manager, to determine when the learner is ready for the next phase of training. Various other features can be designed into the system software. One is the capability for the instructor to vary the level of difficulty of the task or to modify the elements of the training scenario.

Task-Technology Match

In general, the tasks selected for further study and analyses tended to fall into three categories: (a) procedurally oriented operation of aircraft subsystems and checklists, (b) monitoring and computational tasks associated with subsystem operations, and (c) planning and decision making associated with the mission.

Training fidelity requirements for these tasks appear to be within the range of capabilities which characterize the SFT technology. For example, provision for essential information, cues, task practice, and feedback seems achievable with microcomputer technology. Operation of aircraft subsystems, in many cases, can be simulated using an SFT. For example, the graphics system could be used to represent the various displays and controls of the aircraft subsystem, and the student could simulate interaction with the controls via a touch screen, mouse, digi-pad, joystick, or other control. Software could be developed to simulate the task in real time, if required, or at a more basic level, to simulate the step-by-step aspects of system operation in non-real time. The training of procedures could be accomplished at several levels of difficulty, beginning with fundamentals and progressing through normal mission scenarios to abnormal operations and emergency procedures. The hardware configuration for SFTs is sufficient to achieve acceptable levels of task fidelity for these procedural tasks. Levels of task difficulty are primarily a function of the sophistication of the software.

Acquisition of computational, mission planning, and decision-making skills can be readily supported by SFTs. Simulation fidelity requirements for these types of tasks are, in many cases, less demanding than for aircraft subsystem operations. The information (knowledge) and concept acquisition associated with the performance of aircrew tasks can be easily supported with SFTs. However, knowledge level requirements, in many cases, may be more efficiently treated and tested through individual reading materials and exercises. For example, for knowledge acquisition, pretraining is most effective when the student is given the opportunity to apply knowledge in a mission-related, operational context.

To summarize, there appears to be a useful correspondence between the tasks tentatively selected using the survey data and the potential of the SFT technology to train the tasks effectively.

Aircrew Member Comments

One of the major opinions expressed in the open-ended response portion of the questionnaires was the need for more realistic, combat, or hostile environment training. This opinion surfaced in nearly all of the questionnaires across aircraft and crew member positions and was mentioned particularly frequently by KC-135 pilots/copilots and flight engineers, C-141 pilots/copilots and navigators, and C-130 pilots/copilots. See Appendix A. Other frequently mentioned training needs (listed in approximate order of frequency) were as follows: (a) greater access to simulators (KC-135 pilots/copilots and boom operators; C-130 pilots/copilots and navigators; C-141 loadmasters, pilots/copilots, and flight engineers); (b) more efficient use of flight time (KC-135
navigators, pilots/copilots, and boom operators; C-130 flight engineers, pilots/copilots, and loadmasters; B-52 pilots/copilots; (c) better training technology/training materials (KC-135 pilots/copilots, boom operators, and navigators; C-130 pilots/copilots and navigators; B-52 navigators and gunners); (d) more flight time (KC-135 pilots/copilots, navigators, and boom operators; C-141 pilots/copilots and navigators); (e) better fidelity and maintenance of simulators (B-52 electronic warfare officers; C-141 pilots/copilots and loadmasters; B-52 pilots/copilots; KC-135 pilots/copilots); (f) better use of simulator time (KC-135 navigators and pilots/copilots; B-52 pilots/copilots; C-130 pilots/copilots); (g) integration of weapon system training into the training syllabus (KC-135 navigators; B-52 electronic warfare officers, navigators, and gunners); (h) use of SFTs or CPTs (C-141 pilots/copilots, flight engineers, and navigators; KC-135 navigators); (i) better use of instructors (KC-135 pilots/copilots and navigators); (j) more emergency procedures training (KC-135 navigators and pilots/copilots; C-130 flight engineers); (k) more crew coordination training (KC-135 navigators and pilots/copilots; B-52 gunners); (l) more hands-on training (KC-135 boom operators; C-141 loadmasters); (m) more aircraft systems training (C-130 flight engineers; KC-135 pilots/copilots; C-141 navigators); and (n) more off-station (strange field) training (KC-135 pilots/copilots and navigators).

The opinions of C-130 and C-141 aircrew members expressed relative to SFTs reflect a growing awareness of the capabilities of this type of technology, possibly engendered by recent experimental applications of SFTs by MAC.

V. CONCLUSIONS

The results of the present effort have been systematically tabulated and examined, and an initial identification of tasks has been accomplished based on the opinion data. Now required is a dialogue with the user MAJCOMs, in which the survey data can serve as a point of departure for discussions whereby other selection criteria can be added and a final priority can be assigned by the commands to the appropriate tasks. These tasks will then be extensively analyzed and used in experimental environments in which various part-task training methods are employed to determine how to subdivide and reintegrate tasks during training. Part-task training methodology will then be applied to the development and evaluation of several prototype SFTs. The ultimate objective is to demonstrate optimal mixes of training devices and training methodology as a means of improving aircrew training while reducing training costs.
APPENDIX A:  AIRCREW TASK QUESTIONNAIRE SAMPLE

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS STRATEGIC AIR COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA 68113

B-52 RADAR NAVIGATOR, NAVIGATOR TASK SURVEY

Your responses to this questionnaire are important. They will contribute to improved B-52 training. The purpose of this questionnaire is to determine your perceptions about training for tasks you perform. Data will be used to prioritize program improvements, not to justify reduced flying hours or simulator buys. Questions relate to adequacy of training, training difficulty, task media matching, and potential use of microcomputers.

Enter ONLY the information requested below:

Assigned Wing __________________________________________
Primary Mission __________________________________________
Total flying hours ______ Total B-52 flying hours ______
Hours per month currently flying __________________________

All responses to this survey are anonymous. Please answer all items candidly and completely. Comment freely. If you feel important tasks have been omitted, list them.

PLEASE OPEN THE QUESTIONNAIRE

USAF SCN: 54-158
INSTRUCTIONS. For each task listed below answer questions A.B.C.D. shown on the facing page. Select the desired response number for each question and write it in the appropriate column (A.B.C.D) and row on this page.

Example: Task: Calibrate equipment

B-52 TASKS: RADAR NAVIGATOR NAVIGATOR

<table>
<thead>
<tr>
<th>Task</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Questions (Next pg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perform A/C prefix, docmts, Chk A/C eqpmnt</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>3</td>
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<tr>
<td>2. Perform before exterior inspection</td>
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<tr>
<td>3. Perform ext inspection, Chk condtn bomb bay</td>
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<tr>
<td>4. Perform interior inspection</td>
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<td>5. Perform after engine start procedures</td>
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<td>6. Perform before takeoff prods</td>
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<td>7. Perform MITO, formation flying and enroute cell</td>
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<td>8. Perform inflight TA functional chck</td>
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<td>9. Perform air refueling rendezvous prods</td>
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<td>10. Perform OSS enabling prods</td>
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<td>11. Complete weapons preparation for release chck list</td>
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<td>12. Perform before IP chck list</td>
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<td>13. Perform asynchronous bomb run</td>
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<td>14. Perform missile launch</td>
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<td>15. Complete short retain weapons nuclear chck list</td>
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<td>16. Perform climb after low 'eave' chck list</td>
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<td>17. Perform withdrawal chck list</td>
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<tr>
<td>18. Perform emergency/abnormal OAS prods</td>
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<td>19. Analyze resolve nornl unsafe weapons status instrns</td>
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<tr>
<td>20. Analyze resolve weapons release malfunctions</td>
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<tr>
<td>21. Perform before instant chck list</td>
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<tr>
<td>22. Perform instant and before landing chck list</td>
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<tr>
<td>23. Perform after landing duties</td>
<td></td>
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</tbody>
</table>

List additional tasks here (optional)
### QUESTIONS

**A.** How do you rate the adequacy of training for this task in the current B-52 program?

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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>very inadequate</td>
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<tr>
<td>inadequate</td>
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</tr>
<tr>
<td>neither adequate nor inadequate</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>adequate</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>very adequate</td>
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</tbody>
</table>

**B.** Compared to the other tasks within the mission, how much training time did you require to learn to perform this task?

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</thead>
<tbody>
<tr>
<td>much less than average</td>
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<tr>
<td>less than average</td>
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<tr>
<td>average</td>
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<td>more than average</td>
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<tr>
<td>much more than average</td>
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</table>

**C.** Devices/methods below are ranked from high to low by estimated overall training cost. Which of these could provide minimally adequate training for this task at least cost, assuming the device/method is available as needed?

1. Aircraft
2. Weapons Systems Trainer (WST) B-52 real time simulation plus full-color visual system
3. Operations Flight Trainer (OFT) WST less visual system
4. Cockpit Procedures Trainer (CPT) Basic aircraft subsystems instrumentation/controls
5. Special Function Trainer (SFT) Microcomputer-based desk top trainer with interactive touch-screen graphics, self-paced procedures and task specific skills testing
6. Classroom instruction
7. Mockups, training aids, audiovisuals, etc.
8. Workbooks, refs, study guides, arts, etc.

**D.** How useful would a Special Function Trainer (described in C5 above) be for providing training for any part of this task?

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</thead>
<tbody>
<tr>
<td>not useful at all</td>
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<tr>
<td>slightly useful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>moderately useful</td>
<td></td>
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<td></td>
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<tr>
<td>useful</td>
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<tr>
<td>very useful</td>
<td></td>
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</tbody>
</table>

Comments:
Please provide brief written responses for these questions:

1. What changes in the current training program do you feel are needed to insure the highest possible levels of aircrew combat readiness?

2. How can available flying hours be more effectively used for various phases of the current training program?

3. How can available simulator hours be more effectively used within the program?

4. What additional equipment or methods not now available is are needed to enhance training effectiveness?

5. Please make other suggestions or comments about improving the training program.
APPENDIX B: SUMMARIES OF OPEN-ENDED RESPONSES
Table B-1. SAC B-52 - Pilot/Copilot (N = 104)

<table>
<thead>
<tr>
<th>Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. More realistic training</td>
<td>32</td>
<td>12</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>51</td>
</tr>
<tr>
<td>2. Better use of simulator time (weapon system trainer)</td>
<td>14</td>
<td>27</td>
<td>4</td>
<td>2</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>3. No change/positive comment</td>
<td>5</td>
<td>12</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>4. Better maintenance on simulator/WST/cockpit procedures trainer</td>
<td>1</td>
<td>17</td>
<td>3</td>
<td>4</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>5. More efficient use of flight time</td>
<td>19</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>6. More hostile environment training</td>
<td>19</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>7. More aerial refueling and low level</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>8. Shorter local missions</td>
<td>5</td>
<td>12</td>
<td>3</td>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>9. Eliminate long strategic training range complex runs - more local</td>
<td>3</td>
<td>14</td>
<td>1</td>
<td>0</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>10. Better training technology/materials</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>13</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>11. Fewer students; more instructors</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>12. Better scheduling</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>13. Add simulator with visual system</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>14. More electronic warfare officer training</td>
<td>12</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>15. More crew coordination training</td>
<td>4</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>16. More tactical missions</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td></td>
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<tr>
<td>17. More enemy weapons/tactics training</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>18. Better pre-mission training</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>12</td>
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<td>19. More variety in aircraft training</td>
<td>5</td>
<td>4</td>
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<td>20. More strange field/low level</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>13</td>
<td></td>
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<tr>
<td>21. More simulator time</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>22. Other administrative change</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>23. Terrain avoidance calibration and flying</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>24. More cell training</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>25. More flying time</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>26. More aircraft system training</td>
<td>0</td>
<td>8</td>
<td>2</td>
<td>1</td>
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Table B-5. SAC KC-135 - Pilot/Copilot (<i>N = 171</i>)

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<td>3. More efficient use of flight/simulator time</td>
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<td>11. Fewer students; more/better use of instructors</td>
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<td>12. More aircraft systems training</td>
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<td>13. More reliable/simplified calculator/computer programs for performance computation</td>
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<td>14. More proficiency hours</td>
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<td>15. Coordinated aerial refueling on different tracks with different receivers</td>
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<td>16. Add simulator with visual system</td>
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<td>17. More/better academics</td>
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<td>18. Other administrative change</td>
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<td>19. More electronic warfare officer system training</td>
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<td>20. More/better copilot training</td>
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<tr>
<td>21. Access to special function trainer</td>
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<td>22. Better use of time spent on alert</td>
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<td>23. Better continuity in training program</td>
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<td>24. Better understanding of command regulations</td>
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<td>26. Access to inertial navigation system digital navigation system mockup</td>
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<td>27. Other methods procedures</td>
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<td>29. Shorter local missions</td>
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<td>30. More/better pre/post-mission planning</td>
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<td>32. More segmented cell training</td>
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<td>33. Better/longer off-load training</td>
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<td>34. More minimum interval takeoff procedures training</td>
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Table entries are counts of responses.
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Table B-7. SAC KC-135 - Boom Operator (N = 152)

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<td>18. More practice of gear and flap lowering procedures</td>
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Table B-8. MAC C-130 - Pilot/Copilot (N = 178)

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<td>8. More tactical missions</td>
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<td>9. Better training technology/materials</td>
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<td>11. Better use of flying time</td>
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<td>12. More/better emergency procedures training</td>
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<td>14. More enemy weapons/tactics training</td>
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<td>15. More flexible routes</td>
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<td>16. More flying time</td>
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<td>17. More variety in aircraft training</td>
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<td>18. More single-ship routes</td>
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<td>1. Present training acceptable</td>
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<td>2. Develop special function trainers</td>
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<td>3. Develop more realistic simulator</td>
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<td>4. Allocate local available flying hours based on needs</td>
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<td>11. Use pilot as instructor for copilots</td>
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<td>24. Fewer mandatory training events</td>
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<td>25. Train pilots separately while conducting flight engine training</td>
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<td>30. Train instructors to teach, not evaluate</td>
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<td>31. Upgrade to pilot based on ability, not flying hours</td>
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<td>7. Defer single-ship qualification for local unit training</td>
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<td>10. Observe pilot missions and systems operation in simulator</td>
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<td>11. Provide programmable calculator with standardized computation programs</td>
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<td>14. Publish navigator's specific responsibilities and tasks</td>
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<td>15. Increase length of training time at Altus AFB</td>
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<td>16. More training in monitoring instrument departure approach</td>
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<td>24. Use of simulators for refresher course</td>
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<td>26. Place training at squadron level</td>
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<td>27. Add visuals to simulation</td>
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<td>4. Better selection/upgrading standards</td>
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<td>5. Higher fidelity</td>
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<td>8. More classroom</td>
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<td>22. Use of computers</td>
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<td>26. Low level/airdrop training</td>
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END
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