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BEHAVIORAL TAXONOMY OF UNDERGRADUATE PILOT TRAINING TASKS AND SKILLS: SURFACE TASK ANALYSIS, TAXONOMY STRUCTURE, CLASSIFICATION RULES AND VALIDATION PLAN

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The objective is to analyze and specify the fundamental flying abilities which comprise the training objectives of Undergraduate Pilot Training (UPT). The results of this analysis will be used as a foundation for structuring research on and recommendations for improvements in Air Force flying training programs. The Phase I effort focused on a review of literature relevant to the development of a taxonomy of flying tasks and skills, a surface analysis of fundamental flying tasks, generation of a basic taxonomic structure and classification rules and planning for an evaluation of the taxonomy. Reports of the results of previous taxonomic studies were reviewed to avoid duplication of effort in the present research. Analyses of relevant flying tasks were reviewed and used in producing task analysis. A concept of the pilot-aircraft system operation was evolved and subsequently applied in configuring

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both the surface analysis and the taxonomy structure. Examination of previous task and skill taxonomies failed to provide a useable basis for the present effort. The surface task analysis was developed on the basis of a breakdown of task elements according to the cue, mental action and motor action involved. The flying tasks analyzed were found to fall into three categories: fundamental transitions, composite transitions and continuous transactions. The surface task analysis was organized so the more complex flying maneuvers could be accommodated by a sequence of two or more of the three categories of task types identified. A cubic taxonomic structure was developed with cue, motor action and mental action dimensions. A set of classification rules were provided for locating any flying training task in a specific "pigeon hole" within the taxonomic structure. A procedure for evaluating the validity of the taxonomic system was established for use during Phase II of this program.

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WILLIAM V. HAGIN, Technical Director
Flying Training Division

Approved for publication.

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Commander

SUMMARY

This report presents the first part of an ongoing research program to develop a behavioral taxonomy of Undergraduate Pilot Training (UPT) tasks and skills. The purpose thus far has been to assimilate and direct taxonomic theory toward a practical application in flying training research. A surface task analysis and a set of taxonomy rules have been developed along with a plan to test the validity of the system. The research is however, still in a formative stage and will be subject to modification and revision before the goal of a useful and reliable taxonomy of flying tasks and skills is achieved. Therefore, the reader is advised that subsequent reports should be reviewed to obtain the final results of the study.

PREFACE

This study was initiated by the Flying Training Division, Air Force Human Resources Laboratory, Williams AFB, Arizona 85224, under Project 1123, USAF Flying Training Development, Dr. William V. Hagin, Project Scientist; Task 112302, Instructional Innovations in USAF Flying Training, Mr. Gary B. Reid, Task Scientist. Design Plus, St. Louis, Missouri 63132, is accomplishing the study under contract F41609-73-C-0040. Mr. Robert P. Meyer, Design Plus, is the Principal Investigator. Dr. Edward E. Eddowes, Flying Training Division, Air Force Human Resources Laboratory, is the Contract Monitor.

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INTRODUCTION

The purpose of this study was to define and analyze Undergraduate Pilot Training (UPT) flying tasks and organize them into a classifiable structure of behavioral objectives. A surface task analysis provided the basic data base to determine fundamental flying skills. The analysis was based on cues, the flying tasks encountered during UPT, and on the mental and motor actions associated with them.

The intent of this research was not a reorganization of a descriptive task analysis. For although such an analysis is an important part of a training program, it alone does not provide training development personnel with the insight needed to refine the methods and media of instruction nor does it identify an optimum strategy for flying training research. It also does not specify the most efficient and most cost effective training systems. A new approach based on a taxonomic structure would provide a tool of sufficient depth and flexibility to cover the prime areas of research interest for the Air Force Human Resources Laboratory (AFHRL) Flying Training Division.

The benefits of a successful taxonomic study would indicate where redundancy and commonality exist in the present UPT system. The result would be an objective description of tasks and skills in the training program, providing a basis for modification of the current UPT syllabus and departure from present training methods. In addition, tasks generated to fill new training requirements would be clearly supportable by the taxonomy and thus more acceptable to those rooted in traditional training methods.

This research program was divided into three phases. The Phase I effort reported here established a foundation structure for the classification of flying tasks and skills and thus established the technical direction for the work to be carried out in the two later phases. In addition to the generation of a surface analysis of flying tasks, research results relevant to a taxonomy of UPT tasks and skills were reviewed during Phase I to provide a sound basis for the present taxonomic development effort. An annotated bibliography of the literature studied is presented in Appendix B. In Phase II, the developed taxonomy will be evaluated and revised, as required, and applied to the current T-37 syllabus, while Phase III extends the taxonomy to the T-38 syllabus and to future training requirements.

METHOD

In order to obtain the required information to support this research, relevant literature was examined to learn current and future UPT training objectives. Discussions regarding present and future objectives were held with AFHRL/FT staff members. Present training and research facilities stressing multi-media instruction and simulation were observed. Research in areas of task analysis, principles of learning and information regarding the implementation of taxonomic structures and classifications was examined. A computerized literature search was made for additional information and data relevant to the categories noted above. Information from the civilian sector of flying training was reviewed through the cooperation of American Airlines, Trans World Airlines, and the Federal Aviation Agency.

The literature search also provided information concerning the principles of learning and the theory which surrounds them. Specific areas of skill learning offered a unique approach to the organization of pilot tasks and skills.

An organization of tasks and skills was developed which established a clearer relationship between the fundamental and the more advanced piloting skills. The surface task analysis thus developed was oriented toward the pilot in the flight environment. This placed the emphasis on man in the system and eliminated reference to any particular kind of aircraft. Methods also were developed to make the surface analysis compatible with the requirements of a classification system.

The rules and rationale for a taxonomic classification structure were developed concurrently with the surface analysis effort. It became obvious that, although much had been written on the subject of taxonomy, little had been done and taxonomic development has remained at a rather primitive level. The emphasis underlying the present organization of the taxonomic rules was simplicity. It was expected that a simple taxonomy would prove more useful than those taxonomies generated previously.

Finally, a glossary of words and terminology used in Phase I was developed. This glossary of both flying and psychological terms was included to define their exact meanings within the context of this research.

SURFACE TASK ANALYSIS

The purpose of the surface task analysis was to provide a flexible yet discrete behavioral description that would serve as a useful tool in the classification of flying tasks. For the purpose of this research a surface task analysis was defined as:

> An investigative process that lists behavioral flying tasks in sufficient detail in accordance with established ground rules, to be utilized as a tool for classifying these tasks into specific flying training categories.

It was quickly determined that a critical balance existed between the analysis requirements and the level of detail which should be involved. This insight resulted in a number of iterations of the analysis until the desired level of detail was obtained. Earlier attempts in this study had produced cumbersome listings of flying task elements resulting in procedural minutiae too deep to be adaptable in developing a useful classification system. Subsequent organizational refinements coupled with the evolution of a set of workable ground rules produced the desired intuitive and functional results.

<u>Task Definition</u> - The surface analysis required the development and definition of the term task in its application to the taxonomy structure. There exist numerous definitions of "task", yet no single one is generally accepted. Some are broad in scope, while others are extremely detailed. Therefore, the following definition was developed to meet the requirements of this analysis:

> A task is a group of related work elements performed in close temporal proximity and directed toward the accomplishment of a definable work goal.

The work elements, (i.e. Stimulus, Cognition, Response) were modified into more meaningful terms of Cue-Mental Action-Motor Action. This activity is expressed as a C-Me-Mo sequence.

<u>Methodology</u> - The initial surface analysis development was begun as a concurrent effort with the detailed literature survey. This approach provided a logical starting point from which to form the nucleus of the analysis methodology. Instructional information contained in the FAA Flight Training Handbook-1965 was selected as

having the basic common denominators of fundamental flying techniques. These fundamentals are listed as Straight and Level flight, Climbs, Turns, and Glides (Descents). Brecke and Gerlach (1972) discussed the transitional aspects of going from one steady-state to another in doing basic flight maneuvers. These steady-states correspond closely to the four fundamentals of flight mentioned above. With the four fundamentals, the transitional aspects of what occurs when the pilot maneuvers his aircraft from one steady-state to another were subsequently examined.

Results

1. Fundamental Transitional Flying Tasks - From the examination of the four fundamentals of flight, (i.e. Straight and Level, Climbs, Turns and Descents) twelve fundamental transitonal tasks evolved. These twelve transitions provided the first rational breakdown of flying activities and provided a logical building block approach to other more complex tasks required for a complete repertoire of flying skills. Table 1-A defines and lists these tasks. Defining the twelve fundamental transitions was the initial step. There remained, however, an obvious need for several additional categories which would express the fundamentals in terms of such practical tasks as takeoffs, landings, cross-country, and aerobatic flying. Consequently, two additional categories were developed to satisfy this need, designated composite transitional tasks and continuous transitional tasks.

2. Composite Transitional Tasks - Composite flying tasks are defined as: combinations of two or more fundamental transitions performed in a procedural sequence to perform a more complex flying requirement. In the context of this research study, the transition becomes the primary building block in learning to fly. As these transitions occur in more rapid succession and in more stressful situations, they then take on paramount importance. Table 1-B defines and lists the composite transitional flying tasks. The surface analysis in the Phase I effort analyzed the takeoff and the landing as composite tasks.

3. Continuous Transitional Flying Tasks - This category was developed to generally include traditional aerobatics. The continuous task is defined as a combination of any number of fundamental and composite transitions strung together in rapid succession to complete a flight requirement. Continuous transitional tasks were then broken down into primary and advanced tasks.

Table 1. Flying Task Characteristics

A. Fundamental Transitional Tasks - The twelve control segments derived from the four steady-state flight paths, Straight-and-Level (St & L), Turn (T), Climb (C), and Descent (D):

1. St & L $\rightarrow$ T
2. St & L $\rightarrow$ C
3. St & L $\rightarrow$ D
4. T $\rightarrow$ St & L
5. T $\rightarrow$ C
6. T $\rightarrow$ D
7. C $\rightarrow$ St & L
8. C $\rightarrow$ T
9. C $\rightarrow$ D
10. D $\rightarrow$ St & L
11. D $\rightarrow$ T
12. D $\rightarrow$ C

The Fundamental Transitional Task is the smallest task part.

B. Composite Transitional Tasks - Two or more fundamental transitional tasks combined to perform a more complex flying requirement. The following are examples of Composite Tasks:

1. Take-Offs
2. Climb-Outs
3. Approaches
4. Landings
5. Chandelles
6. Lazy-8's
7. Slow Flight
8. Stalls
9. All X-Country Flying

C. Continuous Transitional Tasks - Any number of fundamental and composite tasks combined in rapid succession to complete a complex flight requirement. Continuous Transitional Tasks are divided into Primary and Advanced tasks. The following are examples:

<u>Primary</u>

1. Loops
2. Barrel Rolls
3. Aileron Rolls

<u>Advanced</u>

1. Clover Leafs
2. Cuban 8's
3. Immelmans

The primary tasks again provide the basics for more involved aerobatics and form the initial exposure to the unusual flight attitudes of aerobatics. With the mastery of the fundamentals, composites, and primary continuous transitional tasks, all other aerobatics can be accomplished. The surface task analysis in this phase analyzes the loop as a primary continuous task. Table 1-C defines the continuous transitional flying task and lists the primary tasks and most common advanced tasks.

Appendix A contains surface task analyses of the twelve fundamental transitional flying tasks; takeoff and landing, composite transitional flying tasks; and the loop, a continuous transitional flying task.

Flight Environmental Considerations - Once the number of flying task categories was established, it was then necessary to analytically describe the total flying process and man's involvement as the focal point of the process. Figure 1 identifies the physical properties of the three dimensional flight environment in terms of outside world visual and non-visual stimuli. It also shows aircraft generated cues as the amplification, modification, and reinforcement of environmental cues through mental processing and the resulting motor action. Finally, it shows the results of these processes measured against a learned standard or norm. This sequential process of analyzing flying tasks was selected as the logical basis for the surface analysis methodology.

Ground Rule Development - As previously mentioned, the analysis format evolved from several attempts to create the key analytical device for achieving a taxonomy of flying tasks. The process and format as shown in Table 2 for the main body of study was selected not only for its compactness and usefulness, but also for the flexibility it possessed to analyze fundamental, more complex composite, and continuous transitional flying tasks. The following ground rules were developed for the surface analysis as a result of the above mentioned considerations.

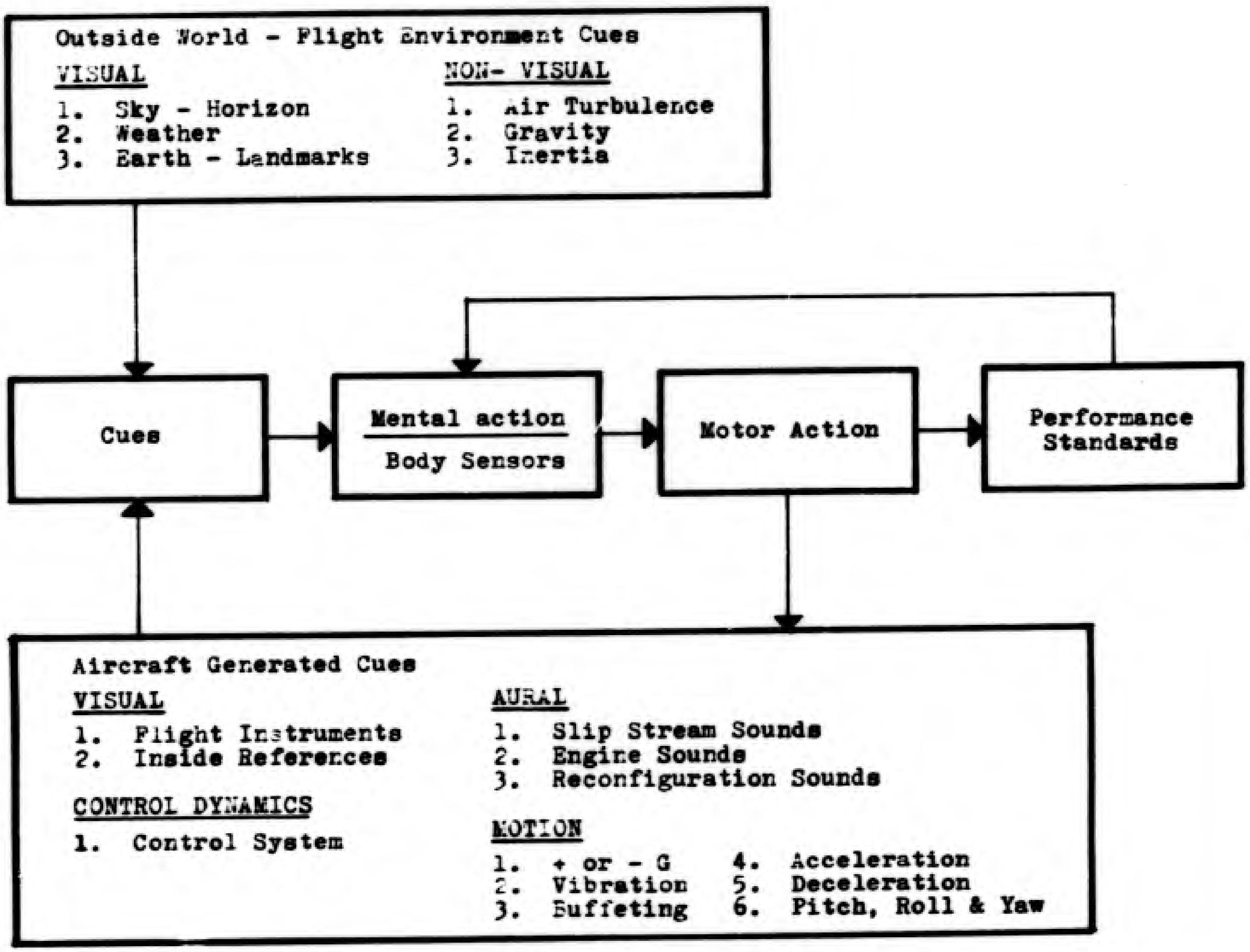

Figure 1. Pilot-aircraft Paradigm

Table 2. Example of Surface Analysis Format

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. P-1 TASK Straight and level/transition to coordinated level turn - 60°

TASK GOAL To establish constant bank level turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS TURN		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral pres. Motion-Normal G		
2.		Anticipates transition to 60° bank turn	
3.			Coordinates aileron, rudder and elevator
(B)	STARTS ROLL		
1.	Visual-Pitch att: increasing Bank att: rolling Instr. cross-check Aural-Normal envir. sound Control-Increased stick & rudder pressure Motion-Positive G onset, rolling, pitching up		
2.		Determines satisfactory roll rate & need for power	
3.			Maintains coordinated aileron & rudder pres; increases elevator pres. & adjusts throt.
(C)	CONTINUES ROLL		
1.	Visual-Pitch att: increasing Bank att: rolling Instr. cross-check Aural-Change in envir. sound Control-Constant aileron & rudder pres., increased elevator pres, throttle adv. Motion-Increasing pos. G, rolling, pitching up		

Rules

1. The aircraft considered was pure jet with retractable landing gear, flaps and a full complement of flight instruments.

2. Each task contains a short situation described to set the steady-state from which the transition is to begin. A goal is also noted toward which the transition or transitions are to progress.

3. Each event in the task is broken down into elements consisting of a C-Me-Mo sequence. This sequence permits a simple homogeneous categorizing of tasks. The number of elements have no specific bearing on task difficulty, nor is there any particular correlation with a time base intended. However, the format does permit a continuity sequencing system.

4. A task function is included at the end of each complete task. This is a description of what is occurring within the task and how it may relate to other tasks.

5. Cues are not listed in order of importance and it is recognized that more than one cue can be perceived almost simultaneously.

6. Visual cues are referenced in terms of pitch and bank attitudes. All visual references are confirmed by appropriate instrument cross-checking. An integrated method is suggested which utilizes both real world and flight instrument references.

7. The aural cue is noted in general terms since it is recognized that each type of aircraft has its own particular sound qualities.

8. Control feedback describes cues or stimuli which can be sensed by body limbs or extremities through the control devices of the aircraft. The control feedback input has been shortened to Control in the cues column of the surface analysis.

9. Motion cues are noted as cues or stimuli which can be sensed by the body receptors as a result of aircraft movement.

10. The mental action category of the surface analysis mechanism lists the cognitive process resulting from one, or several perceived stimulus cues. The mental actions are identified by the following verbs: anticipates, determines, observes and sustains.

11. Anticipates is used to describe the mental action which is the precursor of the subsequent motor action. It is the recalling of learned facts and sequences in the planning of a task or maneuver.

12. Determines is used to identify the decision process which confirms that a motor action be done or has been achieved.

13. Observes is used to indicate the selection of a dominant environmental or aircraft cue upon which a motor action is based.

14. Sustains is used to describe the thought process which integrates the actions for the steady-state portions of a task or maneuver.

15. In all motor action, the pilot is considered to be perfect. This rule eliminates the need for developing a drawn out list of multiple contingencies. Motor actions are identified by the following verbs: moves, maintains, relaxes, adjusts and activates.

16. Moves is used when the displacement of a control from a previous position is described.

17. Maintains is used to describe the continuation of a controlling pressure on an aircraft control.

18. Relaxes is the reduction or easing of a controlling pressure on an aircraft control.

19. Adjusts is the incremental regulation of a specific aircraft control.

20. Activates describes the discrete engagement of a specific toggle switch type control.

21. Reference to use of rudder is made for analysis purposes to include either manual input or through an aileron, rudder interconnect system.

22. Trim action is dependent upon the task and is an evaluation, based on experience, as to when and where it would occur.

Surface Analysis as a Codable and Classifiable System- The classification system was broken into two schemes. The first scheme covered the classification of the twelve fundamental transitional flying tasks. The second covered the composite transitional tasks such as takeoffs, landings, cross-country, etc. It also included the continuous transitional flying tasks (i.e. aerobatics such as loops, rolls, etc.). The two schemes are not distinctively different, because the second was a logical extension of the first.

The following is the coding system for all surface analysis tasks in this classification effort.

1. All "Fundamental" transitional tasks are coded with an F designator followed by the number of the task.

2. All "Fundamental Instrument" transitional tasks are coded with an Fi designator followed by the number of the task.

3. All "Composite" transitional tasks are coded with a Cp designator followed by the number of the task.

4. All "Continuous" transitional tasks are coded with a Ct designator followed by the task number.

5. Within each transitional task the following breakdown was used. The entire sequence was given a single letter identifier. Each element in a C-Me-Mo sequence was given a respective 1-2-3 identifier.

Table 2 shows an example of task number F-1. With this system any task, task sequence or element within a sequence can be noted in a classification matrix; and when so noted may be retraced to the task whenever necessary.

TAXONOMY DEVELOPMENT

The literature search revealed that researchers do not agree on the depth or the structure of a taxonomy. Likewise there was no agreement on the manner in which a taxonomy study should be conducted. There was even confusion as to the difference between a task taxonomy and a task analysis. Some of these difficulties are understandable since both a task analysis and a task taxonomy may contain common task performance items and common behavioral interactions. One must clearly define the intended use of the methodology (analysis or taxonomy) before exact definitions are meaningful for the project at hand. It is perhaps also true that precise definitions for these behavioral methodologies may never find universal application.

Taxonomy Description - For the purpose of this research effort, the surface task analysis provided the description data base of behavioral activity for use in developing the taxonomy. The taxonomy was defined as:

> A manner of classifying, and the rules and principles concerned with classification of the behavioral elements found in the skills described in the surface analysis in such a way that a useful relationship can be established among them.

This definition is in agreement with Miller (1967). Skill, as used in this study, was defined as all behavioral elements that are required to perform each task sequence. The major objectives of this taxonomy were to identify and label the components of the skills required for flying in such a way that the behavioral elements required to perform each task will be discovered. Once this has been accomplished, flying training research programs can be reviewed and reevaluated. If necessary these programs can be reoriented to place emphasis on or develop new approaches toward the teaching of those behavioral elements that will have the greatest payoff in the total program.

Methodology - The approach in developing the taxonomy was to extract, by the application of certain rules, those behavioral elements which were required for the performance of flying tasks. The rules were developed specifically for this application after careful examination of many behavioral classification categories from the works of Willis (1961), Folley (1964), Berliner as modified from Rabideau (1964), Miller (1967) and Matheny, Lowes, Baker, and Bynum (1971).

Each task as identified by the surface analysis was systematically subdivided into its components until the behavioral element emerged as the smallest task part in the structure. Along with and at the same level as the behavioral element, several descriptors or modifiers were identified. These behavioral elements and descriptors uniquely defined a skill necessary in the performance of a task.

Results of Application of the Taxonomy Development - The initial division in the classification methodology followed the surface analysis structure and identified the parts of a skill in terms of a Cue, Mental Action, or Motor Action segment. Each of these segments was further subdivided into specific behavioral elements and descriptors. Table 3 shows the possible categories available for each part of a skill.

Rules for Cue Structures

1. All cues were initially identified as visual, aural, control or motion.

2. A Complexity Category was assigned equal to the number of different types of cues presented. For example if a cue was only perceived as a visual sensation, a Complexity Category of 1-cue was assigned. If both vision and motion cues were perceived, it was placed in the 2-cue block.

3. If more than one kind of cue was present (complexity of other than 1-cue) an additional category, the Agreement Category was addressed. The Agreement Category was divided into Non-conflicting or Conflicting Cues.

Rationale for Cue Category Selection - The freedom of selecting cue categories was bounded on one side by the detail available in the surface analysis and on the other side by the obvious goal of making meaningful distinctions of the effect of the cues on the skill. Basic guidelines for distinctions were found in Matheny, et al. (1971). In this detailed investigation of multi-sensory cueing, Matheny developed the concepts of: relevant and non-relevant cues; primary, secondary, complementary cues; and conflicting cues. Non-relevant cueing was not addressed in the taxonomic structure, since by definition, non-relevant cues did not affect performance and were therefore not identifiable from the surface analysis.

Table 3. Behavioral Element Categories

A. CUES

KIND	COMPLEXITY	AGREEMENT
Visual	1 - Cue	Non-Conflicting Cues
Aural	2 - Cues	
Control	3 - Cues	Conflicting Cues
Motion	4 - Cues	

B. MENTAL ACTION

COMPLEXITY	MEMORY ACCESS	INFORMATION PROCESSING
1st. Level	Short Term	Recalls Facts
2nd. Level		
3rd. Level	Long Term	Recalls Procedures
4th. Level		

C. MOTOR ACTION

CONTINUITY	COMPLEXITY	EFFECTOR OUTPUT
Establish Attitude	1 - Effector	Elevator
	2 - Effectors	Aileron
Establish Rate of Attitude Change	3 - Effectors	Rudder
	4 - Effectors	Throttle
	5 - Effectors	Trim

Similarly the surface task analysis did not identify secondary cues which were defined as cues that were in the same modality as the primary cue, but of lessor importance. Complementary cues were reinforcing to the primary cue, but in a different modality. If more than one kind of cue was listed, the additional cues were either complementary or conflicting. These cues affected the complexity category assignment. Conflicting cues were those which did not reinforce the primary cues. Indeed, these cues may impede or confuse the Mental Action process necessary for skill performance. When such a condition was present, a Conflicting Cue Category was assigned. The total number of primary, complementary, and conflicting cues determined the complexity category. Cues which have a complexity of two cues or more but contain only primary and complementary cues were categorized as non-conflicting.

Rules for Mental Action Classification

1. Of prime importance in selecting classification categories for the Mental Action components of a skill was the desire to describe what was occurring rather than to attempt to determine how it was occurring. To properly describe the Mental Action it was necessary to examine the cues preceding the Mental Action and the following Motor Action. A complexity value was determined by the number of cues perceived and the number of effector outputs in the Motor Action component of the skill. Four levels of complexity were available: first level equals one kind of cue followed by a 1 effector output; second level equals one cue followed by multiple effector outputs OR multiple cues and one effector output; third level equals multiple cues and multiple effector outputs; fourth level equals presence of conflicting cues.

2. Memory was always involved in the flying skills and was identified as Short Term or Long Term memory access. Those items or bits of information which were recalled from memory to be used in the performance of the skill can be thought of as having been acquired either prior to or during the performance of the skill. Information remembered which was obtained during the skill performance was described as being from Short Term memory while that obtained prior to skill performance was from Long Term memory.

3. The final definable Mental Action category area selected was: Recalls Facts or Recalls Procedures.

Rationale for Mental Action Categories - The Mental Action rules were the most difficult to formulate as all behavioral classification schemes rely heavily on theory and conceptualization in describing mental activity. Additionally, the categories usually presented for describing mental activity overlap considerably. It was felt that no clear distinction could be made between categories such as considers, decides, determines, concludes, evaluates, etc. For this reason, it was decided that more meaningful information would be obtained if selection of categories were limited to those describing observable inputs to and outputs from the mental activity and those utilizing information about memory which can be inferred from observation and not dependent on theoretical considerations.

Rules for Motor Action Classification

1. Motor Actions were definable by the number and type of Motor Actions used to perform aircraft control. For the flying skills these Motor Actions were defined as effector outputs. Effector outputs of elevator, aileron, rudder, throttle and trim were available. Skills require simultaneous employment of from one to five effectors.

2. The number of effectors in use thus defined the complexity entry.

3. Continuity was differentiated by whether the goal is to establish a fixed aircraft attitude or to achieve a rate of attitude change.

Rationale for Motor Action Category Selection - Motor Actions were the easiest component of the skill to observe and thus can be readily differentiated as to type. After considering that all motor outputs were directed toward establishing a "state" of the aircraft with respect to its environment, it was natural to define Motor Action in terms of the control exerted on the aircraft. Hence, effector output categories of elevator, aileron, rudder, throttle and trim were conceived. The complexity of the motor task may vary widely from a relatively simple job of leveling the wings to the complicated job of performing a skill in accomplishing the landing pattern task. Motor skill complexity was directly definable in terms of number of effector outputs required simultaneously. The final categories for the taxonomic structure were based on the dichotomous question, "is the product of the Motor Action an established attitude or is it a rate of attitude change?" This was similar to the more classic distinction of discrete or continuous Motor Action, but more meaningful for a categorization pertaining to flying skills.

TAXONOMIC STRUCTURE

The developed taxonomy can be organized in many different ways. Previous taxonomies such as those in biology have used a tree-like structure to show similarity and divergence. Unfortunately such structures tend to become unwieldy and hard to understand in any but the simplest forms. An alternative approach to presenting the current taxonomy in a more understandable format was based on a cubic, or three dimensional structure.

Within the developed taxonomy there are three basic classification categories: cues, mental actions, and motor actions. As each of these categories is independent of the others, each can be placed on a face of a cube as illustrated in Figure 2.

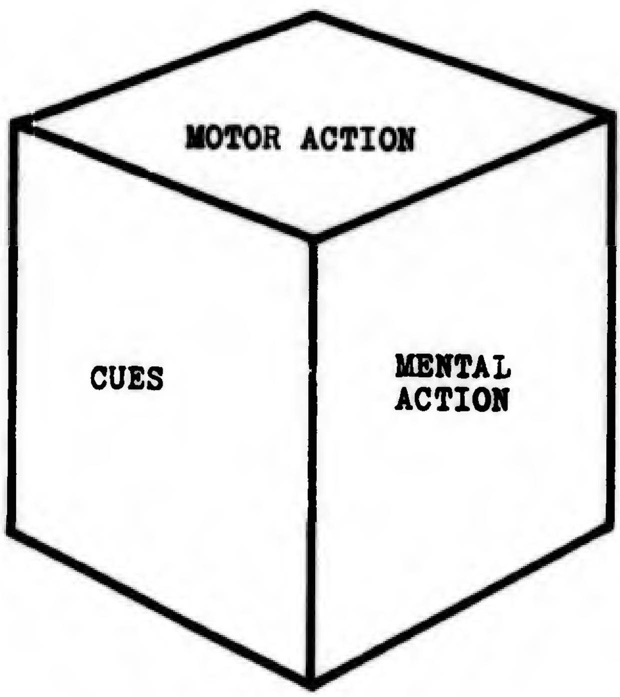

Figure 2. Taxonomic Cubic Structure

On each face of the cube are subdivisions of the categories. The cues face can be divided into the total number of outcomes of cue rules. The same is true for the mental action, and motor action faces. It is important to note that it is not the rules, per se, which appear on the faces, but rather the total number of skill categories or "pigeon holes" generated by the rules. Should there be two rules for a face, one with two possible choice outcomes, and one with three possible outcomes, then the total number of pigeon holes is six. This number is derived from the summation of all possible outcomes, or in this case: two x three.

The number of possible outcomes and related data for each cube face is shown in Table 4. In summary, there are thirty-two outcomes for the cues (C) face, sixteen for the mental action (Me) and fifty for the motor action (Mo).

Table 4. Number of Rule Outcomes

ELEMENT	RULES	RULE OUTCOMES	TOTAL OF FACE OUTCOMES
CUES	Kind Complexity Agreement	4 4 2	32
MENTAL ACTION	Complexity Memory Access Information Processing	4 2 2	16
MOTOR ACTION	Continuity Complexity Effector Output	2 5 5	50

The utility of this structure becomes apparent when the correct number of pigeon holes are placed on the appropriate faces as shown in Figure 3. It is then possible to uniquely define any skill as the intersection of a single cue pigeon hole, mental action pigeon hole, and motor action pigeon hole. In simplified format, a skill can be defined by its coordinates on the cube as xC, yMe, zMo, where x is the specific cue outcome, y the specific mental action outcome, and z the specific motor action outcome. Any two skills which have the same x, y, z coordinates are identical within the taxonomy. Thus, the cubic classification readily permits the determination of identical skills as well as indicating in what cube areas different skills fall.

The end product of the cubic structure is then a concise notation for skill classification, and one which lends itself to computerization and automated access. Further, the structure provides a rapid technique for use in the initial classification of the surface task analysis skills since the outcome of any skill classification is a three number coordinate. It is expected that this technique can be easily taught to, and used by, the personnel who will validate the taxonomy.

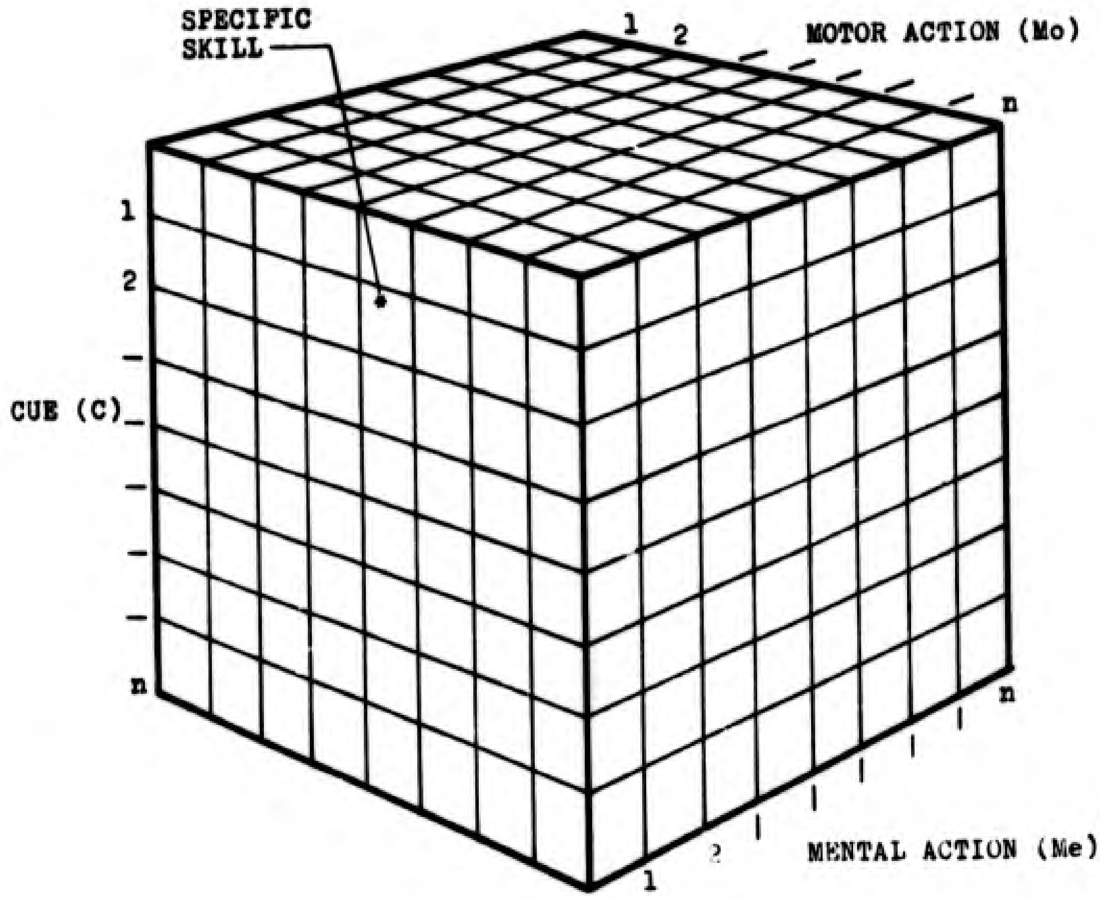

Figure 3. Detail of the Cubic Structure

CLASSIFICATION VALIDATION PROCEDURE

The purpose of the classification validation is to determine how well the taxonomy works. More specifically, the validation serves a two-fold purpose. The main objective is to determine if the taxonomy is applicable by demonstrating that it can be used to categorize all skills derived from the surface task analysis. Here, the concern is with the possibility of ambiguous classification leading to sorting the same skill into more than one category, or the failure of a skill to fit into any category.

The other purpose of the validation is to determine whether personnel unfamiliar with classification can understand the taxonomy rules, and can such personnel successfully apply the rules to generate the taxonomy? It cannot, and should not be expected that only a group of skilled professionals experienced in classification methodology be the only people capable of executing this task. Rather, any person with some background in aircraft piloting duties should be able to understand the rules, and develop applications of the taxonomy. Only when this criterion is met can it be stated that the taxonomy is truly usable by pilots and flying training research personnel.

Procedure - To answer the research questions posed, a group of subjects, naive with respect to classification methodology, but not naive with respect to aircraft pilot experience will be utilized. These subjects will be given the classification rules and skills in the surface analysis format and then asked to classify the skills into a taxonomy. Based upon the experiences of the subjects carrying out the validation test, a determination of problem areas can be made. These problem areas will then be resolved, enabling the taxonomy to categorize all skills. Schematically, the research plan is shown in Figure 4.

Data will be collected at two times to fully answer the research questions. The first data collection point will be immediately after the subjects have read the taxonomy rules, but before they have started the task. At this juncture, information on understanding of the task can be made. The second data collection point will be at the completion of the task. Here, information concerning rule application and applicability can be made.

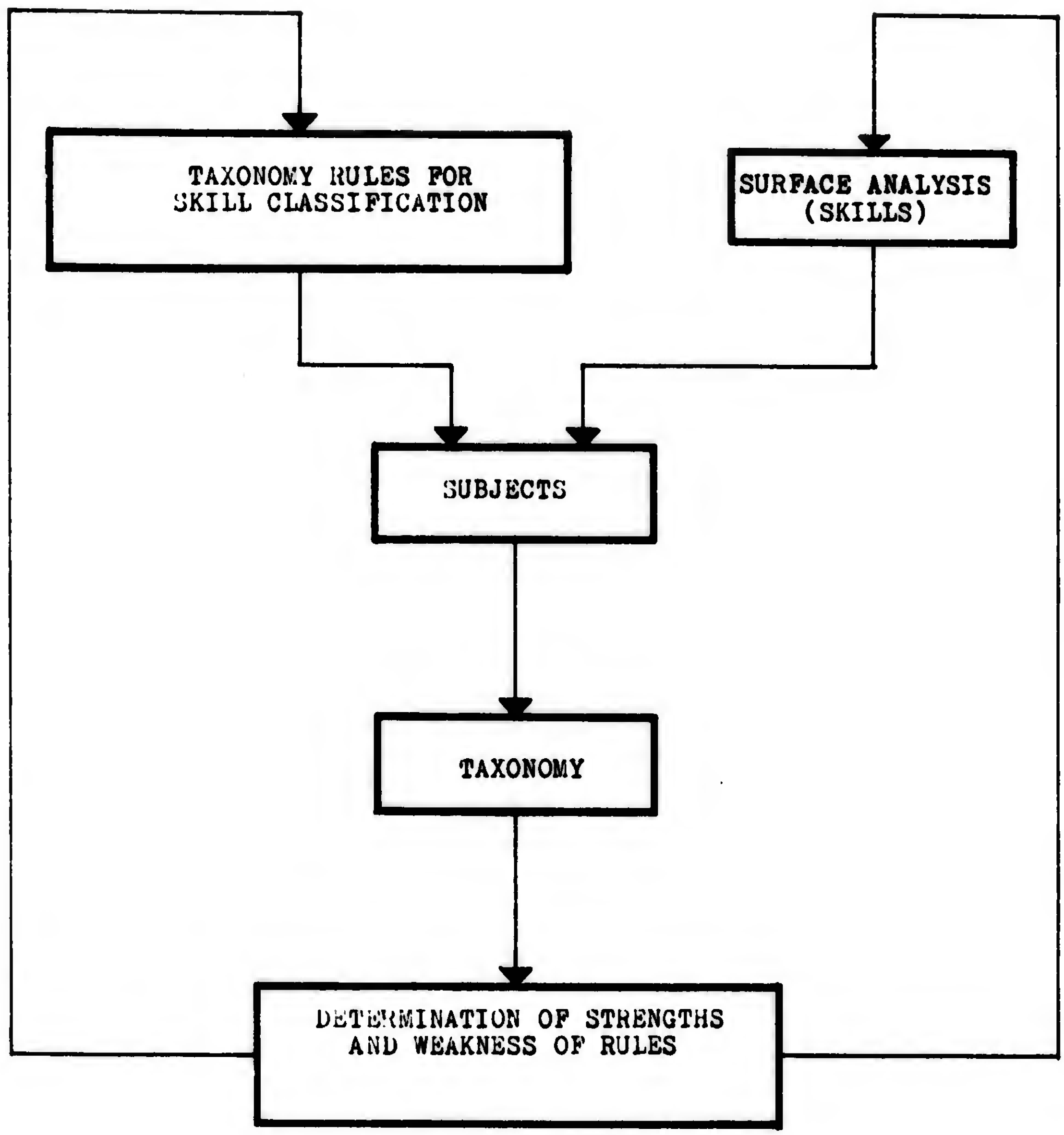

Figure 4. Taxonomy Validation Plan

In both data collection cases, statistical techniques are not appropriate due to task complexity, and a limited number of subjects, most likely three to five Air Force instructor pilots and student pilots. As the taxonomy will still be in an evolutionary process, early in Phase II, structured interviews with each subject will be used for data collection. These interviews will investigate difficulties encountered, time to accomplish the task, what was unclear, where ambiguities occurred, and other subject comments. A sample of the interview questionnaire is presented in Table 5.

Data Analysis - The questionnaires will be evaluated to determine any problem areas in the taxonomy development. All such problems will be studied and the deficiencies identified corrected. Should any problem not be easily resolvable, then a determination as to its cause will be made. One such cause could be a basic flaw in the taxonomy structure, while another might be due to a faulty surface analysis structure. The results of the evaluation will be fed back into the taxonomy rules, so that the classification system can be improved.

Table 5. Sample Interview Questionnaire

ANALYSIS KIT QUESTIONNAIRE

Age__________ Pilot Experience:

Military Pilot__________
Private Pilot __________
Commercial Pilot __________

1. Were the instructions in the analysis kit clear?__________
2. If not, where were they unclear?__________
____
3. Did you have a problem with any of the Classification Rules?__________
4. With which Rules did you have a problem? Give details below:
Rules for 1.__________
____
Rules for 2.__________
____
Rules for 3.__________
____
5. Did you have a problem with any of the task sequences?____
If yes, state your problem by task sequence__________
____
____
____
6. How long did it take you to complete the Classification?
____
7. Did you consider the Classification a complex job?__________
If yes, why?__________
____
____

REMARKS:

____
____
____

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GLOSSARY

Activates - the discrete engagement of a specific control such as a toggle switch in the surface analysis.

Adjusts - the incremental regulation of a specific control described in the surface analysis.

Anticipate - describes the mental state which is the precursor of subsequent motor action.

Attitude - the position of the aircraft considering the inclination of its axis in relation to the horizon.

Aural - cues or stimuli which can be sensed through hearing.

Bank - to tip, or roll about the longitudinal axis of the aircraft. (Banks are incidental to all properly executed turns.)

Basic Skill - a fundamentally learned series or forged element chain which can be triggered by a single set of cues or stimuli.

Climb - a state of flight in which the aircraft is increasing in altitude.

Composite Transitional Task - two or more fundamental transitional tasks combined to perform a more complex flying requirement. Composite transitional tasks have a Cp designator in the surface analysis.

Continuous Transitional Task - any number of fundamental transitional and specialized tasks combined in a rapid sequence to complete an aerobatic flying requirement. Continuous transitional tasks have a Ct designator in the surface analysis.

Control - a device used by a pilot in operating an airplane.

Control Feedback - cues or stimuli which can be sensed by body limbs or extremities through the control devices of the aircraft. The control feedback input has been shortened to Control in the cues column of the surface analysis.

Coordinate - the movement or use of two or more controls in their proper relationship to obtain a desired effect.

Pitch - the angular displacement of the longitudinal axis of the aircraft with respect to the horizon.

Procedural Skill - a cluster of intermediary skills strung together to form a repertoire of piloting capability.

Relaxes - the reduction of a controlling pressure on an aircraft control described in the surface analysis.

Roll - displacement around the longitudinal axis of the aircraft.

Short Term Memory - information remembered which was obtained during the performance of a skill.

Skill - all behavior elements used in the performance of a task sequence.

Steady-State - flight situation when the dynamic forces are trimmed to allow essentially "hands off" flight.

Straight-and-Level - a state of flight in which the aircraft is in a constant heading at a constant altitude with wings in the same plane as the horizon.

Surface Analysis - a systematic description of an interaction between surface elements; i.e. cue and motor action and the depth element, mental action; as they relate to the environment, the criteria, and the system.

Sustains - the thought process which integrates the actions for the steady-state portions of a task or maneuver described in the surface analysis.

Task - a group of related work elements performed in close temporal proximity by one person and directed toward the accomplishment of a definable goal.

Task Element - the smallest part of the surface analysis which is expressed as a major input or action heading, i.e. Cues or Mental Actions or Motor Actions are task elements of the analysis.

Task Sequence - a complete set of interacting behavioral elements, (i.e. Cues, Mental Action, and Motor Action) found in the surface analysis.

Cue - environmental or system stimuli which excite the sensory systems of the human body.

Descend - a state of flight in which the aircraft is decreasing in altitude.

Determine - to reach a decision.

Effector Output - pilot motor action in terms of control exerted on the aircraft, (i.e. elevator movement resulting from control stick movement to change aircraft pitch attitude).

Flare Out - to decrease the rate of descent and airspeed by slowly raising the nose of the aircraft during landing.

Fundamental Transitional Task - one of the twelve control segments derived from combinations of the four steady-state flight paths.

Glide - sustained forward flight at idle power in which airspeed is maintained only by loss of altitude.

Intermediate Skill - a combination of two or more basic skills chained together to form a skill cluster.

Long Term Memory - information which was acquired prior to the performance of the skill.

Maintains - the continuation of a controlling pressure on an aircraft control described in the surface analysis.

Maneuver - any planned motion of the aircraft in the air or on the ground.

Mental Action - cognitive process initiated by perceived stimulus cues and preceding motor actions.

Motion - cues or stimuli which can be sensed by the body receptors as a result of aircraft movement.

Motor Action - those physical actions resulting in movement of aircraft controls.

Moves - the displacement of a control from a previous position as described in the surface analysis.

Observes - the selection of a dominant environmental or aircraft generated cue upon which a motor action is based.

Taxonomy - a manner of classifying, and the rules and principles concerned with classification of phenomena in such a way that a more useful relationship can be established among them.

Transition - the activities required to change from one steady-state to another.

Trim - the balance of all dynamic forces of the aircraft so the aircraft can be flown essentially "hands off" the controls.

Turn - to create a change of direction of flight by causing the aircraft to roll about its longitudinal axis.

Visual - cues or stimuli which can be sensed by the eye.

APPENDIX A

SURFACE TASK ANALYSES

SITUATION: Aircraft straight and level at cruise speed and power

TASK NO: F-1 TASK: Straight and level/transition to coordinated level turn - 60°

TASK GOAL: To establish constant bank level turn

TASK FUNCTION:

Task elements performed by the pilot in this transitional sequence cause the aircraft to enter a 60° turn from straight and level flight. All cues received and mental and motor actions accomplished are consistent with all transitions to turn from straight and level. The degree of abruptness or gentelness of the transition will vary with flight requirements. The 60° bank angle was chosen as a standard. Shallow bank angles will present less positive G forces, less stick back pressure, and perhaps no trim needed. Steep bank angles at high speeds present high G forces, high stick back pressure, and perhaps a need for trim depending on the aircraft. This task in its most abrupt and steepest form is a basic offensive and defensive combat maneuver. The task in more moderate iteration is used in the following examples:

1. All level course changes in cross-country flying.
2. 360°-720° level turns.
3. Landing patterns.

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. F-1 TASK Straight and level/transition to coordinated level turn - 60°

TASK GOAL To establish constant bank level turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS TURN		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral pres. Motion-Normal G		
2.		Anticipates transition to 60° bank turn	
3.			Coordinates aileron, rudder and elevator
(B)	STARTS ROLL		
1.	Visual-Pitch att: increasing Bank att: rolling Instr. cross-check Aural-Normal envir. sound Control-Increased stick & rudder pressure Motion-Positive G onset, rolling, pitching up		
2.		Determines satisfactory roll rate & need for power	
3.			Maintains coordinated aileron & rudder pres; increases elevator pres. & adjusts throt.
(C)	CONTINUES ROLL		
1.	Visual-Pitch att: increasing Bank att: rolling Instr. cross-check Aural-Change in envir. sound Control-Constant aileron & rudder pres., increased elevator pres, throttle adv. Motion-Increasing pos. G, rolling, pitching up		

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. F-1 TASK Straight and level/transition to coordinated level turn - 60°

TASK GOAL To establish constant bank level turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES ROLL		
2.		Determines proper bank attitude approaching	
3.			Coordinates aileron and rudder, and maintains elevator pressure
(D)	STOPS ROLL		
1.	Visual-Pitch att: nose high Bank att: constant Instr. cross-check Aural-Normal envir. sound Control-Neutral aileron & rudder pres. & constant elevator pres. Motion-Constant positive G, rolling stabilized, pitching stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pres.
(E)	ESTABLISHS STEADY STATE		
1.	Visual-Pitch att: nose high Bank att: constant Instr. cross-check Aural-Normal envir. sound Control-Neutral stick & rudder pressure Motion-Constant positive G		
2.		Determines goal established.	
3.			Maintains turn control

SITUATION: Aircraft straight and level at cruise speed and power

TASK NO: F-2 TASK: Straight and level flight/transition to straight ahead climb

TASK GOAL: To establish constant speed climb

TASK FUNCTION:

Task elements performed by the pilot in the above transitional sequence cause the aircraft to climb straight ahead. The cues received and mental and motor actions accomplished are consistent with all transitions from straight and level flight to a straight ahead climbing flight. The degree of climb (i.e. the angle of attack and airspeed) and the intenseness or gentleness in the translation of this transition will vary with the flight requirements. This will have an effect on the attention value of the cues and the size of the motor action. This task is used as a segment of the following maneuver examples:

1. Take-offs.
2. All transitions to higher altitudes.
3. Entry to a number of aerobatic maneuvers.

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. F-2 TASK Straight and level flight/transition to straight ahead climb

TASK GOAL To establish constant speed climb DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS CLIMB		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to climb	
3.			Coordinates elevator & throttle adjustment
(B)	STARTS PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Increased stick pressure & throttle advance Motion-Positive G onset, pitching up		
2.		Determines satisfactory pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH INCREASE		
1.	Visual-Pitch att: increasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Constant stick pressure & throttle advance Motion-Increasing positive G, pitching up		

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. F-2 TASK Straight and level flight/transition to straight ahead climb

TASK GOAL To establish constant speed climb DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH INCREASE		
2.		Determines climb attitude approaching	
3.			Relaxes elevator, & stops throttle adjustment
(D)	STOPS PITCH INCREASE		
1.	Visual-Pitch att: climb Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Decreased stick pressure Motion-Decreasing positive G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pressure
(E)	ESTABLISHES STEADY STATE		
1.	Visual-Pitch att: climb Bank att: level Aural-Normal envir. sound Control-Neutral stick pressure Motion-Normal G		
2.		Determines goal established.	
3.			Maintains climb control

SITUATION: Aircraft straight and level at cruise speed and power

TASK NO: F-3 TASK: Straight and level flight/transition to straight ahead descent

TASK GOAL: To establish constant speed straight ahead descent

TASK FUNCTION:

Task elements performed by the pilot in this transitional sequence cause the aircraft to descend straight ahead. All cues received and mental and motor actions accomplished are consistent with all transitions from straight and level flight to straight ahead descent. The degree of abruptness or gentleness of this transition will vary with flight requirements. A rapid onset induces a high level of negative G. This task in its most abrupt form is a combat maneuver called a pushover. The task in more moderate iterations is used in segments of the following examples:

1. Landing approaches.
2. All transitions to lower altitudes.
3. Entry to many aerobatic maneuvers where additional airspeed is required.

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. F-3 TASK Straight and level flight/ transition to straight ahead descent

TASK GOAL To establish constant speed straight ahead descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS DESCENT		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to constant speed descent	
3.			Coordinates elevator & throttle adjust.
(B)	STARTS PITCH DECREASE		
1.	Visual-Pitch att:decreasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Increased stick pressure & throttle reduction Motion-Negative G onset, pitching down		
2.		Determines satisfactory pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH DECREASE		
1.	Visual-Pitch att:decreasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Constant stick pressure & throttle reduction Motion-Constant negative G, pitching down		

SITUATION Aircraft straight and level at cruise speed and power

TASK NO. F-3 TASK Straight and level flight/ transition to straight ahead descent

TASK GOAL To establish constant speed straight ahead descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH DECREASE		
2.		Determines descent attitude approaching	
3.			Relaxes elevator pressure & stops throttle adjust.
(D)	STOPS PITCH DECREASE		
1.	Visual-Pitch att: descent Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Decreased stick pressure Motion-Decreasing negative G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator press.
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: descent Bank att: level Aural-Normal envir. sound Control-Neutral stick pressure Motion-Normal G		
2.		Determines goal is established	
3.			Maintains descent control

SITUATION: Aircraft in 60° bank, level turn, constant speed

TASK NO: F-4 TASK: 60° turn transition to cruise level flight

TASK GOAL: To establish straight and level flight from a turn

TASK FUNCTION:

Task elements performed by the pilot in this transitional sequence cause the aircraft to return to level flight from a 60° banked turn. All cues received and mental and motor action accomplished are consistent with all transitions from banked turns to level flight. The degree of abruptness or gentleness of the transition will vary with flight requirements. The 60° bank angle was chosen as standard. The task is used to return to level flight from any turn. The task is used in the following examples:

1. Heading changes.
2. 360°-720° level turns.
3. Landing patterns.

SITUATION Aircraft in 60° bank, level turn, constant speed

TASK NO. F-4 TASK 60° turn transition to level flight

TASK GOAL To establish straight and level flight from a turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS ROLL OUT		
1.	Visual-Pitch att: nose high Bank att: constant Aural-Normal envir. sound Control-Neutral stick pres. Motion-Constant positive G		
2.		Anticipates rolling out of turn	
3.			Coordinates aileron & rudder with elevator movement
(B)	STARTS ROLL		
1.	Visual-Pitch att: decreasing Bank att: rolling Instr. cross-check Aural-Normal envir. sound Control-Increased stick & rudder pressure Motion-Decreasing positive G pitching down, rolling		
2.		Determines satis. roll rate & need to reduce power	
3.			Maintains coordinated aileron & rudder pressure, reduces elevator pres. & adjusts throttle
(C)	CONTINUES ROLL		
1.	Visual-Pitch att: decreasing Bank att: rolling Instr. cross-check Aural-Change envir. sound Control-Constant aileron & rudder pressure, increased elevator pres. & throttle reduction		

SITUATION Aircraft in 60° bank, level turn, constant speed

TASK NO. F-4 TASK 60° turn transition to level flight

TASK GOAL To establish straight and level flight from a turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES ROLL		
1.	Motion-Decreasing positive G pitching down, rolling		
2.		Determines approaching wings level	
3.			Moves aileron & elevator & relaxes rudder
(D)	STOPS ROLL		
1.	Visual-Pitch att: cruise Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Neutral aileron & rudder pressure & constant elevator pressure Motion-Normal G, pitch stabilized, roll stab.		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pressure
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral stick & rudder pressure Motion-Normal G		
2.		Determines goal is established	
3.			Maintains cruise control

SITUATION: Aircraft in 60° bank, level turn, constant speed

TASK NO: F-5 TASK: 60° level turn transition to climb

TASK GOAL: To establish climbing turn

TASK FUNCTION:

The task elements performed by the pilot in this transitional sequence cause the aircraft to climb from a 60° turn. All cues received and mental and motor actions accomplished are consistent with all transitions from turns to climbs. The degree of gentleness or abruptness of this transition will vary with flight requirements. A rapid onset will cause higher additional G forces and more drastic power changes than a more gentle onset. In the most aggravated form this transition causes stall situations. The task is used in more moderate iterations as a segment of the following examples:

1. Spiral climb entries.
2. Any change in prescribed altitude during a turn.

SITUATION: Aircraft in 60° bank, level turn, constant speed

TASK NO: F-5 TASK: 60° level turn transition to climb

TASK GOAL: To establish climbing turn

TASK FUNCTION:

The task elements performed by the pilot in this transitional sequence cause the aircraft to climb from a 60° turn. All cues received and mental and motor actions accomplished are consistent with all transitions from turns to climbs. The degree of gentleness or abruptness of this transition will vary with flight requirements. A rapid onset will cause higher additional G forces and more drastic power changes than a more gentle onset. In the most aggravated form this transition causes stall situations. The task is used in more moderate iterations as a segment of the following examples:

1. Spiral climb entries.
2. Any change in prescribed altitude during a turn.

SITUATION Aircraft in 60° bank, level turn, constant speed

TASK NO. F-5 **TASK** 60° level turn transition to climb

TASK GOAL To establish climbing turn **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS CLIMB		
1.	Visual-Pitch att: nose high Bank att: constant 60° Aural-Normal envir. sound Control-Neutral pressure Motion-Positive G		
2.		Anticipates transition to climb	
3.			Coordinates elevator & throttle adjust.
(B)	STARTS PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att:constant 60° Instr. cross-check Aural-Change in envir. sound Control-Increased stick pressure & throttle adv. Motion-Increasing positive G, pitching up		
2.		Determines satisfactory pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att:constant 60° Instr. cross-check Aural-Change in envir. sound Control-Constant stick pressure & throttle adv. Motion-Constant positive G, pitching up		
2.		Determines climb attitude approach.	

SITUATION Aircraft in 60° bank, level turn, constant speed

TASK NO. F-5 **TASK** 60° level turn transition to climb

TASK GOAL To establish climbing turn **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH INCREASE		
3.			Relaxes elevator & stops throttle adjustment
(D)	STOPS PITCH INCREASE		
1.	Visual-Pitch att: climb Bank att: constant Instr. cross-check Aural-Normal envir. sound Control-Decreased stick pressure Motion-Decreasing positive G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pressure
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: climb Bank att: constant Aural-Normal envir. sound Control-Neutral stick pres. Motion-Constant positive G		
2.		Determines goal is established	
3.			Maintains climb control

SITUATION: Aircraft in 60° bank, level turn, constant speed

TASK NO: F-6 TASK: 60° level turn transition to descent

TASK GOAL: To establish descending turn from level turn

TASK FUNCTION:

Task elements performed by the pilot in this transition from 60° level turn to a 60° banked descent cause the aircraft to enter a descending turn. All cues received and mental and motor actions accomplished are consistent with all descending 60° banked turns. The 60° bank angle was chosen as standard. The degree of abruptness or gentleness of the transition will vary with the flight requirements. The task in varying iterations is used in the following examples:

1. Initiate descending turns or spirals.
2. Initiate more moderate air-to-ground weapons delivery.
3. Landing approaches (pitch outs).

SITUATION Aircraft in 60° bank, level turn, constant speed

TASK NO. F-6 TASK 60° level turn transition to descent

TASK GOAL To establish descending turn from level turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A) 1.	BEGINS DESCENT Visual-Pitch att: nose high Bank att:constant 60° Aural-Normal envir. sound Control-Neutral pressure Motion-Positive G		
2.		Anticipates transition to constant speed descent	
3.			Coordinates elevator & throttle adjust.
(B) 1.	STARTS PITCH DECREASE Visual-Pitch att:decreasing Bank att:constant 60° Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres. & throttle reduction Motion-Decreasing positive G, pitching down		
2.		Determines satisfactory pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C) 1.	CONTINUES PITCH DECREASE Visual-Pitch att:decreasing Bank att:constant 60° Instr. cross-check Aural-Change in envir. sound Control-Constant stick pres. & throttle reduction Motion-Decreasing positive G, pitching down		
2.		Determines descent attitude approach.	

SITUATION Aircraft in 60° bank, level turn, constant speed

TASK NO. F-6 TASK 60° level turn transition to descent

TASK GOAL To establish descending turn from level turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C) 3.	CONTINUES PITCH DECREASE		Relaxes elevator & stops throttle adjustment
(D) 1.	STOPS PITCH DECREASE Visual-Pitch att: descent Bank att:constant 60° Instr. cross-check Aural-Normal envir. sound Control-Decreased stick pressure Motion-Normal G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pressure
(E) 1.	ESTABLISHES STEADY-STATE Visual-Pitch att: descent Bank att:constant 60° Aural-Normal envir. sound Control-Neutral stick pressure Motion-Normal G		
2.		Determines goal is established	
3.			Maintains descent control

SITUATION: Aircraft climbing at constant airspeed on constant heading

TASK NO: F-7 TASK: Straight ahead climb/transition to straight and level flight

TASK GOAL: To establish straight and level cruise flight

TASK FUNCTION:

Task elements performed by the pilot in this transitional sequence cause the aircraft to return to level flight. All cues received and mental and motor actions accomplished are consistent with all transitions from straight ahead climb to straight and level flight. The degree of abruptness or gentleness of the transition will vary with flight requirements. An extremely abrupt transition from a very steep climb would cause a high degree of negative G force. This maneuver is called a pushout. A moderate iteration is used in the following example:

1. All level-offs from straight climb procedures.

SITUATION Aircraft climbing at constant airspeed on constant heading

TASK NO. F-7 TASK Straight ahead climb/ transition to straight and level flight

TASK GOAL To establish straight and level cruise flight DATE Oct., 1972

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS LEVEL OFF		
1.	Visual-Pitch att: climb Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to level flight	
3.			Coordinates elevator & throttle adjust.
(B)	STARTS PITCH DECREASE		
1.	Visual-Pitch att:decreasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres. & throttle reduction Motion-Negative G onset, pitching down		
2.		Determines satisf. pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH DECREASE		
1.	Visual-Pitch att:decreasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Constant stick pres. & throttle reduction Motion-Constant negative G, pitching down		

SITUATION Aircraft climbing at constant airspeed on constant heading

TASK NO. F-7 TASK Straight ahead climb/ transition to straight and level flight

TASK GOAL To establish straight and level cruise flight DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH DECREASE		
2.		Determines correct pitch attitude approaching	
3.			Relaxes elevator pressure & stops throttle adjust.
(D)	STOPS PITCH DECREASE		
1.	Visual-Pitch att: cruise Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Constant stick pres. Motion-Decreasing negative G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pressure
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral stick pres. Motion-Normal G		
2.		Determines goal is established	
3.			Maintains cruise control

SITUATION: Aircraft climbing at constant airspeed on constant heading

TASK NO: F-8 TASK: Straight ahead climb/transition to coordinated climbing turn - 30°

TASK GOAL: To establish climbing turn

TASK FUNCTION:

Task elements performed by the pilot in this transitional sequence cause the aircraft to turn while in a climb. The angle of bank expressed at 30° is arbitrary and depends upon aircraft performance. All cues received and mental and motor actions accomplished are consistent with all transitions from climb to turn. The degree of gentleness or abruptness will vary with flight requirements. This transition fulfills the major segment of the classic climbing turn maneuver. It is also used as a segment in the following examples:

1. Climbing turns.
2. Climbing turn stalls.
3. Chandelles.

SITUATION Aircraft climbing at constant airspeed on constant heading

TASK NO. F-8 TASK Straight ahead climb/ transition to coordinated climbing turn - 30°

TASK GOAL To establish climbing turn DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS TURN		
1.	Visual-Pitch att: climb Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to 30° turn	
3.			Coordinates aileron & rudder, & moves elevator
(B)	STARTS ROLL		
1.	Visual-Pitch att: climb Bank att: rolling Instr. cross-check Aural-Normal envir. sound Control-Increased stick & rudder pressure Motion-Positive G onset, rolling,		
2.		Determines satisfactory roll rate	
3.			Maintains aileron & rudder pressure & moves elevator
(C)	CONTINUES ROLL		
1.	Visual-Pitch att: climb Bank att: rolling Instr. cross-check Aural-Normal envir. sound Control-Constant aileron & rudder pressure, incr. elevator pres. Motion-Increasing positive G, rolling,		

SITUATION Aircraft climbing at constant airspeed on constant heading

TASK NO. F-8 **TASK** Straight ahead climb/ transition to coordinated climbing turn - 30°

TASK GOAL To establish climbing turn **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES ROLL		
2.		Determines proper bank attitude approaching	
3.			Moves aileron & elevator, relaxes rudder pressure
(D)	STOPS ROLL		
1.	Visual-Pitch att: climb Bank att:constant 30° Instr. cross-check Aural-Normal envir. sound Control-Neutral aileron & rudder pres.,constant elevator pressure Motion-Constant positive G, roll stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pres.
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: climb Bank att:constant 30° Aural-Normal envir. sound Control-Neutral stick pres. Motion-Constant positive G		
2.		Determines goal is established	
3.			Maintains turn control

SITUATION: Aircraft in constant airspeed climb, maintaining heading

TASK NO: F-9 TASK: Straight ahead climb/transition to straight ahead descent at constant airspeed

TASK GOAL: To establish straight ahead descent

TASK FUNCTION:

Task elements performed by the pilot in this transitional sequence cause the aircraft to descend straight ahead. All cues received and mental and motor actions accomplished are consistent with all transitions from a straight climb to a straight descent. The degree of abruptness or gentleness will vary with flight requirements. A steep climb transitioning to a steep descent will induce a high amount of negative G force. A moderate iteration of this transition is a segment of the Vertical S-A.

SITUATION Aircraft in constant airspeed climb, maintaining heading

TASK NO. F-9 TASK Straight ahead climb/transition to straight ahead descent at constant airspeed

TASK GOAL To establish straight ahead descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS DESCENT		
1.	Visual-Pitch att: climb Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G,		
2.		Anticipates transition to descent	
3.			Coordinates elevator & throttle adjust.
(B)	STARTS PITCH DECREASE		
1.	Visual-Pitch att:decreasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres. & throttle reduction Motion-Negative G onset, pitching down		
2.		Determines satisfactory pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH DECREASE		
1.	Visual-Pitch att:decreasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Constant stick pres. & throttle reduction Motion-Constant negative G, pitching down		

SITUATION Aircraft in constant airspeed climb, maintaining heading

TASK NO. E-9 **TASK** Straight ahead climb/transition to straight ahead descent at constant airspeed

TASK GOAL To establish straight ahead descent **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH DECREASE		
2.		Determines descent attitude approach.	
3.			Relaxes elevator & stops throttle adjust
(D)	STOPS PITCH DECREASE		
1.	Visual-Pitch att: descent Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Decreasing stick pressure Motion-Decreasing negative G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pressure
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: descent Bank att: level Aural-Normal envir. sound Control-Neutral stick pressure Motion-Normal G,		
2.		Determines goal is established (Sustains constant speed descent)	
3.			Maintains descent control

SITUATION: Aircraft descending, power idle

TASK NO: F-10 TASK: Straight ahead descent/transition to straight and level flight

TASK GOAL: To establish straight and level flight

TASK FUNCTION:

Task elements performed by the pilot in this transitional segment cause the aircraft to return to straight and level flight from a straight ahead descent. All cues received and mental and motor actions accomplished are consistent with all transitions from a straight descent to level flight. The degree of abruptness or gentleness of the transition and the angle of descent will vary with flight requirements. In its extreme form the transition can be a pull out from a dive with high airspeed and accompanying high positive G forces. In varying iterations it is used as a segment of the following examples:

1. Approaches.
2. Return to level from a let down penetration.

SITUATION Aircraft descending, power idle

TASK NO. F-10 **TASK** Straight ahead descent/ transition to straight & level flight

TASK GOAL To establish straight and level flight **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS LEVEL OFF		
1.	Visual-Pitch att: descent Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to level off	
3.			Coordinates elevator & throttle adjust.
(B)	STARTS PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres & throttle advance Motion-Positive G onset, pitching up		
2.		Determines satisfactory pitch att. movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Constant stick pres. & throttle advance Motion-Constant positive G, pitching up		

SITUATION Aircraft descending, power idle

TASK NO. F-10 TASK Straight ahead descent/ transition to straight & level flight

TASK GOAL To establish straight and level flight DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH INCREASE		
2.		Determines cruise attitude approach.	
3.			Relaxes elevator pressure & stops throttle adjust.
(D)	STOPS PITCH INCREASE		
1.	Visual-Pitch att: cruise Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Constant stick pres. Motion-Decreasing positive G, pitch stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pres.
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral stick pres. Motion-Normal G		
2.		Determines goal is established	
3.			Maintains cruise control

SITUATION: Aircraft descending straight ahead, constant airspeed

TASK NO: F-11 TASK: Straight ahead descent/transition to descending turn, 60° bank

TASK GOAL: Establish descending turn from wings level descent

TASK FUNCTION:

Task elements performed by the pilot in this transitional segment cause the aircraft to turn while descending. All cues received and mental and motor actions accomplished are consistent with all transitions from descending to descending turning flight. The abruptness or gentleness of this transition will vary with flight requirements. The task in varying iterations is used in the following examples:

1. Approaches to landing (downwind & final turns)
2. Descending turns.

SITUATION Aircraft descending straight ahead, constant airspeed

TASK NO. F-11 TASK Straight ahead descent/ transition to descending turn, 60° bank

TASK GOAL To establish descending turn from wings level descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS TURN		
1.	Visual-Pitch att: descent Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to turn	
3.			Coordinates aileron & rudder, moves elevator
(B)	STARTS ROLL		
1.	Visual-Pitch att: descent Bank att: rolling Instr. cross-check Aural-Normal envir. sound Control-Increased stick & rudder pressure Motion-Positive G onset, rolling		
2.		Determines satisfactory roll rate	
3.			Maintains aileron & rudder pressure, moves elevator
(C)	CONTINUES ROLL		
1.	Visual-Pitch att: descent Bank att: rolling Aural-Normal envir. sound Control-Constant aileron & rudder pressure, inc. elevator pres. Motion-Increasing positive G, rolling		

SITUATION Aircraft descending straight ahead, constant airspeed

TASK NO. F-11 TASK Straight ahead descent/ transition to descending turn, 60° bank

TASK GOAL To establish descending turn from wings level descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES ROLL		
2.		Determines proper bank attitude approaching	
3.			Moves aileron & elevator, relaxes rudder pressure
(D)	STOPS ROLL		
1.	Visual-Pitch att: descent Bank att: constant Instr. cross-check Aural-Normal envir. sound Control-Neutral aileron & rudder pressure, constant elevator pressure Motion-Constant positive G, roll stabilized		
2.		Determines trim required	
3.			Adjusts trim & relaxes elevator pres.
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: descent Bank att: constant Aural-Normal envir. sound Control-Neutral stick pres. Motion-Constant positive G		
2.		Determines goal is established	
3.			Maintains turn control

SITUATION: Aircraft in constant speed descent

TASK NO: F-12 TASK: Straight ahead descent/transition to straight ahead climb

TASK GOAL: To establish a wings level climb from descent

TASK FUNCTION:

Task elements performed by the pilot in this transitional segment cause the aircraft to climb straight ahead after a straight ahead descent. All cues received and mental and motor actions accomplished are consistent with all descents to straight ahead climbs. The degree of abruptness or gentleness of the transition and the angle of descent and climb will vary with flight requirements. In its extreme the transition can be accompanied by high speed and high positive G forces. In varying iterations it is used as a segment of the following examples:

1. Pullout after air-to-ground weapons delivery.
2. A zooming altitude gaining combat maneuver.

SITUATION Aircraft in constant speed descent

TASK NO. F-12 TASK Straight ahead descent/ transition to straight ahead climb

TASK GOAL To establish a wings level climb from descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS CLIMB		
1.	Visual-Pitch att: descent Bank att: level Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Anticipates transition to constant speed climb	
3.			Coordinates elevator & throttle adjust.
(B)	STARTS PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres. & throttle advance Motion-Positive G onset, pitching up		
2.		Determines satisfactory pitch attitude movement	
3.			Maintains constant elevator pressure & continues throttle adjustment
(C)	CONTINUES PITCH INCREASE		
1.	Visual-Pitch att:increasing Bank att: level Instr. cross-check Aural-Change in envir. sound Control-Constant stick pres. & throttle advance Motion-Constant positive G, pitching up		

SITUATION Aircraft in constant speed descent

TASK NO. F-12 TASK Straight ahead descent/ transition to straight ahead climb

TASK GOAL To establish a wings level climb from descent DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH INCREASE		
2.		Determines climb attitude approach.	
3.			Relaxes elevator & stops throttle adjustment
(D)	STOPS PITCH INCREASE		
1.	Visual-Pitch att: climb Bank att: level Instr. cross-check Aural-Normal envir. sound Control-Constant stick pressure Motion-Decreasing positive G, pitch stabilized		
2.		Determines need for trim	
3.			Adjusts trim & relaxes elevator pres.
(E)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: climb Bank att: level Aural-Normal envir. sound Control-Neutral stick pres. Motion-Normal G		
2.		Determines goal is established	
3.			Maintains climb control

TASK NO.: Cp-2

TASK: 360° Overhead Landing

TASK GOAL: Landing the Aircraft

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS PITCH OUT		
1.	Visual-Pitch att: cruise Bank att: level Outside ref, approaching pitch out point Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Determines pitch out point	
3.			Coordinates aileron, rudder & elevator; throttle adjustment
(B)	STARTS PITCH OUT		
1.	Visual-Pitch att: increasing Bank att: rolling Instr. cross-check Aural-Change in envir. sound Control-Increased stick & rudder pressure; throttle reduction Motion-Positive G onset, deceleration, rolling pitching up		
2.		Determines satisf. roll rate & pitch attitude	
3.			Maintains coordinated aileron & rudder pres. & increases elevator pressure
(C)	CONTINUES PITCH OUT		
1.	Visual-Pitch att: increasing Bank att: rolling Outside reference Instr. cross-check Aural-Change in envir. sound		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	CONTINUES PITCH OUT		
1.	Control-Constant aileron & rudder pressure, increased elevator pressure Motion-Increasing positive G, deceleration, rolling, pitching up		
2.		Determines proper bank angle approaching	
3.			Coordinates aileron & rudder, and moves elevator
(D)	STOPS ROLL IN		
1.	Visual-Pitch att: increasing Bank att: constant Instr. cross-check Aural-Change in envir. sound Control-Neutral aileron & rudder pressure, increased elevator pressure Motion-Constant positive G, decelerating, rolling stabilized, pitching up		
2.		Sustains bank att.	
3.			Increases elevator pressure
(E)	HOLDS ESTABLISHED BANK		
1.	Visual-Pitch att: increasing Bank att: constant Outside reference Aural-Change in envir. sound Control-Increased stick pres. Motion-Constant positive G, deceleration, pitching up		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 **TASK** 360° overhead landing

TASK GOAL Land aircraft **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(E) 2.		Determines roll out point	
3.			Coordinates aileron, rudder & moves elevator
(F) 1.	STARTS ROLL OUT Visual-Pitch att: increasing Bank att: rolling Instr. cross-check Aural-Change in envir. sound Control-Increased stick & rudder pressure Motion-Decreasing positive G, decelerating, rolling, pitching up		
2.		Determines pitch attitude & roll rate satisfactory	
3.			Coordin tes aileron & rudde , and moves elevato
(G) 1.	CONTINUES ROLL OUT Visual-Pitch att: increasing Bank att: rolling Outside reference Aural-Changing envir. sound Control-Constant aileron & rudder pres. & increasing elevator pres Motion-Decreasing positive G, Decelerating, rolling, pitching up		
2.		Determines approaching wings level	
3.			Coordin tes aileron & rudde , and moves elevato

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(H)	STARTS DOWN-WIND		
1.	Visual-Pitch att: increasing Bank att: level Outside reference Instr. cross-check Aural-Normal envir. sound Control-Neutral aileron & rudder pres, increasing elevator pres. Motion-Normal G, decelerating, rolling stabilized, pitching up		
2.		Determines need for speed brake	
3.			Activates speed brake & moves elevator
(I)	CONTINUES DOWN-WIND		
1.	Visual-Pitch att: changing Bank att: level Outside reference Instr. cross-check Aural-Change in envir. sound Control-Speed brake switch movement & increased stick pressure Motion-Normal G, deceleration, buffeting, & pitching		
2.		Determines speed to lower gear	
3.			Activates gear & moves elevator
(J)	CONTINUES DOWN-WIND		
1.	Visual-Pitch att: changing Bank att: level Outside reference Instr. cross-check Aural-Change in envir. sound		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(J)	CONTINUES DOWN-WIND		
1.	Control-Gear handle movement & increased stick pressure Motion-Normal G, deceleration, buffeting & pitching		
2.		Determines gear down & need for increased power	
3.			Moves elevator & adjusts throttle
(K)	STARTS ROLL INTO FINAL TURN		
1.	Visual-Pitch att: nose high Bank att: level Outside reference Instr. cross-check Aural-Change in envir. sound Control-Throttle increase & increasing stick pressure Motion-Normal G, vibration, pitching		
2.		Determines position for beginning final turn & flap extension	
3.			Coordinates aileron & rudder, moves elev; activates flaps
(L)	CONTINUES ROLL		
1.	Visual-Pitch att:decreasing Bank att: rolling Outside reference Instr. cross-check Aural-Change in envir. sound		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(L)	CONTINUES ROLL		
1.	Control-Flap handle movement, increased stick & rudder pressure Motion-Normal G onset, deceleration, rolling, pitching down		
2.		Determines flaps extended, pitch attitude & roll rate satisfactory	
3.			Maintains coordination of aileron & rudder & maintains elevator pressure
(M)	STOPS ROLL		
1.	Visual-Pitch att: correct Bank att: rolling Outside reference, correct ground track Instr. cross-check Aural-Normal envir. sound Control-Constant stick & rudder pressure Motion-Normal G, rolling, pitch stabilized		
2.		Determines correct pitch & bank attitude approaching	
3.			Coordinates aileron & rudder, and moves elevator
(N)	CONTINUES FINAL TURN		
1.	Visual-Pitch att: descent Bank att: constant Outside reference Instr. cross-check Aural-Normal envir. sound		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(N)	CONTINUES FINAL TURN		
1.	Control-Neutral aileron & rudder; constant elevator pressure Motion-Normal G, rolling stabilized		
2.		Anticipates roll out on final & need for throttle increase	
3.			Coordinates aileron, rudder & elevator; adjusts throttle
(O)	STARTS ROLL OUT ON FINAL		
1.	Visual-Pitch att: descent Bank att: rolling Outside reference Instr. cross-check Aural-Change in envir. sound Control-Increased stick & rudder pressure; advances throttle Motion-Normal G, rolling		
2.		Determines pitch attitude & roll rate satisfactory	
3.			Coordinates aileron & rudder; moves elevator
(P)	CONTINUES ROLL OUT		
1.	Visual-Pitch att: descent Bank att: rolling Outside reference Instr. cross-check Aural-Normal envir. sound Control-Constant stick & rudder pressure Motion-Normal G, rolling		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(P)	CONTINUES ROLL OUT		
2.		Determines wings level	
3.			Coordinates aileron & rudder, and moves elevator
(Q)	STOPS ROLL		
1.	Visual-Pitch att: descent Bank att: level Outside reference Instr. cross-check Aural-Normal envir. sound Control-Neutral aileron & rudder; constant elevator pressure Motion-Normal G, rolling stabilized		
2.		Sustains approach attitude & determines trim required	
3.			Adjusts trim & relaxes elevator pres.
(R)	ESTABLISH STEADY STATE		
1.	Visual-Pitch att: descent Bank att: level Outside reference Instr. cross-check Aural-Normal envir. sound Control-Neutral stick & rudder Motion-Normal G		
2.		Determines point for round out & position to decrease rate of descent	
3.			Adjusts throttle & moves elevator

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUE	MENTAL ACTION	MOTOR ACTION
(S)	STARTS ROUND OUT		
1.	Visual-Pitch att: increasing Bank att: level Outside reference Instr. cross-check Aural-Change in envir. sound Control-Increased stick pressure & throttle reduction Motion-Normal G, pitching up, deceleration		
2.		Determines speed & rate of descent satisfactory	
3.			Moves elevator & adjusts throttle
(T)	COMPLETES ROUND OUT		
1.	Visual-Pitch att:increasing Bank att: level Outside reference Aural-Change in envir. sound Control-Increased stick pres. & throttle reduction Motion-Normal G, decelerating		
2.		Anticipates touch-down	
3.			Moves elevator & adjusts throttle
(U)	TOUCHDOWN		
1.	Visual-Pitch att: nose high Bank att: level Outside reference Aural-Change in envir. sound Control-Increased stick pressure and throttle reduction Motion-Normal G, vibration & deceleration		

SITUATION Aircraft at initial approach speed, level and maintaining ground track over centerline

TASK NO. Cp-2 TASK 360° overhead landing

TASK GOAL Land aircraft DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(U)	TOUCHDOWN		
2.		Determines proper speed to lower nosewheel & retract speedbrake; engages nosewheel steering & retracts flaps	
3.			Relaxes elevator; activates speed-brake, nosewheel steering & flaps
(V)	STARTS ROLL OUT		
1.	Visual-Runway centerline Instr. cross-check Aural-Change in envir. sound Control-Decreased stick pressure; flaps, nose-wheel steering & speedbrake movement Motion-Normal G, vibration & deceleration		
2.		Determines need for brakes & directional control	
3.			Activates brakes & maintains directional control with rud.
(W)	COMPLETES ROLL OUT		
1.	Visual-Runway centerline Aural-Change in envir. sound Control-Increased brake pressure Motion-Deceleration, normal G, vibration		
2.		Determines aircraft decelerating & goal accomplished	
3.			Maintains roll out control

SITUATION: Aircraft positioned on section line, straight and level, cruise power

TASK NO: Ct-1 TASK: Straight and level/transition thru a loop

TASK GOAL: To perform a 360° turn in the vertical plane and return to straight and level flight

TASK FUNCTION:

Task elements performed by the pilot in this continuous transitional sequence cause the aircraft to descend straight ahead to increase airspeed and then pull into a loop describing a smooth 360° turn in the vertical plane and return to level flight. All cues received and mental and motor actions accomplished are consistent with all continuous loop transitions beginning from straight and level flight and returning to straight and level flight. The loop is considered a primary continuous transitional task in this taxonomy and is preparation for portions of the following advanced continuous transitional tasks:

1. Immelmans
2. Cuban 8's
3. Clover Leafs
4. Split S's

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 **TASK** Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(A)	BEGINS PRE-ENTRY ACCELERATION		
1.	Visual-Pitch att: cruise Bank att: level Outside reference: section line Aural-Normal envir. sound Control-Neutral pressure Motion-Normal G		
2.		Determines position to commence descent & increase throttle	
3.			Coordinates elevator movement & throttle adjustment
(B)	STARTS SHALLOW DIVE		
1.	Visual-Pitch att: descent Bank att: level Outside reference: section line Instr. cross-check Aural-Change in envir. sound Control-Increased stick pressure; throttle adv. Motion-Decreasing G onset, acceleration, pitching down		
2.		Determines satisf. descent attitude; need for trim	
3.			Maintains elevator pressure & adjusts trim
(C)	BEGINS RETURN TO LEVEL FLIGHT		
1.	Visual-Pitch att: descent Bank att: level Outside reference: section line Instr. cross-check Aural-Change in envir.sound		

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 **TASK** Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(C)	BEGINS RETURN TO LEVEL FLIGHT		
1.	Control-Neutral stick pres. Motion-Normal G;acceleration		
2.		Determines proper airspeed at return to straight and level flight	
3.			Moves elevatc
(D)	STARTS PULLUP		
1.	Visual-Pitch att:increasing Bank att: level Outside reference: horizon Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres. Motion-Positive G onset; pitching up		
2.		Anticipates a constant back pressure (to maintain a constant rate of nose movement)	
3.			Coordi[illegible]tes elevator and ai[illegible]ron
(E)	CONTINUES PULLUP		
1.	Visual-Pitch att:increasing Bank att: level Outside reference: horizon Aural-Change in envir. sound Control-Increased stick pres. Motion-Increasing positive G; pitching up		
2.		Determines satisf. rate of nose movement & desired seat pressure	

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 **TASK** Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(E) 3.	CONTINUES PULLUP		Maintains coordinated elevator & aileron pressure/ movement
(F) 1.	CONTINUES PULLUP TO VERTICAL POSITION Visual-Pitch att: increasing Bank att: level Outside reference Aural-Change in envir. sound Control-Increased stick pres. Motion-Constant positive G, pitching up, deceleration		
2.		Anticipates nose reaching & passing through zenith	
3.			Maintains coordinated elevator & aileron pressure/ movement
(G) 1.	CONTINUOUS MANEUVER OVER-THE-TOP Visual-Pitch att: at zenith Bank att: level Outside reference Instr. cross-check Aural-Change in envir. sound Control-Increased stick pres. Motion-Constant positive G, pitching up, deceleration		
2.		Determines satisf. rate of nose movement & constant seat pressure	
3.			Maintains coordinated elevator & aileron pressure/ movement

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 TASK Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(H)	CONTINUES MANEUVER DOWN THE BACK SIDE, INVERTED		
1.	Visual-Pitch att:decreasing (inverted) Bank att: level Outside reference Aural-Change in envir. sound Control-Increased stick pres. Motion-Constant positive G, pitching down, acceleration		
2.		Anticipates relaxing back pressure slightly at inverted position as nose passes through horizon	
3.			Relaxes elevator movement slightly
(I)	CONTINUES MANEUVER INTO DIVE		
1.	Visual-Pitch att: wings level (inverted) Bank att: level Outside reference: horizon Aural-Change in envir. sound Control-Decreased elevator pressure Motion-Decrease in positive G; pitching down		
2.		Determines need for increased stick pressure to return to constant seat pressure	
3.			Moves elevator

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 **TASK** Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(J)	CONTINUES TO A DIVE		
1.	Visual-Pitch att: dive Bank att: level Outside reference Aural-Change in envir. sound Control-Increased elevator pressure Motion-Constant positive G, pitching down, acceleration		
2.		Determines satisf. wings level nose movement; continuation of desired seat pressure	
3.			Maintains coordinated elevator, aileron & rudder pressure
(K)	CONTINUES THROUGH NADIR POSITION		
1.	Visual-Pitch att:increasing Bank att: level Outside reference: section line Instr. cross-check Aural-Change in envir. sound Control-Constant elevator pressure Motion-Constant positive G, pitching up, acceleration		
2.		Anticipates nose passing through nadir	
3.			Maintains coordinated elevator, aileron & rudder pressure

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 TASK Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane DATE Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(L)	CONTINUES PULLUP TO STRAIGHT AND LEVEL FLIGHT		
1.	Visual-Pitch att:increasing Bank att: level Outside reference: section line Aural-Change in envir. sound Control-Constant elevator pressure Motion-Constant positive G, pitching up, acceleration		
2.		Anticipates return to straight & level flight, & need to relax elevator pressure	
3.			Relaxes elevator pressure
(M)	TRANSITION TO STRAIGHT AND LEVEL FLIGHT		
1.	Visual-Pitch att:increasing Bank att: level Outside reference Aural-Change in envir. sound Control-Decreases elevator pressure Motion-Decreasing positive G, pitching up		
2.		Anticipates approaching straight & level flight	
3.			Coordinates elevator, aileron rudder pressure

SITUATION Aircraft positioned on section line, straight & level flight, cruise power

TASK NO. Ct-1 **TASK** Straight and level/transition thru a loop

TASK GOAL To perform a 360° turn in the vertical plane **DATE** Oct., 1973

EL. SEQ.	CUES	MENTAL ACTION	MOTOR ACTION
(N)	STOPS LOOP		
1.	Visual-Pitch att: cruise Bank att: level Outside reference Aural-Normal envir. sound Control-Constant elevator pressure Motion-Normal G		
2.		Determines trim required	
3.			Adjusts trim; & relaxes elevator pressure
(O)	ESTABLISHES STEADY-STATE		
1.	Visual-Pitch att: cruise Bank att: level Aural-Normal envir. sound Control-Neutral stick pres. Motion-Normal G		
2.		Determines loop accomplished	
3.			Maintains cruise control

APPENDIX B

BIBLIOGRAPHY

BIBLIOGRAPHY

This annotated bibliography presents a general review of the research related to taxonomy development and application with special emphasis on items related to flying tasks. The references are organized by topics which are: 1. general background, 2. general task and taxonomy, 3. flying taxonomy, and 4. related flying items. Each topic is explained with the associated references following.

General Background References - The references of this topic provide a basic framework for system organization and development. In addition, cues obtained through the sensory system are discussed with respect to man's environment. Together, these items provide for an understanding of the complex requirements and methods for the analysis of flying tasks.

DeGreene, K. B. Systems Psychology, McGraw-Hill Book Company, New York, January, 1970.

This text provides a framework for the orderly anticipation, planning and development of the systems approach to complex technical problems involving people. The following chapters were used as reference: I - Systems and Psychology, II - The Human Operator in Control Systems, XI - Psychological Factors in the Persistency and Consistency of Design.

Fogel, L. J. Biotechnology: Concepts and Applications, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1963.

This text deals with both the theoretical and practical aspects of man/machine relationships as they influence present and future design systems. Human limitations are examined in respect to 1. information gathering and processing, 2. decision making and 3. the human's ability to transmit the results of such decisions to the controlled equipment system. Man/machine relationships are defined through the use of quantitative descriptions and analysis.

Gibson, J. J. The Senses Considered as Perceptual Systems, Haughton-Miffin Company, Boston, Massachusetts, 1966.

This text emphasizes how man is able to have the constant perceptions he needs for effective action in his environment. The author regards the senses as actively seeking mechanisms for looking, listening, touching, etc. - and that these senses are interrelated.

Meister, D. Human Factors, Theory and Practice, Wiley-Interscience, a division of John Wiley and Sons, Inc., New York, New York, 1971.

This text presents a realistic and practical guide for the human factors specialists during systems development. It outlines step by step descriptions on the performance of human factors analyses. Chapters of specific importance to the taxonomy effort were: Methods of Performing Human Factors Analyses and Human Factors Research.

General Task and Taxonomy References - The references of this topic provide theoretical and practical concepts of taxonomy development for learning theory and task analysis. Reports define, explain, and present examples of task analyses, taxonomies and related terms. The ideas discussed have relevance to the current taxonomy development.

Angell, D. Study of Training Performance Evaluation Techniques, Naval Training Device Center Technical Report NAVTRADEVCEN-TR-1449-1, October, 1964, AD609 605.

This report takes a look at a number of training performance evaluation techniques. The section of specific interest to this taxonomy program was the development of a Behavioral Classification. This section suggested a relationship between the number of task categories, ease of location and completeness of coverage. A rather complete listing of behavioral action verbs were suggested as possible performance descriptions.

Chambers, A. N. Development of a Taxonomy of Human Performance: A Heuristic Model for the Development of Classification Systems, American Institutes for Research, Silver Spring, Maryland, Technical Report 4, March, 1969, AD 688 605.

In this report, a heuristic model is presented as a means of explaining systematically the issues and options regarding human performance classification. With this model as the framework, the use of classification performance systems, their content, and methods available for development were discussed. It is concluded that classification systems available are incomplete, inconsistent, and inconclusive as to their utility; however, they provide the structure on which useful systems can be built.

Cotterman, T. E., Stolurow, L. M. A Taxonomy of Learning Task Characteristics, AMRL Technical Report TDR-64-2. January, 1964.

This report is designed to assist a training specialist in the design and development of effective training programs in support of Air Force positions. It presents a system for classifying learning tasks which was developed under the contract for the purpose indicated. The research and analytical procedures are summarized along with findings produced by a tryout of the system with a group of training specialists.

Deese, J., Hulse, S. H. The Psychology of Learning, McGraw-Hill Publications, New York, 1967.

This text deals with the theory of the learning process and is rich in experimental test data conducted by various researchers in the learning field. The specific areas of interest to this study were the chapters on concept learning, and skill learning and development.

Earle, T.C. Interpersonal Learning, Oregon Research Institute Technical Report, Office of Naval Research Contract No. N00014-68-C-0431, Contract Authority Identification Number NR 153-311, May, 1971, AD 727 151.

This report conceptualizes interpersonal learning within the lens model framework developed by Brunswik and Hammon. The learner, instructor and subject being learned about are described as interacting systems made up of depth and surface elements. The laws of the system are defined as a relationship between its surface and depth elements. The consistency of the system is the extent to which the laws can be inferred from directly observable surface elements. The proposed conceptualization of interpersonal learning is demonstrated in three experimental investigations.

Folley, J. D. Development of an Improved Method of Task Analysis and Beginnings of a Theory of Training, Naval Training Device Center Technical Report NAVTRADEVCEN 1218-1, Port Washington, New York, June, 1964, AD 445 869.

This report undertook to develop an improved method of task analysis for use in guiding the specifications of military training devices and regimens. There is also included a start on a theory of training to stimulate research and controversy which could result in increased activity to identify and work out present training problems for the Navy.

Miller, R. B. "Task Taxonomy: Science or Technology?", Ergonomics 10 (2), pp. 167-176, 1967.

This paper defines the term taxonomy and gives a description of the types and alternatives possible. There is a section discussing the objectives of a taxonomy, and possible depths and validity of a taxonomic classification system as a quantitative tool. The paper further discusses possible classification categories and a proposed scheme for sorting out the classified information.

Smith, B. J. Task Analysis Methods Compared for Application to Training Equipment Development, Naval Training Device Center Technical Report NAVTRADEVCEN 1218-5, Port Washington, New York, September, 1965.

Many methods of task analysis developed for structuring behavior into system specifications differ widely in the scope of the behavior analyzed, basic task taxonomy, and even in terminology. The purpose of this study was to compare the different features and their commonality, to examine the theoretical or empirical foundation and identify which features are included by some analysts and excluded by others.

Staats, A. W. and Staats, C. K. Complex Human Behavior, A Systematic Extension of Learning Principles, Holt, Rinehart and Winston, New York, New York, 1964.

This book explores various experimental and naturalistic observations of complex human behavior in terms of learning principles.

<u>Flying Taxonomy References</u> - The references of this topic have direct impact on the currently developed taxonomy. They show the state-of-the-art in the flying field. Items covered include detail maneuver analysis, in-flight pilot performance analysis, pilot training, task analysis, and task taxonomy development.

Brecke, F. and Gerlach, V. <u>Model and Procedures for an Objective Maneuver Analysis</u>, AFOSR-TR-73-0523, Technical Report 21201, Instructional Resources Laboratory, Arizona State University, Tempe, Arizona, December, 1972.

This report describes a procedural method to more objectively analyze the performance of an aircraft maneuver. The maneuver, a vertical S-A, was used as an example maneuver. The maneuver is broken down into steady-state and transitional phases. All phases of the maneuver are analyzed giving critical details and parameters.

Brecke, F. and Reiser, R. <u>Critical Components of Flight Instruction as Perceived by IPs and SPs</u>, Technical Report 21129, Grant No. AFOSR 71-2128, Instructional Resources Laboratory, Arizona State University, Tempe, Arizona, November, 1972.

The report describes the results of similar questionnaires completed by a selection of Instructor Pilots (IPs) and Student Pilots (SPs) at Williams AFB, Arizona. The purpose of the questionnaire was to learn what IPs and SPs considered critical components of flight instruction and what areas of instruction they considered in need of improvement.

Gerlach, V., Brecke, F., Reiser, R. and Shipley, B. <u>The Generation of Cues Based on a Maneuver Analysis</u>, Technical Report - 21202, Grant No. AFOSR 71-2128, Instructional Resources Laboratory, Arizona State University, Tempe, Arizona, December, 1972.

This report takes the critical details and parameters of the vertical S-A and describes in detail the procedural cues, i.e. what to look for, in a vertical S-A maneuver. This description of cues is broken down by phases: steady-state and transitions.

Knoop, P. A. and Welde, W. L. Automated Pilot Performance Assessment in the T-37: A Feasibility Study, AFHRL Technical Report TR-72-6, April, 1973.

This report describes research conducted to develop a capability for qualification of in-flight pilot performance used in Undergraduate Pilot Training (UPT). This was a feasibility effort directed to overcome the disadvantages of traditional subjective rating of a pilot trainee's performance by an instructor pilot. A T-37 B aircraft was instrumented to digitally record 24 flight and engine parameters. An extension computer software system was developed to reduce and analyze the recorded training maneuvers.

Matheny, W. G., et al, An Investigation of Visual, Aural, Motion and Control Movement Cues, Naval Training Device Center Technical Report NAVTRADEVCEN 69-C-0304-1, April, 1971.

This report is devoted to determining how multi-sensory cues can be simulated and effectively used in the training of pilots. An analytical base and cue taxonomy is developed and cues are postulated on the basis of information gained from the real visual world, aircraft sounds and motion cues from control movements. Hypotheses are developed based on effects of these postulated cues as they function independently and interact with cues of other modalities.

Semple, C. A. and Majesty, M. S. Operational Tasks Oriented Flying Training Program for Pilot Training: The Systems Approach, AFHRL-TR-68-4, January, 1969.

This report presents a systems methodology for determining knowledge and skills common to piloting tasks required by differing aircraft missions for the purpose of structuring a data base from which an operational tasks oriented flying training program could be developed. The approach attempts to identify and classify specific tasks performed by USAF pilots and the level of proficiency required for the successful performance of each task.

Smode, A.F. and Meyer, D.E. Research Data and Information Relevant to Pilot Training, AMRL Technical Report, 66-99, Vol. I, July, 1966. AD 801 776.

This report is a result of findings at selected operational pilot training schools in major air commands that are headquartered in the United States. It describes general

features of Air Force pilot training from entry into the undergraduate pilot training program through the specialized schools conducted by the major using commands. As a result of on-site visits with authoritative training personnel, a number of researchable issues that hold promise for the improvement of selected aspects of pilot training are reported.

Smode, A. F., Post, T. J. and Meyer, D. E. Research Data and Information Relevant to Pilot Training, AMRL Technical Report 66-99, Vol. II, July, 1966. AD 803 281.

This report describes specific pilot training programs for aircraft that are representative of those flown by the various operational commands in support of their assigned missions. Pilot activity descriptions are included to form a bridge between the programs of training and the functions for which the pilots are trained. In addition to descriptions of training programs for current aircraft and weapon systems, pilot requirements for the coming generation of aircraft are discussed in terms of their projected missions.

Related Flying Items References - The references of this topic provide source material for current flight training techniques and devices. The references include current Air Force and FAA instructional texts for contact and instrument flying. Research in simulator technology and instructional techniques are also found here.

American Airlines, Optimized Flight Crew Training, A Step Toward Safer Operations, April, 1969.

This study reports the results of forty captains trained under a new sequence of flight simulator training, local takeoff and landing practice in the airplane and closely supervised line experience. The program results indicate a superior product with improved safety for all phases of training and line operations.

Air Training Command, Syllabus of Instruction for Undergraduate Pilot Training, T-41/T-37/T-38, ATC Syllabus P-V4A-A, 1972.

This syllabus describes the general training required to enable the student pilot to achieve the standards of proficiency as set forth in ATC Training Standard P-V4A-A.

It prescribes an overall plan of instruction, special instruction and time requirements for an average student to acquire the necessary skill in the stated subjects or phases.

Air Training Command, Instructional System Development, AF Manual 50-2, December, 1970.

This manual serves as a guide for applying the AF systems approach to the development of education and training programs. It presents a technology of instructional design and presents the model for developing cost effective instructional systems.

Federal Aviation Administration, Flight Instructor's Handbook, AC 61-16A, 1969.

Information in this handbook provides guidance to pilots preparing to apply for their civilian flight instructor certificates and for use as a reference by certified civilian instructors. The handbook covers fundamentals of teaching and learning, teaching methods, aerodynamics useful to flight instructors and flight training syllabuses.

Federal Aviation Agency, Flight Training Handbook, AC 61-21, 1965.

This handbook provides information and direction in the introduction and performance of training maneuvers. Procedures and standards for flight test maneuvers are found in the appropriate flight test guides. The handbook was prepared for use by civilian flight instructors, flight students and pilots preparing for flight ratings.

Moran, W. P. The Use of Simulation to Promote Safety and Economy in Flying Training. Paper presented to the Fourth International Simulation and Training Conference, Atlanta, Georgia. May, 1971, S.A.E. Report 710475.

This paper describes how the combination of simulation and improved training techniques ensures a safe and economical flying training program. The paper points out that with this approach American Airlines has reduced airplane training and flight check hours by more than seventy-five percent.

Reiser, R., Brecke, F., and Gerlach, V. On the Difference Between Procedure and Technique in Pilot Instruction. Technical Note 21128, Grant No. AFOSR 71-2128, Instructional Resources Laboratory, Arizona State University, Tempe, Arizona, November, 1972.

This technical note describes the difference between flying procedures and flying techniques. It also offers a definition of each term and how these two variables enter into the training and more specifically into the instructional systems.

Trans World Airlines, Flight Simulator Evaluation, June, 1969.

This report describes TWA's new task-tailored and phase-oriented concept of flight simulator training. An outline syllabus is provided along with lesson plans and briefing outlines.

Williges, B. H., Roscoe, S. N. and Williges, R. C. Synthetic Flight Training Revisited, Technical Report ARL-72-21/AFOSR- 72-10, August, 1972.

This report reviews the critical issues in the development and use of synthetic flight trainers. Key factors discussed are degree of simulation/fidelity of simulation, problems of learning measurement, transfer and retention. New and potentially useful techniques for improving synthetic flight training are also discussed.

Wood, M. E. Multi-Media in USAF Pilot Training, Air Force HRL Technical Report - TR-71-14, Williams AFB, October, 1971, AD 732 611.

This report suggests how new developments in educational technology, from both a philosophic and equipment standpoint can provide new opportunities to train airborne skills on the ground thus saving large amounts of airborne practice time.