SYMPOSIUM PROCEEDINGS

Proceedings of the 5th Symposium on Psychology in the Air Force. Sponsored by the Department of Behavioral Sciences and Leadership, US Air Force Academy, 8-10 April 1976.

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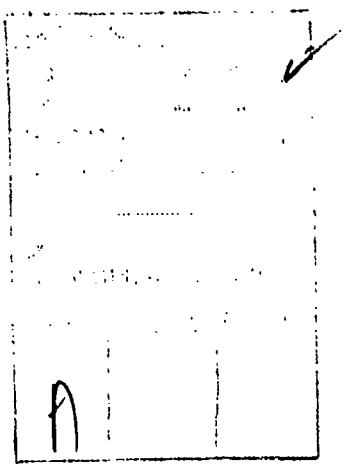

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: USAFA-TR-76-12	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Proceedings, Psychology in the Air Force, Fifth Symposium	5. TYPE OF REPORT & PERIOD COVERED: Proceedings
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Proceedings Editors: Maj Jock C. H. Schwank, Capt John F. Swiney, Maj Jefferson M. Koonce, Lt Col Dirk C. Prather, Capt Mickey R. Dansby	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Department of Behavioral Sciences and Leadership	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: DFBL, USAF Academy, CO 80840	12. REPORT DATE: June 1976
	13. NUMBER OF PAGES: 257
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Psychology	Training	Women in the Military
Symposium	Unions in the Military	Visual Display and Processing
Air Force	Learning	Cadets, Air Force Academy
Military	Pilot Performance	Attrition
Personnel	Organizational Development	Stress Management

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

These proceedings encompass papers and panels presented dealing with a wide range of psychology and research in all military establishments of the DoD: Personnel, Women, Training, Human Factors Engineering, Organizational Development, Simulation, Performance, Leadership, Attrition and Stress.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19. (Cont'd
Human Factors
Simulation
Family Separaration
Tracking
Leadership
Instructional System Development

~~FIFTH~~ ANNUAL SYMPOSIUM,

PSYCHOLOGY IN THE AIR FORCE (5th),

8 April - 10 April 1976,

Department of Behavioral Sciences and Leadership

United States Air Force Academy

Colorado Springs, Colorado

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on
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Evanston, Illinois

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Participants: *Chris Mann, Dept of Air Force*
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*Panel Discussions on the topics listed were held as part of the Symposium; however, the Proceedings do not contain summaries of the content of these discussions. Some of the panel participants did submit papers, which are included. For those who desire information about the panels, we suggest you contact the participants concerned.

KEYNOTE ADDRESS

Dr. Charles C. Moskos, Jr.

ARMED FORCES IN AMERICAN SOCIETY: FROM INSTITUTION TO OCCUPATION

Our purpose here is to apply developmental analysis to the emergent military establishment in American society. Most simply, developmental analysis entails historical reconstruction, trend specification, and, most especially, a model of a future state of affairs toward which actual events are heading. Developmental analysis, that is, emphasizes the "from here to there" sequence of present and hypothetical events. Put in a slightly different way, a developmental construct is a "pure" type placed at some future point by which we may ascertain and order the emergent reality of contemporary social phenomena. Models derived from developmental analysis bridge the empirical world of today with the social forms of the future.

Put pliantly, what is the likely shape of the armed forces in the foreseeable future? Or more formally, what is the range of structures through which the functions of armed force will be carried out? Initially, a comprehensive developmental construct will be presented which seems best to fit current empirical indicators. This is the proposition that the American military is moving from a predominantly institutional format to one more resembling that of an occupation. Secondly, there will be a specification of some expected organizational outcomes in the military system resulting from the shift to an occupational model.

Institution Versus Occupation

Terms like institution or occupation suffer from imprecision both in popular and scholarly discussion. Nevertheless, they each contain core connotations which serve to distinguish them from one another. For present purposes these distinctions can be described as follows.

An occupation is legitimated in terms of the marketplace, i.e. what are prevailing monetary rewards for equivalent skills. In a modern industrial society employees usually enjoy some voice in the determination of appropriate salary and work conditions. Such rights are counterbalanced by responsibilities to meet contractural obligations. The occupational model implies first priority inheres in self-interest rather than in the employing organization. A common form of advancement of group interest is the trade union.

An institution is legitimated in terms of values and norms, i.e. a purpose transcending individual self-interest in favor of a presumed higher good. Members of an institution are often seen as following a calling. And because a calling is associated with notions of self-sacrifice and complete dedication to one's role, it usually enjoys high esteem in the larger community. A calling does not command monetary reward comparable to what

one might expect in the general ecomony. But this is often compensated for by an array of social supports which signal the institution's intent to take care of its own and which sets the institution apart from the general society. If individual redress is sought, it takes the form of "one-on-one" recourse to superiors or a trust in the paternalism of the organization.

Of course, the models of an occupation versus an institution are as much caricature as they are descriptions of reality. In the case of the armed forces, moreover, the situation is complicated in that the military has elements of both models. But the overarching and clearly dominant trend in contemporary military social organization is the decline of the institutional format and the corresponding ascendancy of the occupational model.

Although antecedents predated the appearance of the all-volunteer force in early 1973, it was the end of the draft which served as the major thrust to move the military away from an institutional format. In contrast to the all-volunteer force, the selective service system was premised on the notion of citizenship obligation -- with concomitant low salaries for draftees -- and the ideal of a broadly representative enlisted force (though this ideal was not always realized in practice). In point of fact, it was the occupational model which clearly underpinned the philosophic rationale of the 1970 Report of the President's Commission on an All-Volunteer Armed Force ("Gates Commission Report"). Instead of a military system anchored in the normative values of a calling -- captured in words like Duty, Honor, Country -- the Gates Commission explicitly argued that primary reliance to recruit an armed force be based on monetary inincentives determined by marketplace standards. Perhaps the ultimate in monetary inducements has been reached in the "bonus" used to recruit young men into the combat arms since the end of the draft.

While the termination of the selective service system is the most dramatic change in the contemporary military system, other indicators of the trend away from the institutional format toward the occupational model can also be noted: (1) the significant salary increases given the armed forces since 1971 in an effort to make military salaries competitive with civilian rates; (2) proposals to make civilian-military pay "comparable", e.g. doing away with the allotment system by which service remuneration is partly determined by the service member's marital and family status; (3) proposals to eliminate or reduce a host of military benefits, e.g. subsidies to commissaries and exchanges, the G.I. Bill, health care for dependents, the pension system; (4) the separation of work and residence locales accompanying the growing proportion of enlisted men residing off the military base; and (5) the increasing aversion of many military wives at officer and noncom levels to take part in customary social functions. The sum of these and related changes is to confirm the ascendancy of the occupational model in emergent military social organization.

Consequences of the Occupational Model

A shift in the rationale of military service from an institution to an occupation implies organizational consequences in the structure and perhaps function of the armed forces. The discussion which follows is not to be construed as advocacy of such organizationall consequences nor even of their inevitability. But it is to argue that if the industrialization of the military continues then certain outcomes are to be anticipated. If any of these outcomes are deemed undesirable, attention should be directed at their root causes -- the transformation of the military system into an occupation -- and not simply to the outcomes themselves.

Two changes in particular are presently apparent in military social organization: (1) the growing likelihood of unionization in the armed services, and (2) the increasing reliance on contract civilians to perform military tasks. Even though seemingly unrelated, both such organizational changes derive from the ascendant occupational model. Each deserves a little elaboration.

Trade Unionism

That trade unionism might take place within the armed forces of the United States was barely more than a remote thought just a few years ago. But today there are signs that such an eventuality could come to pass. The growing labor militancy of previously quiescent public employees at municipal, state, and federal levels may be a precursor of like activity within the military system of several Western European countries. But it was the advent of the all-volunteer force which made unionization of the American Armed forces a live possibility. The reliance on monetary incentives to recruit an armed force is quite consistent with the notion of trade unionism.

In July, 1975, the American Federation of Government Employees (AFGE) of the AFL-CIO announced it was planning an organizing campaign within the military services and that it intended to ask the delegates at its 1976 convention to approve the campaign. In December, 1975, the National Maritime Union (NMU) also of the AFL-CIO reported that it was considering organizing sailors. The independent Association of Civilian Technicians (ACT) has been for some time a union for civilians who work for the reserve and Guard (almost all of whom are also members of the unit employing them). In the spring of 1976 the ACT began to recruit directly from reserve and Guard personnel with the announced targets of 100,000 out of the 700,000 so-called "weekend warriors."

It is important to stress that groups like the AFGE, NMU, and the ACT are staunchly patriotic, conservative in their approach to social change, and professed bread-and-butter unions. There is no connection between these unions and the radicalized and self-styled serviceman's unions which appeared during the Vietnam War. Also indicative of the changing scene

are those cases in which groups of military technicians whose special enlistment bonuses were canceled have demonstrated and filed suit for either payment of their bonuses or immediate discharges.

Legal obstacles do exist in the way of military unions. Current Defense Department directives allow service members to join unions, but forbid commanders from negotiating with unions. Additionally, legislation was introduced in both the House and Senate in early 1976 to prohibit unionization of the armed forces (including reserve/Guard as well as active-duty personnel). Passsage of the bill appeared uncertain and even if it became law, its constitutionality would certainly be tested. Military commanders, however, are allowed and have already negotiated with unionized civilian employees on military installations. Since 1975, moreover, military commanders have been delegated authority to sign local labor agreements with civilian personnel.

It goes without saying that military unions are anethema to almost all senior officers and many civilians. Yet throughout the ranks of career personnel there is a widespread view -- and a quite accurate one at that-- that the institutional qualities of military life are being undermined. Currently this dissatisfaction centers around the perceived erosion of military benefits, and the job insecurities resulting from periodic reductions in force. Not so well understood is that the institutional features of the military system have been traded off for the relatively good salaries enjoyed by military personnel in the all-volunteer force. The potential for unionization is great precisely because military social organization has moved in the direction of the occupational model while much of its membership harkens to the social supports of the older institutional format. It is also possible that a unionized military would not be accorded the favor it presently enjoys from the public (which is prone to view the military in institutional terms). Indeed, it is likely that a military union might be looked upon in more crass terms that would be anticipated owing to the burgeoning reaction against public employee unions in general.

Civilian Technicians

Where trends toward military unionization are organizational developments which could be incorporated into the structure of the armed forces, another consequence of the ascendant occupational model departs entirely from formal military social organization. This is the use of civilians to perform tasks which by any conventional measure would be seen as military in content. The private armies of the Central Intelligence Agency have long been an object of concern within the regular military command. But what is anomalous in the emerging order is that, rather than assigning its own military personnel, the U.S. government increasingly gives contracts directly to civilian firms -- with salary levels much higher than comparable military rates -- to perform difficult military jobs. The very structure of the military system, that is, no longer encompasses the range of military functions.

It is hard to overstate the degree to which the operational side of the military system is now reliant on civilian technicians. The large warships of the U.S. Navy are combat ineffective without the technical skills of the contract civilians who permanently serve aboard those ships. Major Army ordnance centers, including those in the combat theater, require the skills of contract civilians to perform necessary repairs and assembly. Missile warning systems in Greenland are in effect civilian-manned military installations run by firms who are responsible to the U.S. Air Force. In Southeast Asia and Saudi Arabia, private companies such as Air America and Vinnel Corporation are given U.S. government contracts to recruit civilians who carry out military activities. Bell Helicopter and Grumman established a quasi-military base in Isfahan, Iran, staffed by former American military personnel who train Iranian pilots. The American monitoring force in the Sinai is contracted out to private industry with the government retaining only policy control.

External political considerations certainly impinge upon the decisions to use civilian contracts for military tasks. But if task efficiency is the issue, a more nagging implication also suggests itself. Namely, military personnel cannot or will not perform arduous long-term duty with the efficacy of contract civilians. If this were to become the accepted norm, beliefs conductive to organizational and societal respect -- the whole notion of military legitimacy -- become untenable. The trend toward the employment of contract civilians to carry out military tasks could well be the final culmination of the industrialization of the military purpose.

Conclusion

Developmental analysis applied to military social organization reveals the impetus and probable outcomes of present trends. The concept of the ascendant occupational model in the military system alerts one to and makes sense out of organizational changes in the form and function of armed force. The logical outcome of an industrial ethic in the armed services is military trade unionism. Concurrently, military functions, hitherto the province to armed forces personnel, will increasingly be performed through civilian structures.

Developmental analysis does not imply the observed trends are inexorable. It does, however, set the broader context for researchers in the social science of the military. Most important, by its focus on the root causes of organizational transformation, developmental analysis allows for more directed social control toward desirable ends.

SESSION I-A

Quality of Life Survey

POW Study

Family Separation

Chairman: James E. Klusman

MEASURING THE QUALITY OF LIFE OF AIR FORCE PERSONNEL

Charles W. McNichols, T. Roger Manley, Robert A. Gregory

Air Force Institute of Technology

In support of an AF Chief of Staff chartered study group, a large scale survey of AF military members, civilian employees, and military spouses was conducted using a nine dimensional quality of life model to structure the survey. When a principal component analysis of the nine dimensions was performed, satisfaction with the work situation emerged as the most significant factor. Civilian and military results in this analysis were similar, except for the higher correlation of the Equity quality of life dimension with the work satisfaction factor in the civilian sample.

In his forward to a book documenting results of a Quality of Life symposium (Environmental Protection Agency, 1973) Stanley Greenfield described the Quality of Life as "a very personal expression of one's sense of well being...that set of 'things' which, when taken in the aggregate, makes the individual happy." This multivariable description of factors leading to satisfaction with life quality seemed to provide an appropriate model for an extensive survey program of Air Force military members, civilian employees, and military spouses performed as part of the Air Force Management Improvement Group's (AFMIG's) activities in the summer and fall of 1975. The Chief of Staff established the study group, under the direction of the current DCS/Personnel, Lt Gen K. L. Tallman, and specified as its charter: "making a good service better." To this end the survey effort was intended to sample attitudes on a wide range of topics including changing life styles, economic aspects of AF life, leadership and discipline, and other issues related to specific study group tasks.

Method

Once the decision was made to structure the survey effort using a Quality of Life model, the researchers reviewed previous AF and civilian studies and decided that nine basic dimensions could be hypothesized as encompassing the scope of the Quality of AF Life (QOAFL) as well as satisfying specific study group data needs. The chosen dimensions were: Economic Standard, Economic Security, Free Time, Work, Leadership/Supervision, Equity, Personal Growth, Personal Standing, and Health. Fig. 1 provides definitions for each of these dimensions. For the survey of military spouses, separate dimensions for paying and nonpaying work were used, and the leadership/supervision dimension was dropped.

Survey Instruments

Separate survey instruments were prepared for each study population with approximately 150 questions on each instrument. Each survey instrument was divided into a biographic section, and separate sections

for each of the nine QOAFL dimensions. The biographic section contained 17 demographic questions and included measures of career intent and job satisfaction (Hoppock, 1935) as potential criterion variables. Total response to the surveys included 10,996 military members, 17,110 civilian employees, and 10,637 military spouses.

A Porter-Lawler scheme was used for measuring each of the nine QOAFL dimensions, with respondents separately indicating the importance level of each dimension along with the degree of their satisfaction. Data obtained on these nine dimensions allowed rapid identification of differences among demographic subgroups in both importance level and satisfaction, and indicated which subsets of survey items appeared most promising for initial detailed analysis. Some results of this initial analysis for the military survey along with a more detailed explanation of the importance/satisfaction presentation of data and a canonical correlation analysis relating the nine dimensions to career intent and job satisfaction are given in Manley, Gregory, and McNichols (1975).

Figure 1

QOAFL FACTORS

ECONOMIC STANDARD: Satisfaction of basic human needs such as food, shelter, clothing; the ability to maintain an acceptable standard of living.

ECONOMIC SECURITY: Guaranteed employment; retirement benefits; insurance; protection for self and family.

FREE TIME: Amount, use, and scheduling of free time alone or in voluntary associations with others; variety of activities engaged in.

WORK: Doing work that is personally meaningful and important; pride in your work; job satisfaction; recognition for my efforts and my accomplishments on the job.

LEADERSHIP/SUPERVISION: Has my interests and that of the Air Force at heart; keeps me informed; approachable and helpful rather than critical; good knowledge of the job.

EQUITY: Equal opportunity in the Air Force; a fair chance at promotion; an even break in my job/assignment selections.

PERSONAL GROWTH: To be able to develop individual capacities; education/training; making full use of my abilities; the chance to further my potential.

PERSONAL STANDING: To be treated with respect; prestige; dignity; reputation; status.

HEALTH: Physical and mental well-being of self and dependents; having illnesses and ailments detected, diagnosed, treated and cured; quality and quantity of health care services provided.

Results

In the original model formulation, the authors assumed the "importance" scale could be used as an indicator of the intensity of an individual's feeling about a specific dimension. If this assumption was correct, it would have been appropriate to use the importance response as a multiplier for the deviation of the satisfaction response from the neutral point in forming a single measure for each one of the nine dimensions. However, in analyzing data obtained from the surveys, little variation was found in the importance measure across respondents, even on dimensions for which there was substantial variation in satisfaction levels. In most cases, respondents considered all of the dimensions to be highly important. Consequently, we found that we gained little additional information by considering both importance and degree of satisfaction in modeling efforts using the QOAFL dimensions. The degree of satisfaction scale has therefore been used exclusively in the analysis presented in the remainder of this paper.

As an aid to interpreting the nine dimensional model, principal component analyses were performed using correlations among degree of satisfaction responses to the military and civilian surveys. Tables 1 and 2 present the basic results of these analyses. The first two factors account for 51.6% of the total variance in the military data and 56% of the total variance in the civilian data. In both cases, the first two factors were rotated using a varimax procedure. These results are also presented in Tables 1 and 2.

In both the military and civilian analyses, it appears from the factor loadings that the first factor represents a general measure of satisfaction with the work situation, and the second represents a measure of satisfaction with economic aspects of life as a military or civilian employee.

An interesting difference between the two groups is the higher correlation of the equity dimension with the first factor for civilian employees than for military members. Satisfaction with the equity aspects of their lives seems to be more a part of satisfaction with the total work situation for civilians than for military members. If additional principal components (beyond the first two) are extracted, a single component with a high loading for equity and low loadings for all other dimensions emerges in the military data. In the civilian analysis, however, the equity variable retains its high loading on the first factor. In reviewing more detailed questions related to equity in the civilian survey results, as well as qualitative survey comments, the principal source of discontent in this area was discovered to be the civil service promotion system. Furthermore, civilian respondents focused their discontent on the "system" rather than various levels of supervisors above them.

Table 1

Principal Component Analysis: Military Survey N = 10,996

Factor	Eigenvalue	Cum % of Variance	Loadings After Rotation Dimension	Factor 1	Factor 2
1	3.60	40.0	Economic Standard	.16	.77
2	1.04	51.5	Economic Security	.10	.82
3	.81	60.6	Free Time	.38	.41
4	.77	69.1	Work	.77	.10
5	.65	76.3	Leadership	.71	.14
6	.62	83.1	Equity	.54	.38
7	.56	89.4	Personal Growth	.73	.25
8	.51	95.0	Personal Standing	.73	.26
9	.45	100.0	Health	.25	.47

Table 2

Principal Component Analysis: Civilian Survey N = 17,110

Factor	Eigenvalue	Cum % of Variance	Loadings After Rotation Dimension	Factor 1	Factor 2
1	3.92	43.6	Economic Standard	.14	.84
2	1.12	56.0	Economic Security	.18	.82
3	.83	65.3	Free Time	.34	.48
4	.73	73.3	Work	.76	.19
5	.57	79.6	Leadership	.74	.12
6	.52	85.4	Equity	.78	.20
7	.48	90.7	Personal Growth	.78	.18
8	.46	95.8	Personal Standing	.73	.21
9	.38	100.0	Health	.49	.25

Discussion

The Quality of Air Force Life (QOAFL) model adopted in the AFMIG survey effort indicates that work itself accounts for the largest single source of variation in life quality among both military and civilian employees. Correlations among the nine QOAFL dimensions are quite similar in the two groups, leading to similar results when a principal components analysis is performed for the military and civilian samples. One exception to this similarity is the high correlation in the civilian results of the equity dimension with the factor representing satisfaction with the total work situation.

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THE MASLOWIAN HIERARCHY OF NEEDS AND AIR FORCE PERSONNEL

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The results of some empirical tests of a mathematical model of Maslow's hierarchy of human needs are described. The data used is from Air Force surveys covering active duty officer and enlisted personnel for the period 1971-1973. Multiple linear regression was the primary technique used in statistical analyses of the data. The results displayed little or no evidence supporting the hypotheses derived from Maslow's theory. However, the analyses did suggest an alternative relationship between the strengths of different type needs. This alternative relationship resembles and supports the equilibrium-disequilibrium theory of motivation.

Introduction

Data was used from six separate Air Force personnel surveys to test a set of hypotheses derived from a model of Maslow's theory of human motivation (1943, 1970). The data came from surveys administered to active duty Air Force officers and enlisted personnel during the period Nov 1971 through March 1973. The surveys were sent out to five or ten percent random samples of the active force during these periods. Sample sizes ranged from just over 8,500 to over 23,000.

The Theory and Model

The hypotheses being tested were developed as part of an eleven-equation model of Maslow's theory. Basically, Maslow's hierarchy of human needs states that normally healthy humans operate primarily at one of five different need types. These five types are: (1) physiological needs, or the need for food, air, water, sex, etc.; (2) security needs, or the need for some level of security, stability, structure, etc.; (3) belongingness needs, or the need for affiliation, affection, and social interrelationships; (4) esteem needs, including self-esteem, esteem for others, esteem from others, self-respect, status, etc.; and (5) self-actualization, or the need to become all that one is inherently capable of becoming, the need for realization of one's potential.

As important to the theory as these five need types is the hypothesized process by which each class of needs becomes important, active, salient, or potent. These five need categories are hypothesized to exist

in a hierarchy of prepotency, such that satisfaction of the lower or more basic needs normally must sequentially precede emergence and satisfaction of the higher or less basic needs. This means that before any of the higher level needs will become potent, or strong, a person's physiological needs must first be largely satisfied. "A person who is lacking food, safety, love, and esteem would most probably hunger for food more strongly than for anything else." (Maslow 1970, p. 37)

Once these physiological needs have been satisfied, however, their strength or importance decreases, and the next higher level of needs, security, become the strongest drive of behavior. This process of "increased satisfaction - decreased importance - increased importance of the next higher need" repeats itself until the highest level of the hierarchy is reached, given that certain other conditions are satisfied -- conditions such as reasonable psychological health, a certain age span, etc. At the highest level, self-actualization, Maslow has hypothesized that a reversal occurs in the satisfaction-importance relationship. He stated that for this need, increased satisfaction leads to increased need strength. "When we examine people who are predominantly growth-motivated ... gratification breeds increased rather than decreased motivation...." (Maslow 1968, p. 30)

Finally, Maslow stated that he conceived of a long time period (in years) between the emergence of the various need levels for any individual. He suggested that in the fortunate (psychologically healthy) life history the safety needs become salient and satisfied during childhood, the belongingness needs during adolescence, and the esteem needs during early adulthood. Only as a person nears his 50's will the self-actualization need generally become strongly salient. (Hall and Nougaim, 1968, p. 34)

This verbal version of Maslow's hierarchy is modeled in Figure 1. Note that Need Strength (S) takes on values 1 to 5. A strength range of 1 to 3 is "low" strength and is considered either prepotent (unemerged) or largely satisfied. A strength above 3 is "high" and is considered a potent, or operating, need strength. This particular five-point strength scale derives from the measurement instruments used in the data collection effort. The horizontal dimension in Figure 1 represents Age and is divided into five regions, each corresponding to the stage of life in which a need type is hypothesized to emerge from prepotency into potency and then become largely satisfied, thereby falling off in strength.

The mathematical model of eleven equations derives directly from Figure 1 and its underlying logic. Basically, conditions were set on strength of one need type being potent. A second order parabolic form was then used to approximate the relationship between a potent need strength and age. First order linear and non-linear forms were used to approximate the relationships between a prepotent need strength and

age. First order linear and non-linear forms were used to approximate the relationships between a prepotent need strength and age; or between a largely satisfied need strength and age. These relationships were then used to develop the relationships really sought after, that is, the relationships between potent and largely satisfied adjacent need types, and between potent and prepotent adjacent need types.

The Air Force Data

Data appropriate for use in testing the model was available in raw form from periodic surveys given to Air Force active duty officer and enlisted personnel going back to 1971. The surveys include important demographic factors such as age, sex, educational level, rank, marital status, etc. Also included in these particular surveys were questions and statements involving how the respondent felt about different factors, called motivators in this paper.

Six surveys were used in testing this model. An empirically based transformation matrix was generated to transform the responses the Air Force members made to the survey statements (motivators) into their need strengths for each of the five Maslowian need types. These need strengths were then used in multiple regression programs to test the goodness of fit of the actual data to the hypothesized mathematical forms.

The Results

Of the many hypotheses available for testing from the mathematical model, only two will be discussed in this paper. These two involve the relationships between the strengths of potent and prepotent adjacent need levels, and between the strengths of potent and largely satisfied adjacent need levels. Together these two relationships form the heart of the Maslowian "prepotency-potency-largely satisfied" mechanism in the theory.

We can easily summarize the results. Briefly, we found no evidence supporting the hypothesized relationships between prepotent and potent need strengths. Similarly, we found no evidence to support the hypothesized relationships between largely satisfied and potent need strengths. That is, the results indicated that emergence of a need type into potency does not depend on the next lower need type being largely satisfied; and that a need strength is not held to prepotency by the next lower need type being potent. Interestingly, however, these results did suggest some alternative hypotheses. One of these was that emergence of higher need levels is not nearly as dependent on the satisfaction of lower need levels as Maslow had suggested. Though there may be some tendency for different types of needs to be emphasized as one satisfies other need types, this emphasis is certainly too subtle to be picked up very strongly by the available measurement instruments.

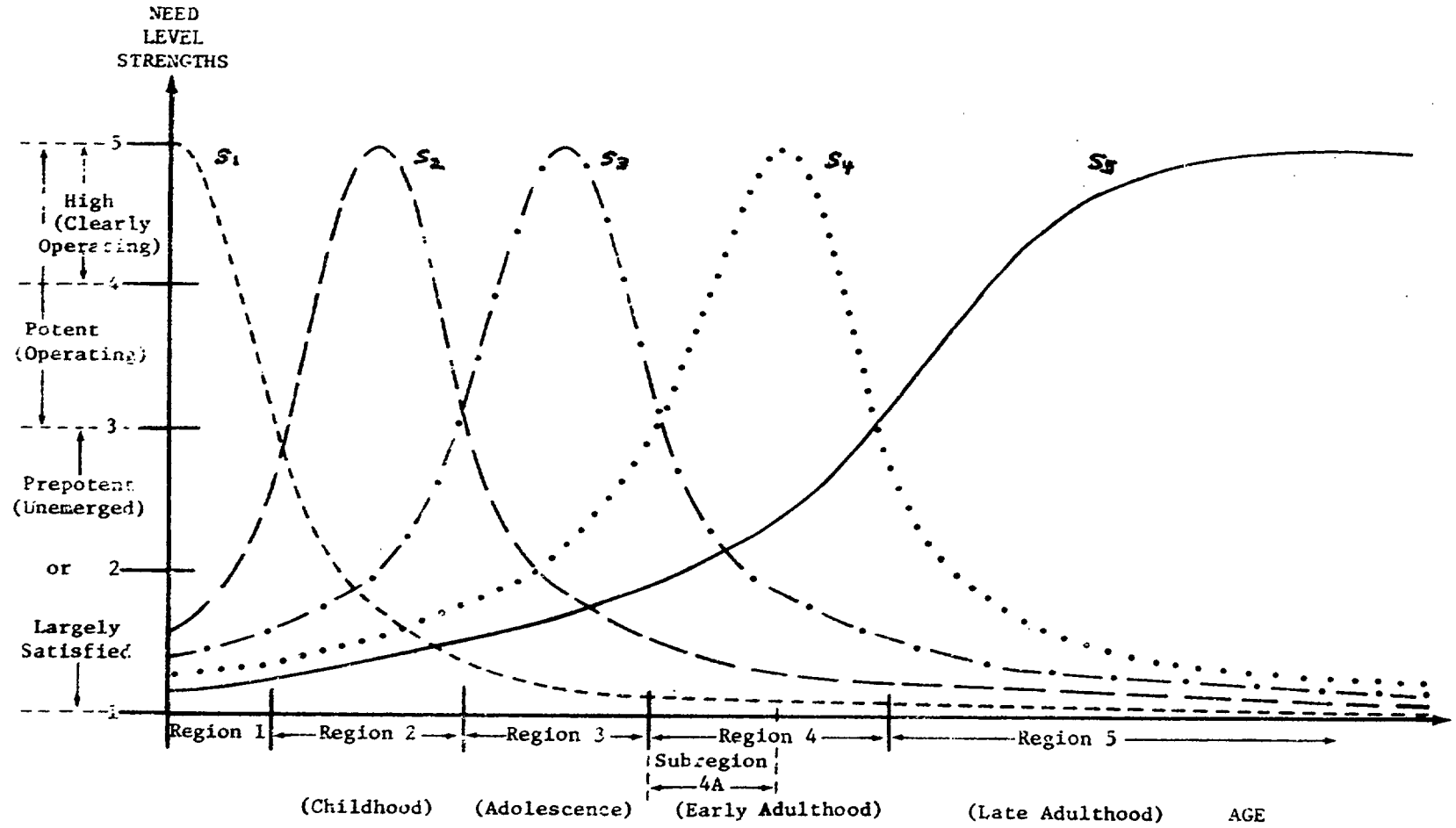

Figure 1: The Model: Relationships among the Strengths of Needs for the Five Need Levels as a Function of Age

Secondly, these results suggested a positive parabolic relationship between need strengths of adjacent need levels. That is, if one need type shows a high need strength, other need types tend also to show high need strengths; and low need strength of one need type tends to go hand in hand with low need strength of other need types. Furthermore, these different need strengths tend to move together in the same direction, much as a pendulum swings back and forth. These findings are entirely consistent with the equilibrium-disequilibrium school of motivation theorists, who hold that needs are dynamic in nature, never staying satisfied, but needing continual resatisfying over time. (Lewin, 1935; Hull, 1943; Cofer and Appley, 1964)

Conclusions

The need strengths and satisfactions of active duty Air Force personnel do not seem to support the hierarchical theory of human motivation proposed by Maslow. Instead, it appears that the different types of needs measured by the various survey questions used in this study never remain fully satisfied, but re-emerge into potency just in the course of time, and require resatisfying in a cyclical manner. Furthermore, it also appears that these different needs may all be active at once, or any subset of these needs may be active at the same time--and, conversely, may all be satisfied at the same time. Thus, to the extent that Maslow's theory has been (1) properly specified, and (2) accurately tested by the data from these Air Force surveys, then we can say that we find little support from this data to support Maslow's theory.

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Psychological Dysfunction in Repatriated American Prisoners Of War and Its Relationship to Captivity and Demographic Variables*

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The psychological dysfunction evidenced by 235 recently repatriated Army, Navy, and Marine Corps former POWs was examined in relation to their captivity experiences and demographic variables. Two criteria -- cognitive dysfunction and emotional/social dysfunction were uniquely predicted by both captivity and demographic variables. Measures of the captivity experience and demographics were examined and discussed in relation to the psychological dysfunctioning of the returnees following repatriation.

Historically, psychiatric examinations of repatriated prisoners of war (POW) have been less than optimal from a research point of view both in formulation and execution. Following the end of World War II, because of the large numbers of men to be evaluated, only a very general physical examination was administered to returning POWs. This included a brief psychiatric screening procedure designed as to detect gross pathology (Brill, 1946). After the Korean War, the first systematic psychiatric evaluations of repatriated POWs were carried out. (Lifton, 1954, and Strassman, Thaler, & Schein, 1956).

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*Paper presented at the Fifth Psychology in the Air Force Symposium, USAF Academy, Colorado, 8 April 1976. This study was supported by the Department of the Navy, Bureau of Medicine and Surgery, under Work Order Request Number Number N00018-76-WR-0003 dated 9 July 1975 and by the Office of the Surgeon General, Department of the Army under Military Interdepartmental Purchase Request Number 76-01 dated 11 September 1975. The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or as necessarily reflecting the views of the Department of Defense.

Many of the studies of concentration camp survivors (Bettelheim, 1960; Chodoff, 1966; Koranyi, 1969) have emphasized the irreversible nature of the effects of environmental stresses within the concentration camp. Some authors thought that psychiatric problems induced or precipitated by extreme coercion and oppression might be reduced or even disappear once the stresses were removed. However, Eitinger (1964) found evidence of a latency period during which psychological dysfunction was apparently absent; but subsequent to this latency period, psychiatric symptomatology sometimes emerged. At the time of release from prison camp, a state of euphoria on the part of the returnee, coupled with the desire to return home as quickly as possible, often led to inadequate documentation of the physical and mental status of the POW. These factors may, at least in part, have accounted for what appeared to be a lack of psychological dysfunction which may have been present initially.

The purpose of this paper is to examine the relationship between demographic variables and captivity experiences on the one hand, and psychological dysfunction in former Army, Navy, and Marine Corps prisoners of war of the Vietnam Conflict following repatriation.

The Sample:

Of the 241 repatriated Army, Navy, and Marine Corps POWs who returned in early 1973, the records of 235 (97.5%) were utilized for this study. The records of six additional Navy POW returnees were eventually obtained but these were not available for analysis at the time this study began.

Navy RPWs numbered 138; an additional 26 RPWs were Marine Corps personnel; and there were 77 Army returnees. Navy returnees were all officers and flight personnel, ranging in age from 23 to 42 years at time of capture. Almost half of the Marine Corps personnel were aviators. Their ages ranged from 19 to 36. Of the Army personnel, 49 were enlisted and 28 were officers. The Army, Navy, Marine Corps POWs represented 42.6 percent of the 566 military POWs returned during Operation Homecoming. The remaining RPWs were Air Force personnel whose records were not used in this study.

All returnees received extensive physical and psychiatric evaluations at the time they were repatriated. The results were recorded on a standardized medical form, titled the Initial Medical Evaluation Forms (IMEF). There were two psychiatric sections contained in the IMEF. These were completed by military psychiatrists at eleven Naval and eight Army hospitals throughout the United States. Form VI of the IMEF is the Psychiatric Questionnaire which is composed of two portions. The first portion consists of 10 open-ended questions pertaining to experiences in captivity. Only two items from this section were used in the analysis: (a) whether the POW felt proper clothing/shelter were lacking in captivity and (b) whether the POW suffered from serious illness or injury while imprisoned. The second portion of the Questionnaire was used to record the frequency of

25 different types of manipulations the captors used to control the prisoners' behavior, such as solitary confinement, physical punishment, and use of propaganda.

Other predictor variables were taken from the captivity debriefings and the men's service records, including: (a) number of weeks in solitary confinement, (b) where the prisoner was held (North Vietnam, South Vietnam, Cambodia, or Laos), (c) time spent in cuffs and irons, (d) length of captivity, (e) rank at capture, (f) age, (g) whether the returnee was an officer or enlisted, (h) regular or reserve, (i) religion, (j) birth order, (k) race, (l) marital status, and (m) number of male and female children.

A multidimensional rank-ordering cluster analysis, utilizing a procedure similar to the Burt-Holzinger method, was performed on the items contained in the second section of the Psychiatric Questionnaire. Two clusters were derived: (1) "Harsh" treatment by the captor, and (2) "moderately harsh" treatment by the captor. The "harsh" treatment cluster included items pertaining to (a) actual punishment, (b) threatened physical punishment, (c) withdrawal or diminishing of food or water, (d) placement in isolation, (e) actual harm to other prisoners of war, (f) torture devices or procedures, (g) forced self-punishment, and (h) sleep disruption/deprivation.

The "moderately harsh" treatment cluster included the following items: (a) promises of early release, (b) logical persuasion, (c) attempts to induce guilt for bombing and role in war, (d) special privileges or treatment, and (e) attempts to induce guilt for violation of camp rules.

The independent variables were (1) the "harsh" and "moderately harsh" treatment clusters, whether proper clothing/shelter were lacking, and whether serious illness or injury were present, (2) variables derived from the captivity debriefings, and (3) demographic variables taken from both the IMEF and service records.

Form VII of the IMEF is the Psychiatric Examination which consists of a comprehensive mental status examination divided into 13 areas of psychological functioning, as follows: (a) reliability of information, (b) barriers to communication, (c) state of consciousness, (d) orientation, (e) memory, (f) appearance and behavior, (g) characteristics of speech, (h) thought process, (i) affect and feelings, (j) perception, (k) intellectual functions, (l) somatic functioning, and (m) social interaction and personality characteristics. Each subject was given a score of either "0" or "1" on each of the 13 scales of the Psychiatric Examination. A score of "0" was assigned if the psychiatrist found that no psychological dysfunction was present, and a score of "1" was assigned if dysfunction were present. The dependent variables were also clustered by a multidimensional rank ordering of the intercorrelations of the 13 scales. Two clusters emerged. They were identified as the criterion variables in this study. The first was labeled the "cognitive cluster" and consisted of items such as memory and perception, while the second

cluster was labeled the "social/emotional cluster" and contained items such as social interaction, affect and feeling.

Results and Discussion

Data analysis occurred in two steps: (1) correlations of the dependent and independent variables, and (2) linear multiple regression analysis procedures. Signficant correlations between the predictor and criterion variables were identified and then introduced into a linear multiple regression equation.

Table 1

EQUATIONS PREDICTIVE OF PSYCHOLOGICAL DYSFUNCTION

Variables Uniquely Predictive of Cognitive Dysfunction

Variable	Validity	Beta Weight	p of Beta	R
Captivity Location	.344	.25179	<.001	.380
Officer/Enlisted	.310	.18574	<.01	

Variables Uniquely Predictive of Emotional/Social Dysfunction

Variable	Validity	Beta Weight	p of Beta	R
Lack of clothing/ shelter	.194	.20489	<.001	.422
Solitary Confinement in weeks	.239	.28720	<.001	
Officer/Enlisted	.231	.30199	<.001	

Both captivity and demographic variables were examined to determine whether they contributed to the variance in both the cognitive and emotional/social dysfunction criteria. Analysis of the data revealed that both pre-captivity and captivity variables accounted for unique variability in the returnees' adjustments at the time of their repatriation.

Among the captivity variables, the following emerged as unique predictors of the criteria: (1) Captivity location; (2) lack of proper clothing and shelter, and (3) length of solitary confinement. Those prisoners confined in areas other than North Vietnam (i.e., South Vietnam and Laos) endured harsher conditions of captivity, greater nutritional deprivation, and inferior health services. Furthermore, those men held captive in the South were closer to active combat areas and were confined with fewer prisoners, thus precluding the elaborate military and social organization reported by those PWs imprisoned in North Vietnam. Those prisoners who suffered from lack of proper clothing and shelter also evidenced significantly greater emotional/social dysfunction. They were ill-provided with

sufficient physical resources to withstand extremes of heat, cold, and tropical rain, apparently regardless of the areas of confinement.

Solitary confinement was endured for longer periods than PWs in past military conflicts, the longest being confined alone in Vietnam for periods in excess of five years. Isolation and sensory deprivation have long been reported in the psychological literature to be associated with heightened suggestibility, auditory and visual hallucinations, intellectual deterioration, and lack of ego discrimination. (Bexton, Heron, and Scott, 1954). Accordingly, one might expect profound effects upon psychological functioning resulting from the experience of prolonged solitary confinement. The results tend to support this expectation. Those prisoners confined alone for the longest periods appeared to have the greatest difficulty in emotional/social dysfunction following repatriation.

A single demographic predictor, officer vs enlisted status, was predictive of both criteria. Enlisted personnel, were primarily imprisoned in areas other than North Vietnam and thus endured comparatively harsher conditions of captivity and less interaction with fellow prisoners. Furthermore, enlisted personnel were younger, less well-educated, and less experienced in dealing with stresses associated with military life. Nardini, 1952 and 1962, has also suggested that lower ranking personnel, being younger and more inexperienced, had more difficulty adjusting both to captivity and repatriation during World War II.

Conclusion:

The pre-captivity and captivity factors examined in this investigation were found to be related to the psychological functioning of former prisoners at the time of repatriation. The more potent predictors of dysfunction were factors which were aspects of the captivity experience as such, i.e., location of captivity, length of solitary confinement, and lack of proper clothing and shelter. Although it had less predictive weight, one demographic factor (officer-enlisted status) was identified as a unique predictor of both criteria.

In conclusion, this investigation has demonstrated that captivity factors, when evaluated in conjunction with pre-captivity variables, significantly enhance the explanation of variations in psychological dysfunction evidenced by the POWs during the repatriation period.

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FATHERS AT SEA:
Characteristics of Navy Families
Vulnerable to the Stresses of Separation

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Family separation is an enigmatic aspect of life in the military. It is a common concern of Army, Air Force and Marine Corps personnel assigned to remote locations and of Naval personnel deployed at sea. All branches of the Armed Forces have examined aspects of family adjustment to separation with the hope of understanding family needs and improving upon existing services to these men and their families (McCubbin, Dahl & Hunter, 1976). Although generally of high quality, investigations conducted to date, such as the recent work of Spjut and Studer (1975) on Air Force families with fathers in remote assignments and the work of the Army and Navy on prolonged separations, (McCubbin, Dahl, Metres, Jr., Hunter & Plag, 1974) have tended to study families at a single point in time, usually during separation, and focus upon the problematic aspects of father absence. Investigations have not examined the problem prospectively and have not given due consideration to the dynamic and adaptive aspects of separations, and thus, have ignored the interrelationship of (1) the family's predeployment preparations; (2) the family's and the deployed father's coping with separation; and (3) the family's adjustment to reunions. Only through examination of these aspects of separation is it possible to identify families vulnerable to the stresses of separation, to determine the dynamics of family adjustment and coping with routine separation, and ultimately, to determine the relationship between family functioning and health and performance of the serviceman. Although these are objectives of our prospective investigation entitled *Squadron Without Wings* conducted by the Naval Health Research Center under the auspices of the Naval Research and Development Command, realistic limitations of data collected to date in this 2-year project have restricted the scope of the present paper.

This paper focuses on some of the initial findings related to the family's predeployment experiences and their relationship to family stresses the aviators and aircrewmen were concerned about during the initial days of an 8-month deployment.

METHOD

Sample: The families in this study were randomly selected from the total population of pilots, RIOs and aircrew assigned to fighter squadrons and attack squadrons designated for an 8-month deployment aboard a Navy carrier scheduled for departure to the Western Pacific. These squadrons and their families

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represented two types of communities. Families in the fighter squadrons (Officers = 17; Enlisted = 14) were stationed in an "open community" in which they were not dependent upon the military community for their social support. The families in the attack squadrons (Officers = 21; Enlisted = 30) were stationed in a "closed community" in which families were housed in a limited geographic area and were primarily dependent upon the military community for their social support. As a total group the husbands ranged in age from 19 to 44 years with an average of 30.2. Their education level averaged above high school (14.2 years) with a range of between 10 and 18 years. The majority of the men were members of the flight crew or administrative staff (58%), with a high percentage as pilots (31%) or Radio Intercept Officers (11%). The wives ranged in age from 18 to 44 years, with an average of 29.04 years. Like their husbands, they tended to be above high school in education level with an average of 13.54 years. The range between 2 and 17 years of education was greater for the wives than for the husbands. Families had an average of 1.6 children, with a range of 0 to 6 children. The majority, (71%) of the families, had 2 to 4 children. The length of marriages averaged 7.5 years and most families indicated prior experience with deployments, with an average of 2 previous unaccompanied tours. The majority of the wives (62%) were not working; however, a noteable percentage were either employed part-time (7%) or full-time (31%).

Procedure

At the time of this writing, predeployment family interviews, conducted during the two to three month period preceding the ship's scheduled deployment, and the initial interviews with the men at sea had been completed. The protocol used during the pre-deployment phases of the study consisted of structured interviews with husband and wife separately, self-report questionnaires for each spouse, and brief introductory interviews with the children who were also requested to complete an individual standardized questionnaire. These procedures were designed to obtain data on family functioning, attitudes, problems and family preparation for the separation. Approximately six weeks after the predeployment interviews the servicemen were interviewed at sea during the first five days of the cruise. The men were interviewed regarding the number and types of family stresses which were of concern to them in the areas of child rearing, family development, marital and personal adjustment, family decisions, financial stability and stresses unique to deployments (e.g., fear of accidents, etc.).

Predeployment predictor variables

For the purpose of deriving a composite of critical family and background variables to explain the variability in the serviceman's family stresses aboard ship the following variables were considered: I. BACKGROUND INFORMATION: Husband's Characteristics - (1) age, (2) years of formal education, (3) rank (officer versus enlisted), (4) military occupational specialty (pilot, RIO, crew, administration), Wife's Characteristics - (5) age, (6) years of formal education, (7) length of time as a member of the military with present husband, (8) number of previous unaccompanied tours, (9) extent of outside employment,

(10) occupational skills, (yes/no), Family Characteristics (11) number of children at home, (12) family development stage at time of deployment, (13) length of the marriage, (14) quality of the marriage -- wife's assessment of, II. WIFE ADJUSTMENT FACTORS: (15) previous difficulty with prior deployments, degree of, (16) feelings about life in the military based on experience, (17) anticipation of hardships as a result of husband's departure (personal, family and child problems), (18) degree of distrust and discomfort with military family support programs, (19) awareness of informal military services (CO wife, wives' club, etc.), (20) awareness of formal military programs (medical counseling etc.) (21) awareness of civilian family programs (legal, medical etc.), (22) awareness of military and civilian programs, (23) perceived helpfulness of military informal programs, (24) helpfulness of military formal programs, (25) helpfulness of civilian programs, and (26) helpfulness of both military and civilian programs, (27) wife's family life stress units - family stresses felt at the time of predeployment, (28) altered living arrangements as a result of husband's deployment, III. HUSBAND ADJUSTMENT FACTORS - (29) husbands life stress units - family stresses felt at time of predeployment, (30) degree of distrust and discomfort with military family support programs, IV. FAMILY/MARITAL ADJUSTMENT FACTORS - (Husband and wife independent assessment of) (31) sensitivity and quality of family communication, (32) family strengths (sex, finances, management etc.), (33) allocation of family roles (extent of husband vs. wife control), V. FAMILY ENVIRONMENTAL FACTORS (as assessed by husband and wife independently) (34) family achievement orientation, (35) family organization, (36) family cohesiveness, (37) family expressiveness, (38) family control, and (39) family conflict, (40) open vs closed community.

Criterion

The criterion for this investigation was the number of family stresses the men reported to be of concern to them during the initial stages of the ship's deployment.

Statistical Analysis

In order to establish the degree of relationship between the predictor variables and the criterion, Pearson product-moment correlations were calculated. This procedure permitted the identification and elimination of those variables having little or no relation to the dependent variable. Linear stepwise multiple regression procedures were utilized for the purpose of analyzing the unique contribution of each of the significant predictors in accounting for the variance in the serviceman's stresses of separation.

RESULTS

Seventeen of the original forty independent variables showed negligible relationships with the criterion of family stresses perceived by the servicemen aboard ship and were eliminated from the regression analysis. The remaining twenty-one variables and significant first order correlations are presented in Table 1.

Table 1: Significant First Order Correlations with Criterion

	Predictors	Family Stress Aboard Ship
HUSBAND:	age	-.325**
	education	-.229*
	rank	-.322**
	military specialty-air crew	.311**
	distrust of military family programs	.204*
	#of family stresses before deployment	.556**
	positive feelings about military life	-.284**
WIFE:	age	-.228*
	having occupation	-.264*
	distrust of military family programs	.249*
	#of family stresses before deployment	.348**
	anticipated hardships before deployment	-.383**
	positive feelings about military life	-.284**
	preparation for separation	-.263*
	awareness of family programs: informal military	-.337**
	formal and informal military	-.299**
	civilian and military	-.223*
FAMILY:	strengths	-.377**
	family roles-wife with more responsibilities	-.232*
	family environment-expressiveness	-.298**
	family relocation-moved to new home	.340**

*p < .05 **p < .01

A regression equation was derived in which the *beta* weights of the predictors were statistically significant at or beyond the .05 level. Three variables met this level: husband's age, ($\underline{r}(80) = -.297$, $\underline{b} = -.1899$, $\underline{t} = -2.066$, $p < .05$), wife's assessment of the family strengths pre-deployment, ($\underline{r}(80) = -.209$, $\underline{b} = -.2091$, $\underline{t} = -2.218$, $p < .05$), and the husband's assessment of family stresses pre-deployment, ($\underline{r}(80) = -.438$, $\underline{b} = .4382$, $\underline{t} = 4.525$, $p < .001$). These variables yielded a multiple correlation of .62, ($\underline{F}(3,78) = 16.224$, $p < .001$) and accounted for 38 percent of the variance. Hence, the combination of these three variables was significantly greater than any of the variables taken independently.

DISCUSSION AND CONCLUSION

The findings indicate that predeployment factors are important for understanding the serviceman's perception of family stresses while at sea. Specifically, seven key factors emerge: (1) family and individual background variables; (2) husband's and wife's attitudes towards life in the military and distrust of family programs; (3) intra-family factors such as expressiveness and strengths; (4) wife's awareness of both informal and formal family support programs; (5) additional family stresses, specifically family relocations in addition to husband's deployments; (6) strength of wife's role in the family, and (7) family preparation for separation.

In the final analysis, only three variables remained: husband's age, husband's stresses before deployment, and wife's assessment of family strengths. The findings indicated that the younger the man, the greater his perception of family stresses even during the early stages of deployment. As might be expected, it appears that the younger man's family is less mature and less secure

in the military setting, having had less exposure to the demands of military life, as well as the advantages of the military community. Shorter marriages, greater control by the husband of family decisions rather than promoting wife's responsibility, little experience with previous deployments, and distrust of available military and civilian family programs, all of which were significantly related to husband's age, are indicative of this inexperience and insecurity, and would contribute to the serviceman's concern for his family while away from them.

The high correlation between the man's predeployment assessment of family stresses and his assessment during the deployment is not unexpected, yet somewhat distressing since the finding would indicate that stresses noted earlier have not been totally resolved prior to deployment. Family and individual attitudes regarding life in the military appear to be important. For, in fact, men who score high on predeployment stresses also tend to indicate negative attitudes towards life in the military and greater distrust of informal and formal military support afforded families. Families who need help may be more reluctant to seek help in resolving stresses and therefore may be more vulnerable in the long run to the demands of separation. For some men the stressful situation was further complicated by having to relocate their families before the deployment.

The emergence of wife's assessment of family strengths as a predictor is not surprising. Wives who view the family as having fewer strengths, are not only those who indicate weaknesses in family communication and marital problems, but also see themselves as having fewer personal resources, specifically less education and fewer employable skills. It appears that the wife's subordinate role in the family was a contributing factor to her devaluation of family strengths.

The final prediction equation consisting of husband's age, husband's stresses before the deployment, and wife's assessment of family strengths indicate that family vulnerability to stress may possibly be determined even before the serviceman's departure. Importantly, the data indicate the value of predeployment programs for families in promoting family preparation for separation, in orienting them to services, decreasing their apprehensions about such programs, and increasing the probability families would seek assistance if needed. Certainly, the concept of family vulnerability to stress warrants careful study and validation within this investigation. Subject to the constraints of a single sample, without cross-validation, evidence was provided for the importance and validity of our prospective approach to the study of family separation. In addition, the role of family research in the military in the identification of families vulnerable to stress and in determining how this may affect the man at sea was substantiated.

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SESSION 1-B

Motor Learning

Pilot Prediction

Chairman: Eugene H. Galluscio

THE EFFECTS OF VISUAL AND PROPRIOCEPTIVE FEEDBACK ON MOTOR LEARNING[1]

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The experiment examined the effects of augmentation and minimization of visual and proprioceptive feedback on motor learning. Learning trials with knowledge of results (KR) were followed by test trials where KR was withdrawn. Variables were number of KR trials, whether visual and/or proprioceptive feedback were augmented or minimized in the KR trials and the KR withdrawal trials, and whether the conditions of feedback remained the same or were changed from the KR trials to the KR withdrawal trials. The main results were that both feedback channels were found to determine motor behavior, with visual feedback the more powerful influence of the two. Learning with both visual and proprioceptive feedback present degraded the use of proprioceptive feedback.

Response-produced feedback is the stimulus accompaniment of movement. Vision and proprioception are the most common kinds of feedback, but tactual and auditory stimuli can also be produced by movement. There are two theoretical conceptions of how motor behavior is governed, and they are differentiated by their reliance on feedback. One conception is motor program theory which holds that a central agent for sequencing a movement, called the motor program, develops with learning, and it has some power to regulate the movement without feedback. The role of feedback in motor program theory is not well defined at this time (Keele, 1973, pp. 124-128) but, presumably, as learning progresses, the motor program becomes increasingly capable of regulating the movement and so there is an increasing independence of feedback. Accounts of motor program theory can be found in the writings of Keele (1973), Pew (1974a, 1974b), and Schmidt (1975).

Adams (1971) has a closed-loop theory of motor learning which contrasts with motor program theory by being feedback centered, where peripheral feedback, not a central program, is the basic agent for governing movement sequences. Learning increases, not decreases the role of feedback as motor program theory contends. A key construct of Adams' theory is the perceptual trace whose definition and strength is a function of the amount and type of feedback, and amount of exposure to feedback. Over practice trials with knowledge of results (KR) the perceptual trace becomes an internal reference of correctness for the response. In the early trials the subject is dependent on KR to inform about error in responding, but as trials progress the perceptual trace can become

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[1] A preliminary report of this work is published in Proceedings of the Human Factors Society 19th Annual Meeting, Dallas, Texas, 1975. The final report is available as Technical Report ARL-76-3/AFOSR-76-3 from the Aviation Research Laboratory, Institute of Aviation, University of Illinois at Urbana-Champaign.

sufficiently articulated and strong to be a reliable basis of error information. When KR is withdrawn the perceptual trace is left as the sole source of error information, and the contributions to it of feedback channels that have been experienced, current conditions of feedback in the KR withdrawal trials, and number of prior KR trials, can be inferred.

Experiments by Adams, Goetz, and Marshall (1972) and Adams and Goetz (1973) were done under the guidance of Adams' theory, and the results supported the theory. The study by Adams, Goetz, and Marshall (1972) found evidence that feedback became an increasingly important variable for governing movement as KR trials progressed, which is evidence for closed-loop theory. Error detection and correction are at the heart of closed-loop theory, and the Adams and Goetz (1973) study dealt with the effects of feedback and number of KR trials on them. Both were found to be potent variables, as closed-loop theory contends. These experiments compared full, unrestricted feedback in all channels (visual, proprioceptive, auditory) with minimal feedback where these channels were minimized or denied, as a first means of approaching the feedback and learning issues of theoretical interests. The purpose of the experiment presented here was to focus on the specific behavioral effects of individual visual and proprioceptive channels that had been pooled in a feedback composite in the earlier studies. Without evidence to the contrary, Adams (1971) theorized that all feedback channels contribute equally to the perceptual trace. Proprioception and vision are considered to have the same importance in the regulation of movement, for example. However, some feedback channels may be more effective than others in the guidance of movements, and the experiment is intended to clarify this matter for theory.

Method

Experimental design

The subjects learned a displacement of the arm by moving a slide 20.3 cm along a linear track. Vision and proprioception were independently manipulated and could be either augmented or minimal. Specifically, there was augmented visual feedback (V) where a subject could see the apparatus and his movement, minimal visual feedback ($\bar{V}$) where visual cues were absent, augmented proprioceptive feedback (P) where spring tension was on the slide, minimal proprioceptive feedback ($\bar{P}$) where spring tension was removed from the slide, or combinations of these four conditions. Auditory feedback of the slide moving along the track was eliminated throughout by injecting white noise at 100db into the subject's headset whenever the slide was in motion.

There were two types of groups for inferring about the potency of the feedback channels for regulating movement. Each had 15 or 150 acquisition trials with KR before being given 50 test trials with KR withdrawn. One type had neither, one, or both of the feedback channels augmented, and the designated channel remained unchanged throughout acquisition and KR withdrawal. The other type had both feedback channels augmented in acquisition, but one or both channels minimized in the KR withdrawal trials. Specifically, the experiment had 14 groups:

15 Acquisition Trials		150 Acquisition Trials	
Feedback Changed	Feedback Constant	Feedback Changed	Feedback Constant
15PV:$\overline{PV}$	15PV:$\overline{PV}$	150PV:$\overline{PV}$	150PV:$\overline{PV}$
15PV:$\overline{P}$V	15$\overline{P}$V:$\overline{P}$V	150PV:$\overline{P}$V	150$\overline{P}$V:$\overline{P}$V
15PV:$\overline{P}\overline{V}$	15$\overline{P}\overline{V}$:$\overline{P}\overline{V}$	150PV:$\overline{P}\overline{V}$	150$\overline{P}\overline{V}$:$\overline{P}\overline{V}$
	15PV:PV		150PV:PV

On the left-hand side of the colon are the conditions of acquisition with KR, and on the right-hand side are the conditions of test without KR.

Apparatus

The slide which the subject moved had ball bearings for smooth action, and it was moved along a 38.1 cm rod from right to left; right-handed subjects found it easiest to operate. The slide had a 5.1 cm handle which the subject grasped to move the slide, and the handle had a button on top which the subject had to hold down while moving the slide. Releasing the button when the movement was completed locked the slide in place. The error in movement was read in 1/8 inch units on a scale visible only to the experimenter.

The apparatus was on a table, with the subject seated in front of it and the experimenter in back of it, and it was behind a panel with a one-way mirror. The panel had the lower 12.7 cm cut out of it so that the subject, with his elbow resting on the table top, could reach through and manipulate the slide. Visual feedback was controlled by lighting the front or rear of the one-way mirror. Illuminating the rear of the mirror made the apparatus and the subject's forearm and hand visible to him, and illuminating the subject's side of the mirror and darkening the other side removed the visual scene. The incident light on the apparatus display, measured through the one-way mirror, 3.02 cd/m^2. As ar additional control of visual feedback, a cloth was draped over the subject's shoulder of his using arm so that he could not derive cues about the course of movement from the upper arm. When spring tension was required for increased proprioceptive feedback, the experimenter hooked a spring to the slide which had a starting pull of 170 grams and a pull of 736 grams at a 20.3 cm displacement. Without the spring the slide had very light action for minimal proprioceptive feedback.

Procedure

Instructions were presented by tape recorder with the lights on so the subject could observe the response requirements, but the slide was neither moved by the experimenter nor manipulated by the subject during the instruction period. The subject was instructed to make one smooth movement, avoid vacillating corrective adjustments, and to release the button on the handle when the movement seemed correct to him. There was no mention in the instructions of the length of movement to be learned.

The cue for the subject to start his movement on a trial was the onset of white noise. In the case of the visual feedback condition the onset of the noise was simultaneously accompanied by the light. At the completion of his

response the subject gave his estimate of the direction and magnitude of error in 1/8-inch units to evaluate his accuracy in error perception (Adams, 1971, p. 127). After the subject had made his estimate he returned his hand to a standard position in front of the panel and the experimenter then turned off the light if it was used, returned the slide to the starting position, and turned off the noise. Ten seconds after the response had been completed, the experimenter gave the subject his KR in terms of the direction and amount of his actual error in 1/8-inch units (e.g., "Five short"). Three seconds after the KR report the experimenter said "Hand," which was the cue for the subject to place his hand on the slide, and 2 sec. after that the signal was given to start the next trial. Thus the intertrial interval was 15 sec. On the test trials without KR everything was the same except that the experimenter omitted his KR report.

The groups with 15 acquisition trials rested for 3-min. after Trial 15. The groups with 150 acquisition trials had a 3-min. rest after every 50 trials. Just before the end of the 3-min. rest period and before the start of the test trials there were brief instructions about the withdrawal of KR and the nature of new feedback conditions if feedback change was to occur.

Subjects

The 210 subjects were right-handed male university students who participated as part of a requirement in a course in introductory psychology. Fifteen subjects were randomly assigned to each group.

Results

Absolute error of the S's response is a fundamental measure of skill, and was used as the primary dependent variable for analysis and interpretation.

The effectiveness of visual feedback is revealed in the KR withdrawal trials. Proprioception and vision were compared for their power to control performance in the KR withdrawal trials after 15 KR trials. Groups 15 $\overline{PV}$:PV and 15 $\overline{PV}$:$\overline{PV}$ were compared in a groups by trials analysis of variance, and the main effects and their interaction were all significant ($p < .01$). The same analysis was made for Groups 150$\overline{PV}$:PV and 150$\overline{PV}$:$\overline{PV}$; groups was a significant source of variation ($p < .01$). Performance was sustained better with visual feedback than proprioceptive feedback in these comparisons.

A groups by trials analysis of variance was used to compare Groups 15$\overline{PV}$:$\overline{PV}$ and 15PV:PV on the 50 KR withdrawal trials, which inquires of the consequences of minimizing visual feedback. The main effects and their interaction were all significant at better than the .05 level. The same evaluation was made for Groups 150$\overline{PV}$:$\overline{PV}$ and 150PV:PV, and groups was found to be significant variable ($p < .01$). The absence of visual feedback throughout degrades performance in the KR withdrawal trials. In the same fashion, inquiring of the consequences of minimizing proprioceptive feedback throughout, and leaving only vision to control performance, the same analysis of variance was performed for Group 15$\overline{PV}$:$\overline{PV}$ vs. Group 15PV:PV and for Group 150$\overline{PV}$:$\overline{PV}$ vs. Group 150PV:PV. None of the main effects or their interactions were significant in either of the analysis; the minimizing of proprioceptive feedback had no discernible effect on performance.

With vision as a potent feedback channel there is the possibility that proprioception is ignored when learning is with the vision-proprioception compound. This does not appear to be so because performance with proprioception feedback alone is better for Group 150PV:$\overline{PV}$ than for Group 15PV:$\overline{PV}$ in the KR withdrawal trials, showing that an increased dependence on proprioception develops with training even though vision was also present. Vision does not cause proprioception to go unattended.

Visual feedback does not totally prevent the use of proprioceptive feedback, but conceivably the joint presence of visual and proprioceptive feedback during the KR trials could attentuate the use of proprioceptive feedback when later it is the only source of feedback available for regulating movement. If so, the expectation would be that the PV:$\overline{PV}$ condition would be poorer in the KR withdrawal trials than the $\overline{PV}$:$\overline{PV}$ condition. Groups 15PV:$\overline{PV}$ and 15$\overline{PV}$:$\overline{PV}$ were compared in their performance on the 50 KR withdrawal trials with a groups by trials analysis of variance, and only the interaction of groups and trials was significant ($p < .01$). The same test for Groups 150PV:$\overline{PV}$ and 150$\overline{PV}$:$\overline{PV}$ found the groups comparison significant ($p < .01$), however. There is no evidence of attentuation of proprioceptive feedback after a small number of prior KR trials but the evidence is definitely there for a large number of KR trials.

Vision attenuates the use of proprioceptive feedback, but is the converse true? Is the effectiveness of visual feedback impaired when practice had occurred jointly with proprioceptive feedback? The answer is No. Neither the comparisons of Groups 15PV:$\overline{PV}$ and 15PV:$\overline{PV}$, nor Groups 150$\overline{PV}$:$\overline{PV}$ and 150PV:$\overline{PV}$, on the KR withdrawal trials with a groups by trials analysis of variance produced main effects or interaction terms that were significant at the 0.5 level.

Discussion

One of the consistent and impressive effects in our data was the power of visual feedback for the controlling of movement. Whether it was acquisition or KR withdrawal trials, error was low when vision was present and comparatively high when vision was absent. Theoretically this means that proprioception is weighted less than vision in the perceptual trace, but its weight is not zero because proprioception was found to play a part in the regulation of movement. There is an old belief in experimental psychology that proprioception is particularly eminent in the regulation of movement (Adams, 1968), perhaps because it is a necessary accompaniment of movement. On the basis of our data we recommend this up-dating of the belief: Proprioception plays a role in the regulation of movement, but not as big a one as vision. When it is combined with vision it continues to play a role but it is a minor one. Stelmach and Kelso (1975) have also found evidence of the importance of vision for motor behavior.

But the theoretical issue is more complicated than weighting. Not only is there differential weighting of feedback channels, there is interaction among them as well. Visual and proprioceptive feedback interact as they play out their roles in regulating movement, and vision dominates the interaction. Training in the KR trials with a visual-proprioception compound worsened the power of proprioceptive feedback alone to regulate movement. Sensory interinteraction is not a new finding for sensory psychology (London, 1954; Loveless,

Brebner & Hamilton, 1970; Ryan, 1940), nor is the dominance of vision a new finding for perception (Rock & Harris, 1967), but it is a new one for motor learning. Interestingly, the interaction is one way. Vision overpowers proprioception when it is present and degrades proprioception's influence, but proprioception is not potent enough to work conversely and erode the influence of vision.

This research was partially supported by the Life Sciences Program, Air Force Office of Scientific Research, Contract No. F44620-76-C-0009. Dr. Charles E. Hutchinson was the scientific monitor of the contract.

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MANUAL VERSUS AUTOMATIC ADAPTIVE SKILL TRAINING

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Three training conditions (fixed difficulty, automatically adaptive, and manually adaptive) were each used to train six male and six female students to perform a two-dimensional pursuit tracking task. A seven-minute tracking session in which task difficulty shifted each minute was used to measure transfer. Although training type did not result in differences in training time, students trained under a high degree of student control (manually adaptive) had less error during transfer. Females required on the average twice as much training as males. However, during transfer no sex differences were noted. The apparent sex differences in training may represent only a measure of previous experience with similar motor-control tasks.

Recently a great deal of research has been directed toward optimizing individualized motor skills training. Specifically, automatic adaptive training techniques have been investigated under the assumption that such training provides an optimum learning model for motor skills training (see Kelly, 1969). Adaptive training is a closed-loop system in which some aspect of the student's performance is measured and used in a computer algorithm to manipulate the difficulty of the training program. As a result the level of student performance remains relatively stable over the training period, whereas task difficulty fluctuates upward and downward.

While research in motor skills has been directed toward the use of computer algorithms to manipulate the training situation, efforts in computer-assisted instruction have involved greater student control over the learning sequence. Several researchers using cognitive tasks have discovered that permitting student control of branching results in at least as much transfer as using a computer algorithm (Lahey, Hurlock, and McCann, 1973; Mager and Clark, 1963; and McCann, Hurlock, and Lahey, 1973). On the other hand, Fry (1972) found that, although students trained under a high degree of student control were more positive toward training, they learned less than students trained using either an instructional sequence developed by an expert or a random instructional sequence. The question arises as to how learner control of the instructional sequence in motor skills training will affect the learning process.

In general, studies which examine performance with motor-control tasks have involved male subjects only. If women were used as subjects, they were included in unequal numbers across experimental conditions so that no analyses could be made concerning potential sex differences in learning these tasks. Consequently, little data on female performance in motor control situations are available.

To investigate learner control in motor skills training and to expand the meager data base on female performance with motor-control tasks, a study was conducted in which an equal number of male and female subjects were trained using one or three types of training--fixed difficulty, automatically adaptive, or manually adaptive. The fixed difficulty condition is the traditional learning

situation in which the final task is presented, and student performance improves as the task is learned. Automatically adaptive training uses a computer algorithm and some aspect of student performance to manipulate task difficulty and maintain a stable level of error during learning. Manually adaptive training permits the student to determine when to increase or decrease task difficulty during training.

Method

Subjects

For each of the three training types, six male and six female subjects were trained. Subjects were volunteers paid for their participation. All were undergraduates at the University of Illinois, nonpilots, and naive to the particular motor task to be learned.

Training Task

Students performed a two-dimensional pursuit tracking task in which two random, band-limited functions were used to determine the position of the forcing function symbol (X) on the cathode-ray tube display. Control output, symbolized by an 0 on the display, was generated using a dual-axis force control stick. Task difficulty was adjusted by manipulating the forcing function frequency (Hz.) using the cutoff frequency of the band-limited, low-pass filter.

Two performance bars appeared, one on each side of the display. The bar on the right indicated the level of task difficulty, and the bar on the left indicated the tracking accuracy of the student. On each performance bar a line appeared about three-fourths of the way up the bar indicating acceptable performance. Students had to get both bars up to or above these lines and keep them there for a period of 20 continuous seconds. Training was divided into three-minute tracking sessions and one-minute rests and continued until the exit criterion was reached.

A Raytheon 704 digital computer was used to generate inputs for the CRT display, to process signals from the subjects, and to measure time-to-exit. A two-button keyboard was used by subjects in the manually adaptive condition to change task difficulty.

Transfer Task

The transfer task was similar to the training task except that no performance information was provided. In addition, transfer involved one seven-minute tracking session in which task difficulty shifted after each minute of tracking. Three levels of difficulty were presented: the same as the exit criterion during training (.55 Hz.), more difficult than the exit criterion (.65 Hz.), and less difficult than the exit criterion (.45 Hz.).

Results

Training

The dependent variable of interest in training was the time required to reach the exit criterion. A two-factor analysis of variance using training

type and sex was conducted on the training time scores. A reliable main effect of sex ($F_{1, 30} = 12.14$, $p < .001$) was revealed. Males required approximately 9 minutes of training, whereas females required more than twice as much time (approximately 20.5 minutes). Type of training was not a reliable effect ($p > .05$) despite the apparent advantage in using adaptive systems with female subjects. The failure to obtain a reliable effect with female subjects may have resulted from the relatively small sample and/or the extreme variability in performance among female subjects. These results are summarized in Table 1.

Table 1
Average Training Time to Exit (Min.)

Training Type	Males	Females
Fixed Difficulty	8.0	27.2
Automatically Adaptive	9.0	18.1
Manually Adaptive	9.7	16.2

Transfer

In transfer, vector RMS error was integrated over each minute of tracking. A three-factor analysis of variance on training type, sex, and level of difficulty was conducted. The main effect of level of difficulty was reliable ($F_{2,60} = 88.79$, $p < .001$) indicating that error increased as the level of difficulty was adjusted upward. The main effect of training type was also statistically significant ($F_{2, 30} = 3.99$, $p < .05$). A subsequent Newman-Keuls analysis indicated that the reliable comparison was between the fixed difficulty and manually adaptive training conditions. More transfer resulted when students were trained under the manually adaptive condition. Finally, although a highly reliable sex difference appeared in training, no reliable differences ($p > .05$) in performance between males and females were found in transfer even when task difficulty exceeded the original exit criterion. Transfer results are summarized in Table 2.

Discussion

Sex Differences

It is interesting to note that the highly reliable sex difference that appeared in training was nonexistent during transfer. Particularly important is the failure to find a sex difference when task difficulty was increased to a level higher than that required during original training. This would indicate that, although women may require some additional training time initially on the motor-control task used in this study, in general, no performance differences by sex will appear once training is accomplished. In fact, the difference in training time required may actually represent a difference in prior experience with similar motor-control tasks rather than a true sex difference.

Table 2
Average Vector RMS Tracking Error in Transfer

Training Type	Males	Females
Difficulty 1 (.45 Hz.)		
Fixed Difficulty	.018	.020
Automatically Adaptive	.016	.013
Manually Adaptive	.013	.012
Difficulty 2 (.55 Hz.)		
Fixed Difficulty	.030	.029
Automatically Adaptive	.026	.022
Manually Adaptive	.024	.023
Difficulty 3 (.65 Hz.)		
Fixed Difficulty	.043	.040
Automatically Adaptive	.040	.040
Manually Adaptive	.034	.032

Adaptive Logic

Much effort has been expended in attempting to optimize the human learning model. And yet, this study would indicate that the student is quite capable of effectively manipulating the learning situation based on his own internal model. Naturally, the computer model used in this study may have been suboptimal. But, until more sophisticated human learning models are available, the training designer might be well-advised to consider a learner-centered approach to individualized motor skills training.

Acknowledgments

Contractual support for this project was provided by the Life Sciences Program, Air Force Office of Scientific Research, Contract Number F44620-76-C-0009. Th authors wish to thank Roger A. Hunt for assistance with software requirements.

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USE OF TWO-AXIS TRACKING TASK IN PREDICTING PILOT TRAINING SUCCESS

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Forty Air Force Academy cadets performed a two-axis attitude tracking task for four seven minute trials. The second and fourth trials included a digit cancelling side task. Performance measures on these tasks were correlated with their performances in T-41 light aircraft pilot training. Initial results indicate this tracking task correlates as well as some GAT-1 simulator measures with T-41 training success.

The goal in selecting candidates for training programs is to insure that those selected would have the maximum probability of success while those not selected would have been the ones most likely to have failed had they been selected. Present concerns over training costs, fuel shortages, and budgetary constraints have created a positive set toward identifying more economic and accurate means of predicting pilot training success.

In 1971, Hill and Goebel used automated GAT-1 performance measures to discriminate between three levels of pilot ability: beginner, intermediate, and advanced. They found twenty-seven measures that clearly discriminated between these levels of piloting ability. A careful review of those twenty-seven measures indicated that tracking error, pitch, roll and their associated flight parameters were the strongest discriminators.

McGrevy and Valentine (1974) reopen the issue of the use of psychomotor tests in the pilot selection process because of the increased reliability and accuracy of the new solid state versions of the traditional psychomotor devices. They found the "new" psychomotor tests to be fair predictors of pilot training success, but in conjunction with the AFOQT they correlated 0.56 with a graduation/elimination dichotomous criteria. Of the psychomotor tasks, the complex coordinator had the greatest correlation with pilot training pass/failure, $r = 0.44$, while the AFOQT correlated 0.37 by itself. The complex coordinator required the subject to keep a two-axis moving target centered with the use of a joy stick while keeping a separate line centered by using foot pedals, a version of the former "stick and rudder task".

Although tracking performance indicates different levels of performance between subjects its ability to distinguish between levels of capability might be masked by the fact that subjects have different individual tolerance levels to which they perform their tasks. Passey and McLaurin (1966) made an extensive review of the work done in the

perceptual-psychomotor area focusing on selection tests for aircrew personnel. Of the three general categories of behavioral characteristics important to successful aircrew operation that they noted was the capacity for integration and processing of information from several sources. Golpher and North (1974) and North and Golpher (1974) felt that the measurement of one's ability to maintain a given tracking task was not a sufficient measure of attention capacity, and that the introduction of an additional task might provide a measure of the subject's residual attention; that is, the attention capacity in excess of that required to perform the primary task. They used a secondary side task to the tracking task and studied the shifting levels of priority between the two tasks and the use of a side task along with the tracking task to discriminate between student pilots and instructor pilots.

The purpose of this study was to demonstrate that a basic two-axis tracking task with a side task could yield as much predictive information about flying training success as any other means currently used. It was felt that psychomotor skills related to two axis tracking are basic to all flying skills and are not subject to temporal decay in prediction and would therefore have a greater potential for cross validation.

Method

Subjects

Forty subjects were randomly selected from the roster of those to be enrolled in T-41 training during the second session of Summer 1975. The subjects were told the purpose of the study and the performance and time requirements for participation. After agreement to participate, the subjects were scheduled for a single one-hour session prior to flying the T-41 aircraft.

Apparatus

Each subject was seated in a chair located in a soundproof booth with a two-axis controller, an oscilliscope, and a side task generator. The attitude display was presented on a conventional oscilliscope with the horizon moving and the aircraft symbol fixed on the face of the scope. The horizon line was moved in pitch and roll by two random signal generators. The subject's task was to nullify the random disturbances on pitch and roll with the two-axis controller mounted at the end of the right arm rest of the chair. The outputs of the random signal generators and the two-axis controller were summed within a TR-20 analog computer and the resultant error displayed on the oscilliscope relative to the fixed aircraft symbol. The side task was presented with a unit mounted at the end of the subject's left armrest. Numbers were presented to the subject on a one-inch light emitting diode (LED) display, and they could be cancelled by depressing the corresponding digit on a scrambled array of buttons numbered 0 through 9. Failure to cancel the stimulus digit within ten seconds would result in a continual beeping tone until the digit was

cancelled. Incorrect responses resulted in steady tones. A correct response was followed by another digit within 0.5 to 8.0 seconds. The onset of each digit presentation was accompanied by a momentary tone to alert the subject of the digit's presence.

The subject's performance was recorded on an analog tape recorder and on a paper strip chart recorder. The strip chart recorder was used to give subjects some feedback during the inter-trial rest periods. Pitch error, roll error, correct responses, latency of responses, and incorrect responses along with identifying information were recorded on the analog tape unit for subsequent digitizing and analysis.

Procedure

Each subject was briefed as to the nature of the study and that his participation would have no effect on his performance ratings in T-41 or subsequent undergraduate pilot training (UPT). Each subject was given four seven minute trials with five minutes of rest between each trial. During the rest periods, the subjects were permitted to come out of the booth to look at the strip chart recording of his performance on the last trial and to converse with the experimeter. Trials 1 and 3 were two-axis tracking only. Trials 2 and 4 were the same two-axis tracking task along with the digit-cancelling side track.

The instructor pilots in the T-41 program were not aware of which students were involved with the tracking task. As the students completed the T-41 program their instructors were asked to rate the forty experimental and twenty "control" subjects on a seven point scale as to their potential for pilot training success. Relatively objective measures of the students performance on their final check ride were obtained from their final check ride grade sheets.

Results

The analog recordings of subject performance were digitized at 15 Hz and the mean RMS error per five seconds periods of time were calculated for pitch and roll over the entirety of each of the four seven-minute trials. At the present, only the pitch, roll, and latency on the side task have been correlated with the T-41 performance ratings given by the instructor pilots. An overall multiple R of 0.53 was obtained on trial 4 using pitch error, roll error and latency. Equal weights on these variables will be used (Wainer, 1976) in an attempt at cross-validation using the performance measures of sixty subjects who participated in the study during the Fall of 1975 semester. The data will be retained to determine its predictive validity to ultimate UPT success.

Discussion

At the present, very rudimentary stage of analysis of the data in this study, it has already been demonstrated that the correlation

between this two-axis tracking task and T-41 performance exceeds that of recent studies utilizing the GAT-1 flight trainer in predicting T-41 success/non success. It is anticipated that with further analysis and cross-validation the validation results might be not significantly less than those other predictor tasks that capitalize on the maximum chance relationships without cross-validation. It does appear that the essence of the many variables that can be technically extracted from a GAT-1 trainer are tapping the subjects' ability to control the two axes and their associated flight parameters rather than some global aspect of the "goodness of flying ability" demonstrated by the subject.

May it be noted that this study along with many other recent studies are dwelling primarily on mere psychomotor skills and not on the cognitive skills, communicative aspects, and attention capacities associated with the flying of real aircraft in operational environments.

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THE AUTOMATED PILOT APTITUDE MEASUREMENT SYSTEM

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Performance measures on a five hour learning sample of flight tasks, administered with an Automated Pilot Aptitude Measurement System (APAMS), were collected from 178 candidates for the Air Force Undergraduate Pilot Training (UPT), selected for training with current selection procedures. These performance measures were then compared with the candidates performance during the UPT. The results indicated that performance in all phases of training could be predicted from performance on the learning sample. Candidates who were eliminated from all phases of training, including those eliminated for Manifestation of Apprehension (MOA), Self Initiated Elimination (SIE), as well as eliminees for Flying Training Deficiency (FTD) could be discriminated by their performance on the learning sample. The results indicated that the learning sample approach could contribute substantially to existing pilot selection procedures in reducing current attrition rates in UPT.

The high per student cost of military pilot training programs makes it highly desirable that attrition rates during training be kept at a minimum. Yet attrition rates during UPT in the Air Force for the past few years have been close to 30 percent. The Army and Navy are faced with similar problems.

In an attempt to alleviate this problem, the Air Force Human Resources Laboratory, Personnel Research Division (AFHRL/PD), proposed the development and evaluation of a learning sample technique to augment existing pilot selection procedures. AFHRL/PD requested therefore that a system be developed that could automatically administer a learning sample of representative flight tasks, of approximately five hours duration, to flight naive candidates for pilot training in a Singer General Aviation Trainer (GAT-1). Measures of performance on the learning sample administered with that system were to be collected from candidates selected for pilot training with existing procedures just prior to the beginning of flight training and then correlated with their later performance during the three phases of UPT. This paper describes the system that was developed, and the results of the study conducted to evaluate its predictive capability, by the McDonnell Douglas Astronautics Company (MDAC) in response to the request from AFHRL/PD.

Method

Apparatus

The Automated Pilot Aptitude Measurement Systems (APAMS) which was developed for this study has the capability to automatically administer and score a complete five hour syllabus to two flight naive subjects simultaneously. All instruction

and training, including that required for the understanding, interpretation, and use of flight instruments and controls, and all performance feedback to the subject required for learning is provided with no instructor participation.

The system utilized two Singer General Aviation Trainers (GAT-1s), a Varian 620/f104 minicomputer, two Bell and Howell 756 Filmsound 35 filmstrip systems, two Tektronix 613-1 Storage Display units, two Votrax voice synthesizers, and the essential interface equipment and software programs to integrate these components into an operational system.

The syllabus developed for the study consisted of a five hour sample of flight tasks representative of those required in learning to fly a light aircraft. It included a series of learning tasks involving both the use of the controls and displays required to operate the GAT-1, and the performance of a sequence of maneuvers of increasing complexity typical of flight training. The tasks were based upon the syllabus used by the Air Force in the T-41 training program and the syllabus used by the University of Illinois for private pilot training. Learning tasks and/or flight maneuvers were selected and structured into a syllabus so as to discriminate between individual differences in basic psychomotor abilities, learning rates, multi-task integration, and performance under overload.

The subjects started with very simple tasks, on which instruction, practice and testing were given. These simple tasks were then combined into tasks and maneuvers of increasing complexity, resulting in a syllabus which extended from learning to use a single control to change the pitch or bank angle, or interpret a single instrument, to flying a traffic pattern from take-off to landing with a crosswind. To increase the workload and to obtain some indication of the effects upon performance of stress,a side task was added. Maneuvers were performed with and without the side task and with and without rough air.

Instructions required for operation of the system and the performance of flight tasks were presented automatically by means of the Film-sound system mounted in the side window of the GAT-1. Subjects were assumed to be completely naive with respect to flying, the dynamics of flight, aircraft or simulators, and their displays and controls.

Both auditory and visual displays were developed to provide feedback to the subject automatically. Three types of feedback as usually provided by an instructor in a training situation were used.

(1) Anticipatory feedback aimed at reminding or prompting the student to take some action, presented by means of the Tektronix scope mounted above the windscreen.

(2) Out of tolerance feedback indicating the existence of unacceptable performance presented aurally by means of a Votrax voice synthesizer.

(3) Evaluate feedback at task completion presented on the Tektronic scope in the form of a performance history display.

The Tektronix scope was also used to present the representation of a "rectangular course" and "traffic pattern" which the subjects were required to fly as part of the learning sample.

Data Collection and Performance Measurement

One hundred seventy eight candidates who had been selected for UPT with current selection procedures, drawn from eight consecutive training classes, were used as subjects in the study. Subjects from each class were tested in five one-hour testing sessions, 48 hours apart during a 10 day period just prior to the beginning of the T-41 phase of flight training. On reporting to the testing facility subjects were directed to enter the GAT and were instructed in the operation of the audio visual system which provided the instructions. No further information was provided to the subject by the experimenter during the course of the five training/testing sessions, nor was he permitted to answer any questions asked by the subject.

Performance measures were collected on 15 different flight maneuvers, each performed twice during the five testing sessions. The maneuvers on which performance was recorded included: straight and level flight, climb, descents, level turns, climbing and descending turns, takeoff and climb, a rectangular course at a constant altitude and a traffic pattern from takeoff to landing, all performed with and without the side task. The values of nine flight parameters (pitch, bank, airspeed, altitude, vertical speed, heading, side slip and position) were recorded at .05 second intervals on magnetic tape during the maneuvers. Performance measures consisted of the amount of deviation from some specified value on these flight parameters during each maneuver. Flight parameters whose specified value varied during a maneuver was not scored.

Data Analysis and Results

Each test maneuver was performed twice and each leg of the rectangular course and traffic pattern were treated as a separate maneuver, resulting in a total of 54 test maneuvers. The combination of maneuvers and flight parameters measured for those maneuvers resulted in a total of 312 raw scores per subject. Analysis of the intercorrelations between these scores showed that some of the flight parameter scores were so highly correlated that they were considered redundant (e.g., airspeed and pitch; bank angle and turn rate). Elimination of these redundancies reduced the number of raw scores to 190 per subject.

A factor analysis, using these 190 raw scores, provided 20 factors scores which were then used in a step wise regression analysis. The 20 factors scores were regressed against the following criteria of UPT performance: T-41 final grades; pass versus elimination for Flying Training Deficiency (FTD) for all three phases of UPT (T-41, T-37 and T-38) individually and combined; and, pass versus elimination for all causes, for all phases individually and combined.

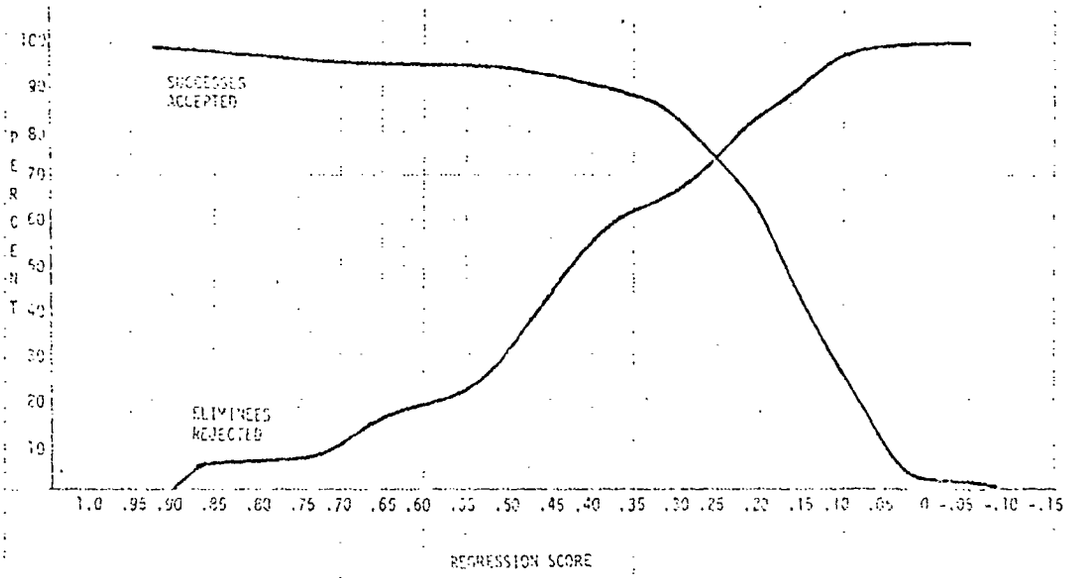
The results from these analysis all showed that performance on the learning sample was highly predictive of all of these criteria of performance in UPT. The data showed moreover that all potential eliminees, regardless of reason for elimination - that is, Self Initiated (SIE) and elimination for Manifestation of Anxiety (MOA) as well as Flying Training Deficiencies (FTD) - could be predicted with roughly equivalent probabilities from their performance on the learning sample.

Since all of the UPT performance criteria used were treated as dichotomous multiple correlation coefficients were not considered to adequately represent the predictive potential of the data. Instead, the data was analyzed in terms of the

percent of the successful candidates who would have been accepted by any given regression score versus the percent of the failures who would have been rejected by that score.

The basic results from the study, shown in this form, for all eliminees from all phases of UPT is depicted in Figure 1. It may be noted from Figure 1 for example that a regression score that would have accepted about 75 percent of all successful candidates, would have rejected 75 percent of those who were eliminated.

FIGURE 1 Percentage of candidates who successfully completed all phases of UPT that would have been accepted versus those who were eliminated for any cause who would have been rejected as a function of regression score



Discussion

The results from the study indicate that the learning sample approach as represented by APAMS, used to augment existing selection procedures, could contribute substantially to the reduction in attrition rates in UPT. Using the regression score noted above that rejects 75 percent of the potential eliminees would result in reducing attrition rates to about seven to eight percent. This would translate into several million dollars per year in cost savings for the Air Force pilot training program.

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TWO EVALUATIONS OF THE EFFECTIVENESS OF COGNITIVE PRETRAINING IN UNDERGRADUATE PILOT TRAINING (UPT): THE COGNITIVE MODEL REVISITED

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Two cognitive pretraining programs are evaluated and the results are interpreted as supporting a cognitive model of what is learned during flying training.

A cognitive model of what is learned during flying training presented at the 1974 Psychology in the Air Force Symposium conceptualized the acquisition of flying skill as an information seeking and processing task in which the pilot's problem is learning what to look for, where to look for it and what to do with it after he finds it (Eddowes, 1974). The cognitive model proposes that during flying training a student pilot's cognitive readiness to make finer and finer discriminative evaluations of more and more aspects of his total flying performance is gradually developed as he gains skill, his performance stabilizes and these increasingly refined discriminations become feasible. Since then, two related research projects have been completed. The following sections of this report describe these studies and interpret their results in terms of the cognitive model.

PRELIMINARY EVALUATION OF AN AUDIO-VISUAL INSTRUMENT TRAINER (AVIT)

AVIT was developed to provide instruction in instrument scanning, interpretation and flight path error correction to prepare a student pilot to take maximum advantage of subsequent instrument training in a flight simulator. AVIT is one of a family of training devices that vary along a continuum of abstractness from academic instruction through flight instruction in the aircraft. This array of trainers can be arranged to match a student's level of discriminative/cognitive readiness for learning with a different level of complexity and representativeness of the training task presented. In the present study the capability of AVIT to provide pretraining for later instruction in a flight simulator was evaluated (Eddowes, McRee and Matheny, 1975). It was hypothesized that a student who completed the AVIT program would perform more accurately on a set of test problems involving aircraft control in the simulator than students who had not received the AVIT instruction.

METHOD

Subjects: Subjects were 45 student pilots of UPT Class 75-08 at Reese AFB, TX randomly assigned to two sections of 23 and 22 students each. The intact section of 22 students was randomly selected to be the experimental group and received training using AVIT. The intact section of 23 student pilots was selected to be the control group and did not receive training using AVIT.

Apparatus: In this study AVIT presented a branching-type, 169-frame, self-instructional program on the use of aircraft flight instruments in the T-37 aircraft. The program instructed the student on how to achieve and maintain straight and level flight. The student interacted with AVIT by means of a simulated aircraft control stick and throttle which are interconnected with the device by logic circuitry. Student responses control the presentation of the program, knowledge-of-results, and automatically branch the program to the next frame of instruction following correct responses or branch it to a remedial sub-program, depending on the characteristics of the error made. Additional technical information or AVIT has been documented elsehwere (Matheny and Crowder, 1974). In addition to AVIT, which was used to present the experimental instruction program, an unmodified Air Force T-4, a fixed-base instrument procedures trainer was used to generate problems in the evaluation test administered to all subjects in both experimental and control groups.

Procedures: The experimental group subjects were briefed on the characteristics of AVIT and instructed to complete the AVIT program as soon as possible. After the experimental group finished the AVIT program, both experimental and control subjects were scheduled for a performance test in the T-4 trainer. The test lasted approximately 15 minutes. All testing was completed during the first three-and-a-half weeks of UPT.

RESULTS

The students who received the AVIT instructional program made significantly more correct control responses on the performance test than the control gorup. This outcome is interpreted as indicating that the additional training provided by the AVIT instructional program led to a higher level of performance on the test problems in the T-4. In addition, the results are interpreted as supporting the validity of the concept of using a family of multi-media instruction distribution devices to foster a student's incremental readiness for learning at several levels of complexity and representativeness of the training tasks presented.

COGNITIVE PRETRAINING OF THE T-37 OVERHEAD TRAFFIC PATTERN

One of the most complex and difficult tasks facing the student pilot prior to his solo flight check is learning to fly the overhead traffic pattern and successfully landing the T-37 aircraft. The pattern must be flown to exacting tolerances and involves a complex sequence of information processing and perceptual motor responses which must be performed quickly and precisely in order to land successfully. The difficulty and criticality of the landing task is further increased by the fact that it comes early in flight training and is prerequisite to solo flight. Furthermore, ground training in this task is severely limited because of training syllabus time constraints. Traditionally, almost all of what is learned in flying the pattern has been acquired through trial-error experience in the aircraft. The problematic nature of the landing pattern as a training task makes it a logical focal point of improved training methodologies.

METHOD

This two-part study tested the concept of cognitive pretraining in Air Force UPT (Smith, Waters and Edwards, 1975). An instructional package teaching the T-37 overhead pattern was developed and tested during Phase I and evaluated during Phase II.

Phase I - The instructional package and criterion test were developed and validated using student pilots from three UPT classes at Williams AFB, AZ. The contributions of the programmed text only vs the programmed text plus sound/slide program were estimated. Instructor pilot and student pilot feedback guided the sequential development of the entire multi-media instructional package. Item analysis of the criterion test on 79 subjects yielded an internal consistency reliability estimate of .978. A content validation was made of the test using graduating T-37 student pilots who had no exposure to the instructional materials. This group indicated that the material taught in the instructional package and tested by the criterion measure was consistent with current flightline instruction.

Phase II - Two randomly assigned sections of 15 student pilots each from Class 76-05 were used to estimate the effectiveness of the instructional package. This evaluation included two areas: (1) student performance on the criterion test, and (2) IP ratings of student performance in the T-37 aircraft. The former measure determined subject learning and short-term retention of the material, while the latter measure evaluated transfer of training to the aircraft.

Group E was given the programmed text five days prior to taking the criterion measure. Group C took the criterion test without specific instruction on the content of the material beyond that which the ATC syllabus provided. The day following this testing, both groups went to the flightline to begin inflight training.

RESULTS

It was hypothesized that Group C would acquire the knowledge which Group E obtained from the instructional package, but would acquire it in their flight training. To test this hypothesis, Group C was randomly divided into thirds, with C_1(n=5) retaking the criterion measure nine days after commencing flying, C_2(n=5) after 16 days, and C_3(n=5) after 23 days. Group E was retested 23 days after commencing flying. The comparison of the mean scores of these sub-groups was designed to evaluate when the information was acquired by the Group C students and whether the flight training increased experimental group performance beyond pre-flying levels.

Results showed non-overlapping distributions of group test scores on the pre-flying testing, with the highest Group C subject scoring lower than the lowest Group E member's score. On the retest, mean scores increased and variability decreased during Group C flying training. After two weeks of flight training, Group C mean test score was statistically no different from the preflying Group E mean test score. By then both groups indicated asymptotic performance.

To evaluate the inflight effectiveness of the experimental treatment, it was necessary to estimate the amount of transfer of training from the instructional program to the aircraft. A rating scale was constructed to record the IP ratings of the performance of their students on the overhead traffic pattern in these categories: (1) overall lesson grade, (2) general flying knowledge, (3) confidence, and (4) coordination. Data was collected through the student's "solo" ride (13th or 14th training flight). Nonparametric statistical analyses were made to compare Group E and Group C group ratings across rides and across number of patterns flown.

This study showed that the instructional program significantly improved the student pilot's recognition of critical cues and improved the student's knowledge,confidence and coordination as rated by the IP's, and resulted in an average of two less flights per subject to attain criterion performance. The greatest impact occurred early in the student pilot's flying training, with significant differences "washing out" after seven to eleven rides. Group E IP's subjectively expressed the opinion that their students were "about two rides" ahead of their prior students after the second or third flight. The IP's were thus able to concentrate more on teaching the motor skills involved in the complex task and less on teaching the cognitive aspects.

CONCLUSION

These two studies provide data that are interpreted as partially confirming certain aspects of the cognitive model. In the first study, cognitive discriminative skills were presented in a simpler, more abstract training situation and students who received the instruction transferred their learning to more complex, more representative training tasks. In the second study, training in the cognitive aspects of a complex psychomotor task given before taking up the complete training task was found to result in increased training effectiveness. Such experimental outcomes provide modest, limited (but encouraging) support for the cognitive model's assertion that what is learned during flying training may involve more than the acquisition of hand-eye coordination.

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SESSION 2

Visual Processing

Visual Displays

Chairman: Jefferson M. Koonce

AN ASSESSMENT OF NAVIGATION PERFORMANCE OF ARMY AVIATORS UNDER-NAP-OF-THE-EARTH CONDITIONS

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Thirty-five Army rotary wing aviators with varying levels of flight experience were tested in a series of three field experiments during which they flew simulated operational missions in a UH-1H aircraft to determine their proficiency in Nap-of-the-Earth (NOE) navigation. The mission was to navigate a specified route starting from an initial point (IP) and identify all landing zones (LZ) while staying within 250 meters of the course line. Those pilots given additional terrain analysis training, as part of the study, performed their missions more effectively, than the group which did not receive this training. Pilots with greater flight experience performed slightly less effectively than pilots who were less experienced but were recent graduates of the Aviation School. Based on the results of this study, improvements in work methods and training are suggested.

Unlike those of past aggressors, the air defense weapons of a potential adversary in a mid-intensity conflict will be highly sophisticated and extremely mobile. As such, they are particularly threatening to helicopter operations.

In a response to this sophisticated air defense threat, the Army has chosen to implement tactics first developed by the Howze board and tested in the early 1960's. These tactics are subsumed under what we now call Nap-of-the-Earth (NOE) flight.

"NOE is to the aviator, what creeping and crawling is to the infantryman." (Maddox, 1973). The aviator must now descend to altitudes previously considered unsafe and use the terrain and vegetation as cover in order to mask his aircraft from enemy radar or optical detection.

The introduction of NOE tactics presents special difficulties to Army rotary wing aviators, particularly in navigation. The navigator's field of view is highly restricted because of his proximity to the ground and the terrain features depicted on an aerial map are viewed from a much different perspective. In an effort to alleviate these difficulties, preliminary NOE training has been introduced at the Army Aviation School and is also being put into effect at operational unit level.

Therefore, this series of studies had four specific goals:

1. To develop and apply a quantified NOE navigation performance measure;
2. To determine the present level of NOE performance;
3. To measure the effects of additional terrain-analysis training;
4. To measure the effects of flight experience.

The achievement of the first goal is, of course, a necessary condition for the achievement of the others. General tests of pilot performance in aircraft control have existed for over 50 years (Jenkins, 1941); however, specific measures of navigation performance in helicopters under NOE conditions are relatively new. Some of these measures were subjective in nature and relied on judgments by an instructor pilot or personnel on the ground (Martin, 1963).

A somewhat more objective approach was developed to evaluate pilot performance during target acquisition and minigun firing under NOE conditions (Thomas, 1964).

However, the most similar work to date has been done by Lewis (1961) in his attempts to evaluate navigation performance under low speed, low level conditions. Rally-type measures such as these are quantitative, objective, and inherently valid (Farrell, 1973).

METHOD

Subjects:

The subjects in this study were 35 Army helicopter pilots who were currently proficient in the UH-1H helicopter and had some exposure to NOE flight, either at entry or unit level. The fourteen pilots in Experiment I were selected to represent the general population of Army UH-1H helicopter pilots and their experience ranged from 200 to 2700 flight hours.

The 14 subjects in Experiment II were selected to achieve a sample of the more proficient, instructor level UH-1H helicopter pilots and their flight experience ranged from 1000 to 3750 flight hours.

The 7 additional subjects in Experiment III were selected as representative of the recent graduates of Army Aviation School who had completed the new 15 hour course in NOE navigation. These pilots had completed 200 flight hours.

Logistics:

The test range used in all experiments is near Troy, Alabama. The range was divided into three areas of operation (AO) each containing four NOE routes. Each route was composed of an Initial Point (IP), 3 or 4 intermediate landing zones (LZ) and a release point (RP) which designated the end of the mission.

Two UH-1H aircraft were employed in the study. The "low ship" which flew NOE was used to transport the subject pilot, who acted as navigator, the instructor pilot, who actually flew the aircraft, and the ARI test supervisor. The high ship flew "Chase" for safety reasons, and it provided the high-altitude platform (approximately 800 feet altitude) from which a second instructor pilot could track the flight of the low ship.

Experimental Design:

Experiment I. The purpose of Experiment I was to determine the effect of terrain analysis training and flight experience.

Seven pairs of subjects were systematically matched for experience and then one member of each pair was randomly assigned to an experimental or control group. The control group flew 12 flights in three phases, each over a different AO. The experimental group flew eight flights, standing down between Phase I and Phase III for a two day terrain analysis course.

In order to control for differences in the terrain composition in each area of operation, the order in which the areas were overflown was systematically varied between subjects. For example, subject 1 flew areas I, II, III in that order, whereas subject 3 flew areas III, II, I.

Experiment II. The purpose of experiment II was to further investigate the effect of specific NOE navigation training. Since the 14 subjects were all highly experienced NOE instructors, the variable of flight experience was deleted. The design of this experiment differed in that the experimental group received its training in the form of mission specific, terrain analysis, briefings rather than the 6 hour refresher course given in Experiment I.

Experiment III. The purpose of Experiment III was to measure the effectiveness of the new 15 hour NOE navigation course which had replaced the original 6 hour NOE familiarization sequence. The subjects used in this study were the most recent (Dec 1974) graduates of the USAAVNS IERW program. These pilots flew six flights, i.e., two over each of three AO's. The design was otherwise identical to Experiment II. Their data was compared with the data from the six graduates in Experiment I who had only been given the 6 hour NOE familiarization sequence.

The dependent measure for all three experiments was the objective mission success score (OMSS) which is a composite metric representative on the subject's scores on four individual measures. The component measures were: number of IP's missed; the number of LZ's missed; the number of 250 meter excursions from the course line; and the number of 1000 meter excursions (Fineberg, 1974).

Procedure:

Each subject received a pre-mission briefing at the Lowe Field office which consisted of three parts, and was conducted by the Senior instructor pilot:

(1) a presentation and discussion of the day's mission;
(2) map analysis of the route to be followed;
(3) and, if necessary, a review of flight safety procedures.

He then received his NOE route to be flown that day. The route was marked in yellow on the appropriate map sheet. The IP, LZ's and RP were also designated. An identical map was given to the observer who flew in the high ship.

The subject pilot then navigated at altitude (800 ft) to the IP of the NOE route, with the high ship flying chase. Identification of the IP by the subject was scored by the instructor pilot as correct or incorrect.

The subject pilot then began flying the route at NOE altitude, following the prescribed course on his map as accurately as possible. The actual course flown by the subject was concurrently being drawn on the duplicate map by the high ship observer. The subject was required to identify and stop at each intermediate LZ. His selection of each LZ was scored by the instructor pilot as correct if he had landed within 100 meters of the correct landing zone.

RESULTS

The results of these studies are presented as individual experiments. The statistical test for significance used in most cases was the Mann-Whitney U (Siegel, 1956) since many of the measures were ordinal rather than interval.

Experiment I. The data show that the group which received map training found the checkpoints (PIP and PLZ) more often and stayed within the 1000 meter corridor more accurately than the group without map training. This superior performance is reflected in the OMSS, which was .59 for the trained group and .51 for the untrained group. Although the differences are not significant according to the usual .05 level, there is preliminary indication of support for the hypothesized benefits of additional map training; however, more data is required for confirmation.

The differences are greatest when the ability to find checkpoints is compared. The trained group had a .86 PIP, while the untrained group scored .67. This difference is significant (P .01). The benefits of map-training show up in the ability to find checkpoints.

There was no significant difference between the navigation performance of the low-experience (214 mean flt hrs) and high (1387 mean flt hrs) groups.

Experiment II. The navigation scores of the 14 highly trained NOE instructors were significantly higher (P .05) when compared to those of the 14 average aviators in Experiment I. The performance of experimental group with additional training was not significantly different from that of the control group.

Experiment III. This experiment was designed to compare the navigation performance of two groups of recent IERW graduates uncontaminated by varying levels and types of operational experience. The first group (Sept 1973 graduates) received only the six hour NOE familiarization sequence while the other (Dec 1974 graduates) received a 15 hour navigation course. The results indicate clear superiority for the group which received 15 hours of specific navigation training.

Combined Results. The scores for all 35 pilots were combined in table 1 to provide a representative sample of Army aviator performance for diagnostic and predictive purposes.

TABLE 1

Mean performance scores, standard errors and associated confidence intervals for all pilots (N = 35) over all flights (242)

Nav Measure	OMSS	PIP	PLZ	#250 EXC	#1000 EXC
Mean N = 35	.63	.85	.77	14.86	3.23
S. E.	.0361	.0295	.0281	1.0217	.4122
CI 95	.58- .68	.80- .90	.73- .81	12.86- 16.86	2.42- 4.04

DISCUSSION

The first and most obvious implication from the results of these experiments is that NOE navigation performance of the Army pilots tested leaves much room for improvement. Checkpoint identification (map/terrain association) appears to be the central and most critical error made in NOE navigation. This finding is based upon the fact that 15 operational combat pilots who rated the importance of the various NOE elements, weighted the two errors dealing with checkpoint identification as the most dangerous to successful mission completion. This is also reflected in the results of Experiment II where increases in checkpoint identification improved the OMSS even though there were decreases in course maintenance accuracy. Increased accuracy in checkpoint identification has another benefit, confidence. The combined results indicate as checkpoint accuracy scores increased, so did the number of 250 meter excursions. Those pilots with NOE specific navigation training tend to be more original in their route selection. They are not quite so concerned with getting lost.

Experience in flight at higher altitudes does not appear to have extensive transfer to navigation at NOE altitude. In Experiment I, the highly experienced pilots without specialized NOE training did not perform any better than the graduates who had only 200 flight hours.

It is also evident that flight experience per se does not necessarily improve identification of checkpoints. This suggests that the identification skill could be taught in a classroom or part-task simulation environment.

The hypothesis that specific NOE navigation training improves navigation performance has been supported in all experiments. This training appears to manifest its benefits in checkpoint identification which helps pinpoint areas of training emphasis. It is also apparent that this training should be given in the initial entry course, i.e., as early as possible, since the more experienced aviators in Experiment II did not benefit from additional training. The amount of NOE navigation training necessary to significantly improve NOE navigation is not overwhelming. The results of Experiment III indicate that an increase from 6 to 15 hrs. of instruction significantly improves the pilots' probability of successfully completing his mission.

Based on these findings, an experimental map interpretation and terrain analysis course (MITAC) was designed and is now under evaluation at the Army Aviation Center, Ft. Rucker, Alabama.

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EFFECT OF HMD AND PMD DISPLAY CHARACTERISTICS ON NOE PILOTAGE NAVIGATION PERFORMANCE

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Twenty Army rotary-wing aviators with varying flight experience are currently being tested in a field experiment to determine their navigation capabilities using panel and helmet-mounted displays and varying fields-of-view. The participants were required to navigate at NOE altitudes over a pre-determined course, and to identify the initial point (IP), intermediate checkpoints (CP), and the release point (RP) while maintaining mask. The results are expected by the end of May.

INTRODUCTION

The US Army's recent emphasis on nap-of-the-earth tactics has raised questions about how well the helicopter crew can perform their complex missions of the future. One critical problem area that is currently receiving attention is NOE navigation with naked eye and with night vision systems. The work just presented by Dr. Fineberg summarizes our latest knowledge on NOE navigation with naked eye. My discussion covers navigation with helmet and panel-mounted displays integrated with a forward-looking infrared (FLIR) sensor.

Under daylight conditions and using the naked eye the navigator is presented with the difficulties of such factors as restricted field-of-view, relating viewed terrain to a map, and maintaining mask. With nighttime conditions and some form of night vision system, however, the problems become even more complicated (e.g., resolution, minification, apparent speed, disorientation, and nausea). Add to these difficulties the complex mission requirements for the advanced attack helicopter and the advanced scout helicopter, and one wonders how the aviator is going to accomplish all of this.

In an effort to address some of these problems and to identify system integration requirements, the US Army Human Engineering Laboratory and the US Army Night Vision Laboratory are currently involved in a field experiment.

The Night Vision Laboratory has supplied an AH-1G (COBRA) helicopter equipped with a forward looking infrared (FLIR) system and helmet and panel-mounted displays. The FLIR system was chosen because it is a true night vision system that can also be used in the daytime. The turret is 16 inches tall, 13 inches in diameter, and rotates plus or minus 90° in azimuth. The elevation function is accomplished by means of an internal mirror system. By simply flipping a switch, three different fields-of-view may be obtained.

The HMD is a monocular unit which receives its image through optics from a 1-inch CRT. Only the CRT and a small video amplifier are located on the helmet while associated electronics are located in the pilot's night vision system power supply. The headtracker linkage assembly consists of two parallel rails mounted longitudinally above and left of the user's head. The added weight to the user's head is less than one-half pound.

The PMD is an 875-line monitor with edgelighted controls. This display is located in the top center of the instrument panel. For the PMD there are manual slew controls for orienting the sensor.

With this system in mind, the objectives of our study are as follows:

1. To determine if there is an optimum combination of display medium and field-of-view that will provide a best image with which to relate the viewed terrain to a map.

2. To determine the minimum field-of-view that a navigator can utilize to successfully complete his mission.

3. To determine what system integration requirements, in addition to those identified by the Army Research Institute, will be needed for users of night vision systems.

METHOD

Subjects - The subjects in this study are 20 AH-1G (COBRA) qualified pilots who are all graduates of the Army NOE Training Course at Fort Rucker, AL. Since we are utilizing a specially qualified group of pilots, it was impossible to control for experience level. Therefore, each subject in this experiment serves as his own control.

LOGISTICS

The test range we are using is located at AP Hill Military Reservation, south of Fredricksburg, VA. The range is divided into three NOE routes of varying types of terrain features. Appropriate counterbalancing is being used to control for these variations. Each route has an initial point (IP) and eight intermediate checkpoints (CP) and a release point (RP) which designates the end of a trial run.

The AH-1G is, of course, the aircraft which transports the subject in this experiment over the various courses at NOE altitudes. (In our case, NOE means treetop and below whenever possible). A UH-1M chase aircraft orbits the subject aircraft at 1,000 AGL. The chase aircraft serves as both a safety aircraft and as a data collection center for the observers.

EXPERIMENTAL DESIGN

The experimental design incorporates three fields-of-view, three NOE courses, and three modes of viewing (naked eye, HMD, and PMD). Counterbalancing is used to control for practice effects and terrain variations.

EXPERIMENTAL PROCEDURE

Each navigator and pilot receives a pre-mission briefing including discussion of the routes and procedures to be followed. The navigator is then issued a map with the courses to be flown marked in yellow. The AH-1G is piloted from the front seat by the safety pilot. The navigator sits in the rear seat enclosed by a curtain (except for naked eye baseline trials) and navigates using only the HMD or PMD and a hand-held map. The subject navigates to the IP and from there along the NOE course, following as closely as he can the pre-planned map route. The overhead observer concurrently plots the actual course flown on an identical map. At the IP and specified checkpoints the subject is required to report his position to the chase aircraft observer. If the navigator misses a checkpoint he is allowed to continue a short distance to see if he realizes his mistake and can reorient himself. If required, the navigator may request that the pilot gain altitude, but this is scored as a deviation from NOE altitude. If necessary, the pilot will reorient the navigator at the last known checkpoint and begin again. An IP or CP is scored as achieved if the navigator is within 100 meters.

The performance measures being collected include errors for IP's and CP's, time to complete mission, speed, distance, off course, and deviation from NOE altitude. Additionally, a workload measure is obtained from a random number canceling task that the navigator is required to perform whenever he is not "ON" the system or referring to his map. Dr. Fineberg's objective mission success score is being adapted for use with our data. All trials are videotaped through the displays from an on-board system. This allows us to determine sensor orientation at missed checkpoints, as well as giving us airspeed and altitude from the display symbology. These tapes are extremely valuable during debriefing analyses of the navigator's flights.

RESULTS

At this point we have only completed the pilot study to determine how well our experimental plan is going to work. After 24 flights we have found that the time to complete the flight is 60% longer with the FLIR system than with naked eye and errors increased 33% when the subjects transitioned from naked eye to the display system. This data is, of course, only pilot study data and we are reluctant to jump to any conclusions.

The experiment proper is scheduled to start on 12 April and we anticipate final results by 1 July. The critical question we now seek to answer is what is the narrowest field-of-view a navigator can successfully use and, what is the optimum combination of display and field-of-view.

THE EFFECT OF HUD SYMBOLOGY SIZE ON OPERATOR PERFORMANCE UNDER VARIOUS LUMINANCE CONDITIONS

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The speed and accuracy with which subjects were able to report designated information from a Head-Up Display (HUD) while performing a secondary tracking task were measured under three luminance conditions using four different symbology sizes. Twelve subjects, divided into four groups of 3 subjects each, "flew" 15 two-minute simulated air-to-ground attack missions. At selected points in the mission, arrow designators were used to identify the information to be read by the subject from the display. The results indicate that symbology size had no appreciable effect on performance. Secondary task performance was, however, significantly degraded under the higher luminance levels.

During test and evaluation flights of the A-10 aircraft, pilots found that (a) excessive head motion (approximately 13 inches in the vertical direction) was required to keep the pipper in view at all times on the HUD; and, (b) clipping of the display symbology occurred as a result of the pilot's attempt to keep the pipper in view.

To resolve these problems, several solutions were offered. These included (1) shortening of the HUD-to-pilot viewing distance; (2) employing a two position moveable combiner; and, (3) reducing the size of symbology used on the HUD. The first two solutions appear to be costly as both approaches would require hardware changes either to the HUD or the cockpit. The third solution affords an approach that can be easily implemented (requiring only a software change) and evaluated. This solution, however, gives rise to the following question: "How much can we reduce the size of the symbology and scales used on a HUD without degrading operator performance?"

A search of the literature pertaining to HUD research indicates that a great deal of research has gone into hardware development but very little has been done with respect to developing design criteria for symbology used on HUDs. For example, Ketchel & Jenny (1968) in surveying the literature dealing with electronic and optically generated aircraft displays state that "We have found almost no research

that pertains to the legibility of HUD alphanumeric symbols." These authors do indicate, however, that symbol sizes of 7 to 10 milliradians (mr) are commonly found on contemporary HUDs. Kelly, Strudwick & Ketchel (1965) in an investigation of HUD high brightness requirements found that a symbol luminance of 1800 to 3500 foot-lamberts (Ft.L) was required for an uncoated combiner when viewed against a 10,000 Ft.L sky background. Against the same background but using a trichroic coating, the symbol luminance requirement was reduced to 900 to 1000 Ft.L.

Although the above references yield information with respect to the size of symbology currently being used on HUDs and the luminance level for such symbology, these references do not provide an answer to the question of criterion symbology and scale size for HUD applications. Therefore, a study was devised to determine the limits of reduction that could be imposed upon the size of symbology and scales used on these devices.

Method

Subjects

Twelve subjects were used. Nine were paid volunteers from a local university and three were technicians working at AMRL. All were right handed and had normal or corrected vision of 20/20. The subjects were randomly divided into four groups of 3 subjects each with each group differing in terms of the size of symbology viewed. Group 1 was tested with the current A-10 symbology size (i.e., vertical scale size of 134 X 1 mr with 6 X 1 mr graduation marks each 5 knots on the airspeed scale and each 100 feet on the altitude scale and 12 X 1 mr midpoint markers between major airspeed and altitude numerics, together with 6 X 1 mr index marks on each scale; numeric symbol size of 10 X 6 X 1 mr; aiming reticle size of 50 mr diameter with 1 mr stroke width, and; roll bars of 20 X 1 mr with 5 X 1 mr wing tips). Group II was tested with symbology 85% that of the A-10; Group III, 70%; and, Group IV, 55%.

Apparatus

A Kaiser HUD with a P-31 (green) phosphor served as the main display upon which was presented the various symbology sizes, mission information, and tracking task. The HUD had an exit aperture of 6 inches. Its total field-of-view was 20 degrees with its instantaneous field-of-view (IFOV) being dependent solely on viewing distance and exit aperture size. The IFOV was made equal to that of the 7-inch A-10 HUD (i.e., 9° X 11°) by adjusting the viewing distance to 28 inches. All symbology and scales, including arrow designators, were generated by a Kaiser Programmable Electronic Symbol Generator. A PDP-11/20 computer was used for the programming and control of the various simulated missions and symbology sizes. It also controlled the input data to the symbol generator. A 1.5 milliwatt helium-neon laser, filtered with a 0.3 ND filter, was used to generate the cursor for the tracking task. The laser was driven by a psuedo-random number generator and was controlled by the subject with a joystick. Two ColorTran Multibeam lights (3200° K color temperature), Model No. 100-31, were used to vary

lumination levels of the background. They were mounted one above the other (8 and 20 inches above the floor) and positioned in-line with the HUD, 18 feet from the background screen. Use of both lights yielded a lumination level of 3000 Ft.L while the top light alone yielded 2000 Ft.L. as measured with a Pritchard photometer directed at the screen surface. A 6 X 7 foot, high gain screen provided a homogeneous background against which both the HUD symbology and laser spot were viewed. Three recorders - a stereo audio tape, a 7-channel magnetic tape, and an 8-channel strip chart - were used to record subject responses.

Procedure

Twenty, two-minute missions were developed for use in this study. In developing these missions, careful attention was paid to insure that all of the parameters (airspeed, altitude, and pitch angle) were within the operating capabilities of the A-10 aircraft. Each mission depicted a simulated air-to-ground attack which began at some given altitude, airspeed, and pitch angle.

During the course of each mission, subjects were required to perform both a primary and a secondary task. The primary task involved reporting the value of one of three information channels depicted on the display at specified points in the mission (symbol reading task). The information to be reported was signaled by the appearance of an arrow designator on the display. The secondary task was a two-axes, compensatory tracking task in which subjects attempted to keep a cursor (laser spot) centered on the pipper located in the center of the aiming reticle.

During the conduct of this study, each subject participated in one training and one data collection session. During the training session, each subject was given a 10-15 minute briefing which consisted of a detailed explanation of the purpose of the study and the tasks to be performed by him. He was then given five training trials on the primary task. After a brief rest period, he was given five minutes of training on the secondary tracking task. He was then given five more training trials in which he performed both the tracking and symbol reading tasks simultaneously. All of these training trials were conducted with the current A-10 symbology size and under ambient room illumination (approximately 20 Ft.L at the screen).

During the data collection session, the subject was seated in front of the HUD and the experimenter again reviewed the tasks to be performed. The tracking task was then calibrated by having the subject indicate when the laser spot was centered (0,0 position) over the pipper. The subject was then given 15 two-minute trials. Five each were given under the 3000, 2000, and 0.001 Ft.L lumination conditions. The order of these conditions was randomized across subjects. A five-minute rest period was given after every fifth trial to allow the subject to rest and to change lumination conditions. A viewing distance of 28 inches was used for all trials.

Results

To determine the impact of symbology size and background lumination on symbol reading and tracking performances, a conventional statistical

analysis (i.e., analysis of variance or ANOVA) was used. The results of the ANOVAs performed on the various performance measures employed indicate that background lumination significantly influenced tracking performance, $p < .05$, $df = 2, 35$. Symbology size, however, did not influence tracking performance. For all other performance measures (i.e., response time, altitude reading error, and airspeed reading error), both symbology size and background lumination showed no significant influence. No analysis of pitch angle reading errors was accomplished since error for this measure was substantially zero.

Discussion

The most consistent finding in this study was the lack of influence of symbology size on subject performance. For all measures of evaluation used, no significant differences in performance were noted due to symbology size. Fortunately, in a study such as this, obtaining no significant influence is just as meaningful as obtaining a significant influence. Therefore, reducing symbology size appears to offer a viable solution to the clipping problem. Based on the range of reduction investigated, it is suggested that relative to the original A-10 specifications, a limit of 15 to 30 percent reduction be imposed upon the size of HUD symbology and scales. Assuming a 20 percent reduction limit, this would result in a vertical scale size of 107.2 mr with 4.8 mr graduation marks and 9.6 mr midpoint markers between major numerics, together with 4.8 mr index marks for each scale. Numeric symbol size would be 8 X 4.8 mr; the aiming reticle would be 40 mr in diameter; and the roll bars would be 16 mr with 4 mr wing tips. A stroke width of 1 mr may still be used.

The significant influence of background lumination upon tracking performance was due primarily to the differences in scores at the 3000 Ft.L as compared with the 2000 and 0.001 Ft.L conditions. This finding, however, is most likely a spurious one. It will be recalled that a neutral density filter was used with the laser. This filter resulted in a 50 percent reduction in the intensity of the laser spot, thus resulting in the spot being relatively "washed out" at the higher lumination condition.

Although the data indicates that a symbol scale reduction of 55 percent of the original A-10 symbol size can be affected without a significant reduction in performance, it must be understood that these data were taken in a laboratory, static base situation, and do not completely represent the dynamics and environmental considerations of the actual vehicle. Flight testing should be performed to validate these results.

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THE POTENTIAL APPLICATION OF HELMET MOUNTED DISPLAYS AS AN ALTERNATE SOURCE OF FLIGHT INFORMATION

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ABSTRACT

The potential use of Helmet Mounted Displays (HMDs) as an alternate source of flight information was examined. In two separate experiments, Air Force T-41 instructor pilots and novice pilots were trained to perform two flight profiles in a GAT-1 flight simulator using either a side-mounted or visor-projected monocular display as the sole source of aircraft flight information. Various HMD and non-HMD viewing conditions were used with the subjects serving as their own control in each case. All subjects were able to transition to the helmet display conditions with little difficulty. Flight precision was slightly decreased under HMD viewing with the side-mounted display, but no loss in flight precision was found when the visor-projected display was used. On a secondary task requiring divided attention between the flight instruments and events outside the cockpit, subjects tended to perform better when not using the HMD. The general conclusion reached from this study was that HMD's are potentially suitable for use as the primary source of flight information.

In recent years the Air Force has been evaluating alternate methods for displaying mission-relevant information to a pilot. One of the most promising ideas has been the development of an innovative visual display system called a helmet mounted display (HMD). This system has a number of unique advantages for portraying information. If, for instance, all pertinent flight information is portrayed on the HMD, the pilot is able to keep his head up and oriented to events of interest outside the cockpit. He is not required to continually change his focal point and reorient to a fixed instrument panel for an instrument cross check. Further, the HMD does not require primary cockpit space, and it has the potential of being coupled with other helmet-mounted systems which could extend the operational parameters of the combat pilot (Birt and Task, 1973; Chason, Schwank, and Hughes, 1973; and de Callies, 1975).

The HMD system puts the pilot in a situation where he must contend with brightness disparity, retinal rivalry, the Pulfrich phenomenon, among other things, which may effect his performance. These and other perceptual, human engineering, and psychological problems have been anticipated (Hughes, Chason, and Schwank, 1973; Miller, 1969; and Shontz and Trumm, 1969) and there is some evidence (de Callies, 1975; Schwank, 1975) to suggest that these perceptual phenomenon will not significantly effect the HMD user.

The HMD user must deal with separate, unique visual environments presented simultaneously to each eye. Although there is reason to believe that both eyes operate as a single sensor the pilot may handle this situation by attempting to process only the signals received by one eye while ignoring signals received by the other, a form of focused attention (Treisman, 1969); or, he may attempt to simultaneously process the signals received by each eye, a true divided attention task (Treisman, 1969). Schwank (1975) has completed a series of dichoptic viewing studies comparing

psychological refractory periods under binocular (focused attention) and dichoptic (divided attention) viewing conditions which showed a retardation in response latency by approximately 5% under dichoptic viewing. This was only a 20 millisecond (approximately) reaction time decrement which therefore would seem to be of little concern in terms of aircraft control with HMD usage.

Only a few studies (see de Callies, 1975) have been reported which evaluate the use of an HMD in simulated or actual flight. None of these studies, however, dealt with the possibility of using the HMD to provide the sole source for flight instrument information. The primary purpose of this study was to investigate this question. Specifically this study was designed to evaluate the efficacy of the HMD as a sole source of flight information under simple and complex flight maneuver conditions.

EXPERIMENT 1

Subjects. The subjects for the first experiment were nine Air Force Academy cadets selected at random, and 11 U.S.A.F. pilots, instructing in the T-41C Cessna.

Apparatus. The dynamic flight simulator used in both experiments was a Link General Aviation Trainer GAT I. A stationary background scene and targets slides (made by drilling precision holes in black 35mm slides) were projected onto the front screen and side windows of the GAT I. Inside the simulator, a high resolution television camera was positioned to provide coverage of the six main flight instruments. During all experimental runs, the subjects wore a Hughes Aircraft helmet assembly and on selected trials a Hughes Aircraft 30/HMD-001 serial 9 display was connected to the right side of the helmet assembly. The dynamic flight parameters of the simulator were recorded in the form of analog data, and then computer processed, producing means and standard deviations for altitude, airspeed, heading and rate of climb.

Procedures. The cadet subjects were given 10 one hour sessions of basic flight training in the GAT I and 3 hours of practice using the Hughes Aircraft display as the sole source of instrument flight information. The instructor pilot subjects were given two one-hour sessions of familiarization training in the GAT I and one hour of practice with the HMD. The subjects were then required to fly under each of the following randomized experimental conditions for 5 minute periods: NHD - No Helmet Display; NHD+T - No Helmet Display plus targets; HD - Helmet Display; HD+T - Helmet Display plus targets.

The subjects were instructed to maintain the following flight profile throughout each experimental session: Altitude - 5000 feet; Heading - 180 degrees; Indicated Airspeed - 115 miles per hour.

For cadet subjects, 10 targets were presented at random intervals during each five minute session designated as a target session. The number of targets was increased to 20 for instructor pilots. Targets were presented singularly with a duration of 2 seconds each. The subjects were told to press the reaction button on the left side of the control yoke only when a target could be seen on one of the projection screens.

The dependent variables for flight performance were absolute deviations in heading, altitude and airspeed from the designated flight parameters. The number of targets accurately detected and target errors were also recorded.

Results. A Wilcoxon test for matched pairs comparing target detection in the HD+T and NHD+T conditions was not significant for cadet subjects but was significant (P .01) for the instructor pilots who detected more targets in the NHD+T condition.

The flight performance data for novice and isntructor pilots were analyzed by a Friedman analysis of variance. Of all the parameters, only heading control while referencing the simulator instruments was significantly more precise that the helmet condition (novice pilots, P .001, instructor pilots, p .01) For the target search task, altitude and heading control were significantly decreased (p .01) in the NHD+T condition compared to the NHD condition. All other comparisons were not significant.

EXPERIMENT 2

Subjects. The subjects were eight USAF Cessna T-41C instructor pilots.

Apparatus. A Link General Aviation Trainer (GAT-1) was fitted with a device which projected a gunsight and reticle onto the windscreen. A projected 2.8 by 5.2 meter aerial scene with superimposed random targets, 2cm spots of light projected onto a black background, was presented to each subject who was wearing the Hughes Aircraft Helmet Assembly with the visor down. Televised flight instruments taken from an instructor console were displayed to the right eye on a transparent screen mounted inside of the melmet visor. Flight parameters of the simulator were recorded and process as in Experiment 1.

Procedures. The instructor pilots were given a complete familiarization in the simulator under all experimental conditions as follows:

STH - Search task using the helmet mounted display
ST - Search task without the helmet mounted display, that is, using the instrument panel in the simulator.
WDH - Weapons delivery task, using the helmet mounted display
WD - Weapons delivery task, without the helmet mounted display

The first of the two tasks performed by the subjects was the search task, a simulated daylight mission which was similar to the one used in experiment 1. The flight profile was: altitude - 5000 feet: Heading - 180 or 360 degrees: Indicated Airspeed - 105 mph. During testing, 30 targets were presented on the background scene for one 6 minute test leg, with the same targets being used under both viewing conditions. The dependent variables were the absolute deviations in altitude, heading, airspeed, the number of targets detected and target error sciores during the 6 minute period.

The second task was a simulated weapons delivery task, a nighttime mission with no visual cues in the test room except the target. The pilot performed a standard toll-in maneuver starting at an altitude of 3000 feet. Once on track, he was to maintain flight parameters of 140 miles per hour, 1500 feet per minute down, and 270 degrees of heading. The subject attempted to keep the bore-sight illuminated red which indicated that he was on target. At 1500 feet of altitude, the subject made a simulated weapon release by pushing a button on the control wheel. The dependent variables were absolute deviations from required vertical velocity, airspeed, heading, and time on target. These were recorded from the time the aircraft passed through 2500 feet during the descent until the weapon release button was pushed, or 1400 feet indicated altitude occurred

Results. An overall F test for repeated measures on the flight scores indicated that there were no significant differences between the experimental conditions. Individual post-hoc F tests for repeated measures were performed for each flight parameter dependent variable. None of the resulting comparisons were significant. Related T-tests were made on the search target and error scores. The only significant comparison revealed pilots made more target errors while flying with the display ($t = 2.55$, $p < .05$).

Mean scores were calculated for heading, VVI and airspeed over three separate weapons delivery runs and an ANOVA was performed on the data. No significant differences were found between WD and WDH conditions.

DISCUSSION

The results of the target identification task for both experiments suggest that the "heads-up" flight capability provided by the HMD did not aid the subjects in target acquisition. Using the side-mounted display, the instructor pilots found significantly less targets than when they were forced to alternate attention between the fixed instrument panel and the target stimuli. This does not necessarily mean that heads-up flight could not be beneficial in this type of divided attention situation It has been previously demonstrated that the physical obstruction of the HMD side mounted hardware can deter the detection of targets on the side where the display is worn (Gnason, Schwank & Hughes, 1973). This appears to have been the case in experiment 1 since - 1) the number of targets missed closely approximates the number displayed on the right screen, and 2) there was no difference in target acquisition between HMD and non-HMD viewing when the visor-projected display was used in experiment 2. Thus, although HMD viewing did not enhance target acquisition, the target error data does suggest that the potential problems of brightness disparity, retinal rivalry and dichoptic viewing problems with the HMD did not significantly affect performance.

Experiment 1 results indicated that heading control was most sensitive to performance decrements under HMD viewing. This was most likely due to two factors: the relative quickness of light aircraft to change heading, and the very small variance found in heading deviation in the NHD condition.

There was no significant difference in heading, altitude, or airspeed control in experiment 2. Additionally, once it is recognized that average deviation in heading control was about 2 to 5 degrees, in experiment 1,

depending on condition, it is clear that we were merely distinguishing between two levels of very fine control. Consequently, although these differences were statistically significant they are of little meaning, practically speaking. It is perhaps more significant that neither cadet nor instructor pilot subjects reported experiencing disorientation or lack of control while flying off boresight using HMD imagery.

Experiment 2 essentially validated the finding from experiment 1 when the pilot was asked to fly a straight and level search task. Decrements in flight parameters were observed regardless of viewing condition when the subjects had to detect targets. None of these decrements were significant. Further, flight control was not significantly affected by HMD viewing during the more demanding weapons delivery task. A pilot can successfully fly a simulator using HMD imagery for flight information during both sole as well as complex flight maneuvers.

Although the use of HMD imagery did not result in improved flight performance or enhance target acquisition, the results from both experiments do indicate that performance is not seriously effected by using a HMD as the sole source of flight information. Additionally, this study demonstrated that both novice and experienced pilots adapt very quickly to the HMD imagery. Further advances in HMD technology leading to improve image quality might well result in increased precision in flight control. Clearly, this study has demonstrated that HMDs are potentially effective in presenting sole source flight information. However, it still remains for these results to be demonstrated in a real as opposed to a simulated flight environment.

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DISPLAY OF SPECTRALLY-ANALYZED DATA

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The effects on target detection of different formats for displaying spectrally-analyzed data were examined. The three formats studied were the conventional gram (multiple horizontal lines with density variations), the integrated line (a single line with amplitude variations), and the time-history waterfall (multiple lines with amplitude variations). For detection of a sinusoidal signal of constant strength, the integrated line format was superior to that of the gram or waterfall. Detection with the waterfall appeared approximately equal to that with the gram, although when the operator was able to manipulate the controls of the waterfall display, detection generally improved. The greatest false alarm rate was obtained with the integrated line, whereas the waterfall was clearly superior to the other two formats.

Introduction

For the detection of targets in spectrally-analyzed information, there exists a wide variety of processors and displays. The manufacturers of these devices make diverse claims which are difficult to evaluate, not only because of basic differences in the processors, but also, because of differences in the way in which processed information is displayed and perceived by the human operator. A superior processor linked to an inferior display will result in system degradation which may be so severe as to cause its rejection in favor of an inferior processor which has a better-balanced display. The Navy is interested in adequately evaluating the processor and display systems for spectrally-analyzed data.

Basic to the objective assessment of different processor and display systems is the knowledge of the effect of the display format on the ability of the human operator to correctly identify targets and to reject spurious signals.

Currently, there are three display formats in use. Each depicts signal strength in frequency over time, but the appearance of the depicted information varies considerably with the different display formats. These formats are the conventional gram (a strip of paper from an electrostatic printer in which signal strength in frequency is indicated by the density of the marking across the width of the paper while variations over time are indicated by the progressive advancement of the lines along the length of the paper), the integrated line (INT) format (usually appearing as a single sweep on a CRT in which signal strength in frequency is indicated by the relative height of the line at different locations across the scope), and the time-history waterfall format (appearing as multiple sweeps on a CRT depicting a sequence of INTs over time). A sketch of these different formats is depicted in Figure 1.

Experimental Design

The primary objective was to determine the effects of display format on operator performance. For this purpose, subjects were tested with identical

inputs to a common processor which displayed the results in gram, integrated line (INT), and time-history waterfall formats.

Additional experiments were conducted with integrated line and waterfall formats appearing on CRT displays and on hardcopies made directly from the CRT displays. Other experiments gave the subjects control over some of the display variables. Another series of experiments varied line amplitude and line separation of the waterfall format on hardcopied data.

The basic sequence of experiments is outlined in Table 1. Each subject progressed through the blocks of sessions in the order indicated. Within each block, however, the sessions were presented in a variety of orders to the different subjects.

Within each session, the input signal-to-noise ratios (S/N), which ranged from -6 dB to -12 dB, and the location of the signal on the display appeared in a psuedo-random, counterbalanced order. The length of each session varied, but on the average, they were composed of approximately 60 presentations or frames.

The term "frame" is used to denote either a CRT, hardcopy (HC), or gram display when viewed as it appeared at 2, 4, or 8 minutes into the analysis period. When a subject was viewing the development of a display on the CRT, he was asked to report at these time intervals whether or not he perceived a signal. Hardcopies were made of the displays as they appeared at these intervals in the analysis period.

In any given frame, there might or might not be a signal. If there were a signal, it would be at a single frequency; no multiple signals were used.

The presentation of displayed information on the CRT was time-consuming. Because hardcopies were made during the scope series, it was possible to test a subject on hardcopies of the same frames which he had viewed on the CRT. It was also possible to test him on the hardcopies of the frames which other subjects had viewed. And because the hardcopy was permanent and easily reused, he was tested and retested on the same frames. Thus it was possible to deter-

Figure 1. Display Formats

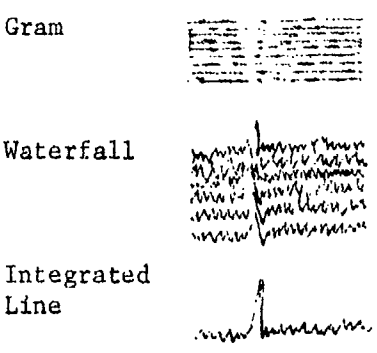

Table 1. Experimental Design

	WATERFALL		INTEGRATED		GRAM
	CRT	HC	CRT	HC	HC
Baseline	X	X	X	X	X
Manipulated Waterfall	X				
Amplitude Variation		X			
Separation Variation		X			

mine how a subject would perform with formats displayed on CRTs vs. on hard-copy; how subjects would perform in comparison with one another; how subjects would perform on subseries employing the same S/N but different signal locations; and whether the performance of subjects would change from testing to retesting in identical subseries.

Four male college students were used in these experiments. More than 14,500 presentations of different display formats were made and over 350 hours of subjects' test time were used.

The data were tabulated according to five categories. A "hit" occurred with the correct identification of a target. An "incorrect location" occurred with identification of a target when a target was present, but the target identified was in the wrong location. A "miss" occurred with the failure to identify a target when a target was present. On noise trials, a "correct rejection" occurred when a target was declared absent, and a "false alarm" occurred when a target was identified incorrectly.

Throughout the testing period, the recorded scores were continually being tallied and examined to determine actual performance, changes in level of performance, differences and similarities between subjects, etc. As a result of the on-going data analysis, decisions were made to extend the baseline series to include -12 dB signals and to increase the number of signal locations presented.

Results

Different display formats result in different levels of performance when different signal strenghts are used as inputs. A system which meets certain criteria at one level may not at another. Thus, a system which has a high hit rate and low false alarm rate at one S/N may prove inferior to another format in one or the other of these characteristics at a different S/N. The graph in Figure 2 combines pertinent information about the hit rate, false alarm rate, and display formats for three S/N levels (-8 to -10 dB).

The graph depicts the percentage of hits plotted against the percentage of false alarms of each of the six major display formats examined. Reading across the graph, from left to right, the display formats in order of increasing false alarm rates are labeled. Directly under each name, in the body of the graph, appear three points representing the hit rates for signals at -8 dB, -9 dB, and -10 dB for that particular display. The false alarm rate for that display remains constant because it was computed on the noise trials only. The points plotted are of the hit rate after the 8-minute time frame. Scores at equivalent S/N for the integrated line (INT) and for the waterfall formats are linked by dotted and dashed lines respectively.

Several findings are graphically illustrated in Figure 2. The superiority of the integrated line (INT) format in terms of hit rate over the gram and the fixed format waterfalls (waterfall CRT and waterfall HC) is clearly indicated. The manipulated waterfall is actually superior to the integrated line at -8 dB, and superior or equal at -9 dB, but woefully inferior at -10 dB. The superiority of the waterfalls in general, and of the manipulated waterfall in particular, in terms of low false alarm rate is also clearly indicated. Consequently, the decision on which display format to utilize should be based on the values and costs of high hit versus high false alarm rates.

WFL MNP	waterfall, manipulated	FA 12%	GRAM	gram	FA 40%
WFL CRT	waterfall, CRT	FA 25%	WFL HC	waterfall, HC	FA 44%
INT HC	integrated, HC	FA 40%	INT CRT	integrated, CRT	FA 58%

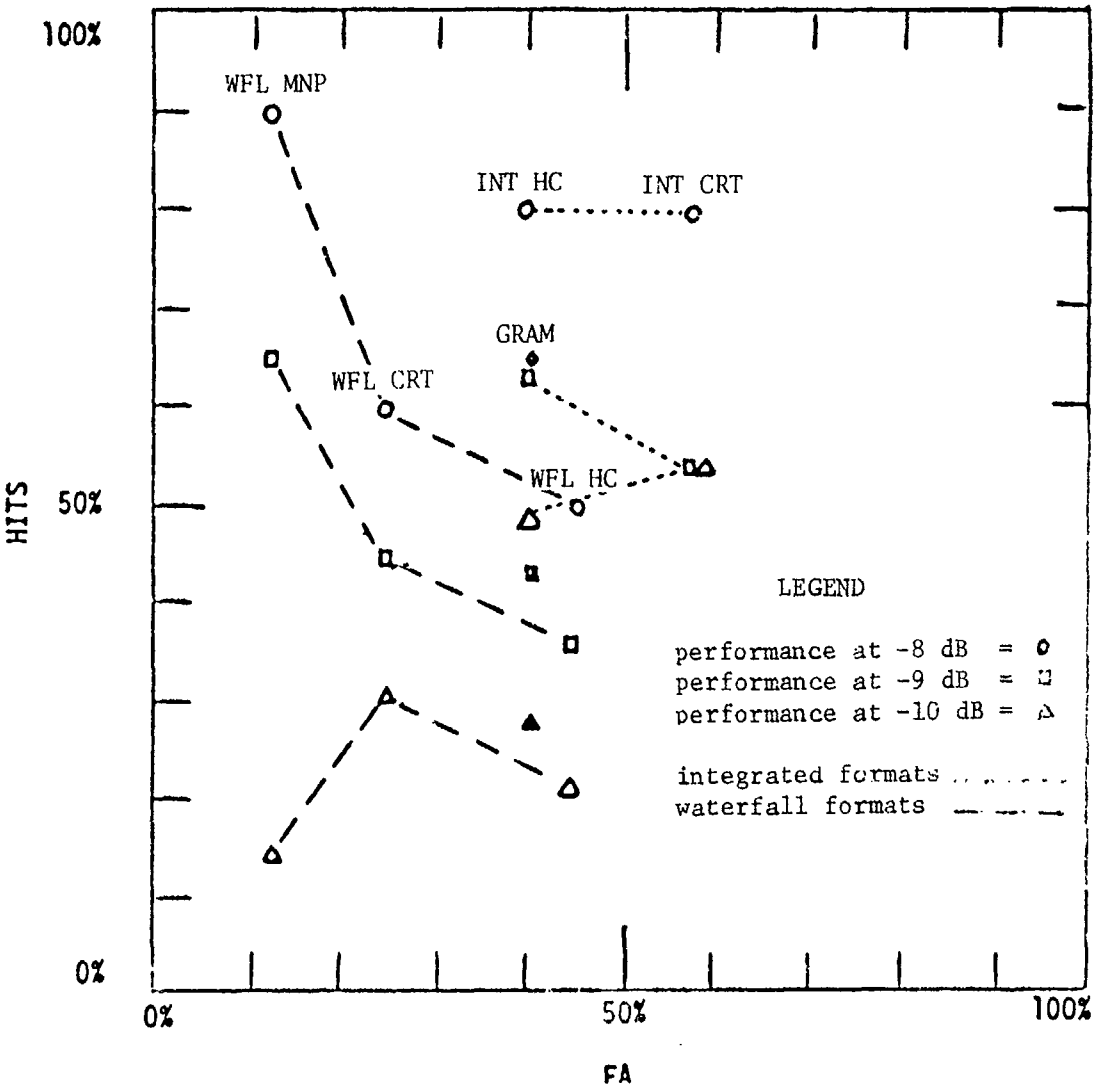

Figure 2. Hit and False Alarm Rates on Different Display Formats

Other aspects of the study revealed that subjects responded very nearly equally as well in terms of detection when viewing data on a CRT or on a hard-copy, that differences between the subjects in terms of performance were slight, that the hardcopy waterfall format was least liked, and that giving the operator control over display variables of the time-history waterfall could result in both improved performance and a more favorable attitude toward that display mode. It should be noted that these results have been obtained with single signals of a steady nature. With different signal characteristics or with different tasks assigned the operator, different display formats may prove superior.

GROUND-REFERENCED VISUAL ORIENTATION: JUDGEMENTS OF SIZE AND DISTANCE

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Mounting interest and activity in the application of dynamic sensor-generated imagery (SGI) and computer-generated imagery (CGI) analagous to a real-time contact view from an airplane call for renewed investigation of the essential visual cues for contact flight. SGI and CGI systems have application both as contact analog flight displays and as outside visual scenes for flight simulators. In either case, systematic errors in distance judgments are encountered with all optical and electronic imaging systems, thereby requiring compensation by magnifying their images. Results of many psychophysical experiments partially account for but do not explain these bias errors in size and distance judgments.

Although the proper magnification correction can be determined empirically for each individual using any specific imaging system to neutralize bias errors in size-distance judgments, a complete understanding of the stimulus variables involved and the magnitudes of their individual influences would allow general rules rather than individual tests to guide the engineer in designing systems. Such understanding requires the formulation and validation of a comprehensive theory of the psychophysiological functions of size-distance perception that will explain, not merely account for, the host of unexplained experimental facts associated with judgments of the size and distance of objects in the visual field, including various optical illusions.

During the past several centuries, countless experiments have been conducted to quantify the effects of reducing the cues to distance present in the peripheral visual field upon judgments of the size and distance of objects viewed foveally. Recently a few experiments have dealt with the influence of the peripheral visual surround upon visual accommodation. But no experiment to date has systematically related these three dependent variables: apparent size, apparent distance, and visual accommodation. Furthermore, textbooks in psychology, physiology, and optics consistently dispense with visual accommodation has having no functional relation to size and distance judgments for objects beyond a few feet.

Despite the arbitrary discounting of accommodation as a mediating mechanism in the perception of size and distance, the experimental literature is replete with evidwence to the contrary. To test the hypothesis that visual accommodation, possibly by attenuating the size of the retinal image projected by the crystalline lens, is a principal neuro-optical reflex mechanism governing size-distance perception, a program of research is in progress at the Ames Research Center, NASA. Judgements of size and distance of objects presented by various accomodation, using an infrared optometer,

as a function of the textural distribution of the peripheral visual surround. The experimental program is a cooperative research effort between Stanley N. Roscoe and Lynn A. Olzak of the Hughes Aircraft Company and Robert J. Randle and Edward M. Huff of the Nan-Machine Integration Branch of the Ames Research Center.

APPARENT MOTION QUALITY AND TARGET DETECTION ON A VISUALLY TIME-COMPRESSED DISPLAY

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Explanations of the superior target detection performance with visually time-compressed radar displays have involved the assumption that the coherent motion of the target against the random motion of background noise facilitates detection, much as the blossoming of a flower is made apparent by time-lapse photography. From the appearance of the display, this assumption seems reasonable; however, experimental findings are not fully explained in terms of apparent motion. The equivocal nature of the relationship between visually apparent motion and target detection on a time-compressed display prompted an investigation of four spatial and temporal display variables using a central-composite response surface experimental design. Subjects performed three tasks: target detection and two ratings of apparent target motion quality, with random noise dots present and absent. Target detection performance was highly correlated with the scale of motion quality resulting from ratings with noise present but less highly correlated with ratings of target motion quality with noise absent.

To obtain a real-time visual time-compression target detection system requires that the display present successive frames of imagery at a sufficiently fast rate to obtain the detection enhancement effect while continuing to keep the display updated with incoming signals from the radar. These two objectives can be achieved by storing several past image frames and playing them back in the order in which they were collected but at a faster rate. Previous studies have clearly demonstrated the detection enhancing effect of visual time-compression (see Scanlan, 1975, for a review). This enhancement has been assumed to be a result of the coherent apparent motion of the target, although an examination of previous results fails to confirm this assumption.

A consideration of both the time-compression literature and the apparent-motion literature identifies four common variables that would be expected to affect both target detection and the quality of apparent motion. Of these four variables, two have previously been investigated in both the apparent-motion and target detection contexts. Frame duration and target return spacing both affect target detection performance and their analogs, stimulus duration and spatial separation, consistently affect apparent motion. This coincidence would suggest that similar underlying processes are involved in the two situations.

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To establish the relationship between the detection of targets on a time-compressed display and the targets' apparent motion, both probability of correct target detection and subjective quality of motion were measured as a function of four independent variables: number of stored frames (NF), target return spacing (TS), frame duration (FD), and interframe interval (FI). Because target detection is hindered by the apparent motion of randomly appearing noise dots on a time-compressed display, the effects of such noise on apparent motion quality were investigated by presenting moving targets at a known position both with and without noise present.

Method

The experiment consisted of three parts: target detection when the position of the signal was unknown, rating of motion quality of the target alone, and rating of the motion quality of the target with random noise also present. The motion quality scales were obtained by means of a paired-comparison procedure. The subject was shown two sets of stimuli and asked to choose the set yielding the better apparent motion.

Each of the four experimental variables was examined over large ranges to insure that a full range of motion quality was achieved. The impracticality of examining four independent variables over large ranges with a traditional factorial design led to the selection of a central-composite response surface design. In this design the levels of the independent variables are coded to obtain constant ranges of ±2. Table 1 presents the transformations between coded and actual variable levels along with the actual variable ranges.

Table 1

Transformations from Coded Values of Independent Variables to Actual Values

NF_{actual}	= (2 x NF_{coded})	+ 6	frames	(2 - 10)
TS_{actual}	= (4 x TS_{coded})	+ 10	resolution elements	(2 - 18)
FD_{actual}	= (30 x FD_{coded})	+ 70	milliseconds	(10 - 130)
FI_{actual}	= (40 x FI_{coded})	+ 80	milliseconds	(0 - 160)

A time-compressed playback sequence consisted of the successive display of all stored image frames in their proper temporal order. Each frame was displayed for a duration specified by the experimental condition followed by a specified interframe interval during which the display was blank. After the first frame was displayed the second was shown, then the third, and so forth until all stored frames had been displayed.

A display frame contained one target dot and 30 noise dots positioned randomly for each frame independently. On successive frames of a playback sequence the target dot was displaced downward by an amount specified for each experimental condition. The position of the set of dots comprising the target was randomly determined with the constraint that all of the dots fall within a single quadrant of the display.

Subjects judged the quality of target motion under two conditions. The stimuli were identical except for the addition of 20 randomly positioned noise dots in the second condition, thereby giving the same appearance as the time-compressed target detection display. In this case, however, the position of the target was known, and the number of noise dots was reduced, based on pretest findings, to avoid giving the subject undue difficulty in finding the target before judging its motion.

The stimulus conditions were generated and displayed using a multifield tachistoscope. This device employs a Digivue plasma-panel display driven by a digital computer and allows unusual flexibility and precision in the manipulation of stimulus conditions. Twelve men and 12 women were recruited from the undergraduate population at the University of Illinois and paid for their participation upon completion of the experiment. Each subject served in four one-hour experimental sessions, two hours of target detection and two sessions of paired-comparison motion rating. Each session took place on a different day.

The target detection task required a forced choice of the display quadrant that appeared to contain a target. After four presentations of the target and noise, the subject was forced to press one of four response keys even if he had to guess which quadrant contained the target. In the motion preference portions of the experiment subjects were shown pairs of dot sequences, with or without noise present, and asked to indicate the more compelling motion or the motion they preferred. Six appropriately labeled motion-preference response keys were arranged in two rows of three each, the top row corresponding to a slight, moderate, or strong preference for the stimulus set presented on the left side of the display, and the bottom row corresponding to successively stronger preferences for the stimulus set presented at the right.

Results

Pearson product moment correlations among dependent variable values for each of the 25 experimental stimulus conditions were calculated. The quality of motion scale for the target alone (SCL1) was found to correlate .46 with probability of correct detection, which is reliable at the .05 level of confidence. Rating of motion with noise present (SCL2) correlated .75 with probability of correct detection, and SCL1 and SCL2 correlated .83 with each other ($p < .01$, in each case).

Multiple regression analyses for the three tasks yielded the following equations:

$$\begin{aligned} SCL1 = {} & -.221 + .377\,NF + .307\,TS + .075\,FD - .203\,FI - .087\,NF^2 \\ & -.084\,TS^2 - .061\,FD^2 - .032\,FI^2 + .023\,NFxTS - .017\,NFxFD \\ & -.050\,NFxFI - .032\,TSxFD + .043\,TSxFI - .021\,FDxFI. \end{aligned}$$

$$\begin{aligned} SCL2 = {} & 1.458 + .306\,NF + .032\,TS + .066\,FD - .179\,FI - .078\,NF^2 \\ & -.116\,TS^2 - .077\,FD^2 - .017\,FI^2 - .048\,NFxTS - .016\,NFxFD \\ & -.059\,NFxFI + .093\,TSxFD + .111\,TSxFI - .012\,FDxFI. \end{aligned}$$

$$\begin{aligned} PD = {} & .757 + .097\,NF - .058\,TS + .010\,FD - .059\,FI - .023\,NF^2 \\ & -.064\,TS^2 - .010\,FD^2 - .019\,FI^2 + .001\,NFxTS - .015\,NFxFD \\ & -.007\,NFxFI - .010\,TSxFD + .043\,TSxFI - .020\,FDxFI. \end{aligned}$$

These equations are in coded form which means that the coded values of each variable should be used in calculating the predicted performance.

An examination of the prediction equation for motion quality with noise absent reveals that NF and TS have the largest weights. Both of these terms describe spatial characteristics which suggests that the length of target trail might influence judgment of motion quality. This hypothesis was tested by calculating the correlation between spatial extent, (NF-1) x TS, and motion quality scale values. For judgments in the absence of noise the correlation was .86, for judgments with noise it was .55, and for probability of detection it was .18.

These correlations confirm that judgments of motion quality are associated with the length of the target trail. To neutralize this effect, the deviation of each scale value was calculated from its line of regression on spatial extent. Corresponding calculations were made for the probability of detection data, and the two sets of deviation values were found to have a reliable correlation of .61 ($p < .01$). The removal of some of the spatial factors that influence motion quality preferences resulted in a stronger association between subjective motion quality and target detection.

Discussion

The correlation between judged motion quality and target detection supports the hypothesis that apparent motion is one of the factors influencing detection performance on a time-compressed display. The large correlation between spatial extent and motion rating indicates that the phenomena of apparent motion is more complex than previous research (see Scanlan, 1975, for a review) would indicate and that spatial and temporal factors interact in unexpected ways. A comparison of the two rating tasks indicates that the presence of random noise dots changes perceived motion quality.

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Acknowledgement

The research presented in this report was supported by the Life Sciences Program, Air Force Office of Scientific Research under contract F44620-70-C-0105, with Dr. Charles E. Hutchinson as scientific monitor.

SESSION 3-A

Women in the Military

Chairmen: *James H. Thomas*
Thomas M. Longridge

THE CONCEPT OF CITIZENSHIP AND ATTITUDES TOWARD WOMEN IN COMBAT

David R. Segal Nora Scott Kinzer John C. Woelfel

U. S. Army Research Institute for the Behavioral & Social Sciences

ABSTRACT

Data from a 1973 Detroit area study survey indicate that nearly 75% of the respondents are opposed to women in combat. In contrast, two Army surveys show that 50 to 60% of respondents are opposed to women in combat, women as commanders in a combat unit or women as infantry rifle-carrying persons.

Historically, the role of combatant in warfare has been restricted to the most politically relevant strata of society: the upper social classes in Europe through the 18th century, whites in America through the middle of the 20th century and males through history. The association of the right to bear arms with the citizen role grew out of the American and French revolutions. Both of these events emphasized the right of every citizen to bear arms and to belong to the officer corps. From these revolutions came the concept of the citizen soldier, the modern mass military formation, and the growth of parlimentary institutions (Janowitz, 1975).

The citizenship issue was manifested in the utilization of black soldiers in the U. S. Between the two World Wars, a policy was adopted to keep the number of blacks proportionate to the total population. Most importantly, despite the frequent demands from black organizations for "the right to fight," three quarters of the black soldiers in the segregated Army of World War II served in non-combat roles. In 1948, blacks were integrated into previously all-white combat units, and in Korea, proved to be equal in fighting ability to white soldiers. While some observers bemoan the voluntary overrepresentation of blacks in combat units in the modern Army, an alternate perspective would regard this as the achievement of citizenship. Recall that service in the armed forces has been one way for foreign nationals to achieve U. S. citizenship.

With a lag of almost three decades, the utilization of women in the Army parallels the utilization of blacks. Women have been drastically underrepresented in the Army relative to their proportion of the age-eligible civilian population. The early 1970's have seen the gradual atrophy of the Women's Army Corps as a segregated branch. Women are increasingly being integrated into previously all-male branches and units, and into traditionally masculine military occupational specialties (MOS). They are, however, precluded by interpretation of statute from serving in a combat MOS. Their "right to fight" has been constrained.

Attitudes toward Women in Combat

Recent data are available from three sources that give an indication of current opinion within and outside the military regarding women in combat.

During the spring, summer, and fall of 1973, a survey was conducted in the Detroit area by the Detroit Area Study of the University of Michigan (Segal, 1975). Respondents were asked the degree to which they agreed with the statement that "If anyone should bear arms, it should be men rather than women." Roughly three-quarters of the respondents agreed or strongly agreed with the statement.

A second data base comes from a survey of 724 Army personnel conducted in January, 1974, at Ft. Lewis, Madigan General Hospital, Ft. Dix, and Ft. Meade, (Savell, et al. 1975). The survey instrument contained several questions on women in combat. Above 60 percent of the respondents felt that women should not serve on the front line. About 50 percent did not think they would make good front line combat soldiers if they were properly trained. Fifty-three percent felt that if women were assigned to combat units, the Army would become less effective. Additionally, three-quarters of the sample felt that women should not be combat infantry persons.

A third set of data comes from the November, 1974 Quarterly Survey of Army Personnel, conducted by the U. S. Army Military Personnel Center (MILPERCEN). A world-wide sample of male and female officers and enlisted personnel (n=12,564) was asked "Would you feel as secure in combat with a female commander as you would with a male commander provided both have equal qualifications?" Over half (54.7%) of the sample responded negatively. The remainder answer yes.

In brief, three independent samples surveyed in 1973 and 1974, using a wide range of questions, indicated that both for civilians and for military personnel, between half and three-quarters of the persons interviewed indicated resistence to women in combat. Interestingly, the high figure was defined by the civilian sample, while the military figures for opposition to women in combat clustered in the 50% - 60% range.

The Extension of Citizenship

There does not seem to currently be majority support for the "right to fight" of women. The broad sweep of social change, however, is in the direction of gender equality. With the initial recognition that supporting the notion of women in combat is currently a minority position in America, we shall attempt to identify the segments of society that comprise this minority, and attempt to arrive at some projections for the future on the basis of our findings.

We have a wide range of social background data on the respondents in our three samples. Our understanding of the historical process of citizenship extension, however, gives us a basis for only a limited set of hypotheses.

Hypothesis 1. There will be a difference in attitudes toward women in combat between the genders, with women more favorable. We note that the women who in the abstract, believe that women should be allowed to fight may themselves have no interest in engaging in military combat. The issue of citizenship is a cause, not a job.

Hypothesis 2. The utilization of women in combat will be favored by political liberals and opposed by political conservatives. Almost by definition, opposition to women serving in combat, and thereby extending their citizen participation, is a defense of the status quo. The extension of citizen rights to newly politically relevant social groups, on the other hand, erodes the status quo. Similarly, since there is a relationship between religious and political structures, we would expect opposition to women in combat to be higher among communicants of conservative churches (Swanson, 1967).

Hypothesis 3. The utilization of women in combat will be favored as a function of formal education, and opposed as a function of membership in minority racial groups. Groups that have recently achieved citizenship rights themselves, or groups that hold high status in the system by ascription at a time when the system itself is becoming more achievement-oriented, are likely to be ambivalent at best to the granting of extended rights to other strata (Segal, 1974, 41-43). Groups that hold high status by virtue of their own achievements, however, should be unthreatened by the extension of citizenship. The clearest manifestation of achievement of status is formal certification of educational attainment.

Results

In our civilian sample, the relationship between sex and women bearing arms was not significant. In both military samples, and across all questions asked of them, however, females were significantly less likely to oppose women in combat than were men. Thus, for the military population, there is evidence in support of hypothesis 1.

We had political ideology data for our civilian sample and for one military sample. In all cases for which data were available, people who characterized themselves as political liberals were less likely to oppose the notion of women in combat. The relationship between religion and attitudes toward women in combat was considerably weaker, but here too a significant pattern emerged. There was a tendency for non-Protestants to be less opposed to women in combat than were Protestants - a finding difficult to interpret due to the heterogeneity of the Protestant category. More understandable is the finding that respondents who claimed no religious affiliation were less opposed to women in combat than were people who claimed a tie to a church. In the main, the data support of our second hypothesis, moreso with regard to political than to religious conservatism.

Our third hypothesis did not fare well at all. Data were available for all three samples and all six attitude measures. Four of the six correlations were significant, but one of these was in the wrong direction. While the number of tests sustaining the hypothesis was greater than chance expectation (three out of six tests at $p < .05$), the effect of education on attitudes toward women in combat is clearly less than the effects of sex, of political ideology, and of religious preference. Race likewise is significantly related to attitudes in three of six tests, but the coefficients are small.

Discussion

Women are not precluded from all combat assignments by legal statute. Statutory restrictions against women serving on board combat vessels or warplanes, however, have been interpreted by the armed services as a general exclusion of women from front-line combat units. Current opinion both within and outside the military seems to favor this interpretation.

It is possible that if the women's movement makes the opening of combat specialties to women a political issue, this end will be achieved, as was the opening of the service academies to female students. However, there is reason to believe that the services will not be overwhelmed by women who want to be combat soldiers. As noted above, the issue is a principle, and not necessarily a job. Were there obvious trends toward political liberalism and/or a movement away from traditional organized religion in America, we might anticipate a grass-roots movement favoring the extension of the "right to fight" to women. No such trends are obvious, however, and any change in current policy is more likely to come from organized political activity than from a major change in public opinion. The structural context within which such political activity takes place is also important. If unemployment in the private sector decreases, the alternative to admitting women to combat may be the reinstitution of military conscription, or reduction in the size of the active force. Whatever the unpopularity of the notion of women in combat, it may receive more support than either of these alternatives.

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LEADERSHIP FOR WOMEN IN THE MILITARY

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What kind of leadership will be required of and for the increasing number of women in the military? Leadership models and research to date have not provided concepts upon which situationally effective leader behavior can be postulated. The design and execution of leadership workshops, seminars, research and other educational and training experiences indicate that women because of sex role differences have been denied experience in leadership roles, have a concomitant lack of female leaders as models, and have lower leader position aspirations and realizations than males. The use of appropriate leadership models based upon situational leadership (the behavior of the leader is a function of the elements of leader, followers and the situation) appears to be particularly applicable to women because the stereotypes of past leader behavior or experience is not a vital factor. An overall concept, the Leadership Influence Matrix (LIM) provides a means of categorization, program classification, diagnosis and as one basis for female leadership and leadership training.

Introduction

The Defense Officer Personnel Management Act (DOPMA) provides substantially similar personnel statues and career progression opportunity for all active duty officers below general and flag rank of each service within the Department of Defense. With respect to women, significant changes have been incorporated to the effect that basic provisions relating to appointment, promotion accountability and retirement will apply equally to both male and female officers (Watkins 75). One of the most notable changes in ROTC in recent years is the increase in the number of women enrolling in ROTC units (Commander Digest, 18 September 1975). That the service academies are now accepting females is a well documented fact. The increase in women in all branches of the service is also well reported. Do you know the present percentage of women in the military?

Whether the number of women are representative, are part of a comprehensive equal opportunity plan, are the realization of the necessarily important contribution of over 52% of our population for national security reasons, or are tokenism, is not the point of this paper.

If indeed, females are to be fully integrated into the military as leaders, are there plans, programs, procedures, concepts, or theories that can best assist in accomplishing this goal?

The Problem

What kind of leadership will be required of and for the increasing number of women in the military? Leadership models and research to date have not provided concepts upon which situationally effective leader behavior can be postulated. Furthermore, the basis for most of the present leadership approaches is from male (white) populations. This is further complicated by the simple question. Is there a difference in the leader/follower behavior of males and females?

The traditional sex role differences certainly say there is. "After all, women are never going to be considered as presidential material as long as the president is viewed primarily as the Commander of our Armed Forces. Women don't want to imitate that role and they shouldn't. They (women) should humanize leadership roles for both men and women (Ellsberg 73). In 1971, LCDR Beth F. Coye, (W) USN, in her pioneering study, The Future of the Restricted, Unrestricted Line Officer, generally concluded (based upon the general organizational attitude of ad hocism of the Waves) a posture on the part of women's leadership has been accepted wherein a low profile is maintained. A type of psychological discrimination toward the Wave exists similar to that experienced by all professional women. The overall effect influences the leadership style. The women are continuously conditioned to believe that they were never meant to aspire very high and that inequality of opportunity is part of the natural state of affairs. There is apprehension about femine leadership. Leadership by its nature must be aggressive within societal norms. Female leadership must be both aggressive and "femine," yet there appears an inherent contradiction in terms. The lag in progress in career planning for women may be caused by the role and status ambiguity. Wave leadership is forced to a low profile with no alternative (Coye 71). Traditional "born leader" and "trait leader" theories are the opposite of traditional femine roles. As one leadership seminar participant stated, "When you play dollies, there is no team captain as when boys play baseball, we just don't ever get any practice leadership while we are growing up." "There are no obsolute biological differences other than the clear cut differences between primary and secondary sex organs . . ." (Willet 71).

Research to determine if there is a leader/follower leadership behavior difference, its extent, possible causes, and rectification if desired, should continue. In the meantime, it is proposed that situational appropriate models of leadership be used as the basis for leadership for women in the military.

Recommendations

In Management of Organizational Behavior (1972) Paul Hersey and Kenneth H. Blanchard set forth "The Life Cycle Theory of Leadership." This theory, developed in an attempt to provide a conceptual framework that might help one develop strategies for adapting one's leadership style in working with the many individuals and groups within one's

environment, provides a basic situational appropriate leadership model. This theory is based on a curvilinear relationship between leader task behavior and relationship behavior, and follower maturity. It is particularly applicable to leadership for women in the military because sex role differences and the stereotype of past leader behavior or experience is not a vital factor.

Determination of individual and group maturity is the key to effective leadership style. Beginning with structured task behavior, which is the appropriate behavior for working with immature individuals or groups, Life Cycle Leadership suggests that the leader's behavior should move through (1) high task--low relationship behavior to (2) high task--high relationship and (3) high relationship--low task to (4) low task--low relationship behavior as (and if) one's followers progress from immaturity to maturity over time. See Figure 1.

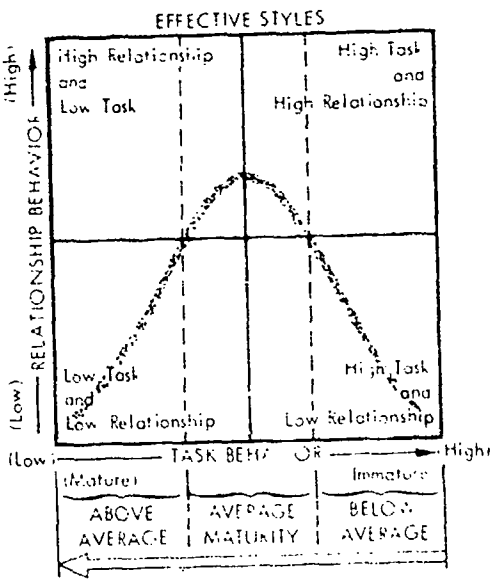

Figure 1. The Life Cycle Theory of Leadership, Task and Relationship Dimension of leader behavior, and maturity level (Hersey and Blanchard, 1972).

In conducting various leadership learning experiences, Moore (1975) developed a Likert type scale of Maturity and Immaturity Continuums. The objective was to have participants in learning experiences directly establish their own group maturity as part of their leadership training. Participating groups in leadership training and education were presented with a variety of tasks. The leader and follower behavior exhibited was observed and analyzed by the participants. Video taping was used when available. Female participants reported gains in skills, and feelings of strength and confidence as a leader and as a follower. The following typifies the female reactions: "The leadership training experience has had considerable impact in my life because my responsibility for conducting groups has increased greatly in recent years and I lacked formal preparation for doing this."

Effective leadership is a function of the leader, the followers, and the situation L = f (l,f,s). The emphasis upon male hierarchical organizations and models, particularly the family, the church, the military, and business, tends to predispose one to think of power as being possessed and exercised only by those in the superior position. Leadership conceptualized as an interpersonal relationship, shows that all (male and female) elements of group effort (leader, followers, and situation) possess power or influence. It may be helpful to think of these influence relationships as shown in Figure 2.

Influence	Leader	Followers	Situation
Leader	Leader Influence on Leader	Leader Influence on Followers	Leader Influence on Situation
Followers	Followers Influence on Leader	Followers Influence on Followers	Followers Influence on Situation
Situation	Situation Influence on Leader	Situation Influence on Followers	Situation Influence on Situation

Figure 2. The Leadership Influence Matrix of the Elements of Leadership (LIM).

Conclusions

1. The ability to diagnose organizational behavior in terms of the elements of leadership provides leaders and followers (male and female) with a situationally appropriate basis for personal behavior within the system.

2. Organizations may be viewed as a series and linking of followers and leaders in various arrays and positions. By systematically establishing the leader and followers in each specific sub-unit a determination of follower and situation influence can be made in order that appropriate leader behavior may be taken. The sub-units can then be reassembled and the system viewed as a whole again.

3. All segments of personal and group life require leadership. A systematic approach such as the Leadership Influence Matrix and situational leadership is required to bring about increased effectiveness and constructive change, as required by the increasing number of women in the military. The LIM and situationally appropriate leadership provides leaders or those who would teach others to be leaders and followers a dynamic, pro-active, functional basis for leader behavior (male and female) in today's and tomorrow's military.

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ATTITUDES TOWARD THE NAVY OF ENLISTED MEN AND WOMEN

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This study addresses the interaction of sex and pay grade on organizational climate dimensions for nonrated and rated shore personnel. Women have an initial tendency to respond optimistically on the Human Resource Management Survey. However, as they advance to the petty officer levels, women become disproportionately disillusioned on certain dimensions. This is consistently true in the area of attitudes toward peers. With increases in pay grade, women appear to feel less a part of the work group team, whereas the opposite trend is true for men. This suggests that the harmonious assimilation of women into the Navy is not adequately sustained as their careers advance.

Since 1972, the number of Navy enlisted women has increased from under 5,000 to a current strength of 18,800, creating an unprecedented male/female ratio and a situation which has far-reaching implications for human resource management. This study investigates attitudes toward the Navy of enlisted men and women. It is hypothesized that their perceptions of organizational climate will differ, and that the profiles of men and women across different pay grade levels will not be parallel, since advancement for women may cause unique problems. Identifying and clarifying such differential patterns should improve the effective utilization and retention of Navy women.

Method

The sample consisted of 1,960 women and 22,073 men in pay grades E-1 to E-6 at 137 commands. The measure was the Human Resource Management Survey, administered from February 1974 through October 1975. The HRMS, designed to assess organizational climate, consists of 88 questions aggregated into 18 main indices representing dimensions of (1) Command Climate, (2) Supervisory Leadership, (3) Peer Leadership, (4) Work Group Processes, and (5) Outcome Measures. The remaining indices, such as Equal Opportunity, relate to special issues. HRMS responses are Likert-scaled from 1 to 5.

Results

Table 1 summarizes results of the sex by pay grade analyses of variance for each HRMS index. Means are presented by sex for the four pay grade groupings, as well as levels of significance for the main effects and the interactions of sex and pay grade.

The newly-enlisted nonrated women (pay grades E-1 through E-3) are consistently more positive in perceptions of their commands than nonrated men. For all respondents, the functioning of the command as a whole is not perceived as favorably as are aspects of supervisory, peer, and work group behavior. An upswing in means with increasing pay grade is typical of most survey indices and probably is due to the attrition of personnel with negative feelings about the Navy. Of central interest are the interactions of sex and pay grade. Table 1 reveals that, of the 19 HRMS indices examined, nearly half yield significant sex by pay grade interactions. This supports the prediction that perceptions by pay grade often are not parallel for males and females.

Table 1

Subsample Means for HRMS Indices

HRMS	Women				Men				F			Total df for the Analysis of Variance[a]
	E-1-3 N=1,213	E-4 N=489	E-5 N=215	E-6 N=43	E-1-3 N=5,487	E-4 N=4,744	E-5 N=6,806	E-6 N=5,036	Sex	Pay Grade	Interaction	
Command Climate												
1. Communications Flow	3.01	2.95	3.06	2.99[b]	2.87	2.87	2.97	3.10	***	***		20,427
2. Decision Making	2.79	2.77	2.79	2.95[b]	2.64	2.63	2.66	2.83	***	***		11,557
3. Motivation	2.95	2.95	3.03	3.15	2.72	2.73	2.97	3.20	***	***	***	23,991
4. Human Resource Emphasis	2.88	2.80	2.79	2.82[b]	2.68	2.66	2.76	2.98	***	***	***	23,984
5. Lower Level Influence	2.75	2.67	2.48	3.00[b]	2.62	2.55	2.57	2.69	***	***		11,509
Supervisory Leadership												
6. Supervisory Support	3.61	3.64	3.74	3.71	3.41	3.52	3.63	3.75	***	***	*	24,019
7. Supervisory Teamwork	3.30	3.27	3.40	3.41	3.14	3.22	3.38	3.56	***	***	*	23,827
8. Supervisory Goal Emphasis	3.59	3.60	3.58	3.64	3.45	3.49	3.60	3.72	***	***		23,830
9. Supervisory Work Facilitation	3.21	3.17	3.13	3.09	3.06	3.10	3.20	3.29	***	***	***	23,916
Peer Leadership												
10. Peer Support	3.65	3.62	3.69	3.57	3.57	3.63	3.70	3.82	***	***	***	23,924
11. Peer Teamwork	3.12	3.10	3.18	3.18	3.01	3.06	3.19	3.29	***	***	***	23,871
12. Peer Work Facilitation	3.07	3.01	3.01	2.91	2.91	2.95	3.04	3.22	***	***	***	23,644
13. Peer Problem Solving	3.14	3.18	3.28	3.11	3.00	3.19	3.26	3.39		***	*	23,838
Work Group Processes												
14. Work Group Coordination	3.24	3.26	3.32	3.24	3.18	3.26	3.36	3.53	**	***	**	23,882
15. Work Group Readiness	3.38	3.34	3.58	3.83	3.37	3.39	3.51	3.68		***		13,570
16. Work Group Discipline	3.48	3.46	3.67	3.80	3.36	3.89	3.46	3.72	***	***		15,906
Outcome Measures												
17. Satisfaction	3.37	3.46	3.52	3.70	3.12	3.28	3.46	3.62	***	***	**	24,002
18. Integration of Men and Mission	2.34	2.33	2.45	2.49	2.06	2.07	2.29	2.62	***	***	*	23,732
Special Index												
19. Equal Opportunity	3.25	3.23	3.36	3.29	2.98	3.09	3.28	3.55	***	***	***	23,747

Note. Results are for two-way analyses of variance. E-7 to E-9 personnel were eliminated due to the scarcity of women respondents at these levels. However, 19 additional analyses were performed with the fourth pay grade comprised of E-6 to E-9 personnel combined. In general, the means for the E-6 to E-9 women grouped were higher than means for E-6 women alone. But the upswing in male means at the chief levels so far surpassed the senior women's that four more indices (6, 7, 13, & 18) yielded significant sex by pay grade interactions.

[a]Analyses of variance were based on varying N's due to the fact that not all questions were administered to total sample.

[b]These means should be interpreted with caution (N<25).

* $.10>p>.05$.

** $.05>p>.01$.

*** $p<.01$.

Command Climate. For the Command Climate dimension, women view Communications Flow, Decision Making, and Lower Level Influence as significantly more adequate than do their male counterparts. The effect of pay grade on these perceptions is not significantly different for the sexes.

Two Command Climate indices did yield significant sex by pay grade interactions. Women, reporting on their own motivation and perceived equity of rewards (index 3), show no change to E-4 status, but have increasingly higher means at the E-5 and E-6 levels. The means for lower pay grade males originate considerably below the means for females. An upswing occurs between the E-5 and E-6 means for men, which surpasses the mean for E-6 women. The overall increase in Motivation means from lowest to highest pay grade is three times greater for men than for women.

The Human Resource Emphasis index, which shows a slight drop in mean responses for both sexes from the nonrated to E-4 level, evidences the typically positive response bias on the part of the lower pay grade women relative to men. The significant sex by pay grade interaction reflects the trend for female personnel to level off around 2.90 in their averaged

view of the commands' Human Resource Emphasis, despite increasing pay grade. The male means show an upward trend from E-4 through E-6, crossing over and ending at a higher level than E-6 women.

Supervisory Leadership. Women at the lower pay grades are consistently more positive than men in perception of supervisory adequacy. Nevertheless, the means for E-6 women are slightly below those of E-6 men on Supervisory Support, Teamwork, Goal Emphasis, and Work Facilitation. On these four indices men show a much steeper trend of favorableness from the nonrated to the E-6 level in their evaluation of supervisors. Only on Supervisory Work Facilitation do the differences across pay grades between male and female patterns achieve significance. In graphing this index a line drawn for men crosses over that for women and ends at a higher level for E-5 and E-6 men.

Peer Leadership. Three of the four analyses on the peer indices show significant interactions. Men are increasingly positive about their peers; they show immediate improvement in attitudes toward their buddies as they move from nonrated to E-4. Such an increasing sense of solidarity is not typical, however, of the women, whose peers are probably predominantly male. Women's attitudes are relatively positive initially on Peer Support, Peer Teamwork and Peer Work Facilitation, but decline when the women become rated (E-4). E-5 women are again more positive, probably due to failure of the less satisfied women to reenlist. Perceptions of E-6 women are, in turn, lower than E-5 women except on Peer Teamwork, where no change is noted between pay grades E-5 and E-6. The means for E-6 women fall considerably below those for E-6 men on all four indices. Peer Problem Solving results are similar to those for other peer indices in that the E-6 women drop well below the climbing line for men of higher pay grades. However, the sex by pay grade interaction term is not significant for index 13.

Work Group Processes. The pattern of subgroup means for Work Group Coordination, which measures trust and involvement with peers in the immediate work group, is similar to the Peer Leadership dimension and yields a significant sex by pay grade interaction. Males become more positive with increasing pay grade, with E-6's displaying the highest mean of any subsample on index 14. Women are most positive at pay grade E-5, then drop off to a level below males at E-6.

Indices 15 and 16 do not measure peer interaction directly. Work Group Readiness assesses the team's emergency preparedness and day to day functioning. Men and women rate their work groups more positively on this index with increasing pay grade. Evaluations of Work Group Discipline show a more irregular pattern. Neither index evidences significant sex by pay grade interactions.

Outcome Measures and Special Index. The results for index 17 reveal that women report a high level of overall satisfaction with aspects of the job, supervisor, and command that is enhanced with increasing pay grade. Their initial optimism, as compared to nonrated men, is impressive. However, the slope of the line for men rises more steeply from the lower to the higher pay grades (significant sex by pay grade interaction).

Index 18 measures the balance between the command's meeting of individual needs and its effectiveness in getting people to meet its objectives.[1]

[1]Unlike other indices, this index is not the mean of the questions which comprise it. The formula, where A is the item with the lower score and B is the item with the higher score, is: $\frac{A}{B} \times \frac{(A+B)}{2}$.

The scores for women are consistently high but reveal only slight improvement with increasing pay grade. E-1 to E-4 males rate their commands low on Integration of Men and Mission. Perceptions of higher pay grade men are much improved, however, and surpass those of women at the E-6 level.

The Equal Opportunity index is based on five questions administered to a sufficient proportion of the sample for analysis. Four ask the respondent directly whether she/he has experienced equal opportunity for job assignment, advancement, training, and recreation, and the fifth assesses fair military justice. Entering Navy women have positive attitudes relative to males, revealing that the Navy's equal opportunity stance is being communicated to female enlistees. Certainly the Navy compares well to the civilian community on such issues as equal pay for equal work. Since the positiveness of the nonrated women on index 19 is similar to their optimistic tendency on all survey dimensions, it is not interpreted as evidence of favoritism experienced by women vis-a-vis male sailors. Objectively speaking, many doors for training and assignment remain legally closed to Navy women, and difficulties are experienced in advancement, particularly in seagoing rates (Thomas, 1976). By pay grade E-5 and E-6, men gain and then surpass women, though women are still not dissatisfied as evidenced by their responses to these questions. The steep increase between male means from E-1 to E-6, in comparison to the women's pattern, yields a significant sex by pay grade interaction for the Equal Opportunity index.

Discussion

The focus on differential changes with pay grade in the organizational perceptions of men and women reveals a disturbing trend in the response patterns of Navy women. Despite views which are consistently more positive than those of their male counterparts at entry level, women are often more negative than men by pay grade E-6. This is true on 14 of the 19 indices. The favorable attitudes of women relative to nonrated men may be due to the fact that the selection ratio and objective standards for enlistment are more stringent for women and, therefore, contribute to an initially greater sense of pride and identity with the Navy. Opportunities for women in the Navy may be perceived as extensive relative to their opportunities in industry. If subsequent disillusionment is occurring, it simply may be that the women's expectations are unrealistically high. With increasing rank, Navy women probably use their male peers as a comparison group and thus become more aware of the limitations imposed upon them.

Women's relative dissatisfaction at pay grade E-6 is slight, but noteworthy since, by the second enlistment, the more discontented women have departed the Navy. One would expect that the female reenlistees would be more positive than their entering sisters, as is true on all indices for male petty officers vs. nonrated men. Yet this is not the case on seven indices for women.

One group of indices showing consistent contrast, i.e., where men's means increase greatly and women's do not, measures interactions among peers (indices 10-14). Research in civilian settings indicates that women may be frustrated when they reach more responsible levels within an organization. Cultural expectations calling for deferential behavior in women conflict with the appropriate interactions among male and female

peers on the job (Loring & Wells, 1972). The potential for role conflict is even greater if women are supervising men. Further, even indirect competition with men may impose additional hardships. Success is perceived as offering negative as well as positive payoffs for women and often is seen as unfeminine by both sexes (Horner, 1969). Such considerations help explain why Navy enlisted women of middle rank, while viewing the Navy positively as an organization, may experience stress in the area of peer relations. Studies in other settings reveal that women experience greater isolation on the job than men and receive fewer sociometric choices from coworkers on such criteria as friendship, influence, and prestige (Miller, Labovitz, & Fry, 1975). These differences are more pronounced at advanced levels within the organizations. An increase in the sheer numbers of female petty officers may ease the Navy situation by decreasing the incidence of "solo" women working in groups of men. Navy women may be resented by men in the same ratings, who often believe the women are taking their shore billets despite the quota system that prevents this.

Interpretation of the Satisfaction and Equal Opportunity results is not straightforward. Inequities may be imperfectly reflected in comparative subjective evaluations of job rewards and opportunities by men and women. It has been found that low status women, objectively experiencing adverse working conditions and job constraints, have actually reported less job strain and more job satisfaction than men; however, this pattern was reversed at the higher levels of education, authority, and occupational rank, where women began to pay a disproportionate price for their advancement (Miller et al., 1975). The Navy Satisfaction data show only a convergence in men's and women's responses. The Equal Opportunity measure, as well as all the other indices evidencing sex by pay grade interactions, show a full reversal pattern where, despite the optimism of the entry level females, women are less positive than men by the E-6 level. Longitudinal data and information on the composition of work groups by gender is necessary to further clarify the meaning of these trends.

In summary, the present study suggests that women who move up occupationally in the Navy, as in the external society, run the risk of losing friendship, team feeling, and the relatively unquestioning favorableness with which they view their jobs. Such a trend, indicating that the initially harmonious assimilation of women into the Navy is not being maintained over time, portends not only frustration among the women but also a loss of personnel effectiveness for the Navy.

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HABITABILITY ASPECTS OF WOMEN ABOARD SHIP

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During 1973, the USS SANCTUARY, a hospital ship with a crew of approximately 500, was in operation with 50 women crew members. Human factors personnel were assigned to conduct a study directed primarily at examining the habitability aspects of the ship, with particular attention to differences in the male and female living areas. Alterations in the crew's quarters necessitated by the introduction of women crew members were noted together with suggestions for areas of improvements in the spaces occupied by both males and females. Subjective data included observations and formal and informal interviews. Objective data included physical measurements, environmental recordings, and usage counts. The principal finding was that women can be accommodated aboard large ships with a minimum of alterations to existing hotel functions. Additional findings were that alterations in the social customs and physical conditions would improve the habitability aspects of having women aboard ship.

Introduction

In an effort to more effectively utilize the personnel resources available to the Navy, women have been assigned to sea duty aboard the USS SANCTUARY during 1973. By having women in active sea duty, the Navy could conceivably avail itself of the support of more than half the adult population. Women have performed distinguished service in the commercial and military fleets of other nations. In addition, the presence of women aboard ships might serve to make prolonged sea duty less unattractive to men, thereby lessening the impact of one of the major reasons cited for failure to re-enlist.

The introduction of women crew members in the Navy was begun on an experimental basis to determine the feasibility and desirability of extending the policy to other ships. One of the factors that might mitigate against having women on board would be if extensive changes in the physical plant were required. Human factors personnel were assigned the task of determining the habitability aspects of women aboard ship--identifying what changes were necessary to accommodate female crew members.

A team of three females and four males was selected to collect data on the USS SANCTUARY. In order to prepare the team members to examine the habitability conditions experienced by the women aboard ship, a basis for comparison was established by conducting site visits to the women's housing provided at the Naval Training Center in San Diego and to men's berthing aboard several naval ships.

The site visitations indicated that in the housing provided the women at the Naval Training Center, the women have a relatively large amount of personal space as they live, for the most part, in two and three person rooms. They identify their territory by extensive use of personal decorations. In

contrast, visitations to shipboard berthing indicated that the men have little physical space and virtually no personal space which they can identify as their own.

From the site visitations, it was evident that women serving aboard ship would have to undergo a drastic alteration in personal space configurations, from the relatively large, semi-private, personalized areas of the dormitories to the exposed, de-personalized, public areas of the berthing compartments.

Prior to collecting data on the USS SANCTUARY, team members met with the crew of the USS GOMPERS. This ship had transported approximately 70 women dependents to Japan in 1971. From interviews with several officers and crew members, the following conclusions were drawn: Women aboard ship presented no major problems in terms of housing or social interaction. Only one rule was in effect, viz., members of one sex could not enter the other's berthing and sanitary areas. Women aboard ship had a desirable effect in bolstering the morale of the men, improving the work climate, and positively altering the behavior patterns of the men. Women who took an active part in the functions of the ship were accepted even more fully, overcoming much of the lingering resentment of some crew members about having outsiders aboard.

On the USS GOMPERS, the women dependents had been berthed in normally vacant berthing space. No modification of the areas was in evidence. The berthing compartments in most sections aboard the USS GOMPERS were spacious in appearance because of the high overheads and the wide aisles between the berths. Sanitary facilities were directly accessible by the women from the berthing compartment.

The experience reported on the USS GOMPERS indicated that women adapted to the berthing compartments without major problems, that they had a desirable effect on shipboard life, and that those who assisted in the functioning of the ship were accepted more fully. This experience suggested that women aboard ship for a limited period of time could accommodate themselves with little disruption and with possible improvement to the hotel functions and habitability aspects of a ship.

Approach

After conducting a series of preliminary visitations to the USS SANCTUARY, during which time modifications in the data collection techniques were developed, team members sailed with the ship. In order to become familiar with different areas of the ship, team members were assigned berthing in several locations. The women were housed in the women's berthing area, two men were housed in the medical corpsmen's berthing area, and two others were housed in officer's country. By living in these different territories, the team members became familiar with the problems the occupants themselves faced. In addition, the ship's personnel became personally acquainted with the researchers and were more inclined to divulge their candid views about their environment. (Stereotyped responses, given to reporters and to those who would perform only a cursory examination of the living conditions of the crew may convey false impressions of either a favorable or unfavorable nature.) By living with the ship's personnel and sharing their conditions, the real areas of concern were more likely to be revealed. By this means, a close rapport was developed with many crew members.

In conducting a habitability study, it is necessary to collect both subjective and objective data. Because the purpose of the hotel functions of a ship is to provide for the ship's personnel, feedback from them was desirable in order to determine how well the design of the ship was satisfying their needs. Physical measurements, alone, portray only a part of the shipboard environment. It is necessary to consider the interaction of the physical characteristics with the psychological and sociological factors when evaluating the adequacy of hotel functions. This was especially true aboard the USS SANCTUARY.

Initially, it was intended to utilize a questionnaire to query the members of the USS SANCTUARY regarding the adequacy of the habitability aspects aboard the ship. Such a questionnaire was designed, concentrating on berthing, sanitary, messing, recreation, and other common spaces. As members of the team interacted with the ship's personnel before the cruise, it became apparent that the crew members, especially the women, had been subjected to such a barrage of interviews and questioning by newspaper and magazine reporters that direct questionnaires would not be a desirable method to employ. The questionnaire was redrafted in the form of a scoresheet for a structured interview.

In practice, the collection of subjective data depended on recording observations and comments from casual encounters, group discussions, group rap sessions, and an occasional, formally-structured interview. The subjective data were augmented by the personal impressions and the behavior observations made by the human factors personnel.

A large battery of objective measurements was devised. Some of the data collected were entered on the Ship's Physical Evaluation Form scoresheet. Other measurements were made using temperature and comfort schedules, sound level meters, physical measurements of the dimensions of the physical spaces and of the furniture and fixtures contained in the living areas, number counts and usage records of facilities, and photographs of representative areas aboard ship.

The subjective and objective measurements complemented one another, allowing for meaningful conclusions to be drawn concerning the habitability of the shipboard environment. The subjective measurements were to indicate the areas of the physical environment which proved satisfactory or unsatisfactory in terms of the hotel functions provided ship's personnel. The objective, physical measurements were intended to indicate what the specifications were of the problem and non-problem areas. Neither measurement, alone, would permit the identification of the specific, offending characteristics of problem areas.

Conclusions

The principal finding of this study was that women can be accommodated aboard large ships with a minimum of alterations to existing hotel functions. Given existing social constraints, a separate berthing area with direct access to sanitary facilities is needed. Such arrangements should be readily available aboard most large ships. Some of the minor alterations to the physical plant of the berthing and sanitary areas include the introduction of washers and dryers, the removal of urinals, the replacement of mirrors over the sinks to other areas of the berthing or sanitary compartments. No alterations of the messing, recreation, and other common spaces aboard ship appeared necessary to accommodate women.

The crew members aboard the USS SANCTUARY were able to identify numerous minor problems with the habitability aspects of the ship, but these complaints were voiced equally by the men and women. Objective data were collected about these problem areas, including such factors as clearance above the top rack in a bunk, the location of the reading lamps above the bunks, the height of the top rack, the adequacy of lockers and storage space, the temperature and air-flow conditions, etc. But the similarity of the comments obtained from men and women indicated that they share very nearly identical concerns for the specifics of the improvements desired for their shipboard environment.

Observations were made about the work and social characteristics aboard the USS SANCTUARY, for these factors inevitably intrude on habitability factors. The psychological and sociological factors interact considerably with the perception of the physical environment. A physically inferior environment may be reacted to positively if the proper social/psychological situations prevail; or a superior environment, negatively, if adverse conditions exist.

In the work environment, women crew members functioned well in all departments with the exception of the engine room. Although 40% of the women were associated with medical activities, more than 10% were members of the deck and other support crews. They performed at high levels in all departments. If there were a task which a women was unable to do because of her stature or size, other crew members would share in the task. Several of the men commented that it had been common practice to assist shorter or smaller men in performing physically-demanding tasks, and that equal consideration for the women was a natural expectation. Men and women worked together to aid one another in getting a job done. Physical differences were inconsequential.

In the social environment, everyone interviewed was pleased with, or at the worst, indifferent to, the effect of having women aboard the USS SANCTUARY. Officers and enlisted men, personnel experienced and inexperienced with sea duty, all thought that having women in the fleet at sea had several beneficial effects. Even those who wanted to serve on other classes of ships or who had initially had negative expectations about the effects of having women on board emphasized that they enjoyed working with the women on the USS SANCTUARY. A healthy, coeducational situation existed aboard the ship similar to that which may be found in any sexually-integrated society. Most men and women appeared to have mature attitudes about the relationships between individuals. Antagonisms over jealousies or favoritisms seemed minimal. Morale appeared high because of the presence of women.

From the experience aboard the USS SANCTUARY, several recommendations for ship conversion guidelines can be developed. Ships selected for women crew members should be large vessels with several separate living areas. The introduction of women to a given compartment requires that a careful balance be maintained so that over-crowding or under-crowding in the sexually-differentiated compartments will not result. Design alterations to accommodate the needs of the women appear minimal, but the preferences and patterns of women should be examined to determine whether design alterations would produce an enhanced habitability aspect. When women are first introduced aboard ship, the attitudes of the officers do much to establish the psychological framework in which they will operate. Equal treatment of men and women is necessary, both in job assignment and in the freedom they are given to personalize their life spaces.

UTILIZATION OF WOMEN IN AIR FORCE INDUSTRIAL CAREER FIELDS

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The Air Force has recently opened many of the traditionally all male career fields to women. A diversity of opinions concerning the effectiveness of women in these career fields suggests that there are dramatic differences in the utilization and acceptance of women in these jobs. To ascertain the existence and magnitude of problems related to the utilization and effectiveness of women in these jobs, surveys and interviews were conducted with supervisors and non-supervisors (women and men) in both the traditional and non-traditional career fields for women. The results revealed that men and women (non-supervisors) in all career fields perceived discrimination toward women. The men felt women were treated better and the women felt their work was judged more harshly. Supervisors, primarily in the industrial career fields, perceive that women are not as capable as men. Supervisors further report that women learn job tasks equally as well as men, progress in upgrade training equally as well as men, require less attention from their on-the-job-trainers (OJT) and are equally as motivated.

In 1972, the Air Force opened many of the traditionally all male career fields to women. Since that time, increasing numbers of women have entered these career fields and are presently in training or on the job. Since these career fields have traditionally been all male, there has been significant discussion concerning women's ability to do these jobs, their acceptance by coworkers and supervisors, and their effective utilization. The diversity of opinions regarding the effectiveness of women in these career fields, suggests that there are dramatic differences in the utilization and acceptance of these women. Since the Air Force plans to continue assigning women into these fields, it is essential that a method be developed to surface the problem areas, investigate the magnitude, and, if necessary, develop, implement and monitor a program to correct the deficiencies.

METHOD

To measure the attitudes, perceptions, and opinions of the women, their supervisors, and male peers, three teams of two persons each visited five Air Force installations and administered surveys to individuals in selected career fields.

SAMPLE

One thousand five hundred ninety five Air Force men and women from the non-traditional career fields: NTCF (aircraft/missile maintenance, civil engineer, security police) and traditional career fields: TCF (administration, personnel and supply) participated in this survey. There were 255 women in the NTCF and 218 women in the TCF. The women were in grades E-1 thru E-5; with the largest percentages in grade E-3 (47%). There were 337 male coworkers in the NTCF and 322 male coworkers in the TCF. The coworkers were in grades E-1 thru E-6 with the majority being E-3s and E-4s (33%/31%).

There were 251 supervisors in the NTCF and 212 in the TCF. The supervisors ranged in grades E-5 thru E-9 and were primarily E-5s and E-6s (37%/31%).

With samples of the above cited sizes, sample data are generally within plus or minus .05 of the population parameters at the .95 level of confidence based on the June 1975 census of the selected career field groups surveyed.

APPARATUS

The survey instrument was developed at the Air Force Human Resources Laboratory (AFHRL) at Lackland Air Force Base, Texas.

PROCEDURE

The Consolidated Base Personnel Offices (CBPO) on five Air Force installations were notified to assemble, at random, groups of supervisors, coworkers and women from the selected career fields. Three teams, composed of two Air Force personnel, visited two installations each. They administered the surveys, and forwarded the answer sheets to AFHRL. The answer sheets were scanned, and frequency distributions were forwarded to AFMPC for analysis. The data was refined, summarized, and submitted to the Air Force Chief of Staff by the Air Force Leadership and Motivation Division of the Deputy Directorate for Human Resources Development.

RESULTS

The results of the survey showed that the women and their male coworkers in all career fields perceive discrimination. Men more than women perceive sex discrimination. Sixty percent of the men/NTCF and 50% of the men/TCF report that women receive better treatment on the job; 23% of the women/NTCF and 27% of the women/TCF report this to be so. The majority of all groups feel that women are given the same responsibility as men and are utilized the same as men. However, a large percentage of the men in the NTCF feel differently; 42% feel that women in their career fields are given less responsibility, and 41% believe that women are utilized less.

Approximately 18% of the women feel their work is judged more harshly and approximately 14% of the men feel that women's work is judged more leniently. A large majority (71% +) of all respondents report that women do encounter negative attitudes on the job in varying degrees because they are women. Approximately 19% (both men and women) in all career fields perceived a lack of acceptance by their supervisors when they first entered the job. However, all groups report that acceptance improved after a period of time on the job.

The women and the men were inconsistent in their report on how men view women. The majority of men and women in all groups report that men view women as professional working women and equal working partners. However, greater than 60% of all groups report that men view women as inferior to men and only working until they can find a husband.

In response to the questions of degree of satisfaction with the Air Force "in general," women in both the NTCF and TCF are more satisfied than are men (85% versus 75%/NTCF and 81% versus 63%/TCF.) Women and men are equally satisfied with their career fields (74%/76%/NTCF, 72%/72% respectively TCF.)

The women in the TCF are more interested in cross-training from their present career field than are the men and women in the NTCF and men in the TCF. (71% compared to 51% women/NTCF, 54% men/NTCF and 48% men/TCF.) The majority (50% +) of all respondents feel that women should be in the industrial career fields. When personnel in the NTCF were asked about their desires to work in their career fields prior to entrance, 87% of the men and 56% of the women express they had a desire for these career fields.

Supervisors were queried as to their opinions and attitudes concerning women working in their career fields prior to encountering a woman in the work environment. Twenty-five percent of the supervisors in the TCF and 37% of the supervisors in the NTCF report having a negative attitude about women. Yet after supervising women, the reported negative opinions held by the supervisors in all career fields changed for the better.

A majority of the supervisors in the NTCF believe that women are not as capable as men (51%). Whereas, 9% of the supervisors in the TCF believe that women are not as capable as men. Conversely the majority of all supervisors (NTCF and TCF) report that women learn job task equally as well as men, progress as well as men in upgrade training, require less attention from their on-the-job trainers, and are motivated the same or more than men to reach the required standards of job performance.

A notable percentage of supervisors reported a leniency in their treatment of women. One of four supervisors in both career field groups report that they would be more reluctant to take disciplinary action against a woman than a man. More than half report that they would make allowances for women that they would not make for men. Supervisors in all career fields report they have no preference as to which sex they supervise.

DISCUSSION

The study indicates that sex discrimination is perceived to some degree by all groups of people in all career fields. The data suggests that some supervisors do discriminate based on sex and the non-supervisors (women and men) are aware of this discrimination. The discrimination perceived appears to paternalism by supervisors toward women. The male non-supervisors view this as leniency and the female non-supervisors view this as harshness. It is significant to note that all opinions and perceptions change for the better as more women are in career fields for a period of time. The Air Force views women as an integral and essential human resource in the United States Air Force. Their morale, effectiveness, and productivity are directly affected by the attitudes of their coworkers and supervisors. Therefore, positive acceptance of women as equal working partners and professionals is essential.

PERFORMANCE OF MALE AND FEMALE PERSONNEL ON SEVERAL PREDICTIVE TESTS OF AEROBIC POWER

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Cardiorespiratory fitness was measured using a direct as well as several predictive techniques. Four hundred male and female Ss volunteered to participate in a series of work capacity tests and to answer a questionnaire regarding their attitudes towards physical activity and physical self-concept. These tests of work capacity may become an intergral aspect of personnel evaluation and MOS selection in the Armed Forces.

The capacity to perform aerobic work is limited by the combined capacity of the respiratory and cardiovascular systems that transfers oxygen to the working muscles. However, because of the complexity of performing a direct determination of $\dot{V}O_2$ max, several attempts have been made to estimate maximal oxygen uptake based on individual performance on a submaximal work task. Perhaps the best known and the most widely used of these is the Astrand-Rhyming work test which uses a nomogram to predict $\dot{V}O_2$ max based on weight, age, and heart rates elicited by submaximal work load.

Another method used to predict aerobic power has been the distance run test. Cooper 1968, and Doolittle, 1969 have demonstrated that this test can be used to estimate aerobic power ($\dot{V}O_2$ max). However, though there has been a substantial amount of data collected on men for these tests, only fragmentary information is available regarding the prediction of aerobic capacity of women under similar conditions.

The purpose of this study was to compare men and women in terms of their aerobic work capacity before and after a 6 week training cycle and to validate several predictive tests of aerobic power which may be suitable for use in the mass screening of populations of young men and women.

Method

Four hundred male and female personnel between the ages of 17 and 26 years of age were selected from the basic training cycles at Ft. Jackson, SC during the months of October and November 1975. They were asked to participate in the study and 390 signed informed consent and volunteer statements.

Procedure

A detailed medical history was obtained and a psychological instrument was administered to evaluate attitudes toward exercise and physical self concept. All subjects were familiarized with the treadmill and bicycle ergometer. The treadmill test for maximal aerobic capacity followed the procedure of Taylor et. al (1955).

The subjects performed a submaximal warmup at 5 or 6 mph, 0% grade (6 minutes) followed by 2 or 3 interrupted runs of 3-4 minutes duration to establish the $\dot{V}O_2$ max plateau with increasing workload. Each load was intervened by a 5-8 minute rest period. Oxygen uptake and minute ventilation were measured during the last 30-60 seconds of each run by collection of expired air through a triple-J valve into Douglas bags. Oxygen and carbon dioxide concentration were determined with a paramagnetic O_2 analyzer (Beckman E-2) and infrared CO_2 analyzer (Beckman LB-1). Heart rate was recorded electrocardiographically during both the treadmill and bicycle ergometer test. The submaximal predictive bicycle test for $\dot{V}O_2$ max was performed following the procedure of Astrand and Rhyming (1954). Subjects began pedaling on the bicycle and the workload was set so as to achieve a steady state heart rate between 128 and 170 bpm. The test continued for approximately 6 minutes or until the steady state was achieved.

Subjects were given the standard army physical fitness test at entry and at completion of Basic Training and the times for the 1 mile and 1/2 mile run were recorded.

Results

The following table of the means for the actual and predicted $\dot{V}O_2$ max data and distance run times for male and female personnel before and after basic training.

TABLE 1

		Male		Female	
		Before	After	Before	After
$\dot{V}O_2$ Max	M	50.8	55.1*	38.1	39.5
(ml/kg/min)	SD	6.1	4.4	3.5	4.1
	N	92	85	92	95
Predicted	M	47.3	47.5	41.9	41.2
$\dot{V}O_2$ Max	SD	10.3	7.1	8.8	7.8
(ml/kg/min)					
1/1-1/2 mile	M	7:45	6:46*	4:14	3:57
Run Times	SD	:52	:34	:34	:24
min:sec					

*$p < .05$

An analysis was performed on the mean values and it is clear that $\dot{V}O_2$ max improved significantly as a result of basic training for the male ($p < .05$) but not for female (p=NS) trainees. The Astrand-Rhyming predictive test however, did not reflect this significant improvement in men's cardiorespiratory fitness.

The times for the men's 1 mile run reflected the significant improvement ($p < .05$) in aerobic power but the women's 1/2 mile run time only improved slightly and reflected the small and insignificant improvement (p = NS) in cardiorespiratory fitness seen in the women with training.

The following table is a summary of the results in attitude toward physical activity and physical self concept for male and female subjects before and after training.

TABLE 2

	Male		Female	
	Before	After	Before	After
Attitude toward	31.6	35.0*	31.7	31.4
physical activity	11.7	9.2	10.8	10.6
Physical self-	21.1	23.9**	20.1	19.9
concept	86	101	7.9	8.4

*$p < .05$ **$p = < .01$

Discussion

From the results of this study, it is clear that the cardiorespiratory fitness of males entering the Army can be considered to be very good ($\dot{V}O_2$ max = 50 ml/kg/min) according to the standards set by Astrand, 1970; Cooper, 1969. It is also apparent that the physical training portion of basic training was effective in improving cardiovascular fitness as indicated by a significant increase in the $\dot{V}O_2$ max values (55 ml/kg/min). However, though the females entry level of cardiorespiratory fitness (38 ml/kg/min) is about average for sedentary college age females, there was no significant improvement in this level (39 ml/kg/min) with basic training. The explanation for this finding is probably that the women's basic training does not involve as frequent or as intense a physical training regimen as the men's training involves therefore, little or no improvement in aerobic power. The prediction of $\dot{V}O_2$ max using the Astrand test shows that for low levels of fitness the bike ergometer test slightly over predicted the maximum oxygen consumption. But with high levels of fitness, it underestimates $\dot{V}O_2$ max as shown by the men's data. The findings that the predictive test did not reflect the increase found in $\dot{V}O_2$ max as a result of training is difficult to explain since the main use of this test has been in the documentation of changes in cardiorespiratory fitness with training. It must be concluded, from these data, that the Astrand predictive test may be useful in establishing broad fitness categories but does not appear to be sensitive enough to discriminate changes in cardiorespiratory fitness resulting from training programs. The use of field tests, such as the mile run, as an assessment of cardiorespiratory fitness, besides having high face validity, also seemed to reflect the significant improvement in the men's aerobic power, but as Cooper, 1968 noted, a distance of 1-1/2 or 2 miles would probably be a better test of cardiorespiratory fitness level. The 1/2 mile run times for women showed only a slight improvement but this also reflects the small change in fitness level previously noted.

The fact that men experienced a significant improvement in their physical ability to do work also provides a basis for the improvement in their attitude toward physical exercise and their self concept and confirms what many people have always felt; that basic training provides a growth experience and a challenge for young men. However, the fact that there was no improvement for women in any of the fitness factor or in attitudes toward their physical self suggests that the positive experience of men's training is not present or can not be measured in the women's program. It is evident that further research into the question of the physical capabilities and the potential for training of women is needed so that the Army's basic training program may be modified as well as dispelling antiquated stereotypes about women's physical ability and training potential.

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INTEGRATION OF FEMALES INTO A PREVIOUSLY ALL-MALE INSTITUTION

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Focuses upon the salient aspects of social, peer, physiological, and faculty considerations relevant to the integration of women into a previously all male institution. The data are a compilation of information provided by other educational institutions that have integrated.

All individuals applying for entrance into the United States Air Force Academy must take a series of tests both mental and physical. These tests along with other factors are combined into a composite profile. All cadets entering the Academy must be fully qualified or above a specific cutoff on their composite profile. Candidates must take a College Entrance Exam Board (CEEB) as part of their composite. If our experience is the same as that at Yale University, the men will be slightly higher in the Math and the women slightly higher in verbal skills (See Table 1). Yale University selects from the top 2% of the high school population and the United States Air Force Academy usually attracts the top ten percent. (Arnstein, 1974)

TABLE 1: The Average CEEB Scores on Entry to Yale University for the Classes of 1973 thru 1976 (Arnstein, 74, p. 29)

	Yale		USAFA	
	Math	Verbal	Math	Verbal
Men	700	670	650	560
Women	670	690	-	-

Grade Information: Yale has found that as a group women earn higher grades than men initially. The women earned 5% more A grades than men and 5% less C grades than men with the B grades being equal. The women also earned 50% less F grades than men. However, many of these discrepant grades between women and men began to equal out at the end of 4 years. At the end of 4 years the F grades and B grades were equal while the A grades had decreased to 3% more for women than men. (Arnstein, 74, p. 40)

Attrition: The attrition problem has been a great concern to USAFA in the past. The Director of Admissions, USAFA, is projecting that the attrition will be the same for women as it has been for men. In fact, this is in keeping with the attrition rate experienced at Yale, a low 3.5%. (Arnstein, 74, p. 27)

Curriculum: The USAF Academy is again emphasizing the importance of Engineering and the Physical Sciences in the curriculum. However, the schools that have recently integrated have indicated that women prefer to enroll in Humanity and Social Science courses with very few planning to enroll in an engineering discipline.

Social Aspects: Yale and Princeton Universities set up special committees tasked to study the integration situation and then conduct a follow up survey of the integration situation. The following aspects are based upon their experiences, however, other universities such as Dartmouth and Notre Dame concurred with the opinions given. Social Mix: The ratio of men to women. The ideal social mix is an equal number of men to women. The minimum acceptable social mix to decrease the potential for social problems is a ratio of 3:1 or three males to every female. The areas of concern when the mix is higher than 3:1 are: (Princeton, 1968 and Wasserman, 1970, p. 3)

1. Tendency to treat women different from the way they would be treated if the mix were more even. This may be the result of the women having a small power base as a group.

2. Women tend to be regarded as having a superior intellect. Initially this may be true in terms of verbal skills and the fact that many of the female applicants will have prior college experience.

3. Women may be regarded as inferior to men in most abilities. This attitude is usually prevalent when minorities initially interact in a new situation or group.

4. Women may tend to make more male friends than they normally would. The committees theorized that this was an attempt to gain support from the power base which would be essentially male in a highly unequal social mix.

5. Women need an unusual sense of self order to maintain their self respect. High ego strength is needed. Both of these factors are undoubtedly tied to the power base concept.

6. There was a tendency to socially reject the women. Many co-eds could not get dates even though there were many men without dates for a given occasion.

7. Some women are content with their minority, subordinate role, a situation which would probably remain even with a more favorable social mix of 3:1. This could well be a personality situation but uncharacteristic of a woman willing to be a pioneer in integrating a traditional male institution.

8. Some women will assume the "super women" role. Again a personality characteristic where the women attempt to deal with the power base on its own terms. This could be called an "I'll show you" type of logic.

9. The social mix is important during the initial integration phase but tends to decrease in importance as a function of time. This is the reported experience at the Merchant Marine Academy at Kings Point, New York, and at various integrated military training centers such as Officer Training School (OTS) and AFROTC Summer Training Camps.

The last social aspect concerns co-ed dormitories. Generally speaking, all students (male and female) preferred co-ed dorms. There are several reasons for this, but most of them deal with protection. Initially the women at Yale and Princeton received threatening phone calls, there were a few peeping incidents as well as trashing the stair wells and doorways.

Stress: There is a tendency to show more test anxiety than men. When placed under stress to the point of frustration women tend to become verbally aggressive while men have a greater tendency to become physically aggressive. Generally speaking women exhibit higher overall anxiety than men; however they may have a higher frustration tolerance. Women tend to have a stronger need for affiliation and seek socialization while under stress. Finally, women tend to exhibit immobilizing behavior when confronted with a fearful situation. This increased level of emotional behavior while under stress is probably culturally learned and therefore expected and tolerated. Experience at Officer Training School Air Force ROTC Summer Training Camp, and the Merchant Marine Academy indicate that women tend to cry when placed under stress but will cease this behavior when they learn that this is not socially acceptable behavior. Initially women can be expected to seek more counseling than men but this should equalize when they become accustomed to the situation and stress. (Dinsmore)

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COUNSELING THE WOMAN AIR FORCE ACADEMY CADET: SOME RELEVANT ISSUES

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This paper presents some of the areas of interest to counselors in the Cadet Counseling Center with the coming of women cadets to the Air Force Academy. The paper addresses two major areas that are of concern and that could surface in the counseling environment. Although little data is available to address these areas, preparations made by Center personnel for counseling women are presented here.

The current social emphasis on the changing role of women has created important implications for those who counsel women (McEwen, 1975). An entire issue of The Personnel and Guidance Journal (1972) was devoted to "Women and Counselors," and The Counseling Psychologist (1973) also designated an issue to the subject of "Counseling Women." Recent monographs (Cook & Stone, 1973) as well as an increasing amount of recent research reported in Dissertation Abstracts International (Horner, 1969; Moore, 1972) on the subject of counseling women also highlight concerns in this area.

With the decision that women would attend the United States Air Force Academy in June, 1976, the staff of the Cadet Counseling Center increased its preparation for receiving women clients. Developing anticipated problem areas and potential solutions was not a simple task, however, as research cited in professional literature is meager, especially in the area of career development (McEwen, 1975). Given this fact, the counseling staff sought to supplement the literature with some current information gathered by personal contact. As a result, the senior author visited two co-educational universities, two co-educational colleges, an Air Force Reserve Officer Training Corps (AFROTC) detachment open to women cadets and a clinic that deals in psychological referrals from these agencies. All institutions were located in the Minneapolis-St. Paul, Minnesota area, and the visits took place in February, 1976. Data were collected by means of a personal interview using a pre-planned interview guide and a patterned evaluation technique. Interviews averaged one hour in length, and, in all but one case, involved the director and assistant director from the counseling department of that institution. Thus, with the addition of this data, counseling personnel felt better able to address anticipated problem areas and the Center's preparation to deal with these problem areas.

Problem Areas

Adjustment

Data from AFROTC personnel indicate that few differences between men and women cadets should be expected in terms of separation from family and adaptation to the pressure of cadet life. Major differences can apparently be anticipated, however, in two areas. The first of these is the frequency with which women cadets will require or request counseling time from professional counselors. The Minnesota counselors interviewed were virtually

unanimous in the opinion that women students are more likely to openly discuss their "problems", and are generally more unwilling to suppress their feelings in a "socially acceptable" way. Men students, on the other hand, appear to be less willing to share their problems and more likely to suppress their feelings.

The second adjustment concern centers around the ratio of women to men in the Class of 1980. The Academy environment will certainly continue to be predominantly male, and Davis (1974) found that women were more likely than men to drop out of a predominantly male academic environment. This research is supported by the experience of most of the schools interviewed who agree that they are having a great deal of trouble keeping women students in such predominantly male programs as engineering sciences despite sustained effort to make such studies more appealing to qualified women.

Career Development Counseling

One of the most consistent concerns in career counseling is sex bias. Again, research results are inconsistent, but seem to indicate that counselors exhibit sex bias regardless of the sex of the counselor (Pietrofesa and Schlossberg, 1970; Thomas and Stewart, 1971; Bingham and House, 1973). Schlossberg and Pietrofesa (1973) state that "since people-in-general hold strong beliefs about sex-appropriate behavior, we can assume that counselors also hold these notions." These researchers further document bias for one of the best vocational interest inventories available, the Strong Vocational Interest Blank (SVIB). Obviously, then, sex bias is an issue for both male and female Counseling Center personnel.

A second area of concern in providing career counseling to women is the finding that women show a great deal of instability in career choices for a period of five years following high school (Astin and Myint, 1971). In addition, women entering nontraditional careers may experience role conflict and what Horner (1969) calls M-s, motive to avoid success. Both of these findings could certainly affect women cadets, since most will be entering the Academy directly after high school and all are entering a nontraditional career.

A final area of concern is the question of career role models for women cadets. Interview data from the Minnesota schools show that the members of the faculty can have a definite impact on occupational aspiration levels of women college students. Further, Elliot (1973) found female role models to have significant effect on the career aspirations of freshman women, and Little (1974) found that career modeling by male counselors was more effective than modeling by female counselors in increasing interest in nontraditional occupations for women. Thus, career modeling by both male and female counselors seems critical to the full career development of women cadets.

Preparations

Considering the problems mentioned above, it seems clear that definite actions by the counseling staff are required if women are to be adequately counseled. The five points listed below define the major preparations made to date.

1. Training. McEwen (1975) points out that the counseling of women should be done by nonsexist persons, be they male or female. While the complete elimination of sex bias seems unlikely, exposure to training programs such as those proposed by Schlossberg and Pietrofesa (1973) should help counselors to identify their bias. Training will be applicable to both male and female counselors, and will be completed prior to the entry date for the Class of 1980.

2. Accurate Information. As reported earlier, Bingham and House (1973) found that both male and female counselors had misinformation about career opportunities for women. As career information appears central, the Counseling Center is in the process of acquiring an updated library on all aspects of counseling women.

3. Modeling. Since role and career models of both sexes appear necessary, a woman officer counselor has been added to the counseling staff. With this addition, women cadets should be able to find a variety of both role and career models.

4. Counseling Time. Clearly, counselors must be prepared to schedule increased time for female clients if necessary. Just as important, however, is the necessity for possible referral sources to be aware of the need. Women cadets must be allowed free access to counseling sources, and referral sources must not hesitate to refer as often as necessary. This approach also provides virtually the only approach to the problem of the men-to-women ratio.

5. Career Information. Based on existing research, it appears important that career information encourage women to relate an Air Force career to their total life span and life style in order to reduce role conflict. Recognizing this need, counseling personnel have begun interviewing women officers working in various AFSCs. Video tapes of these interviews are being produced and the resulting TV productions are being made available to all cadets to enhance their career planning. As a result, women cadets should be able to view the Air Force as a viable career encompassing their entire life style.

Conclusion

Despite modifications in the counseling program, the counseling staff does not anticipate any major changes will be required in the areas of counseling technique, counseling facilities or counseling equipment. Most importantly, we will continue to respect the value of the individual, recognize the individual's uniqueness and provide counseling on the most professional, bias-free level possible.

Perhaps our position in regard to counseling women cadets is best reflected in a quote by Ashly Montague (Cook and Stone, 1973): "Every person embodies an adventure of existence, and the art of life consists in the guidance of this adventure, an adventure in which men and women must participate equally. The prime business of a democracy, the great democratic task of men and women, is not the making of things, not even making of money, but the making of human beings...".

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SESSION 3-B

Training

Chairmen: *Mickey Dansby*
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TASK FACTOR BENCHMARK SCALES FOR USE IN DETERMINING TASK TRAINING PRIORITY

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Further development of a methodology using occupational analysis data to determine task training priorities requires the measurement of task factors across specialties against common frames of reference. This requirement is being met by developing task factor benchmark scales. A set of benchmark scales, one for each of three task factors, has been developed for each of three aptitude areas, and a validation test conducted on the first set. This paper reports the procedures adopted and results to date.

The Occupational and Manpower Research Division of the Air Force Human Resources Laboratory (AFHRL) is engaged in ongoing research into an advanced methodology for determining task training priorities. One element of this research is the development of benchmark scales for measuring task factors that contribute to training priority decisions. To put the benchmark scales into context, this paper will comment briefly on the overall training priority research before detailing the methods adopted to develop the scales. Finally, it will discuss results obtained to date.

AFHRL has identified four task factors which appear to be the best determinants of a task's priority for formal training (Mead, 1975). They are:

a. Percentage of first-term airmen performing the task.

b. Probable consequences of inadequate performance of the task.

c. The delay that can be tolerated between the time the need for a task becomes evident and the time when performance must begin.

d. Task difficulty.

The feasibility of using regression equations to compute a training priority index from these task factors, as postulated by Christal (1970), has been confirmed (Mead, 1975); and new CODAP (Comprehensive Occupational Data Analysis Programs) programs (Christal and Weissmuller, 1975) can use these equations to list all the tasks in a specialty ordered from high to low on this index, this listing including the pertinent task factor data beside each task. The tasks near the top of this list are those on which formal training is essential, and those near the bottom are the ones with low priority for training. In between these two extremes are all the "could be trained" tasks listed in order of their priority for universal training.

The major limitation in the methodology at present is the method used for measuring the three secondary task factors. (The primary factor, percent-performing, is an absolute value and presents no problem.) Raters consider each task in turn, and then allocate it a rating relative to all other tasks in their specialty. The problem is that the numerical value so ascribed to a task depends on the nature of the other tasks in the specialty. If the general level of a factor in a specialty is low, the tasks will receive spuriously high ratings. While such ratings can be used to predict training priorities within a specialty, a new regression equation must be computed for each specialty. The possibility exists that, provided the task factors can be measured using common scales, common weights can be computed that apply across a number of specialties.

In order to examine this possibility benchmark scales are are being developed which should permit measurement of the secondary task factors against common frames of reference for various specialties. A benchmark scale comprises 27 tasks drawn from a variety of specialties. They are divided into nine subgroups of three tasks, each subgroup representing one of nine levels on the relevant factor. In operational use, specialist raters will rate each of the tasks in their specialty against the 27 tasks of the benchmark scale rather than against the other tasks of their own specialty. For each task the rater will decide which group of three tasks in the scale has about the same degree of the factor under consideration, the level associated with that group of three being his rating for the task under consideration.

Three sets of scales are being developed. They are the A/G series for the Administrative/General aptitude area, and the E and M series for the Electronics and Mechanical aptitude areas respectively. Each set comprises three scales, one for each of the three secondary factors: Consequences of Inadequate Performance, Task Delay Tolerance and Task Difficulty.

Method

The development of a benchmark scale is a two-phase process. Initially, data is gathered and analyzed for a reasonably large inventory of tasks and this data is then used to select the 27 tasks for the draft benchmark scale. This phase is followed by a validation phase.

The initial inventory comprises task statements selected from the task inventories for a variety of specialties. To aid identification, each task statement includes the AFS (Air Force Specialty) from which it is drawn. For each factor, raters rate each inventory task relative to the other tasks in the inventory. The raters are selected randomly from the first-line supervision level (7-skill level) from specialties within the appropriate aptitude area, different raters being used for each factor.

Each rater's ratings are standardized to a common mean and standard deviation. The mean and standard deviation of these adjusted ratings for a task are taken, respectively, as appropriate measures of the relevant factor for that task, and of rater agreement on that measure. For each factor, the tasks are then ordered on the mean rating, this ordered list being used to select the nine groups of three tasks for the benchmark scale. All three tasks representing one level must lie near each other on this listing, but be relatively distant from the groups chosen to represent the levels on either side. The magnitude of the difference in mean rating between successive groups must be uniform, and preference is given to tasks with the lowest standard deviations--this indicating the best rater agreement. Similarities within groups and differences between groups must be apparent as well as measured.

The results of this initial phase of the developmental process is a list of 27 task statements for each factor. They are presented in sets of three, each set purporting to define by example one of nine graduated levels of that factor. The validation phase tests whether raters can use these definitions of the levels to rate tasks on that factor. As already noted, each task statement in the initial inventory includes the title of an Air Force Specialty that is normally associated with the task. About ten of these specialties are selected, and all the tasks associated with them in the initial inventory are extracted to form the validation phase inventory. This is a list of about a hundred task statements, the number associated with each of the represented specialties varying from as low as four to as high as twenty. For each factor, a set of raters is selected using the same criteria used for selection of raters in the

initial phase. They are asked to give a task factor rating for each task listed in the validation phase inventory, using the nine levels as defined by the nine sets of three task statements in the benchmark scale. These may be thought of as "general" ratings to distinguish them from a second set of ratings also gathered during the validation phase. This second set, the "specialist" ratings, are obtained using the same rating technique as used for the "general" ratings; but the raters are selected only from the specialties associated with task statements included in the validation phase inventory, and these raters rate only the tasks associated with their own specialty. For the tasks in the validation phase inventory there are now three sets of ratings for each factor: the "general" ratings, the "specialist" ratings and, of course, the ratings on the corresponding tasks in the original inventory used in the initial phase. Statistical comparisons between these sets of ratings will permit conclusions to be drawn about the effectiveness of the benchmark scale.

Results and Discussion

All the scales have now been prepared; and the validation phase for the A/G series has been accomplished. The validation phases for the E and M series have yet to be designed and executed.

The initial phase inventories used for the A/G, E and M series contained 438, 392 and 323 tasks respectively, about 50 specialties being represented in each inventory. About 125 raters, selected at random from throughout the corresponding aptitude area, rated each inventory on each factor. As previously noted, different raters were used for each factor. One aspect of concern was whether such a diverse group of raters could give consistent factor ratings on such heterogeneous inventories. This concern has evaporated. For the nine sets of ratings (three factors for each inventory) the inter-rater reliability for the stability of the mean rating (R_{kk}), as measured by the intraclass correlation technique (Lindquist, 1953), ranged from .985 to .992. The corresponding reliability for a sample rater (R_{11}) ranged from .370 to .507. Having obtained such stable mean ratings, they were used for the drafting of the benchmark scales.

As a first step in selecting the 27 tasks for the benchmark scale for each factor, the inventory tasks were divided into nine hierarchical groups on the basis of mean adjusted ratings for the factor under consideration. The difference between the highest and lowest mean rating in each of groups 2-8 was half a standard deviation, with the middle group straddling the mean. Groups 1 and 9 were the lower and upper tails respectively. The set of three tasks representing each level was then selected from the corresponding group, observing the previously prescribed principles. To maximize the differences between adjacent sets while keeping them relatively uniform, the three tasks for level 5 were selected from as near the mean as possible (the middle of group 5), and those for the other levels were selected from the part of the corresponding group that is the farthest from the mean.

The validation phase seeks to answer a series of questions. Can the benchmark scales be used to obtain task factor ratings? How do the benchmark scales compare with the relative scales for efficiency? Do raters using the benchmark scales converge on the same vector as they do using the relative scales? Can specialists use the scales to rate tasks from their own specialty? Do specialist raters converge on the same vector as do general raters? Finally, are such factor measurements comparable across specialties?

For the A/G series, 13 specialties were selected, and the 127 tasks associated with them were extracted from the original inventory to form the validation phase inventory. Two sets of ratings for each factor were obtained using

the benchmark scales to define the nine levels of each factor. An average of 24 raters per factor, selected randomly from the 7-skill level throughout the Administrative and General aptitude areas, rated all 127 tasks; and an average of 13 raters for each factor, selected randomly from each of the thirteen specialties chosen, rated only the tasks from their own specialty. These ratings were not standardized to a common mean and standard deviation.

The first data analysis was the computation of a series of inter-rater reliability coefficients (Lindquist, 1953). For the general raters, the reliability for a single rater (R_{11}) ranged from .535 to .595. This is even better agreement than obtained in the initial phase which used the relative scales, and in that case the ratings were adjusted to a common mean and standard deviation. This alone answers two of the questions posed earlier: the benchmark scales can be used to obtain task factor ratings, and in doing so they are more efficient than the previously used relative scales.

To address the question of whether specialists can use the scales to rate tasks from their own specialty, inter-rater agreement coefficients were computed for each factor for each of the 13 specialties using the specialist ratings. As there were only a few tasks from each specialty with resultant drastic restriction in true variance, consideration of the absolute reliability coefficients would be misleading. To provide a comparison, corresponding reliability coefficients were computed, specialty by specialty, using the general ratings. When these two sets are compared with each other the specialist raters generally indicate better inter-rater agreement. Hence, specialist raters can use the scales to rate tasks from their own specialty.

Correlation between the mean ratings made against the benchmark scales and the mean ratings made on relative scales would indicate whether the two types of ratings converge on the same vector. The general ratings gathered during the validation phase were made against the benchmark scales; and the ratings on the corresponding 127 tasks in the original inventory during the initial phase were made against relative scales. For the three factors, the correlations between these two sets of ratings are .971, .959 and .959 respectively. This is sufficient evidence that the benchmark scales measure the same thing the relative scales measured.

The next step was to determine whether specialist raters converged on the same vectors when they rated tasks from their own specialty against the benchmark scales. To test this hypothesis, the correlations between the general and specialist ratings were computed, one for each factor within each of the 13 specialties. Because of the small number of tasks within each group, the resultant restriction of true variance becomes significant. Pearson's correction formula (Guilford, 1956, pp. 318-322) was applied to each of the 39 coefficients giving estimates of the correlations on the unrestricted range. The average corrected coefficient was .892. While this is lower than the correlation between the original and specialist raters, it is high enough to conclude that the specialists are rating essentially the same factor as the general raters are rating. The lower correlation is probably the result of the specialists using their superior knowledge of the tasks to provide more accurate ratings than the general raters were able to provide.

The final question the validation phase addressed was whether the ratings obtained using the benchmark scales apply across specialties. To test this, the mean ratings provided by the general raters were compared with those from the specialists. In all three cases, the specialists' mean rating was significantly displaced towards the more demanding end of the scale. That is, when a specialist is asked to use the benchmark scales to rate tasks from his own specialty

he tends to inflate his ratings. This would be no problem provided the inflation was uniform across specialties. To test this hypothesis, analyses of covariance were computed using the general ratings as a control variable and testing the significance of the difference in specialist rating between specialties. The result in the case of Consequences of Inadequate Performance was inconclusive, the F statistic being just equal to the 5% significance level value; for Task Difficulty the F statistic was significant at the 1% significance level, indicating that the inflation is probably not uniform across specialties. The F statistic for Task Delay Tolerance was high (5.2), leaving no doubt that the inflation is not uniform across specialties. Further analysis was accomplished in an effort to isolate the nature of the inflation. Generally speaking, the degree of inflation was a function of the average level of the factor for the specialty. The further towards the less demanding half of the scale the mean rating for the specialty lies, the more pronounced the inflation of the ratings for that specialty. Also, for Task Delay Tolerance, the inflation is negligible if a task's value lies in the more demanding half of the scale. This research has therefore produced the three sets of benchmark scales for measuring task factors. While the validation phases for the E and M series are yet to be accomplished, it has been established that the A/G series can be used to measure the factors, and they are more efficient than existing scales. Rater inflation will be further addressed in subsequent research. In this study the specialists rated only a few tasks from their specialty; the inflation may not be as pronounced when they rate all the tasks in their specialty. Furthermore, the predictability of the inflation supports the possibility of compensating for it. When using the factors to determine task training priority, Task Delay Tolerance is expected to be most significant when delay cannot be tolerated, the part of the scale where rater inflation is negligible. Even if the inflation problem cannot be overcome, the scales do make a significant contribution by providing a more efficient means for gathering task factor ratings.

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DEVELOPMENT OF A TASK CATEGORY SYSTEM FOR THE DESIGN OF AIR CREW TRAINING

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One problem facing the designer of a modern instructional program is the lack of criteria for making good decisions about that program. A task category scheme has been developed which acts as an analytic tool in establishing decision criteria for sequencing instruction and designing practice and test media. Putting these criteria into an algorithm should lead to efficient production of instruction.

A major problem in any instructional design model is the lack of decision criteria at the decision points in the model. A designer is told to group and sequence learning objectives, but the how of grouping and sequencing is typically abstract; some learning principles may be furnished and helpful hints may be given, but basically the instructor is left to his own best guess.

In designing a training program for the F-14 aircrew--a pilot and a Navy Flight Officer (NFO)--the Navy Personnel Research and Development Center (NPRDC) and Veda Incorporated have tried to design an analytic tool for (1) managing the 6000 to 8000 tasks in the aircrew task analyses and (2) making correct instructional decisions on how best to train these tasks. This paper is a brief discussion of this tool.

A little background on the general approach to the F-14 aircrew training program seems appropriate. NPRDC has been involved in both instructional design generally (e.g., Rundquist, 1970; Brock and DeLong, 1975) and aircrew training specifically (e.g., Helenihi, Thode, and McLachlan, 1976) for many years. Veda Incorporated has been associated with fighter aircraft design, test and evaluation, and training since the early sixties.

The Navy Air Systems Command has contracted with Veda to deliver task anlayses, learning objectives, and training syllabi for the F-14 aircrew. NPRDC, in the person of the writer, is serving as instructional consultant to the program. Our basic instructional system design (ISD) model is that developed by Rundquist (1970) as modified by the writer (Brock and DeLong, 1975) and his colleagues at NPRDC (Hellenihi, et.al., 1976).

The NPRDC model is enough like other current ISD models that it will not be discussed in detail. Essentially, the ISD process takes the course developer from a set of job tasks through the development of behavioral objectives to the conduct of a job relevant training course.

In reducing down the jobs of the F-14 aircrew into discrete tasks, a continuum of job task behavior was perceived. At one end of this continuum

is a group of tasks which are singular responses to specific system stimuli; at the other end are tasks requiring unique responses to the aircraft's environment. We call the former "Reactive Behavior" and the latter "Decision Behavior." The "Reactive Behavior" end of the scale is very functional and emphasis is on the machine system stimulus. The "Decision Behavior" end of the scale is highly cognitive and emphasis is on the man.

We were not sure, when we started categorizing tasks along this continuum, what the implications for training were but we were sure there were some. Table 1 shows the scale and its seven discreet categories.

TABLE 1. OPERATOR TASK BEHAVIOR CATEGORIES

TYPE	NAME	DESCRIPTION
1	S-R	Specific operator response to a system generated stimulus.
2	Sequenced Chaining	Specific set of operator responses initiated by a system stimulus.
3	Algorithmic Chaining	Set of operator responses initiated by a system's stimuli; each response may act as a stimulus for further responses in the chain
4	Interactive Chaining	Operator ferrets out system and environmental stimuli and makes sets of responses.
5	Multiple Discrimination	Operator discriminates among system and environmental stimuli.
6	Concept & Rule Application	Operator applies concepts and rules to system and environmental stimuli
7	Decision Making	Operator solves unique problems in the system and environment

Those of you who are familiar with the work of Gagne (1970) will see his obvious influence on the categories. However, it must be emphasized that these operator behavior categories are not analagous to Gagne's or anyone else's learning types. We are here describing behavior; the type of learning required to learn the behavior follows from the categoriaztion, but there is not a one to one relationship.

We use the categories twice in the instructional design process. First, it serves as an aid to sequencing instruction. The behavioral categories of the job tasks do lead to a designation of learning type in the learning objective. We chose as our learning type model that of Markle and Tiemann (1973); it meets our needs in this particular instructional design program. However, both Gagne (1970) and Merrill (1971) have similar learning type models; Table 2 shows the relationship of the behavioral scale to these three learning type models.

TABLE 2. TASK BEHAVIORAL CATEGORY RELATIONSHIP TO THREE LEARNING TYPE MODELS

If task behavioral category is:	Then the learning type will be:		
	Gagne (1970)	Merrill (1971)	Markle & Tiemann (1973)
1. S-R	S-R	S-R	Responses
2. Sequenced Chaining	Chaining or Verbal Assoc.	Chaining or Serial Memory	Chains or Sequences (Serial Memory)
3. Algorithmic Chaining	same as 2	same as 2 or Analysis (?)	Chains or Sequences (Algorithms)
4. Interactive Chaining	same as 2	Analysis	Kinesthetic Reperatories or Verbal Repertories
5. Multiple Discriminations	Multiple Discriminations	Discrete Memory	Associations (Mulitple Discriminations)
6. Concept & Rule Application	Concept Learning or Rule Learning	Classification or Analysis	Concepts or Principles (Rule Applying)
7. Decision Making	Problem Solving	Problem Solving	Strategies

Markle and Tiemann (1973), like Gagne (1970) and Merrill (1971) before them, propose a hierarchy of learning types which prescribe an order to kinds of learning (e.g., in the cognitive domain, concepts must be learned before principles, principles before strategies). We work from the concrete task category to the abstract learning type to assign a sequence of instruction. An algorithm has been designed for this purpose.

The second use we make of the task category scheme is in the assignment of practice and test characteristics. It has been our experience that a high fidelity simulator is not necessarily the best place--or even the adequate place--to practice or measure some kinds of tasks. In our category system, categories six and seven would appear to be best practiced and tested in a classroom or learning carrell where only relevant cues need to be attended to. Solving an intercept geometry problem is a highly cognitive skill which requires much practice; to have to develop finesse at this skill while flying a simulator (with all its attendant problems) is simply unreasonable. This type of classroom cognitive practice and test process has previously been successful with surface Navy officers (McCutcheon and Brock, 1971; Brock, 1972).

The tasks which are in categories four and five are those tasks which do require the high fidelity simulation of a Weapon System Trainer (WST) for task practice and test. Examples of these tasks are flight manevuers for the pilot and complex search procedures for the NFO.

Categories one, two, and three will be best practiced in dynamic part task trainers which only need to simulate key subsystems cues and responses. These part task trainers are currently only a gleam in our eyes.

This instructional design effort is just entering the syllabus definition phase. Early use of our category scheme has proven effective. We have constructed algorithms based on the task category system and the Markle and Tiemann (1973) learning types which are making the sequencing of instruction and designing of practice and test media straightforward and consistent. It is our plan at some future time to present these algorithms and the entire results of this instructional design program for review and criticism.

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INSTRUCTIONAL SYSTEM DEVELOPMENT - A VIABLE DECISION-MAKING PROCESS AT THE COLLEGE LEVEL

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Instructional System Development is examined as a decision-making process, with modified substeps, for application when the goals of instruction emphasize cognitive rather than psychomotor skills.

INTRODUCTION - Instructional System Development (ISD) is a systematic procedure for planning and developing instructional programs which ensure that personnel are taught the knowledge, skills, and attitudes essential for successful job performance. Because the application of ISD has consistently produced gains in the efficiency of instruction, Air Force policy directs the use of ISD in the accomplishment of Air Force education and training programs. (AFM 50-2)

The majority of instructional programs that have been developed using ISD have objectives that deal primarily with psychomotor skills such as operating and maintaining equipment or carrying out manipulative tasks. For these tasks it is relatively easy to utilize the ISD process, because job requirements are readily identifiable and successful job performance can be objectively measured. For the kind of learning that normally takes place at the college level, however, the situation is more complex. Goals of instruction are often very general, and may relate to a number of divergent performance situations. In addition, without a clear indication of what the "job tasks" are, it becomes very difficult to specify what constitutes successful or adequate performance. Nevertheless, the overall principles of ISD are as applicable to these areas in which cognitive skills are emphasized, as they are to tasks which require psychomotor responses. Each step of the ISD process is reviewed below, and suggestions are made for utilizing the steps to develop instructional programs at the college level.

ANALYZE SYSTEM REQUIREMENTS - The first step in ISD is to analyze system requirements. At the collegel level, there is no immediate operational system. A long range goal may be "a competent 2nd Lt who will be a career officer". A short range goal may be to "be qualified to take a subsequent, higher level course." To provide useful direction for the developmen' of an instructional system, further analysis is necessary.

Procedures have been developed to turn fuzzy, abstract goals into statements of observable performances. If the general instructional goal concerns preparation for more advanced coursework, it becomes necessary to analyze the advanced courses as well, to determine prerequisite knowledge requirements. By repeatedly asking "What must a student be able to do before he can do this," a list is compiled of enabling behaviors, which become the equivalent of job performance requirements. If attitudes play a significant role in determining whether or not a particular instructional outcome is achieved, the

basic process requires an identification of approach and avoidance behaviors, from which you are willing to make judgements about the learner's pattern of responding. (Mager, 1972; Lee and Merrill, 1972). A list of observable approach or avoidance behaviors can become the equivalent of discrete job performance requirements.

DEFINE EDUCATIONAL REQUIREMENTS - The next step of ISD is to define educational requirements. First, it must be decided whether adequate task performance requires instruction. Does adequate performance require that certain learning has taken place, or that the consequences of performance are perceived as rewarding? Second, an assessment must be made of the knowledge and performance capability of the target population. If the goals of instruction are already reflected in the repertoire of the learners, then no instruction will be required. The result of step two should be a specification of the actual educational requirements.

DEVELOP OBJECTIVES AND TESTS - In step three, a radical departure is made from conventional curriculum development procedures. Before a text is selected, before lecture notes are prepared, before the length of the course is determined, the final exam is prepared. If it is possible to determine what a student ought to know and feel as a result of the course, it should be possible to state how that will be determined, regardless of the means used to achieve the objective.

Objectives and tests are prepared concurrently, with an assessment instrument being developed for each objective. Although the format for objectives is not rigorous, the more observable, specific, overt, and concrete the objectives are, the more readily achievement can be determined. Whereas the criteria for successful performance of a psychomotor objective may suggest materials, time, and a standard of performance stated as a percentage of a number of trials, objectives in the cognitive domain should specify the critical psychological conditions for performance. For example, the number of problems to be solved may not be as relevant as the constraint that all of the problems be previously unencountered instances. Guidelines for the preparation of such objectives are available. (Merrill and Boutwell, 1974). Test items and instruments should be criterion-referenced. They should allow a fairly objective, reliable judgement about the learner's knowledge in relation to the course objectives rather than in relation to the knowledge of his peers. In most cases, test instruments prepared according to these guidelines will have increased face validity. Students know ahead of time what is expected of them, and the relationship of the test to the overall goals of instruction is apparent.

PLAN, DEVELOP, AND VALIDATE INSTRUCTION - In the fourth step of ISD, many of the conventional curriculum development activities occur. ISD incorporates the state-of-the-art in instructional technology, and directs an empirical approach to course development. Different instructional strategies have evolved which have a demonstrated appropriateness for each level of behavior in the cognitive domain. (See AFP 50-58, Volume IV;

Gagne and Briggs, 1974). Decisions about instructional activities should be made according to the kind and level of behavior required by the objective, not to the structure of organized knowledge in a discipline. A learning hierarchy (See Okey, 1973; Merrill and Boutwell, 1973) will suggest the appropriateness of instructional activities.

The question of information packaging is addressed next. Whether a film or lecture or demonstration or workbook is utilized for information transmission is not as critical as was once thought. What is important is the set of psychological conditions in the learner that are generalizable and definable across learning contexts. The conditions for various levels of cognitive performance are detailed elsewhere (See Gagne, 1970), and may be realized in many formats. A common fear among Professional educators is that an instructional system developed through the application of ISD will be mechanistic. However, by reducing the role of the instructor, where appropriate, as the prime presenter of information, the instructor is freed to humanize the learning situation, motivating, counseling, and relating his feelings and himself to his students.

When course materials are prepared and a basic course management system has been determined, the course can be validated. Conventionally, validation consists of two steps: an instructor reviews his course and a higher level department staff reviews it. With ISD, validation occurs as course materials are actually used with representatives from the target population. Changes are made freely, because the goal is not to "Present material" but to enable students to achieve specific objectives. Ideally, the validation steps occur before the course is implemented; but because of the semester structure prevalent in most colleges, and the possible non-availability of students from the target population, it may be necessary to validate the course during the first semester it is implemented. The administrative atmosphere must clearly allow and encourage necessary modifications to the course as needed during its implementation.

CONDUCT AND EVALUATE INSTRUCTION - Finally, in step five, the course is implemented and the system is evaluated internally and externally. The critical question is, does the instructional system meet the need which originally initiated the ISD process? Although many college courses solicit information at the conclusion of a course relating to its "effectiveness," this is often operationalized only in terms of whether or not the course was liked, instructional activities were enjoyable, etc. The primary focus of internal evaluation should be, can the students achieve the objectives?

External evaluation examines the validity of course objectives. Conducted on a continuing basis, external evaluation at the college level determines whether the training provided is adequate to enable a student to successfully begin higher level courses, and whether it contributes to overall improved functioning in the academic environment.

It is typical for a course developed through the application of ISD to undergo a number of thorough iterations of the process during the useful lifetime of the course.

EXPECTED BENEFITS - A number of benefits can be expected, in addition to maximizing instructional effectiveness, when a college level course is developed through ISD. First, there is usually an increased face validity for all instructional activities and content. Second, there is an improved defensibility of course instructional activities and content, for both students and administrative staff. Third, an empirical base is established for making decisions about: courses which should be offered; course content; course instructional activities; content correlation among courses; changes in existing courses; media software and hardware utilization; and, within the context of an academic department, overall departmental goals and effectiveness. Fourth, a change seems to occur in the whole way of thinking about education, its means and ends, when an instructional staff begin utilizing ISD as a decision-making process. ISD is not a panacea. But where it has been conscientiously applied, the educational process has been improved. It can work at the college level.

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INSTRUCTIONAL SYSTEM DEVELOPMENT: IMPLICATIONS FOR FURTHER RESEARCH

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The results and research implications of a year-long study of Instructional System Development are described. A comprehensive program for advancing course design technology is presented which encompasses: (1) assessment of the state of the art, (2) dissemination of information, (3) applied research, and (4) management support.

Historically, military training programs have been developed by subject matter experts. However, a quantum advance in weapons systems complexity occurred during World War II and brought with it the need for more sophisticated training technology. Instructional technology experts who were brought in to fill these needs often developed, in the tradition of systems analysis, descriptions or "models" of techniques they found useful in solving training problems. In the early 1960's the hypothesis was generated that, if the experts could describe what they do, then those activities could be carried out by laymen to produce the same results at a lesser cost. The process by which a person or group of persons unskilled in instructional technology uses a procedure described in a manual to develop training programs has been referred to by a variety of names, the most recent being ISD. Support for the conclusions outlined here is detailed in Montemerlo (1975a) and Montemerlo and Tennyson (1976). The latter also describes the historical development of ISD.

Over one hundred ISD manuals were published between 1960 and 1975. They grew from slender pamphlets to multi-volume sets over five inches thick. The manuals differ in: terminology, steps included, methods for accomplishing each step, format for reporting each step, and degree of detail with which each step is described. They do not: place limitations on their applicability, indicate the degree to which they have been validated, offer alternative means of accomplishing each step, or state the skills their users must possess.

The literature on theories of instruction and of learning were surveyed to determine if any theoretical or empirical basis existed for the hypotnesis that the design of all training programs could be reduced to a single procedure so automated that it could be applied by a layman. The literature unanimously supported the conclusion that no such basis exists or can be expected in the foreseeable future. A search for validations of ISD manuals indicated that only one validation was ever attempted. That study which yielded negative results, provides the only available systematic empirical data on the specific problems inherent in the use of a course design manual by personnel untrained and inexperienced in training technology. Three analytic reviews of the ISD concept by educational scientists were found. The first stated that the related literature was "long on persuasion but short on critical appraisal"; the second indicated that the concept

had acquired a mystique which it could not live up to; the third concluded that it is a fad.

At the Air Force ISD Conference (The Pentagon, 3-5 Feb 1976), Mr. Bert Cream of AFHRL stated that ISD is based on six unsupportable assumptions: (1) any task can be reduced to a series of stimuli and responses, (2) the resulting task break-down is the best way to teach the task, (3) Personnel who can do a task best can design the best training program, (4) a whole task is nothing more than the sum of its parts, (5) Defining "successful performance" of the task is straightforward, and (6) complexity always yields to successful analysis. To Mr. Cream's list, four more unsupportable assumptions may be added: (7) Training program design is a non-political process, (8) The process requires no creativity, (9) There is one best way to teach any given task and (10) One method of analysis exists which is best for designing all training programs.

The frequent occurrence of the following problems during a decade of military ISD experience supports the above-stated conclusions: (1) Many situations are not covered by the manuals, (2) After doing a media selection, the ISD team finds that the money necessary to implement the results is not available, (3) The course manager or the instructors will not accept the results of an ISD, (4) Conclusions based on ISD are not implementable because they differ from published procedures which take a long time to change, (5) Training objectives are derived from school manuals rather than from operational needs, (6) Agreement cannot be found on specific behavioral objectives, (7) ISD proliferates more paperwork than progress, (8) ISD is done on only one segment of a multi-segment course, (9) Techniques such as proficiency advancement are implemented in one course but the other courses it feeds into are geared to the old way.

In addition to problems of honest but unskilled course design, ISD engenders problems of deliberate misuse. The emphasis on terminology and method rather than on results renders ISD highly susceptible to manipulation. ISD paperwork can easily be employed to cover up the use of traditional course design methods to indicate a greater degree of scientific precision and objectivity than exists, and to justify arbitrary procurements of simulators and other training aids.

The apparent incongruity of the high degree of current ISD activity in spite of the problems described above was resolved by Dr. John P. Campbell. He found that all educational innovations, including ISD, have followed a characteristic three stage life cycle. First a new technique appears and develops a large following of advocates who claim to have successfully applied the technique. Second, numerous modifications of the technique appear. As the number of people with vested interests in the technique grows, it evolves into a political entity, and resistance to critical examination of the technique increases. This causes the technique to attain a reputation beyond that which it actually merits. In the third stage, a backlash occurs as the number of people increases who have attempted to use the

technique and realize that it cannot live up to its reputation. The growing literature on the problems of ISD and the increasing concern, such as that expressed at the recent Air Force ISD Conference, indicates the backlash has begun.

A four step process is recommended for overcoming the problems of ISD and improving course design technology:

(1) Prepare an adequate basis for a research and development program. The "quick-fix" approach has yielded over 100 unvalidated manuals suffering from the problems described above. Tendencies to replace old buzzwords with new ones, to gold-plate inadequate methods, to reinvent the wheel and to preach to the choir must be suppressed if real progress is to be made. Our study has attempted to assure that these pitfalls are avoided, that maximum use is made of available technology, and that past mistakes are not repeated, by: (a) identifying as many of the problems of ISD and their causes as possible, and (b) developing a comprehensive bibliography (Montemerlo and Tennyson, 1976) on all aspects of training program development. The bibliography is designed to serve as the basis for generating an encyclopedia of information on each aspect of course design. This will allow order to be made of existing knowledge, will present all major concepts in one place in terms comprehensible to potential users, and will identify gaps in existing instructional technology.

(2) Disseminate this information widely and promptly in order to: (a) demystify ISD, (b) reduce the anxieties of ISDers and (c) promote a better understanding of course design, e.g., that there is no secret formula, and that variability is the rule, not the exception.

(3) Adopt four management policies: (a) Insure that all instructional design tools are fully validated for the conditions under which they will be used, (b) Estimate the support requirements of future course design techniques before requiring implementation, (c) Insure that further efforts in training technology are free from the political problems which can cause a technique to grow in popularity while stagnating technologically, and (d) Whenever a technique is implemented, modify all of the components of the military system on which the technique will impinge to account for it.

(4) Design and carry out an R&D program to improve course design technology making maximum use of existing knowledge and avoiding the problems of ISD. Since the research will benefit all of the military services, a coordinated comprehensive interservice program is warranted. The necessary work falls into four categories.

(a) Plan and carry out research to fill the gaps in instructional technology identified in Step 1. Once the gaps are identified, estimate the feasibility and cost of filling each, and set realistic R&D objectives and time tables. Centralized direction and a master plan will minimize the inefficiencies of past ISD research.

(b) Develop guidelines for determining which courses will benefit most from which type of analysis, and who should do it. Some courses are so lean or inexpensive that the cost of ISDing them cannot be recovered. Further development of tools for assessing the costs and payoffs of various methods of course design are needed. The circumstances which warrant the training and use of in-house personnel and those which warrant contractual efforts must be determined.

(c) Design a course for training course designers based on research findings. The process of course design needs improved task analysis. Specific behavioral objectives are needed to define the skills necessary for certification as a competent training program developer. A four phase, individualized, proficiency-based, performance oriented, course is recommended. (1) Learn the basics of instructional technology. (2) Use that knowledge to design fictitious courses in a classroom environment. (3) Apply these skills in the real world as an apprentice to a qualified course designer. (4) Manage course design projects and train an apprentice.

(d) Determine the degree to which course design can be standardized. Supplement the analytic results of Step 1 by examining the differences in methodology of expert course developers independently designing the same course.

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NEW HORIZONS IN JOB ANALYSIS: THE ESTABLISHMENT OF HIERARCHIES OF ELECTRONIC KNOWLEDGE FOR AIR FORCE TECHNICAL SPECIALTIES

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There is no systematic method for determining the electronic knowledge required by personnel in technical electronic occupational groups. Such information is crucial in designing technical training. The Electronic Principles Job Inventory (EPI) was developed to collect such data. The EPI consists of 1266 items divided into 62 electronic subject areas. Based on the survey of an Air Force electronic occupational group it is shown that the EPI collects data which can be sorted according to importance for training.

The military services spend a sizeable amount of their budget on training. During times when the services are facing budget and force cuts with no reductions in the defense mission, training becomes even more important than during times of less austere funding. One of the first areas management continually reviews with an eye toward reductions is the amount of money spent on training. Also, since the services have been told to do more with less, training is expected to produce more qualified personnel who are able to perform increasingly complex jobs. Of course the training should be conducted in less time and at less expense.

These kinds of pressures have caused professional trainers to seek new methods and more information in order to develop cost effective training. Almost anyone who has dealt with training in the Air Force is familiar with Instructional Systems Development (ISD), a formalized five-step process used to develop training. Certain portions of the model will be addressed in this paper.

One of the important aspects of the ISD model is that it requires training personnel to determine what the specialists do on the job before developing a course to train individuals to perform that job. This requirement may not sound revolutionary, but it is! It demands that training personnel analyze job performance data as well as technical orders and equipment maintenance data before determining the content of a course.

In the Air Force, the Occupational Survey Program (Christal, Note 1; Driskill, Note 2) has been the primary source for providing job performance data to training personnel. Such data are presented in task statements which are quantified along such dimensions as percent members performing, percent time spent, task difficulty, probable consequences of inadequate

task performance, and task delay tolerance. While the occupational survey data are powerful as tools for designing training content, task statement information can only directly be related to performance training. A great deal of work is necessary to translate tasks into knowledge required to perform the task. This has been a particularly troublesome problem in electronic training in the Air Force.

The Air Force employs more than 63,000 airmen in the various technical electronic specialties. All of these airmen have completed extensive training in electronics at the beginning of their Air Force electronics career. Estimates are that the current cost of this training to the Air Force is about a half million dollars per day. Obviously, it is important for training personnel to discover exactly which electronic knowledges are used as well as to define task performance of electronics specialists.

The goal of the study described below is to provide information to training personnel regarding electronic knowledge used by airmen in a format similar to the one used for providing task performance information.

Method

Overall Strategy. The overall strategy employed was to develop a comprehensive inventory of all "knowledge" included in the five electronics principles courses taught by the Air Force. Since common subject matter and course materials are used in large portions of four of the courses, the problem was the developing of an inventory based on a common core and then adding course specific material.

The instrument was developed in three separate phases:

Phase I. During phase I, a careful review of earlier research relating to electronics training was performed. After determining that the proposed approach was, indeed, innovative the development of the Electronics Principles Job Inventory (EPI) was initiated.

Psychologists with technical backgrounds relating to physics and electronics who were well versed in job and task analysis developed the preliminary edition of the EPI. This first edition of the inventory contained 574 items and represented approximately 40 percent of the electronic principles course subject matter. The sole documentation for development of the preliminary EPI was written material used by students while taking the course. All inventory items were written with a yes-no response format. Items were grouped into sections paralleling the course outline. The basic format of items was, "Do you perform...?" or "Do you use or refer to...?". Instructions were provided to track respondents past subject matter areas that were not relevant to them.

An initial field test of the preliminary EPI (O'Connor, Ruck, and Hickerson, Note 3) involving five electronic specialties of differing complexity and 200 airmen at seven operating locations indicated that the instrument had both convergent and discriminant validity. Based on this data, full development of the EPI was undertaken.

Phase II. Ten specialists in electronics training with considerable experience in both real world electronics and academic electronics spent three weeks with the psychologists who developed the preliminary EPI to review, revise, and add to the instrument. The final EPI contained 1266 items divided among 62 subject areas covering all electronics classified as principles which are taught by the Air Force.

Before publication, the final EPI was field tested again.

Phase III. The EPI was administered to all personnel in the Space Systems Command and Control Equipment Operator/Maintainer occupational area. Personnel (N=72) at three locations completed the EPI under the supervision of psychologists involved in the EPI study. One-hundred two EPI booklets were administered by mail. The data presented in this paper are based on the sample of 174.

Results

The computer programs used to analyze the data were designed by Dr. Raymond E. Christal, Air Force Human Resources Laboratory. The programs are contained in the Comprehensive Occupational Data Analysis Programs package (CODAP).

A hierarchical grouping procedure based on knowledge item responses was performed to determine if personnel holding similar jobs would group according to knowledge used on the job. Not only did personnel in similar positions group together according to knowledge used on the job; but in addition, eleven homogeneous job groups identified based on knowledge used matched very closely the job groups identified based on tasks performed (Keeth, Note 4). Individuals completing the EPI under supervision grouped with individuals completing the booklets collected by mail administration. No distinction between the groups was evidenced in the knowledge item response patterns; the mailed and in-person administered data were pooled for subsequent analyses.

The criteria for organizing the responses to the 1266 items was percent members answering yes. Following the cutoff scores used in Air Training Command for task analysis, items with greater than 50 percent yes responses were judged as being very good items for inclusion in technical training. Items with between 30 and 49 percent yes responses were judged as deserving consideration for possible inclusion in technical training, and items with less than 30 percent yes responses were judged as best suited for on-the-job training.

Subject areas were grouped using the above criteria. That is, if a subject area contained items reaching more than one of the cutoffs, the subject area was placed into the higher or highest category. The groups of subject areas were then ordered by the percent of items within the subject area fitting in the category. For example, the 27 subject areas which according to this system require training for the Air Force specialty in question include: Alternating Current, Oscilloscopes,

Soldering, Transistors, and so on. Medium priority subject areas for technical training (N=18) include: Numbering Systems, Waveshaping Circuits, Antennas, Programming, etc.. Finally, low priority areas include: Infrared, Lasers, Electron Tubes, AM Systems, and so on.

Within each of the subject areas, items can be ordered using percent members performing as a criterion. For the subject area of series and Parallel Resonance, items had a response range from 21 percent to three percent. For example, the following items were responded to by a percentage of job incumbents reflected in the parentheses. Work with, use, or refer to series or parallel resonant circuits or time constants (21 percent), Use or refer to the general rule that a capacitor is fully charged after five time constants (12 percent), and Use or refer to Universal Time Constant Charts (three percent).

Discussion

For any population which uses electronic principles on the job, the EPI is an instrument which may be used to measure the specific "knowledges" used by that population. Furthermore, EPI data may be used, together with computerized hierarchical grouping procedures to identify distinct job groups based on knowledge used on the job. Most important, EPI data can be used to make training decisions concerning emphasis required for subject areas as well as pinpointing specific relevant knowledges within the areas.

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DEVELOPMENT OF AN ADVANCED SIMULATOR FOR TRAINING INTERMEDIATE LEVEL MAINTENANCE TECHNICIANS

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This paper describes the development of a performance specification for an advanced maintenance simulator to be used to train operation and maintenance of the 6883 Converter/Flight Controls Test Station for the F-111 aircraft. The maintenance simulator will be used in Air Force resident training to train technicians to perform a wide variety of intermediate level (I-level) maintenance tasks. The performance specification is the first phase of an effort to develop a prototype simulator. An improved technique for gathering task analytic data for making functional fidelity decisions is also discussed. The basic design approach reported herein centers around a cost effective simulator that will realistically resemble the actual hardware and exhibit psychologically similar outputs but will not require the complex internal circuitry.

The search for new and better ways to conduct maintenance training has generated considerable interest within the military over the past few years. Only recently have advances in computer and simulation technology made it possible to simulate relatively complex maintenance tasks cost-effectively.

Current Training Practices

Maintenance technicians, especially for avionics specialties, are normally trained in resident school by first attending classes in electronics fundamentals and then progressing to "set school" where they are trained on equipment that corresponds to the type of gear they may see in the field. The most common equipment used for training is referred to as a maintenance training unit (MTU), which is most frequently a bench mounted collection of operational equipment from the aircraft system being studied; or it may be actual unmodified equipment. While this approach has proved to be somewhat fruitful with respect to realism and instructor acceptance, there are many inherent disadvantages that argue against their use in a training environment.

Disadvantages of MTUs

The primary disadvantage of MTUs is that of cost. In avionics, for example, typical weapon systems trainers are priced from $500K to well over $1.5M - and the costs for new trainers certainly are not decreasing! Another significant drawback of MTUs is their unreliability in the training environment. It is not uncommon to find avionics trainers that require one to

three hours of maintenance for every hour of operation. As a result, availability rates are often very low and instructors are reluctant to let students perform certain "hands-on" tasks for fear of damaging sensitive equipment. Another important disadvantage is the inability to easily insert malfunctions in MTUs to teach troubleshooting procedures. Knowledge of troubleshooting is, perhaps, the most important tool required of a good maintenance technician. Because of these and other problems associated with the MTU approach, the Air Training Command (ATC) identified a critical research requirement to identify the potential of simulation as an alternative to actual equipment for training.

Research Efforts

Several years ago, AFHRL/TT investigated the applicability and effectiveness of simulation for teaching organizational level maintenance tasks (basically flightline remove and replace actions). The results of these efforts are reported in AFHRL-TRs-74-65, 74-92, 75-13 and 75-14. In general, results of the above investigations indicated that certain procedural and troubleshooting tasks in avionics could be simulated with a relatively low level of fidelity without degrading training effectiveness. In addition, the simulation model that was evaluated, operated with dramatically higher reliability, and at a fraction of the cost of operational equipment. As a result of these investigations, ATC requested that AFHRL/TT develop a cost-effective simulator for training more difficult, hands-on tasks for intermediate level training applications.

Approach

The equipment chosen for development of a candidate simulator was the 6883 Converter/Flight Controls test station, that is used to test line replaceable units (referred to as LRUs or black boxes) against predeterminded tolerance limits for the F-111D aircraft. This particular test station was chosen for its representativeness of a class of test stations and maintenance activities that are taught in I-level technical training. Since the tasks required to operate and maintain the 6883 test station are largely procedural and the system outputs are largely discrete, the 6883 test station appeared to be a logical candidate to demonstrate that cost-effective simulation may be practical for training I-level technicians. As such, simulators do not possess many of the disadvantages of MTUs used as trainers, since simulators are (a) normally less expensive, (b) more reliable, (c) have a larger capability for simulating malfunctions, (d) are practically noiseless and (e) are safe for practicing dangerous and/or expensive procedures. Two courses taught at Lowry Technical Training Center (LTTC) that use the 6883 test station were chosen for the candidate simulator: Avionics Aerospace Ground Equipment Specialist (326X0) and Integrated Avionics Component Specialist (326X1A). In order to make the simulation design requirements relevant to actual 3261A and 326X0 job tasks, the performance requirements were specified before hardware requirements. To accomplish this, a task analytic technique was used to obtain task statements that are appropriate for use in making functional fidelity design decisions. Major tasks were then abstracted from the comprehensive task analysis and rank

ordered using the order of merit method on the following criteria: difficulty, frequency, importance, and proficiency level. The data collected at Lowry was subsequently verified by knowledgeable shop supervisors and technicians at Cannon AFB, NM (the main operating base) In addition, relevant malfunctions were compiled at Lowry and at Cannon using actual Form 95 write-ups (maintenance activity records) to insure job relevancy. A weighted hierarchical ordering of the final task date was then used as a guideline for making decisions about desirable fidelity of the proposed simulator. Those tasks having the highest indices of criticality, difficulty, and the frequency were given proportionate consideration as to the level of fidelity required to perform the subject tasks. All decisions about fidelity levels were made by a group of ATC subject matter experts/instructors, and AFSC engineers and psychologists. The basic design approach for the simulator centered around the development of a device that would appear very much like the real equipment and exhibit psychologically similar outputs, but would not require the complex internal circuitry of the real equipment. Therefore, all system outputs will appear the same to the student as the operational equipment, but are produced digitally in the simulator by a minicomputer. In addition, relevant student inputs are sensed by the simulation computer, such that the student is able to perform various simulated maintenance actions and receive appropriate results, as well as feedback and knowledge of results. Cost benefit is achieved by only duplicating those aspects of the job environment that are determined to be consequential to transfer to an operational job environment.

Results

A list of 25 tasks was identified as representing the major functions of the 6883 test station operator and 35 tasks were identified for the test station repairman. The functional specification reported in AFHRL-TR-75-70, requires that the proposed training device be capable of simulating each of the identified tasks as well as simulation of over 60 faults. The configuration of the specified device includes a student station, instructor station, and the simulation mainframe. Both student and instructor stations include an interactive terminal and can easily be modified, if required. The basic simulator architecture requires that a building block concept be used such that satellite stations may be added to the basic device. In addition,the simulator will be reprogrammable and maintainable at local levels. The accompanying instructional program will emphasize knowledge of results, feedback, flexible sequencing of materials, instructor feedback, response recording, extensive self-pacing capabilities, and other sound techniques that promote efficient learning and transfer of training. Cost-effective state-of-the-art techniques and hardware will be used to insure that the most realistic representations necessary to promote positive transfer of training are used.

Conclusions

The procedure used to rank order tests on the three criteria of interest proved to be a very easy and effective method of acquiring a distributed rating of tasks for the purpose of making functional fidelity decisions. The rationale for using the ranking method for assigning ratings permitted a greater range on

the dimensions of criticality, difficulty, and frequency. It is possible to use this range to establish cut-off points for tasks that may be impractical to simulate in a device owing to trade-offs between cost and ranking. Furthermore, a task ranking can be used by contractors and procurement agencies as an aid in making fidelity and cost decisions. Obviously, those tasks with the highest rankings are given a proportionate consideration as to the level of fidelity and cost that will be assigned to simulate those tasks.

Recommendations

The tasks that were chosen for simulation are all capable of being simulated inexpensively with current state-of-the-art technology. In addition, in-class troubleshooting training, using the simulator, can be greatly expanded owing to the large malfunction insertion capability of the simulator. It is recommended that the next phase of this effort, engineering design, be accomplished under contract followed by the actual fabrication of the specified simulator. Following that, a thorough evaluation of the training/cost effectiveness of the simulator should be conducted after on-site acceptance is completed.

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LOW COST TRAINING USING INTERACTIVE COMPUTER GRAPHICS

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Three studies investigating the use of interactive computer graphic simulations of operational equipment presented on a computer-based (CB) training system were reported. The performance of students who learned oscilloscope, multimeter, or S-3A copilot panel operations using CB simulation and instruction was found to be equal to or better than the performance of students who had learned the same skills from workbook study and hands-on practice with actual equipment. CB simulation appears to offer numerous cost and training benefits.

Numerous researchers, e.g., Caro (1973), have investigated an approach to the design of training devices and programs which offers cost and training benefits. They have suggested that the importance of a training device resides in the manner in which it is used, rather than the degree of its similarity to actual equipment. A training device is properly used if it allows the student to practice behaviors that will be crucial to performance in the operational situation (Analysis of the Transfer of Training, Substitution and Fidelity of Simulation of Training Equipment, 1972).

This paper is specifically concerned with the feasibility of using computer-based (CB) interactive graphic simulations as a training methodology which can provide practice of certain kinds of performance-oriented skills as they would be performed on the job. Currently, only a few studies have attempted to empirically evaluate or document training using interactive graphic simulations as a stand-in for operational equipment. Rigney, Towne, and King (1974), for example, have developed but not tested computer programs which simulate front panel topography and internal functional characteristics of a transceiver to teach troubleshooting.

The present paper reports on three experimental investigations into training with interactive computer graphic simulations. The studies simulated operations and appearances of the USM-140 oscilloscope (Stern, 1975), the Simpson model 260-1 multimeter (Lahey, Crawford, & Hurlock, 1975), and the S-3A Integrated Control System (INCOS) copilot panel (Crawford & Hurlock, 1976). These efforts were jointly sponsored by the Defense Advanced Research Projects Agency.

Method

Subjects

Subjects were trainees from a Sonar "A" School, a Basic Electricity/Electronics (BE/E) School, and the Fleet Aviation Specialized Operational Training Group Pacific Fleet, who participated in the oscilloscope, multimeter, and S-3A INCOS studies, respectively.

Training Materials

Computer-based training (CBT) materials for experimental students were presented at student terminals of the PLATO IV instructional system. Each terminal has a 21.6 cm square plasma panel and a keyboard and touch panel for response input. The touch panel registers input when a student, by pointing at a spot on the display screen, interrupts light rays emitting from the X-Y axes of the display screen.

Training materials for experimental students consisted of computer graphic simulations of front panel topography and operations of the oscilloscope, multimeter, or INCOS panel. The simulations were accompanied by instructional sequences, practices, tests, and extensive feedback. Sequencing of the multimeter and INCOS materials was under the control of the student, while the oscilloscope lesson was under program control. The CBT materials were designed to provide an environment in which the student could actively participate in the practice of performance-oriented skills. In most cases, the student could respond to the displays (by keyboard and/or touch panel), and the simulated equipment (and tactical displays in the case of the INCOS lesson) would react as actual equipment would in the operational situation.

Control students in each study continued to receive training in their school labs consisting of individualized study in a workbook or module plus hands-on experience with actual equipment. Training objectives were similar for experimental and control groups.

Procedure

Following initial training, INCOS and oscilloscope students were given a hands-on performance posttest (PT 1), training on actual equipment or high fidelity simulator, and then a second hands-on performance posttest (PT 2). The training following PT 1 was part of the ongoing training in each school lab. Multimeter students received training and then took the module exam administered at the BE/E school.

Results

Dependent measures used in the oscilloscope study were percentage of test procedures correct and test completion time. Multimeter students were measured on module exam scores and total training time. Data collected from INCOS students included time required for completion of posttests and number of problems completed on the tests.

Analysis of oscilloscope study data revealed that there were no statistically significant differences between groups in their total test scores, but that there were differences in specific procedures as measured on PT 1. Data from performance on PT 2 revealed no differences between the groups.

Statistical comparisons of the CBT and lab groups from the multimeter training study showed that, although the CBT group spent more time in training, there were no significant differences in exam scores.

Analysis of the INCOS performance data showed that CBT students correctly completed more problems and required less time than lab students on both performance tests. No significant differences were found between the performance of CBT students on PT 1 and lab students on PT 2.

Discussion

While CBT has been demonstrated to be an effective alternative to classroom instruction, most investigations have centered around the use of CBT for concept-oriented skills. The research described here examined CBT using interactive graphics for teaching performance-oriented skills and found it to be a feasible alternative to training with operational equipment. Results reported indicate that this methodology appears to have numerous potential cost and training benefits.

There were problems with the simulation of the oscilloscope caused by poor microfiche image resolution and alignment and inability to display all sets of interacting controls at one time. It was also reported that students had trouble using the complex constructed responses required in the lesson. Despite these problems, CBT students performed as well on tests as lab students who had had 4 hours of experience with the actual scope.

Results of the multimeter simulation study showed no differences between CBT and lab students on module exam scores. Verbal reports from lab instructors indicated no unusual difficulties experienced by CBT students in transferring their skills to the actual multimeter.

Data collected in the INCOS study showed that CBT students performed better than lab students on both performance posttests. The fact that no differences were found between the performance of CBT students before training on a high fidelity position trainer and the performance of lab students after this training is important. The findings suggest that practice with the position trainer could be eliminated for this phase of training. Savings that could be accrued for each copilot trainee are: (1) 1 instructor hour, (2) 5 student hours; and (3) 1 hour of position trainer time at a cost of $250.00. PLATO IV training for each copilot in this study was delivered at a cost of $15.00 ($5.00 per hour).

The interactive nature of the CBT materials appeared to be a critical component contributing to the success of the training. In addition, CBT provided an advantage not present in most system-specific simulators; that is, the ability to incorporate such principles of learning as immediate feedback and controlled response sequencing into an environment in which performance-oriented skills could be practiced.

The results of the studies raise several interesting research questions such as what are the effects of additional hours of CBT, what are the limitations as to the kinds of skills which can be trained using this methodology, and what are the potential cost and training benefits of supplementing or substituting conventional training programs with interactive practice on simulated equipment? Further research seems appropriate when cost benefits are considered. The use of a CBT system as a training device which could

replace an expensive system-specific simulator for some aspects of flight training, or which could be programmed to simulate different kinds of equipment for technical training, may recognize significant cost savings. The flexibility of programming with a CBT system makes experimentation with training variables, such as learning strategies, and program revisions that update simulated equipment very straightforward. As a result, further savings can be made on the cost of purchase and maintenance of equipment, as well as savings in instructor and student training time.

Other advantages of computer-based simulations include: (1) automat e performance evaluation, (2) opportunity to practice procedures which might otherwise be dangerous or damaging to real equipment, and (3) eliminating or reducing the need for an instructor.

In summary, the research described here helps demonstrate the feasibility of training performance-oriented skills with interactive computer graphic simulations of operational equipment. Research designed to determine whether this training methodology may be extended to more complex perceptual motor and procedural skills is now in progress.

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THE INSTRUCTIONAL EFFECTIVENESS OF THE PLATO IV SYSTEM IN AN AIR FORCE TECHNICAL TRAINING CONTEXT

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PLATO IV, a computer-assisted instruction system was introduced into four vehicle repairman courses at Chanute Air Force Base as part of an Instructional Systems Development (ISD) effort. To evaluate its instructional effectiveness, four conditions were created: a Baseline, a Non-PLATO control group, a Conventional PLATO condition employing PLATO lessons in a pre-ISD version of the course, and a PLATO-Based system employing PLATO lessons in the context of a systemized course. The results showed the PLATO-Based system to be the most efficient and to have positive effects on student attitudes.

Interest in Computer-Assisted Instruction (CAI) for diverse applications in education and training environments has increased steadily as the cost-effectiveness of the available systems approaches acceptability. A variety of field test evaluations for these systems are ongoing, and reaching the point where evaluation audiences' chief concerns must be assessed. One such project is the service test of the University of Illinois' PLATO IV System at Chanute Air Force Base. PLATO IV is a large scale computer-based educational system with approximately 1,000 terminals connected to the main frame computer at the University of Illinois. The Chanute test is part of a tri-service program supported by the Defense Advanced Research Projects Agency, which has interest in testing the systems at several military training centers.

At Chanute, many of PLATO's CAI and Computer-Managed Instruction (CMI) capabilities were incorporated within an Instructional Systems Development (ISD) effort of the four Special Purpose Vehicle Repairman Courses. Courseware production primarily included on-line lessons and tests, as well as student routing programs and administrative routines. The PLATO lessons subsume approximately 80% of the cognitive information presented to students during the six week period the students of the four courses have in common. The common course segment

design is group-paced, such that each of 8 to 12 student groups progresses through the course at the rate of the slowest student. The use of the task analysis and individualized media (PLATO, programmed texts, etc.) by the Instructional Systems Development team reduced the length of the common course segment by approximately two weeks.

The evaluation of PLATO IV is the joint responsibility of the Air Force Human Resources Laboratory's Technical Training Division and the Chanute Training Research Applications Branch. One area of primary interest is instructional effectiveness. As with other investigations into the effectiveness of computer applications in educational and training settings, the concept will be broadly defined by student performance and affective dimensions. The intention of this paper is to present the evaluation paradigm, some preliminary findings, and a brief discussion of the difficulties incurred.

Method

The evaluation's design was dynamic, changing to conform to or capitalize upon alterations in the instructional setting. Thus, the design presented is the final iteration used between 15 Jan 75 and 30 Sep 75.

Evaluation Conditions

The basic design involved a comparison between four evaluation conditions: Baseline (BL), a Non-PLATO (NP) control group, Conventional PLATO (CP), and PLATO-Based (PB). The Baseline condition refers to a seven month period prior to the introduction of PLATO (15 Jan 75) when Baseline data were obtained. The conventional PLATO condition employed the PLATO lessons in the pre-ISD version of the course by replacing instructor lectures. The PLATO-Based system employed the PLATO lessons in the context of an ISD course. The Non-PLATO condition and the PB and CP conditions were concurrently conducted.

Subjects

The subjects included 421 students who were assigned to the Special Purpose Vehicle Repairman's Courses for training. The number of students in each condition was: 200 for BL, 21 for NP, 43 for CP, and 157 for PB.

Dependent Variables and Instruments

In terms of student performance, block exam scores and completion times were primary indices. Rates for elimination, remedial instruction and probationary continuation were secondary measures.

The attempt to distinguish between the impact of PLATO and ISD Techniques on student performance involved the development of a special topical test which consisted of PLATO mediated and Non-PLATO mediated subtests.

Student attitudes toward PLATO and technical training were measured with two questionnaires: a seven item combination objective and open-ended "short form", and a 66 item objective "long form." The short form survey was administered during each of the four common PLATO blocks in each of the four courses participating in the study. All students in the CP, PB, and NP conditions received this instrument. The long form was given only at the end of the fourth block, and only to students in the PB and CP conditions.

Results

Student Performance Data

A direct comparison of student block exam scores was impossible since new tests were prepared for the PB condition as a result of the scope and depth of instruction changes which resulted from the ISD effort. A comparison between the CP, NP, and BL condition scores yielded no significant differences. Mean PB scores were considerably higher than those of the other conditions, but no direct comparison was possible. The finding that the PB condition had fewer eliminations (1 per 160 students) than the BL (10 per 180) was tested and found to be statistically significant, $\chi^2 = 4.7$ $p<.05$. However, when only academic eliminations were considered the results were non-significant. Since a time reduction of 28% was noted for the PB common course segment, and a 22% mean total course reduction was found, the PB condition was the most efficient. No significant differences were noted in frequency of remedial instruction or probationary continuation. The remedial instruction finding was surprising because of conflicting observational data. Therefore, a 4x4 (block by condition) ANOVA was conducted on remedial instruction time. Results showed that the CP condition students received significantly more remedial instruction, $F(3,389) = 19.8$ $p<.01$, than did the other students. This was true for the majority of possible contrasts at each level of the block factor.

Regrettably, analysis of the topical test and media comparison data has not yet been completed, however, longitudinal PLATO courseware data revealed that the courseware performed adequately despite fluctuations in the target population.

Student Affective Data

An analysis of the short form responses indicated that, overall, attitudes of students declined from the first block to the fourth block.

Students in the CP condition began with the most positive attitudes, followed by the RB condition. At the end of the fourth block, PB students had the most favorable attitudes, followed by the CP and NP students, respectively. Attitudes of the PB students were also more consistent than were attitudes of students in the other two conditions.

The two open-ended items on this questionnaire asked students to specify the best and worst features of their training. Responses to these items revealed results consistent with responses to the five objective agree/disagree items. In each group there were many positive comments in the first block of training followed by declines as training progressed. The most negative aspect of PLATO was its unreliability. Crashes of the system are highly disturbing to students and do more to damage their opinion of PLATO than anything else.

Analysis of the long form survey revealed attitudes toward more specific characteristics of PLATO. A factor analysis of this survey revealed at least five relevant factors. They were (1) PLATO training; (2) PLATO frustration; (3) Training Stress; (4) Non-PLATO Media; and (5) Mechanistic Training. Mean responses to the items in each of these factors were compared between PB and CP students. On Factor 1, PLATO Training, PB students had significantly higher attitudes toward PLATO than CP students. On the second factor, PLATO Frustration, PB students were significantly more frustrated than were CP students. No significant differences were found between PB and CP students for the Training Stress and Non-PLATO Media factors. Factor 5, Mechanistic Training, showed a trend in student perceptions which indicated that PLATO training is less mechanistic for PB students than for CP students.

Discussion

The presently available data indicated that the PLATO IV system can be successfully incorporated into ongoing technical training. The performance indices of the PLATO-Based Special Purpose Vehicle Instructional System established that it is more instructionally efficient than the previous form of the course. Though more substantive information was not available, the PLATO medium is felt to be at least efficient as other media presently employed in ISD efforts.

The most feasible explanation for the greater CP remedial instruction time is the instructor-perceived mismatch of PLATO courseware and the lesson plan content. The instructor, possibly feeling threatened by PLATO, viewed the on-line instruction as inadequate, and consequently provided more remedial instruction during the common course segment. All of the data cited were collected during the implementation of the SPV instructional system. Consequently, the system was still in the formative evaluation stages and had not achieved its most refined state.

Thus, it may be presumed that subsequent data collection and analysis could show even better student performance and attitudes.

Overall conclusions regarding student attitudes toward PLATO were that it had a positive impact on student attitudes toward classroom training, and that it was effective in improving attitudes toward technical training in general. It was felt that the uniformity of PLATO-Based instruction and other individualized media incorporated by the ISD effort reduced variability across instructions and contributed in part to the effects of group-pacing. As students were allowed to progress with more flexibility than their conventional counterparts, there was less of a tendency to become dissatisfied with their rate of progress, i.e., too slow or too fast.

PLATO frustration among PB students may be explained by the fact that, because students progressed at the rate of their class in the PB condition, any difficulty they had with a lesson may have had an impact on the progress of the entire class. Thus, because of peer pressure, they should be expected to feel greater frustration with difficulty than CP students, whose difficulties with lessons had little impact on the progress of the class.

This paper has presented some principal, but initial, instructional effectiveness findings of PLATO IV's application at Chanute. Subsequent reports will probe more deeply into the pedagogical implications of computer applications in technical training. For example, planning is underway to make a direct comparison between PLATO-Based SPV Course and a version using alternative media, thus clarifying PLATO's impact on technical training.

SESSION 4-A

Potpourri

Chairman: Robert G. Eggleston

ELABORATING INSTANCES AS A FACILITATIVE STRATEGY TO PROMOTE CONCEPT CLASSIFICATION BEHAVIOR

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A tentative mental model that accounts for classification behavior is proposed. Mnemonic systems are examined, together with explanations focusing on mental imagery, verbal learning, and elaboration as mediating processes. Arguments are presented that the concept classification process can be facilitated and enhanced by instruction in relevant mediating processes.

CONCEPT CLASSIFICATION

The word "concept" has been used in a variety of research contexts. Generally, a concept is inferred when some similarity between two or more different stimuli makes it meaningful to respond to the stimuli in the same way. In school settings, it is assumed that a student "has" a concept when he consistently indicates class membership of previously unencountered instances. Much of the research on concept attainment has been accomplished in laboratory settings, and may not be generalizable to the classroom (Ausubel, 1966). Yet it is in the classroom that the instructional psychologist desires to apply his strategies for effective learning. A number of authors have argued that virtually all cognitive functioning involves categorizing, and that the majority of college level learning consists of classification (Merrill, 1973; Bruner, Goodnow, and Austin, 1956; Weimer, 1970). In this paper, the focus is on designing instructional paradigms which can promote classification in real world settings.

Merrill and Boutwell (1973) report a series of experiments which have contributed to the evolution of the following instructional guidelines for promoting concept classification: (a) present the student with a label for the concept, together with an identification of critical relevant and irrelevant attributes; (b) sequence both examples and nonexamples according to defined relationships of attributes and instance difficulty; (c) match instances and nonexamples whose irrelevant attributes are as similar as possible; (d) match instances whose irrelevant attributes are as dissimilar as possible; (e) require classification; (f) provide feedback, to include focusing attention on the relevant attributes of an instance. Using these guidelines it is possible to design different instructional sequences and consistently predict the nature of the responses from each treatment group. The averaged data, however, obscures individual differences that are still apparent among subjects in all groups. Internal, mental mechanisms must account for this difference. Although concept acquisition can be optimized for groups by manipulating task variables, an appeal may need to be made to learner variables to assure uniformly consistent concept acquisition by each subject.

FACILITATING STRATEGIES

Recent interest has been shown in the use of mnemonics (Wood, 1967; Bower, 1970) and imagery and verbal processes (Paivio, 1971) to enhance memory. It is productive to examine the kinds of effects these have, for suggestions on improving cognitive functioning at higher levels.

Memory seems to involve a constructive (active) process rather than a tape recording (passive) of stimuli as they are presented. All mnemonics, whether imaginal or verbal, function to increase the meaningfulness of the material to be remembered. This can be done by association with already-learned material and by the generation of vivid, interactive relationships. Memory is somewhat attenuated by the abstractness of material to be remembered. Imaginal elaborations tend to be more effective with concrete material, and verbal elaborations tend to work better at enhancing recall of more abstract material (Paivio, 1971). In a memory task, the subject is asked to respond to a stimulus that he has previously encountered. The mnemonic assists the subject in actually making the response, and is also used during instruction to establish or make the material memorable.

A MENTAL MODEL

When a subject is presented with a concept classification task, following instruction, what he receives is a stimulus (which may be an example or a nonexample) and the class label. His task is to correctly determine class membership. To do this, the following steps are postulated, not necessarily in sequence: (a) recall relevant concept attributes; (b) recall relevant relations among attributes; (c) recall the range of relevant attributes; (d) identify attributes and their relations in the new stimulus; (e) match attributes and relations of the concept with the attributes and relations of the stimulus. If in fact all of these substeps are necessary for a subject to consistently and accurately determine the class membership of previously unencountered instances, then what is needed to facilitate concept classification is a device or strategy to assist in actually accomplishing these five steps, in the same way that a mnemonic assists a subject in actually performing the criterion task.

It can be argued that if a mnemonic helps both in the instructional stage and in the performance stage, then a strategy that fulfills a parallel function for concept classification should be useful during instruction, and should perhaps recreate the instructional sequence at the time performance is required. In other words, some device or strategy is needed that can help the subject generate examples and nonexamples that are both matched and divergent, and that illustrate the complete range of low to high probability examples.

A POSSIBLE STRATEGY

There is some evidence that people represent conceptual categories in terms of analog prototypes that are good examples of the categories.

Other data suggest that people use images of highly probable exemplars to represent the meanings of general terms. (Paivio, 1974). This strategy is both useful and limiting, since it does allow the parsimonious handling of a large variety of instances, but does not facilitate effective classification when the instance has low probability. An instance has low probability when irrelevant attributes are salient or the relevant attributes are on the fringe of the acceptable range. Every school student sooner or later encounters a situation in which "everything was clear in class but nothing on the test looked familiar." What an instructor often does is use the "easy," obvious examples of a concept to illustrate and enliven instruction, and save the "hard" (low probability) examples for the test. The highly probable example that came to typify the concept is easily recalled, but is so different from the stimulus at hand that classification is haphazard at best.

A more deliberate approach to representing categories might be more facilitative. Borrowing from the characteristics of good mnemonics, the following strategy is suggested. During instruction, the previously described paradigm for promoting concept classification behavior is utilized. When the subject can consistently respond correctly to a diverse range of examples and nonexamples, require the subject to generate a mental image (if the concept is concrete) or a verbal chain (if the concept is abstract). In contrast to what a subject might normally do, specify that the image or verbal chain: (a) be an example of the concept; (b) be a low probability example; (c) have salient irrelevant attributes. Traditional considerations for effective mnemonics are appropriate for making the image or verbal association meaningful. But the departure that is suggested would, in affect, enable the subject to store cues that indicate the range which the relevant attributes can take. Finally, the subject must receive feedback to assure him that his elaborated instance is in fact an example.

This approach utilizes the elaborated instance as a carrier or peg on which may be hung the critical characteristics of the concept. Then, during the criterion task, the subject can effectively simulate or recreate the entire learning experience. Examples and nonexamples, together with an attribute list, can easily be "read off" the recalled elaborated instance.

DISCUSSION

At present the only evidence in support of the above rationale is tangential and anecdotal. But this strategy is not necessarily tied to the hypothesized mental model, and could be adapted to other premises for concept classification behavior. The concern at the moment is not whether or not people do use one example as a representative of a concept class, but can they be taught to. Using elaborated instances would help students in the early stages of learning about a new topic,

and could assist dramatically when a student was required to respond infrequently, over perhaps long periods of time, to divergent instances. Very practical applications of this approach are also suggested for nonacademic settings. For example, being able to recognize poisonous snakes or plants requires that a person know the critical characteristics and can discern them readily even though he has not seen that snake or that plant before. Very often the encountered stimulus is somewhat different from the examples introduced during instruction. An elaborated low probability example could be easily recalled and used as a model for analyzing the snake or plant he has encountered. One of the promising characteristics about using elaborated instances is that the subject not only learns the concept at hand, but also learns the generalizable strategy for acquiring any new concept. The strategy would be a powerful mathemagenic device for helping people learn how to learn.

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A PROCEDURE FOR ESTIMATING THE RELATIONSHIP BETWEEN A PERSONNEL CHARACTERISTIC AND OPERATIONAL COMPREHENSIVE OF TECHNICAL WRITING

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A model of the relationship between personnel characteristics and technical manual comprehension was rationally developed and a method was presented for estimating the relationship between a personnel characteristic and operational comprehension of technical writing when only the relationship of both to a third, or intermediate variable, is known. A search of the literature was then conducted to obtain empirically established information relevant to the model. By using the estimation procedure on three sets of data, the correlational relationship between the personnel characteristic of general intelligence and the criterion of operational comprehension of technical writing was computed to be .28, .23, and .32. An empirical study was found which obtained a correlation of .35 for this relationship. Thus the procedure, at least in this case, provides estimates that are on the conservative side.

Since technical manuals (TMs) are a primary source of information for Navy technicians, their inability to adequately comprehend such written material could lower job performance. In this regard, there is some evidence that the reading difficulty of manuals exceeds the reading ability of user personnel (Duffy, Nugent, Millar, and Carter, 1974). The consequence of this mismatch is indicated by the facts that (1) poor readers tend to use manuals less, and (2) even if they do use the manual, their performance is poorer at a job task (Sticht, Caylor, Kern, and Fox, 1971). This situation calls for either an increase in the reading ability of personnel or a reduction in the reading difficulty of TMs. In that the effectiveness of alternative ways of persenting technical material in TMs may well be a function of the characteristics of user personnel, such characteristics must be considered in manual preparation. The overall objective of the effort reported here involves identifying those personnel characteristics which should be considered in producing more effective TMs and, ultimately, a higher level of technician performance.

The main purpose of TMs is to aid the technician or operator in actually maintaining or operating equipment. The final criterion for determining the effectiveness of TMs is their utility for maintenance/operation (operational comprehension). This "operational comprehension" would be measured by how well maintenance or operational procedures are improved through the availability of technical writing. Unless user personnel characteristics can be directly, or through chaining, related to "operational comprehension," they are not of value for aiding TM writers to increase TM comprehension. It is important to recognize that any personnel characteristic related to verbal comprehension of technical writing has no value unless verbal comprehension is, in turn, related to the final criterion of operational comprehension.

A search of the literature, both civilian and military, revealed that little is reported on the direct relationship between personnel characteristics and operational comprehension. There was, however, considerable information that could be relevant. A model, Figure 1, was set-up to organize the information obtained from the literature search.

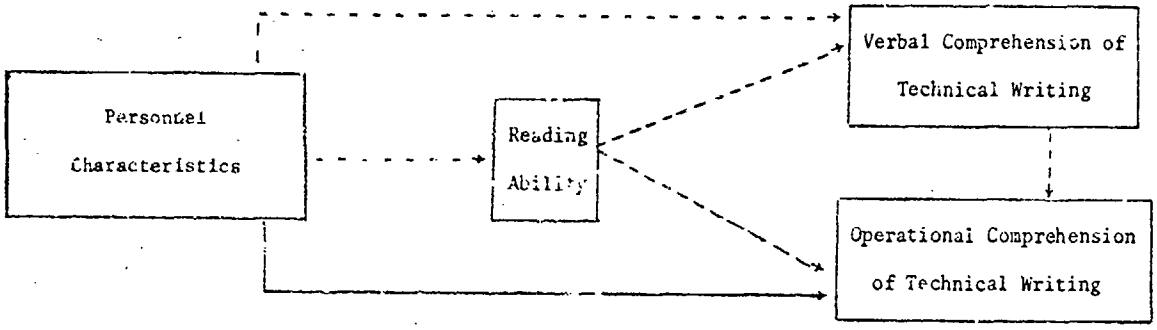

Figure 1. A Model of Relationships Between Personnel Characteristics and Operational Comprehension.

Relating personnel characteristics to operational comprehension by a chaining process, as indicated by Figure 1, should be done with caution. The longer the chain from the prediction variable to the criterion variable, the more tenuous the relationship is likely to be. For example, if some personnel characteristic is correlated .60 with reading ability, which in turn is correlated .60 with operational comprehension of technical writing, then assuming random distribution of relevant variance between variables, the portion of variance in common between the predictor and the final criterion would be .0467 or a correlation of .216.[1] Thus, if the only justification for using a predictor is that obtained by the chaining process, even when the correlation between links is .60, the relationship of the predictor to the final criterion could be negligible.

The relationship shown in Figure 1 that was most documented in the literature is that between personnel characteristics and reading ability. The main finding from the literature search is the paucity of information available on the other relationships shown. Even something so basic as the relationship between verbal comprehension of technical writing and operational comprehension of technical writing has not been well researched.

At the conclusion of the literature search, it was possible to test the chaining of relationships involved. General intellectual ability, the personnel characteristic which has higher correlations with reading

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[1] Computed by obtaining the coefficient of determination (or r^2) for each correlation in the chain, sequentially multiplying the coefficients of determination, and taking the square root, i.e.,:

$$\sqrt{6^2 \times 6^2 \times 6^2}$$

ability than any other was chosen to demonstrate the procedure. This variable is particularly useful for this purpose since the direct link correlation (.35) is available for comparison purposes. The average size of the correlations found for each link is shown in Figure 2.

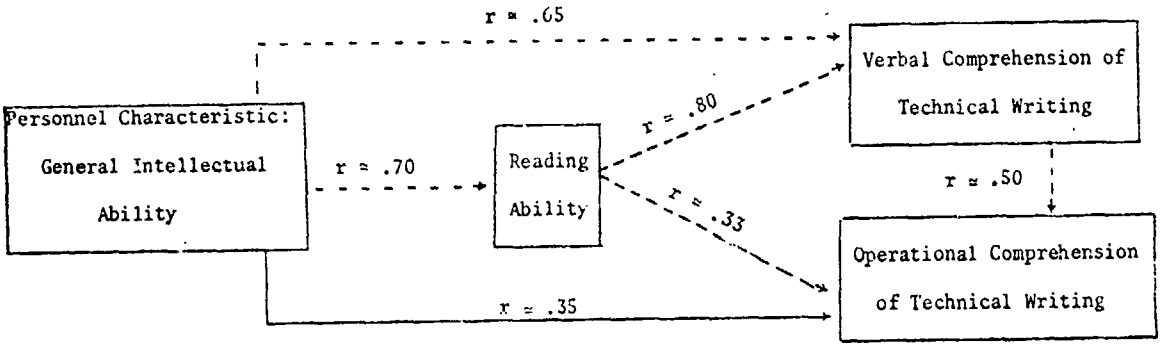

Figure 2. A personnel characteristic chained to the operational comprehension of technical writing.

As can be seen from Figure 2, there are three routes that link general intellectual ability to operational comprehension. If the direct link relationship were not known, but information was available on one of the chains, the direct link could be estimated. Thus, taking the longest chain--personnel characteristic to reading ability to verbal comprehension to operational comprehension as an example, the predicted correlation would be $\sqrt{.70^2 \times .80^2 \times .50^2}$ or $r = .28$. The more direct routes of (1) personnel characteristic to reading ability to operational comprehension and (2) personnel characteristic to verbal comprehension to operational comprehension come out to be $r = .23$ and $r = .32$, respectively. The estimates based on the chaining analysis are all underestimates of the $r = .35$ shown as the direct link. The assumption of random distribution of valid variance evidently provides conservative estimates of the direct relationship in this situation.

This method can be generalized to all situations involving the evaluation of relationships with intermediate criteria.

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SELECTION OF SIMULATION

AS AN INSTRUCTIONAL MEDIUM

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Simulation is an effective instructional medium in a wide variety of circumstances and is typified by active student involvement in individually-paced learning incorporating practice and feedback. Some advantages provided are that simulation can: provide feedback, increase the number and frequency of crises, conflicts, equipment malfunction and emergencies, compress time, vary sequence, provide guidance, provide stimulus support, provide an overview and vary the difficulty level. When simulation's unique capabilities are ignored any comparison is limited. Thus, thorough case studies may provide better simulation design information since they consider a large array of factors, factor weighting, decisions, and results of decisions.

Instructional media refer to the means used to present information to the student, and when properly selected, in a form which can be effectively used by the student. Typical procedures for providing learning experiences combine three elements in varying ways: presentation of information, application or practice, and an evaluation which provides feedback to the student. Simulation can impact on each of these elements.

The design of student exercises, performances, or practice items is based upon the determination of what must be done by the student to provide satisfactory transfer to the job or task being learned. This performance may range from a student's verbal response in a classroom, filling in the blank in a programmed instruction bookley to operating a C5 Flight Simulator. What the student must do controls the learning environment selection or design.

The initial step in media selection is to determine which level of resemblance to the job environment should be selected for the active learning environment. This environment will provide the student a working place with some predetermined level of resemblance to the final application environment. Tasks with concrete information inputs requiring concrete actions would require a learning environment more nearly like the task. Likewise, tasks with abstract information inputs requiring the productions of abstractions are less likely to require that the training task environment resemble the actual task environment.

Neither the job nor the classroom is the best place to learn unless they provide those features deemed necessary in the design of learning. When the

design of learning uses simulation seven unique advantages are provided which may not be possible in the classroom on the jobs. These are:

(1) Simulation can provide feedback. When extra knowledge of results during instruction is needed simulation may be the best means.

(2) Simulation can increase the number and frequency of crises, conflicts, equipment malfunctions and emergencies. When critical events requiring skilled performance normally occur infrequently, simulation may provided needed experience more readily than other techniques.

(3) Simulation can compress time. When it is desirable to reduce the operational time for certain events, so as to increase the amount of practice on critical skills, simulation can provide this time compression.

(4) Simulation can vary the sequence of tasks. When it is desirable in the total performance behavior to vary the part-task sequence (because small amounts of practice on several similar tasks promote more learning than large blocks of practice on a single task) simulation can provide the necessary variation.

(5) Simulation can provide guidance and stimulus support. When it is desirable in the early or initial stages of learning to provide stimulus support or guidance, simulation may be the simplest means.

(6) Simulation can vary the difficulty level. When it is desirable to vary the progressio of difficulty levels (a progressively easy to difficult procedure facilitates transfer of learning) simulation can provide the capability.

(7) Simulation can provide an overview. When it is desirable to reduce separation in time or space to display or emphasize critical relationships, simulation can provide displays enabling the student to form a dynamic cognitive map of the overall situation, interrelating the necessary observations and events.

Simulation provides a representation of a real situation in which tasks are performed or operations carried out. Simulators provide the student with predetermined levels of control over the task or operation, thus permitting controlled practice on representative or critical aspects of the selected tasks or operations. An effective simulator must provide psychological realism according to Miller (1954). A choice frequently must be made between engineering fidelity (of equipment) or physical realism and learning. Physical realism can reduce learning efficiency. In general, psychological realism combines an operational similarity and a motivational similarity in varying proportions. This typically means that information identifiably representative of actual job or task information must be provided. Likewise the student, cued by the system inputs, must be able to exercise some level of control over the system. Furthermore, the consequences of the students interaction with the system must be represented.

An excellent means of gaining active student involvement is through simulation, which often provides practice and feedback opportunities during learning. Simulation allows student involvement in learning, paced to the needs of the individual. Both practice opportunities and forms of feedback usually not available in the typical classroom or when operating in a job environment are provided by simulation.

While simulations represent a real situation, they omit selected parts of the operation. Psychologically unimportant details are left out. So are dangerous activities. (In fact, the omission of dangerous activities in an instructional environment may be a reason for selecting simulation.) Expensive activities are often simulated, frequently providing justification for simulator procurement. Hopefully, simulators also omit some of the real world uncertainties.

Simulation when selected as an instructional medium has been shown effective for learning a wide variety of procedural sequences, perceptual motor skills, identifications, conceptual tasks and team functions. The approach of systematically abstracting and partially duplicating tasks, activities, or operations provides transfer of learning from a synthetic environment to a real environment. There are, however, constraints in the use of simulation.

Two constraints in the selection of simulation as an instructional medium are the course goals and the course design. Simulation must implement the goals of the course. A simulation which provides excellent transfer to some tasks but not those being learned would not implement the course goals. Furthermore, the simulation must be integrated with the course. If simulation is not essential to the course it can be omitted, as could the course if only learning with the simulation transfers to the job environment.

Simulation has been shown as an effective instructional medium in a wide variety of specific operations, tasks, or skills. However, the principles upon which the successes have been based are not clear. No predictive body of knowledge is available which will ensure the adequate design of simulations for effective training. It does not appear that rigorous scientific methods will be applied to isolate and test possible principles. However, it should be possible to systemize available evidence, not only to suggest hypotheses for testing but also to record factual evidence (and inspiration) involved in the decisions required in designing simulations.

Better information is needed in planning and designing simulations, and not just the descriptions of successful simulations (hopefully with some evaluation). Comparisons of simulations with other instructional media are too often limited to the lowest common denominator, ignoring unique advantages (and disadvantages). Simplistic comparisons have some persuasive value in answering the question as to the possibility of achieving certain kinds of goals through simulation. However, we have performed enough persuasive research to show the range of possibilities of learning through simulation. It appears to

me that thorough case studies can provide a way in which information can usefully be provided. While a case study cannot give assurance of reproducibility it can afford to consider a large array of details. While the elements of the situation are not controlled, the case study can tell why decisions were taken, what factors were considered, and what happened as a result. The quality of the case study will be based on how well it is organized, how well the study is interpreted and how effectively it is presented. The unique advantages offered by simulation as the selected instructional media can be helpfully presented in the case study approach.

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SESSION 4-B

Potpourri

Chairman: Thomas M. McCloy

A TEST OF FIEDLER'S CONTINGENCY MODEL OF LEADERSHIP EFFECTIVENESS

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Air Command and Staff College

This project tested Fiedler's Contingency Model of Leadership Effectiveness with Air Command and Staff College students leading interacting teams in a competitive, stressful exercise. Surveys were used to determine each subject's leadership style and the model's situational variables. Teams with opposite style leaders were paired in 23 contests. Winning the contests was the measure of group effectiveness. The results indicated that the model is unable to satisfactorily predict the best leadership style.

Many thoughts, ideas, and theories have been advanced in answer to an important question. What makes a leader effective? Most efforts have focused on the "best way" to lead. One notable exception was the work of Fred Fiedler.

For 15 years Fiedler researched leadership effectiveness of interacting groups (Fiedler, 1967; Fiedler & Chemers, 1974). He developed the Contingency Theory to explain his observations (Fiedler, 1967). The theory recognized that there is no one best style of leadership or array of traits. Instead the leader's effectiveness depends upon the situation. Fiedler expressed his theory in the Contingency Model.

The heart of the model is the correlation of a leader's style with his group's performance in one of eight situations or octants. Fiedler used the least-preferred co-worker (LPC) score to determine the style of each leader. The leader's style was correlated (using the Spearman rank order rho) with his group's effectiveness in the tasks being analyzed. A correlation approaching +1.00 indicated that a high LPC leader should have the most success in the situation. A correlation approaching -1.00 indicated that a low LPC leader should perform best.

The groups used in Fiedler's original work were interacting. An interacting group is one in which all members must work together to accomplish the task. While interacting groups were used to obtain the data used in the model, Fiedler (1967) also discussed the possibility of extending the model to coacting groups. In a coacting group, each member's tasks can be carried out independently and still achieve the group's objective. There is relatively little that a leader needs to do to get all members working together.

LPC scores and their interpretation are important in understanding the model. Fiedler has summarized the meaning as follows:

> The high LPC person tends to describe himself as self-oriented and concerned with good performance on the job, and in favorable situations he is also seen as task-oriented by others. However, in unfavorable and stressful situations he tends to behave in a considerate and relationship-oriented manner. The low LPC person tends to describe himself as concerned with good interpersonal relations; and in favorable situations he is seen as considerate and person-oriented. However in unfavorable and stressful situations he tends to behave in a task-oriented manner. (Fiedler, 1972, pp 392-393, italics added.)

The Contingency Model has undergone considerable testing with mixed results (Brown & Smolinski, 1974; Chemers & Skrzypek, 1972; Fiedler & Chemers, 1974; Graen et al, 1971 a & b; Hunt, 1967). In the studies, few leader LPC-group performance correlations had any statistical significance. Fiedler, however, does not believe that this should detract from the model's validity since a preponderance of the correlations are in the predicted direction (Fiedler, 1973; Fiedler & Chemers, 1974). This issue has been a source of great controversy over the usefulness of the model (Ashour, 1972 a & b; Graen et al, 1971 a & b). Hunt (1967) concluded that his tests supported the model. It should be noted, however, that Hunt's work included both interacting and coacting groups.

From surveying the literature, it appears as though the model has been tested primarily in groups not under stress. The present authors did not find validation tests using groups in a stress or competitive situation with the possible exception of the West Point test (Chemers & Skzypek, 1972). It is not clear to the present authors that either the situation with cadets of different ranks or the short time allowed to perform the task really provided a stress situation. We discount the stress considerations based upon our precommissioning training and conversations over the years with fellow officers who had attended West Point.

The present experiment was designed to fill this perceived void in model validation tests. The research set up a competitive, stressful environment to test the following hypothesis: "The Contingency Model of leadership effectiveness can predict the most effective leadership style in a competitive, stressful situation."

Method

Subjects

The subjects were members of the Air Command and Staff College (ACSC) Class of 1976. ACSC is an intermediate level professional military education institution. The students are among the top 20 percent of the active duty U. S. military officers selected for major. In addition, selected Air Force Reserve, Air National Guard, and Air Force civilians attend ACSC. The students are assigned to seminars each with 14 to 16 members. When the test was performed, the seminars had been together for two weeks.

Situation

The vehicle for this experiment was an exercise entitled TEMPO. The exercise, a regular part of the ACSC curriculum, was designed to permit the players in interacting groups to practice military planning under the constraints of time, uncertainty, and budget (ACSC, Note 1).

Each team began the exercise with identical offensive and defensive force inventories, research and development options, and budgets. The budget was to be spent to (a) operate existing forces, (b) procure additional forces, (c) obtain intelligence, and (d) develop new or modify existing weapon systems. The budget changed each year. Each existing or proposed weapon system had an actual or projected utility measure (utils). Each team's objective was to maximize the number of offensive and defensive utils.

The exercise simulated eight years. The first four were operational years; the last four were programming years concentrating on developing a force mixture to meet longer range objectives. Penalties were assessed when teams exceeded the decision time limits or their total budget allocation. The team with the most offensive and defensive utils at the end of each year won that year. The team that won the most years was declared the winner. If each team won four years, then the team that won year eight was declared the winner.

The authors believe that the subjects were presented with a stressful situation. They were highly competitive members of the military's middle management. Their competitiveness along with the game time deadlines, uncertainty, and budget constraints tend to support our assumption of a stressful environment.

Materials

Pre-experiment. All students completed Hunt's LPC questionnaire during a seminar administration period one week prior to the TEMPO exercise (Fiedler, 1967, Appendix A). At the same time, 15 faculty members familiar with TEMPO as well as leadership and management theory were surveyed to determine the leader's position power and the task structure. The task structure rating was adapted from that used by Hunt (Fiedler, 1967, Appendix D).

Five days prior to the exercise, the students were given a booklet that explained the objectives and rules for TEMPO.

Post-experiment. Each team leader was surveyed immediately following the exercise, using Hunt's questionnaire, to determine his perception of the group atmosphere (Fiedler, 1967, page 269).

Procedures

Team data. Each seminar was divided into two equal teams. The team captains were selected on the basis of their LPC score. The subjects in each seminar with the highest and lowest average LPC scores

were appointed team captains. The high LPC led team in one seminar was paired against the low LPC led team in another seminar. In some cases both teams in a contest were led by persons with an average LPC score of less than 5.0. Since the experiment was designed to have a task-oriented leader competing against a relations-oriented leader, and since Fiedler (1967) had considered 5.0 the high/low LPC break point, contests in which both leaders had LPC scores below 5.0 were excluded from the data. For this reason only 46 teams (23 contests) were included in the data.

Scoring. Winning teams were given a score of 3 and losing teams 1. In one analysis variation, teams that each won four years were given a score of 2.

Data manipulation. Each leader's average LPC score was rank order correlated with his team's performance score. Three different correlations were made. In the first, the TEMPO win/lose rule was used. In the second, ties were permitted. In the third, only those contests in which there was a clear winner were included, i.e., no ties to resolve.

Results

The pre- and post-experiment questionnaires were analyzed to determine the octant placement for each team. Forty-five teams were placed in octant IV and one team in octant VIII.

The team in octant VIII had a low LPC leader and won as predicted by the model. The correlations for the teams in octant IV were (a) TEMPO win/lose rule, rho = .11; (b) ties included, rho = .16; (c) clear winner, rho = .22. There was no statistical significance (i.e., $p > 0.05$) for any correlation.

Discussion

Octant IV is a somewhat favorable situation in which the high LPC leader should perform best, but here the low LPC led teams won at least half of the contests. One explanation might be the stress factor in the test, and Fiedler has equated a stressful situation to an unfavorable one. Since in such a case a high LPC person abandons the task to develop relations and a low LPC person abandons relations to develop a task orientation, the outcome seems reasonable.

To be useful a prediction must have some reliability and not the flavor of a wild guess. It is our opinion that a low correlation with no real statistical significance must be considered to have the flavor of a wild guess. An example of the practical problems with the model can be seen in the previous validation tests. The previous tests except those by Hunt (1967) and Brown & Smolinski (1974) used new groups, and the leader-member relations were determined after the experiment. Even when dealing with on-going groups, Brown & Smolinski found it difficult to place the groups into an octant because some of the tasks performed by the groups were unstructured and some were structured.

Conclusions

The Contingency Model has attempted to develop a leadership effectiveness theory more closely alligned to the intuition of many practicing leaders. For too long, leadership and management development courses have tried to show there is one best style for a leader. In practice, however, a leader knows he must adapt his style to the situation which, ever with the same group in the same task, varies from day to day. The model has also stimulated more research into finding and better defining leadership effectiveness parameters. Therefore, despite our disagreement with the proof offered by previous validation studies and our contention that the present experiment did not support the model, we believe it has served an important purpose. The authors have some reservations about the practical use of the model as now structured. We share Sashkin's conclusion, "Granting a degree of predictiveness validity, by LPC scores, of leadership effectiveness. . . one is left with the question of the practical utility of such a finding." (Sashkin, 1972, p. 359.) The unreliability of the model's predictions would make it impractical to use it as a tool for selecting the best leader for a given job.

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GROUP DECISIONS OF EFFECTIVENESS IN AN ASSESSMENT CENTER

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The Assessment Center method is utilized extensively within industrial organizations for the selection of personnel and the successful prediction of future managerial potential or promotability. To date, however, this technique has not been effectively utilized within the military services. This paper presents an initial attempt to apply the Assessment Center process in a military environment.

Recent developments in the area of personnel decision-making in organizations have focused on the Assessment Center, a standardized procedure involving boards or panels of specially trained observers whose task it is to observe and judge the performance of others. Judgments are based on recordings and observations of behaviors elicited by a variety of carefully selected tasks, exercises, or problems assigned to the assessees. These group and individual exercises are usually developed or derived from a careful analysis of the job or job level to which participants aspire. The exercises reflect specific dimensions of behaviors or capabilities. Exercises include developing plans for realistic problems, resolving group member's preference differences and supervising others. The participant knows he is in an evaluative setting, the consequences of which might affect his career, and in fact the decisions made by the assessors are often couched in terms of the candidate's potential for effective functioning at higher levels of the organization. The length or duration of the Assessment Center can vary from a few hours to a full week. Furthermore, the panel's judgments can be utilized in several ways: at one extreme being given a major weight in regular organizational decisions regarding promotion, the other occurring where the evaluations are used to provide accurate and detailed feedback to the candidate for developmental purposes only.

The research on this assessment procedure has been quite encouraging (Howard, 1974). Data indicate that panel judgments, sequestered from organization decision makers, predict actual rates of promotion over an eight year interval in large sized organizations (Bray, Campbell and Grant, 1974). Participants too have been enthusiastic about being evaluated in a systematic and unprejudiced manner. Thus, numerous studies appear to indicate the usefulness of these Assessment Centers for personnel decision-making.

Despite the optimistic findings to date, little basic research has been performed to determine why Assessment Centers are so effective. (MacKinnon, 1975). Systemic efforts to answer such basic questions as the following are lacking:

1. What is the most effective way to gather Assessment Center data?

2. How should Center data be weighed and combined for most effective predictions?

3. How are Assessment Center decisions or predictions actually made as a board evaluates, deliberates and moves to consensus.

Jeswald (1971) points out that the above constitute but a few of the myriad unanswered questions related to the Assessment Center process.

Another interesting aspect of the Assessment Center process relates to its very limited use in the military services. Until recently (Olmstead, Cleary, Lackey, and Salter, 1974; Bryant, 1975), this procedure had not been used since its well-documented application at Station S of the Office of Strategic Services. This utilization was an attempt to evaluate the qualifications of candidates to serve overseas in spy positions during World War II (OSS, 1948). Olmstead, et. al. (1974) and Bryant (1975) have reported on two recent attempts to employ the Assessment Center process within the services. The former represents an Army project instituted at Fort Benning, Georgia, to evaluate the feasibility of Assessment Centers for utilization by this service. The final report on this project is not available at this time. It is believed, however, that the project has been terminated.

The report by Bryant (1975) presents the history and success rate of an extant Center being conducted by The Aeronautical Systems Division at Wright-Patterson AFB, Ohio. This Center is designed primarily for the assessment of high ranking civil service employees within ASD, however, and military personnel are not involved except as occasional assessment staff team members.

In summary, there are many unanswered questions related to the causes for the impressive successes registered by Assessment Centers within the civilian industrial setting. Likewise, many important questions related to the potential for this technique within the military setting beg answering.

The purpose of this research is twofold: first, to identify some of the salient characteristics that determine quality of predictions made by assessment boards; and, secondly, to determine if this technique has any value within the military environment.

Method

Subjects

The Ss for the experiment consisted of 90 freshmen and sophomore cadets, and 26 senior cadets enrolled in the ROTC program at The Ohio State University. All cadets initially participated in the research as part of course requirements. The senior cadets were paid an hourly wage

during latter stages of the Assessment process.

Apparatus

Four situational or simulated task exercises were used in the Center. These exercises were developed based on a careful analysis of the salient dimensions relevant to the jobs of, a) an effective ROTC cadet and, b) an effective Air Force officer. The four exercises developed are as follows:

1. The In-Basket. A series of tasks or problems a cadet must perform as if he or she were thrust unexpectedly into the role of the cadet commander. The issues dealt with are similar to the se that might be in the "in-basket" on the commander's desk. This is performed individually.

2. Scheduling task. In groups of six, participants must plan an itinerary for a very important military officer who will be the guest of the ROTC unit for a day. Each participant is given a personal schedule and as a group they must make up a set of activities that will create a positive impression of the OSU unit.

3. Special training program. Each one of six group members is given limited information about a hypothetical cadet and asked to get that person nominated for a highly desirable training program. The group must come up with a rank order which reflects their order of choice of who will go to the program.

4. Plea bargaining. In two teams of three, each participant develops a case for the prosecution or defense of a hypothetical student accused of a violation of university codes. After receiving aid from similar prosecution or defense-minded teammates, each person must bargain with his counterparts (from another team) and reach agreement on how to dispose of the case (from dropping the charges to full penalties).

Procedure

The 26 senior ROTC cadets were trained as assessment staff, and assessed the 90 freshmen and sophomore cadets in January of 1976. The underclass cadets were observed in the three group situational exercises. The fourth exercise was performed by each underclass cadet individually and subsequently scored by a staff member. Data gathered from these exercises will be used by the senior cadets to predict the following aspects of future assessee performance.

1. Selection into the upper-class ROTC program.

2. Quality of performance as a senior ROTC cadet.

3. Quality of performance as an officer in the Air Force.

Results

Actual assessment of the ROTC cadets was completed in January 1976. The effects of several variables on decision and prediction processes within the Assessment Boards are currently being determined. The following are examples of such variables:

1. Differing status within assessment boards.

2. The imposition of differing decision rules.

3. Extent of training of the assessment staff in assessment procedures.

4. The effects of knowledge of the military environment.

Follow-up studies will be conducted to evaluate the effectiveness of predictions made. These studies will measure cadet performance through their senior year at the University and into their initial two years on active duty.

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SESSION 5-A

Cadet Attrition

Stress Management

Chairman: John M. Bermudez

PREDICTING AIR FORCE ACADEMY CADET ATTRITION

USING THE STRONG VOCATIONAL INTEREST BLANK

Lawrence O. Short, Michael J. O'Connell,
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United States Air Force Academy

The responses of three Air Force Academy classes of cadets on the Strong Vocational Interest Blank (SVIB) were analyzed to empirically develop keys to predict cadet attrition. Two classes were administered the SVIB within ten days after entering the Academy; the third class completed a mail-out testing after being offered admission but prior to entry. While statistically significant validities remained on cross-validation, time of administration had an extremely significant effect on validity of the attrition prediction scales.

The American public and the Congress of the United States have had a continuing concern with cadet attrition from the United States service academies. Peaking of cadet attrition rates in the early 1970s led to Congressional requests for investigation by the General Accounting Office (GAO). The GAO's investigation, begun in 1973 and completed in 1975, yielded a major report released in March of 1976. The GAO concluded that continuing research on selection of cadets at the Air Force Academy had probably resulted in academic selection procedures as advanced as the state of the art permits and noted that approximately two-thirds of all cadet attrition at all the service academies is voluntary and that this voluntary attrition is essentially unrelated to the selection procedures presently in use at the academies. Consequently, predictors of voluntary attrition have become of major concern to all the service academies.

One recent effort to attempt to predict and ultimately to reduce voluntary attrition at the service academies had its inception at the United States Naval Academy. The Naval Academy asked the Naval Personnel and Training Research Laboratory in San Diego, California, to devise scoring keys for the Strong Vocational Interest Blank to predict attrition among Naval Academy cadets. This request followed earlier successful efforts in developing predictors for retention in Naval ROTC programs (Abrahams, Neumann, and Githens, 1968; Githens, Abrahams, and Neumann, 1968; and Neumann and Abrahams, 1971). As in the ROTC studies, Naval Personnel Laboratory researchers were able to select items from the SVIB which together predicted a significant part of voluntary attrition among Naval Academy cadets (Abrahams, Neumann, and Dann, 1969; Dann and Abrahams, 1970; and Abrahams and Neumann, 1973).

The United States Air Force Academy has administered the Strong Vocational Interest Blank for Men to entering cadets in a number of

classes, including the Class of 1977, for use by cadet counselors. At the request of the Air Force Academy, the Naval Personnel Laboratory staff determined the validity of the Naval Academy attrition scale as a predictor of Air Force Academy cadet attrition. Their analysis completed in February 1974 yielded a biserial correlation of 0.41 between the Naval Academy scale and Fourth Class (freshman) year attrition of the Class of 1977. A follow-up on Class of 1977 attrition showed some shrinkage in validity when all attrition through both the Fourth Class and Third Class years was used (r_b=.29, $p < .01$). A subsequent analysis of SVIB data against attrition during the Fourth Class year of the Class of 1978 provided much less impressive results, however, since the correlation, though still statistically significant, shrank markedly (r_b=.14, $p < .05$). Discussions of these data with staff members of the Naval Personnel Research Laboratory suggested: (1) there could be an improvement in attrition prediction with the development of a key specifically designed to predict Air Force Academy cadet attrition and (2) different conditions of administration of the SVIB which prevailed in the testing of the Air Force Academy's Classes of 1977, 1978, and 1979 might provide additional useful information about the effects of administrative conditions upon the validity of predictions of attrition and retention.

Method

Subjects

Members of the Air Force Academy Classes of 1977, 1978, and 1979 were administered the Strong Vocational Interest Blank for Men. The Classes of 1977 and 1979 completed the instrument within the first ten days after their arrival at the Academy. The Class of 1978 completed the instrument after they were notified of selection but prior to actually entering the Academy. Usable data were obtained from 1368 members of the Class of 1977 (93% of the class), 1447 members of the Class of 1978 (88% of the class), and 1446 members of the Class of 1979 (98% of the class).

Procedure

Using standard item analysis procedures against a criterion of retention versus attrition as of January 1976, keys were developed separately for the Classes of 1977 and 1978. Attrition in the Class of 1977 totaled nearly 36% and nearly 30% of the Class of 1978 had attrited. Items were selected for inclusion in the two scales on somewhat different bases. The Class of 1977 scale, which included 87 of the 399 items of the SVIB, was based upon item responses discriminating between attrited cadets and remaining cadets at or beyond the six per cent level of significance. The Class of 1978 scale contains only 30 items which were significant at or beyond the six per cent level; to provide for a somewhat longer scale with increased reliability, additional items were selected which were significant in discriminating between attritees and remaining cadets at or beyond the ten per cent level. The Naval Academy scale used 71 different items.

Analysis of the items common to the three scales revealed the following: (a) 17 items were common to the Class of 1977 and Class of 1978 scales, (b) 33 items were common to the Class of 1977 and the Naval Academy scales, and (c) only 7 items were common to all three scales. Intercorrelations of scores of the three scales for each of the samples used in the study are presented in Table 1.

Table 1

Intercorrelation of Three SVIB Attrition Scales

USAF Academy Population	Naval Academy & Class 1977 Scale	Naval Academy & Class 1978 Scale	Classes 1977 & 1978 Scales
Class 1977	.69	.38	.30
Class 1978	.66	.39	.31
Class 1979	.67	.41	.31

Results

To compare the predictive accuracy of the two Air Force Academy scales, each scale was cross validated on two other classes. The Naval Academy scale was cross validated against all three Air Force Academy classes. Table 2 presents the means and standard deviations of three attrition scales on the three separate samples of Air Force Academy cadets. Biserial correlations between SVIB scale scores and the criterion of attrition versus retention are presented in Table 3.

Table 2

Attrition Scale Means and Standard Deviations

	Population		
Attrition Scale	Class of 1977	Class of 1978	Class of 1979
Naval Academy	118.9 (8.95)	124.6 (7.97)	120.1 (8.37)
Class of 1977	122.9 (14.42)	129.4 (11.68)	123.3 (13.42)
Class of 1978	100.9 (6.25)	103.0 (6.61)	100.7 (6.48)

NOTE: Standard deviation shown in parentheses.

Table 3

Biserial Correlations Between SVIB Scales and Attrition

Attrition Scale	Population		
	Class of 1977	Class of 1978	Class of 1979
Naval Academy	.266	.133	.303
Class of 1977	.470	.104	.323
Class of 1978	.154	.483	.126

Discussion

The analysis sought to answer two questions: (1) are scales developed on an Air Force Academy population better predictors of Air Force Academy attrition than the Naval Academy scale? and (2) does the SVIB administration condition, namely pre or postentry, influence the predictive accuracy of the scale?

The correlations of Table 3 answer both questions. As expected, scales developed on particular samples yield considerably higher validities against criterion data from those samples than did scales derived from other samples. Cross-validation evidence indicated that condition of administration was a significant factor. This is in marked contrast to the findings of Abrahams, Neumann, and Githens (1971) that scores on the SVIB did not show significant differences between "routine use and selection situations."

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EARLY VOLUNTARY ATTRITION AND THE CLASS OF 1978

AT THE U. S. COAST GUARD ACADEMY

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U. S. Coast Guard Academy

Compares responses on items of the U. S. Coast Guard Academy Interests, Background, Activities Preferences Questionnaire made by new U. S. Coast Guard Academy Cadets who left during the first week of fourth class summer with those Cadets who remained. Differences were noted in 8 items with the largest disparity centering on the influence of the humanitarian work of the Coast Guard on a new cadet's decision to attend the Academy. A theoretical rationale for early voluntary attrition is suggested from Glasser's Identity Society which focused on a shift in work motivation from power or dominance to involvement and cooperation.

Attrition at all the Service Academies is a topic of current national interest with the release to the general public of a General Accounting Office Study in March 1976. Voluntary attrition at the Coast Guard Academy (USCGA) has been a continuing topic of institutional concern during the past decade (Enger, Mednick, & Fisher, 1972; Rootman, 1970). Historically, institutional concern for voluntary attrition vacillates between viewing it as a healthy and expected outcome of the program to a phenomenon mandating avoidance at all cost. A position between these two extremes is more realistic. The institution should examine itself in light of those who depart voluntarily in order to strengthen its program, thus lowering the potential for future voluntary attrition.

One perspective on voluntary attrition is found in William Glasser's theory concerning work motivation of youth as shown by Table 1. Glasser (1972) chronicles a shift in our society during the last 25 years from a concern with "civilized survival" to one of "civilized identity" (p.13).

Table 1

The Four Societies of Man

Society	*Began*	*Ended*	*Main Motivation*
Primitive Survival	*4,000,000 years ago*	*500,000 years ago*	*Intelligent cooperation*
Primitive Identity	*500,000 years ago*	*10,000 years ago*	*Involvement*
Civilized Survival	*10,000 years ago*	*A.D. 1950 (approx.)*	*Power*
Civilized Identity	*A.D. 1950 to ?*		*Involvement and cooperation*

The author is indebted to Malcolm Williams and Robert DeMichell for consultation, assistance in design, and encouragement

This shift is shown by a change in the work motivation of our youth from power (dominance in the civilized survival society) to involvement and cooperation (as found in the civilized identity society). Consequently, goals (" a profession, a diploma, a home, a family, or power and status" (p.8)) are no longer prime motivators of youth as they were for those born prior to 1940 (p.27). Glasser (1972) states that role (to find oneself as a human being, to become aware of and enjoy the pleasures implicit in our own humanity (p.8)) has replaced goal as a prime concern of youth. As a young person said, "to be me, to enjoy myself, to stand for something, to have my own feeling of being someone, to have friends, to have values, to be accepted by others" is most important (p.52). Glasser (1972) states:

> *"The shift in the identity society role sequence, in which the independent role comes first, is not limited to the more publicized young: the hippies, the demonstrators, and the social dropouts. It is not so obvious in other people, but only a rare young person today is willing to subordinate his identity to security. Although many work and seem to be the same as young people of years ago, they are not. Affluence, political freedom, and television, the three building blocks of the identity society that led to the new role sequence, seem to be so firmly entrenched into our way of life that the young, knowing little except these three conditions, have no reason to give up their search for identity. Their search for independent roles and their demand for goals that reinforce their independent roles have caused great conflict within the weakened but still far from dead power structure." (p.39)*

Rootman (1970) suggests that voluntary withdrawal from USCGA is a means of "coping" with "stress", "defined as the existence of an unresolved problem for the individual". (p.168) This study is designed to investigate the "unresolved problem" in light of Glasser's (1972) thesis. This investigation focuses on comparing answers to common questions from the U. S. Coast Guard Academy Interests, Background, Activities Preferences Questionnaire by cadets from the Class of 1978 who voluntarily withdrew after one week from the fourth class summer program with those who remained. An expected outcome of the investigation was statistically significant differences of at least 15% between the two groups on selected items.

Method

Subjects

All subjects were cadets (N=399) at USCGA during the summer of 1974. They are all males between 17 and 18 years of age but range from 17 to 22 from throughout the United States with a few statistically insignificant exceptions.

Apparatus

All cadets routinely take the U. S. Coast Guard Academy Interests, Background, Activities Preferences Questionnaire (commonly referred to as the Fourth Class Questionnaire) during the second week of fourth class summer. Since the early voluntary resignees (N=37) left during the first week of fourth class summer, a questionnaire was prepared using selected items from the Fourth Class Questionnaire. The first twelve items of the 15 were prefaced

by the question, "Which of the following personal reasons were influential in your decision to attend the U. S. Coast Guard Academy?"

Procedure

In November 1974, early voluntary resignees (N=37) were mailed the abbreviated questionnaire to a forwarding address left with the Academy. The packet included a cover letter requesting their voluntary participation and a franked self-addressed envelope for return. Data from the rest of the Class of 1978 had already been tabulated. By 1 February 1975, 60% (N=22) of the early voluntary resignees had responded and the data were then tabulated. Differences of 15% or more between items were arbitrarily decided as significant by the author and were noted.

Results

An analysis of the results indicated differences of 15% or more between the two groups on 8 of the 15 items. Unless a minus sign is present, the early resignees exceed the rest of the Class of 1978 by the percentage shown on Table 2.

Table 2

Difference by Percentage Between the Class of 1978 (N=362) and Early Voluntary Resignees (N=22) on 15 Common Items

1. Which of the following personal reasons were influential in your decision to attend the U. S. Coast Guard Academy?

A - If very influential or most influential
B - If above average in influence
C - If moderately influential
D - If slightly influential
E - If of no influence at all (or deceased)

	A	B	C	D	E
1.1 - Desire for a good engineering education . . .	-	-	-	-	-
1.2 - Desire for a good college education, not necessarily engineering	-	-	-	-	-
1.3 - To get a good technical education	-	16	-	-	-
1.4 - Need for financial help in order to attend college	-	17	15	-	-
1.5 - Desire not to be a financial burden on my parents	-	23	-	-	-
1.6 - Desire to explore the possibilities of a seagoing service career	17	-	-	-	-
1.7 - Desire to explore the possibilities of a service career (not necessarily seagoing) . . .	-	-	-	-	17(-)
1.8 - Ideal of a service devoted to humanitarian purposes	28	-	-	-	-
1.9 - Definite desire to become a Coast Guard Officer	-	22	-	-	-

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	A	B	C	D	E
1.10 - Because of the prestige of being a cadet . .	-	-	-	-	-
1.11 - Because I really didn't know what I wanted to do, and thought I'd give it a try . . .	.25	-	-	-	-
1.12 - Appeal of the fact that selection was by open competition with no congressional appointments required	-	-	-	-	-
2[a] - At the time you accepted the appointment to the Academy, how sure were you that you wanted a career as a regular Coast Guard Officer	.18	-	-	-	-
3[b] - How did your father, step-father, or foster father feel about your coming to the Academy (if deceased, omit item)	-	-	-	-	-
4[b] - How did your mother, step-mother, or foster mother feel about your coming to the Academy (if deceased, omit item)	-	-	-	-	-

[a]A - Quite certain, B - Rather certain, C - Undecided, D - A little dubious, E - Quite dubious

[b]A - Urged me to come, B - Was pleased that I came, C - Was indifferent, D - Questioned my coming, E - Urged me to go elsewhere

Discussion

From the results of this comparison, the expected outcome of statistically significant differences of 15% or more on certain common items between the two questionnaires was attained. It is interesting to note that parental influence in coming to the Academy did not differ significantly for the two groups. What does differ are the items centering on financial concerns, career, "exploring" or "giving it a try", and the appeal of a service devoted to humanitarian purposes.

The delivery of the abbreviated Fourth Class Questionnaire to the early resignees well after departure from the Academy is a variable unaccounted for in this study. Answering the items four to five months after departure from the Academy in a civilian collegiate setting (77% of the early resignees were enrolled in a four-year college or university) may have had some effect, especially in the financial questions.

The study does not directly support the Glasser (1972) thesis on youth motivation but the data certainly points to further investigation. If role (not goal) and involvement/cooperation (not power) are the prime motivators of youth today, then exploration, lack of early commitment to a career (evident in one of two items), and a high regard for humanitarian work (with all its attendant meanings to youth) may well be elements of Glasser's treatise.

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STRESS MANAGEMENT TRAINING AS RELATED TO SCHOLASTIC PERFORMANCE

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ABSTRACT

High and low anxious academically deficient students received either a program in stress management training which utilized biofeedback techniques or a study habits development program. A demand control group received attention from a concerned faculty member, but did not get a specific program designed to eliminate academic problems. All subjects receiving stress management training significantly reduced their EMG tension level. High anxious students receiving stress management training showed significantly more academic improvement than the demand control group or high anxious students in the study habits condition. Low anxious students showed significantly greater academic improvement after study habits training. The results suggest that one must first identify the problem behind academic deficiency and employ a corrective program designed specifically for that problem, if the deficiency is to be eliminated.

The degree of scholastic achievement obtained by a student is affected by a variety of factors. Among those which are often cited to account for poor academic performance are: 1) test anxiety and 2) ineffective study habits. It would seem reasonable that the detrimental performance effects resulting from these completely different factors cannot be effectively reduced by employing a single, standardized prescription. Since the major contributing factor leading to academic failure is clearly different in many cases, the development of a variety of specific programs, each designed to counteract a different factor responsible for poor performance, would seem to be in order.

For this study, two different programs were developed to aid the academically deficient student. One of these was a stress management program employing EMG feedback techniques. This program was designed to minimize the effects of test anxiety. The other program was designed to deal with ineffective study habits.

EMG biofeedback was included in the stress management program because it has been demonstrated that EMG feedback training is a highly effective method for inducing relaxation (Reinking and Kahl, 1975; Stoyva and Budyznski, 1974), and that the skeletal muscle action potential reflected by an EMG recording is a good correlate of sympathetic arousal (Budyznski and Stoyva, 1972; Malmo, 1966). Thus a stress management program employing EMG feedback would seem to be an effective method to help a student reduce arousal level and the concomitant anxiety produced by the stress of the academic testing situation.

The purpose of this study was to assess the usefulness of the biofeedback-assisted stress management program and the study habits improvement program in aiding the student overcome deficient academic

performance. It was predicted that high anxious students would benefit more from the stress management program than from the study habits program. Conversely, low anxiety students were predicted to perform better after study habits training as opposed to stress management training.

METHOD

Subjects. The subjects were 52 USAFA cadets whose mean GPA was approximately 2.2. Forty-two of the subjects took the IPAT Self-Analysis Anxiety Scale and were dichotomized into high and low anxiety groups. The remaining 10 subjects served as a Demand Control (DC) group and did not take the IPAT Self-Analysis Scale.

Apparatus. Two model B-1 biofeedback devices (Bio-Feedback Systems, Inc.) were used to provide auditory feedback of frontalis muscle tension. Two white noise generators (Hewlett-Packard, Model 8057A, and Layfayette Instrument Co., model 1432) were used to provide a uniform noise environment of 43 DB ± 3DB. Voice communication between the subject and experimenter was permitted through the use of a Rheem microphone which was connected directly to the subject's headset.

Procedure. A double blind technique was used to randomly assign 21 subjects with high IPAT anxiety scores to the Stress Management Group (SM), N = 11, and to the Study Habits Development Group (SHD), N = 10. Twenty-one subjects with low IPAT anxiety scores were divided in a similar fashion with 11 assigned to the SM group and 10 to the SHD group.

Each time subjects in the SM group entered the laboratory, they were instructed to complete one of the eight forms of the IPAT 8 Parallel-Form Anxiety Tests. After completing the IPAT 8 Parallel-Form Anxiety Test (approximately 10 minutes) subjects were seated in a dimly illuminated sound proof booth. After a subject was seated, his forehead was cleaned with alcohol and an electrode strip (Bio-Feedback Systems, Inc.) was attached such that the center (ground) electrode was centered one inch above the nasion and the recording electrodes were located in a straight line two inches to each side of the ground electrode. After subject preparation, the experimenter proceeded to the experimenter station immediately adjacent to the chamber where the recording equipment was maintained. The experimenter established voice contact with the subject through the microphone system after checking instrument calibration. The experimenter could see the subject at all times through a one-way mirror in the chamber. If the subject appeared drowsy at any time, the experimenter would remind him to keep his eyes open and follow all commands.

Stress Management Training. SM sessions were approximately 20 minutes long. The total program consisted of 9 sessions, with two sessions scheduled per week per subject. Subjects were told that they would be trained how to relax and that this would help them perform better on examinations provided that they continued to study to the same extent as they had in the past.

The 9 sessions were divided into 3 blocks: relaxation training, autogenic training, and stress management training. At the beginning of session 1, a 5 minute baseline reading was taken where the subject was simply told to sit

quietly and relax. Then, he was asked to tense and relax selected muscle groups for the remainder of the session. This training was continued for two sessions. No EMG feedback was provided in either of these sessions. Block II consisted of 3 sessions. EMG feedback was continuously provided and the subject was asked to repeat specific autogenic phrases (e.g. my arm is heavy) as he was directed to relax selected muscles. The remaining 4 sessions were in block 3, stress management training. During the first 2 sessions in this block, continuous EMG feedback was provided while the subject was asked to imagine test related stress producing scenes. The third session in this block was identical to the first two except EMG feedback was faded out as the subject improved his performance. The final session was identical to the one preceding it except no EMG Feedback was provided. This was done to reduce the subject's dependency on the EMG feedback signal and to increase his use of internal body cues to maintain a relaxed state, since body cues are all that would be available to the subject outside of the laboratory.

A 2 minute baseline reading was taken at the beginning and end of each session. Verbal feedback was continuously used to reinforce improvement in relaxation ability beginning with the third session.

Study Habits Development Training (SHD). The subjects in this group received a 5 lesson program in study habits development. The 5-lesson written SHD program focused on three main factors: 1) increasing study time and improving efficiency by employing a highly structured self modification program, 2) developing test taking skills, and 3) developing reading flexibility.

Demand Control Group (DC). Subjects in this group met once a week for 5 weeks with one of his current course instructors to discuss the subject's academic progress. The instructor took a sincere interest in his problem(s) and provided encouragement in dealing with the problem(s). The tutor also provided general guidance, but he did not present a structured study program.

RESULTS

Stress Management Training. Mean initial baseline EMG levels for the high anxious subjects (SMH) was 6.51mv while the mean for the low anxious subjects (SML) was 3.85mv, or 45% lower than the SMH group. Reduction in frontalis muscle tension was significant ($F(8,152) = 7.03$, $p < .001$) for both high and low anxious subjects. No significant difference was found between the SMH and SML groups and the anxiety level X EMG interaction was not significant.

IPAT 8-Parallel Form Performance. A repeated measures ANOVA on this data revealed no significant change in the self reported anxiety level over stress management training sessions for either high or low anxious subjects.

Academic Performance. Mean accumulative GPA for the SMH, SML, SHDH, SHDL, and DC groups were approximately equivalent prior to the experiment (2.19, 2.10, 2.25, 2.12 and 2.23 respectively). Post-treatment performance changes

were determined by subtracting pre-treatment accumulative GPA from post-treatment semester GPA, thereby yielding a GPA gain score. Differences in GPA gain scores by treatment condition were analyzed by using the Mann-Whitney U-Test. The group comparisons indicated that the SMH group improved significantly more than the SHDH group (mean ranks 7.82 and 1300 respectively) and the SML group (mean ranks 8.95 and 14.05 respectively). The SHDL group improved significantly more than the SHDH group (mean ranks 5.71 and 10.00 respectively). Finally, the SHDL and SMH groups both improved significantly more than the DC group. All other comparisons were non-significant.

DISCUSSION

The biofeedback, stress management training program was effective in reducing arousal level for both high and low anxious subjects. All SM subjects reduced their EMG level below the desired criterion of 3.0mv. EMG levels did increase during block III sessions employing imaginary stress ; however, end of session EMG levels were well below 3.0mv, thus suggesting that the subjects had learned to quickly abort the anxiety response and return to a minimal tension level. This same rapid return to a minimal level of tension was also observed after the last lesson when EMG feedback was not provided. Apparently by this time the subjects had begun to rely on internal physiological cues to tell them when they were relaxed.

The IPAT 8-Parallel Form anxiety data provides a look at anxiety level as perceived by the subject. The results indicate subjective anxiety level was not lowered concomitantly with the reductions in physiological tension accruing from stress management training. This non correspondence between psychological and physiological parameters of anxiety may be more apparent than real, however. The IPAT 8-Parallel Form asks questions about annoyances, embarrassing circumstances, etc., which are likely to be answered from a subject's prior experiences. Since the IPAT-8 Parallel Form was administered at the same time the subject was getting stress management training, he would have had at best a limited opportunity to employ his newly learned skills for coping with his anxiety in annoying, embarrassing, etc. situations. Therefore, it would seem reasonable that subjective anxiety level as measured by the IPAT 8-Parallel Form would not change by the end of EMG, stress management training. On the other hand, it would seen quite reasonable to expect a change in subjective anxiety once the subject has had time to integrate into his life style his newly acquired stress management skills.

Changes in academic performance resulting from the Stress Management training and the Study Habits Development programs were essentially as predicted. High anxious subjects given stress management training performed better academically than either low anxious subjects given the same treatment or high anxious subjects given the Study Habits Development program. Apparently, one cannot reap the benefits of a study habits program until anxiety is reduced to an acceptable level. This is further supported by the fact that the SHDL group performed better academically than the SHDH group.

It was expected that the SHDL group would out perform the SML group. This prediction was not supported, although the mean group ranks were in the predicted direction. Why this difference was not larger is not clear.

A demand control group was included in this study to control for the Hawthorne Effect. As expected, both the SMH and the SHDL groups out performed the DC group, thereby demonstrating the benefits gained from both treatment programs were more than would be expected from merely devoting general attention to the subjects academic problems. On the other hand, if the treatment program was not correctly matched to the subject's anxiety level, the benefits of the respective programs was no greater than that derived from attention, per se. This was demonstrated by the non-significant difference between the SML vs DC and SHDH vs DC group comparisons.

In general, the results of this study suggest that using a single, standard program to help academically deficient students is not an effective procedure. Rather, it would appear to be necessary to first identify the single most important factor responsible for poor academic performance for a given student and to develop a corrective program to overcome that factor. If test anxiety is the major problem, the stress management program used in this experiment would seem to be a reasonably effective method to use to overcome this problem. The study habits program was also reasonably effective, however, it is likely that more effective programs can be designed.

One should be cautioned against making wholesale changes in study programs based on the results of this study. The number of subjects in each condition was relatively small and therefore the study needs to be replicated before the results are unequivocally accepted. Additionally, it should be noted that the subjects in this study had a prior history of academic success. All were good to excellent high school students who performed well on the College Board Entrance Examination (Mean verbal 545, Mean Quantitative 641). Results obtained with this student population may not in any way reflect what one might expect from a group of students who have known only academic failure.

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TEST ANXIETY DESENSITIZATION: A PILOT STUDY

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This research tests the hypothesis that a program of short-term test anxiety desensitization will reduce test anxiety as operationally defined by scores on the Suinn Test Anxiety Behavior Scales (STABS). Fifty-five cadets were treated for test anxiety. These cadets were selected at random after being referred to the Cadet Counseling Center for study skills help. They were administered the STABS in a simple pretest/posttest design. After an initial interview to determine the appropriateness of the desensitization, the program was initiated using Suinn Test Anxiety Desensitization tapes. Results of a correlated means t-test computed between the samples indicated a significant decrease in test anxiety after completion of the program ($t = 13.54$, $p < .001$).

At the United States Air Force Academy, a cadet begins to take a test in one of his academic courses. It seems clear that some of the cadets are nervous, but this particular cadet is experiencing more than the common level of nervousness. He may have sweaty palms, nausea, a feeling of muscular tightness. He may be unable to think or remember clearly, blocking out test answers that he later realizes he knew well. In addition, he may have spent a great deal of his study time worrying about failing the test.

The symptoms discussed above are all related to a concept called test anxiety, an unusually high apprehension or uneasiness related to test taking situations. Because of the high anxiety level of a number of cadets involved in study skills counseling, it became clear to personnel at the Air Force Academy Cadet Counseling Center that the example above was not an isolated case. There seemed to be significant numbers of ordinarily capable cadets who were not performing to their capacity due to test anxiety. Further, a survey of the literature indicated that this problem applied not only to the Academy, but to college populations in general (Albert and Halber, 1963; Suinn, 1968; and Suinn, 1969).

As Academy counselors searched for the most effective treatment for test anxiety, one method emerged as more consistently successful than any other. This was a behavior modification technique called test anxiety desensitization. This procedure seemed to have been widely used with good success. Paul and Erickson (1964) cite a successful case study of test anxiety treatment by desensitization, and Katahn, Strenger and Cherry (1966) report the effective combination

of desensitization, study skills and personal counseling. Emery and Krumboltz (1967) showed significant test anxiety reduction as reflected by anxiety test scores and self-ratings, and Berkley and Sproule (1973) found that high test anxiety is inversely correlated with good performance in both aptitude and achievement tests. Sessions and Njaa (1973) found that group and individual desensitization were equally effective in successfully reducing high test anxiety, while Allen (1972) reviewed recent research and outlined future trends in the behavioral treatment of test anxiety.

Clearly, test anxiety desensitization has been effective in treatment of test anxiety. To test whether the desensitization would be effective with Air Force Academy cadets was the reason for this study. The hypothesis central to this paper is that a program of short-term test anxiety desensitization will significantly reduce test anxiety of Air Force Academy cadets. Test anxiety is operationally defined by scores on the Suinn Test Anxiety Behavior Scale (STABS). Since high STABS scores indicate high levels of test anxiety, the mean posttest score would be expected to be significantly lower than the mean pretest score ($p < .05$).

Method

Subjects

The subjects were 55 male Air Force Academy cadets randomly selected from among those cadets referred to the Cadet Counseling Center for study skills/test anxiety problems during the period from September, 1975 to January, 1976. The class breakdown of the subjects was as follows:

First Class (1976) - 6
Second Class (1977) - 8
Third Class (1978) - 20
Fourth Class (1979) - 21

The ages of the subjects ranged from 18-21 years of age, with an average age of 19.02 years.

Apparatus

The test anxiety desensitization was conducted by means of prerecorded tape recordings purchased from Rocky Mountain Behavioral Science Institute, Inc. of Ft. Collins, Colorado and developed by Richard M. Suinn. The entire program consists of five tapes that contain general relaxation instructions as well as a standardized test anxiety hierarchy. All subjects listened to the same set of tapes, so voice presentation of the desensitization was standardized.

The STABS provided the emperical measure of test anxiety. Also developed by Suinn and marketed by Rocky Mountain Behavioral Science Institute, the STABS is a 50-item, self-report scale composed of statements describing testing situations. The subject responds by indicating the level of anxiety aroused in him by each situation described. High scores on the STABS indicate a high level of test anxiety.

Procedure

All subjects were first interviewed to determine if test anxiety desensitization was appropriate for them. Criteria for treatment were anxiety specifically related to testing situations and the absence of any serious pathology. Both criteria were determined by the counselor conducting the interview.

The treatment program itself consisted of seven individual sessions. In addition to administering the STABS as a pretest, the first session was used to discuss the basic idea that test anxiety is learned and can thus be unlearned and to explain the desensitization procedure. Each counselor met with each of his clients before and after sessions two through six, the sessions when the cadet was listening to the tape recordings through stereo headphones in a private room. This contact was considered absolutely essential to monitor progress and check for problems developing as a result of the test anxiety hierarchy. Session seven consisted of a discussion of the overall program and both the counselor's and cadet's assessment of progress during the sessions. The STABS was also administered as a posttest at this time.

Results

Following completion of treatment, a correlated means t-test was computed to compare mean pretest and posttest scores. The results are shown in the following table:

Table 1
Means, Standard Deviations, and t-test for STABS pretest/posttest

	Mean	SD	t
Pretest	122.49	24.87	13.54*
Posttest	82.00	17.29	

(*$p < .001$, $df = 54$, $r = 0.57$)

Discussion and Conclusion

The results reported here indicate that test anxiety desensitization can be successful in reducing the reported test anxiety of Air Force Academy cadets.

Additionally, cadets reported a very high degree of satisfaction and perceived progress with the program and felt that test anxiety reduction had generalized so that they experienced a reduced anxiety level in other areas of their Academy life.

While results of the research were significant, further research efforts are needed. Ideas for future research include studies that contain control group data, studies that compare desensitization to other methods of anxiety reduction and studies concerning the effectiveness of forming test anxiety treatment groups.

The central hypothesis tested in this research was that a test anxiety desensitization program would reduce test anxiety in Air Force Academy cadets. The results support this hypothesis, if only on a preliminary basis. The authors hope that future research in this area will lead to definitive indications of the value of desensitization treatment programs at the Air Force Academy and to optimized conditions for desensitization.

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SESSION 5-B

Human Factors

Chairman: Joh F. Swiney

HUMAN FACTORS EVALUATION OF TRAINING METHODS[1]

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Traditionally the Army has had two separate initial training programs to transform a civilian into a useful combat arms soldier. The first program is Basic Combat Training (BCT). This eight-week training cycle is designed to provide the new enlistee with the basic skills necessary to function within the Army environment (i.e., marching, marksmanship, military discipline, and courtesy, etc.) The second program, Advanced Individual Training (AIT), is generally a seven to twelve-week training cycle which prepares the new soldier for entering a military job at the basic entry skill level. The dual training system at times becomes repetitious in subject matter, requires a duplication in administrative and logistical support, and is costly in terms of transporting the trainees from the BCT site to the AIT site. Research by this author has shown that BCT units have developed a high degree of group cohesiveness and responsiveness during the latter weeks of their BCT cycle. This group productivity is lost when the trainees are split up and reassigned for AIT and the group developmental process must begin again. Valuable time is lost in reformation and a second traumatic adjustment period is forced upon the trainee. The Army has questioned the wisdom of this dual training system and in 1974 began a One Station Unit Training (OSUT) Program which has new soldiers remaining in the same unit for both BCT and AIT. The question was, which training method was best.

Problem

This question could be answered in several ways: Was it less costly? Were end of cycle scores (i.e., physical training, proficiency rests, marksmanship) higher? Were redundant processes eliminated? These answers are readily obtainable by simply recording statistics. The real question should not only include the above but should also take into account the human variables which become an inherent part of any "people-changing" process. Does the new system produce a soldier who is just as good or better than the old system?

1. OSUT TEST PROJECT July-December 1975.

Method

An Army Infantry Training Post was selected to test three training methods (the traditional BCT/AIT Process, a 15-week single unit, and a reduced 11-week BCT/AIT Program in a single unit). A program was designed to collect data (end of cycle proficiency scores, disciplinary and administrative action statistics, etc.) on the training results of the three methods in an attempt to evaluate which method might be best. The author designed a program to assist the Post in determining if the end of cycle training results were related to the different methods of training or if some human variable (i.e., intelligence, education, leadership, unit management, or leadership, motivation, etc.) might account for any differences. A fifty item questionnaire was developed to collect data on each test unit. The questionnaire was designed in five parts to provide information on demographic variables, training procedures, unit management, training environment, and job satisfaction. All units are to be compared with each other to determine if any units are not alike in any of these five areas. The data from the units will be grouped according to the type of training (training method) each unit receive and an analysis of variance (ANOVA) will be conducted to determine if any significant human factor differences do exist. The presence of human variable differences might suggest that training results are more a reflection of human factors than training methodology.

Results

Biographic/Demographic Data:

Trainees - Results thus far suggest that the trainees in each company are similar in their backgrounds.

Cadre - Results thus far reveal some background differences among the cadre but probably insignificant.

Training Data:

Trainee - No differences noted in their perception of training variables.

Cadre - Differences noted which could have an effect on training outcome.

Unit Management:

Trainees - Some minor differences noted but probably insignificant.

Cadre - Some differences noted which could have an effect on training outcome.

Job Satisfaction:

Trainees - Very minor differences noted, probably insignificant.

Cadre - Some differences noted which might have an effect on training outcome.

Conclusions (Preliminary):

The results indicate the surveyed human factor variables within the trainee test population do not significantly differ between test units. This would suggest that any differences in training outcome would not be a reflection of the surveyed trainee human factor differences.

On the other hand, cadre human factor variables (other than biographical/demographic) differences are noted and there might be a relationship between training outcome and these human factor differences. Until the final evaluation is completed, the only valid assumption which may be made is that this relationship might exist.

HUMAN ENGINEERING DESIGN DEFICIENCIES: A COMPARATIVE ANALYSIS OF THE P-3 and S-3 AIRCRAFT

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Engineering design deficiencies reported during Board of Inspection and Survey Trials involving the P-3 and S-3 aircraft were examined to determine deficiencies of a human engineering nature. The critical incident technique was used to catalogue, describe, and analyze these human engineering design deficiencies in both aircraft. From the 231 P-3 and 540 S-3 recorded deficiencies, 104 P-3 and 224 S-3 human engineering deficiencies emerged. These human engineering deficiencies were categorized according to (a) related system components, (b) design principle infractions, and (c) related operator errors. This categorization procedure provided a relative comparison of the most prevalent types of system component deficiencies, violations of human engineering design principles, and design induced operator errors. The system related deficiencies were sorted into 10 system component categories. Display and control components accounted for 78 percent and 75 percent of the P-3 and S-3 total human engineering design deficiencies, respectively. The results of this investigation suggest that, although the airframes of the two aircraft are dissimilar, there is a basic similarity in their number and types of human engineering design deficiencies. Also, design induced operator errors were different in relative frequency than was found by earlier investigators.

The purpose of this study is to present the results of the application of the critical incident technique in cataloging, describing, and analyzing the various kinds of engineering design deficiencies reported in specific naval aircraft during Board of Inspection and Survey (BIS) Trials. The airplanes selected for this study were the P-3 and S-3 antisubmarine aircraft. The critical incident technique can provide detailed analysis of reported system design errors which in turn can provide insights into the relationship between design error and related operator performance. This relationship between system design and operator performance can provide useful information in terms of system design and system test and evaluation.

The P-3 and S-3 aircraft are typical of systems that are developed and evaluated by the Naval Air Systems Command (NAVAIRSYSCOM) under the Navy's organizational structure. To conduct evaluations the NAVAIRSYSCOM has two test centers - the Naval Air Test Center (NAVAIRTESTCEN), Patuxent River, Maryland, which is charged with the overall weapon system test and evaluation coordination and the Pacific Missile Test Center (PACMISTESTCEN), Point Mugu, California. It is the responsibility of the BIS Trials to insure that the aircraft procured by NAVAIRSYSCOM meet specification requirements and are suitable for Navy use.

The BIS Trials are a formal procedure to determine if the aircraft are suitable for service use and whether or not the contractor has met the performance requirements of the contract. The BIS places each deficiency in one of three categories: (1) mandatory for correction prior to acceptance by the Navy; (2) corrections that will result in significant impovements of the aircraft; or (3) corrections that will improve the service capability of the aircraft.

The deficiencies noted relative to a particular aircraft or weapon system during the BIS Trials results in a final report that combines specifically noted engineering deficiencies and subsystem performance summaries. Each engineering deficiency must contain a detailed description of the deficiency to the extent that each deficiency is capable of standing alone. It will include which design specification was violated along with cross references to related deficiencies or other reports as appropriate.

METHOD

The critical incident technique developed by Flanagan (1954) appeared to be quite applicable to the aims of the present investigation, which was to catalogue, describe, and analyze the various types of human engineering design deficiencies. The incidents with which this technique deals are descriptions of directly observable events which are sufficiently complete in themselves to permit inferences to be made about operator related errors.

Engineering deficiency data involving the P-3 and S-3 aircraft were obtained for the periods between October 1969 to November 1970 and October 1973 to October 1974, respectively, from records kept on file at BIS, NAVAIRTESTCEN, Patuxent River, Maryland. For this investigation, a human engineering design deficiency was defined as any inadequacy in a system component which impacted directly or indirectly on operator performance.

In order to classify human engineering design deficiencies in terms of system hardware components, the following specific categories were adopted: display, control, workspace, lighting, life support, escape egress, seats, parachutes, canopy, and weapons systems. Due to the large number of display, control, workspace, and lighting deficiencies, further categorization of these items was conducted.

Since display and control deficiencies have in the past accounted for a large percentage of human engineering design deficiencies and that these deficiencies have substantial relationship to operator performance, an indepth analysis of these components was conducted. Displays were defined as any device designed to provide information to the operator or decision maker. Controls were defined as any device designed to enable the operator to start, stop, or otherwise intervene in the operation of a system.

To further understand how well displays and controls were integrated into the original design of the systems, an in-depth survey of several current human engineering guides provided a number of display and control design

principles which are used by design engineers to insure the inclusion of good human engineering design practices. By combining the design principles found in the various human engineering guides with information provided by human engineers with field experience, a list of display and control design principles emerged and were used for categorizing deficiencies.

An earlier study by Fitts and Jones (1947) revealed a substantial relationship between display and control design deficiencies and operator performance. Using the results of Fitts and Jones and combining data obtained from various human engineering guides, categories of display and control induced operator errors were developed.

RESULTS AND DISCUSSION

The results of this study indicate that there were substantial numbers of human engineering design deficiencies in relation to total engineering deficiencies encountered in both the P-3 and S-3 aircraft; and that the human engineering design deficiencies had similar patterns in both aircraft when comparing the types of (a) human engineering deficiencies, (b) control and display design principle violations, and (c) operator errors induced by poor controls and display design. The frequency of operator errors related to inadequate control and display design were substantially different than those found by Fitts and Jones. There was almost a completely reversal in rank ordering in each category of control and display related errors. For example Fitts and Jones reported that errors of interpretation caused by poor legibility or inaccurate display information was ranked last while in this study it was the most frequent category of operator errors.

On the basis of the comparisons of engineering design deficiencies between the P-3 and S-3 aircraft, the following conclusions regarding human engineering design deficiencies and operator performance were drawn:

a. There were substantial numbers of human enginering design deficiencies in relation to total engineering deficiencies encountered in both the P-3 and S-3 aircraft.

b. The human engineering design deficiencies in both aircraft had similar patterns in control and display design principle violations and operator errors induced by poor control and display design.

c. Human engineers should develop methodology for eliminating the disproportionally large number of basic human engineering design deficiencies.

d. Human engineers in the test and evaluation process should develop methodology for detecting deficiencies in complex as well as simple control and display systems.

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COLLISION AVOIDANCE RESPONSE STEREOTYPES IN PILOTS AND NONPILOTS

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Two studies were conducted to investigate the effects of target variables upon pilot and nonpilot collision avoidance responses to simulated approaches which were head-on or nearly so. Study I investigated the effect of bearing and found that nonpilots preferred to turn left in a head-on approach. Although pilots generally turned right under the same conditions, 25% exhibited the nonpilot left-turn response. Study II examined the effects of bearing and collision index (a geometric construct representing an index for optimal response selection) upon the responses of 24 pilots. Two subgroups appeared, one apparently attending primarily to bearing while the other attended to aspect. Only one subject appeared to use the optimal collision-index construct for response selection.

Introduction

A hazard encountered in present high-density air traffic operations is the mid-air collision. Crook (1972) indicated that the majority of mid-air collisions were occurring under VFR conditions and at or near uncontrolled airports, situations where the pilot was responsible for maintaining adequate separation by visual means. The pilot, as such, is required both to detect and avoid, unaided, intruding aircraft. It appears necessary, then, to examine both pilot detection of targets and subsequent maneuver selection.

Attempts to aid the pilot in the detection of other aircraft have involved various types of detection devices. These proximity warning indicators (PWI's) have taken several forms which range from a simple range penetration warning to the display of target range, bearing, and elevation. It was necessary for the pilot to select an appropriate response after evaluation of the available information.

An extension of this aiding concept allocates response selection to a collision avoidance system (CAS), thus removing responsibility for approach evaluation from the domain of the pilot (Bates, 1968). A recent report to the Congress (Department of Transportation, 1974) indicated that such systems are as yet prohibitive in cost. The responsibility for both detection and response selection appears, for the present, to remain with the pilot. It seems appropriate, then, to examine pilot behavior in these tasks as affected by salient factors in the immediate environment.

Two phases of experimentation were designed to evaluate the effects of selected target and individual experience variables upon response selection in simulated head-on or nearly head-on approaches. Two target variables, aspect and bearing, should allow the pilot to determine the geometry of the approach and select an appropriate maneuver. Pilot experience could effect both the selection and execution of the maneuver.

Study I

Method

Three groups of 12 subjects each, composed of male nonpilots, female nonpilots, and male pilots respectively, were tested in a Link GAT-1 flight training simulator. The flight control task required all subjects to maintain the simulator in a level flight attitude with pitch and roll motion active. Nonpilots received a short period of instruction in controlling the pitch and bank of the simulator. Instruction continued until reasonable competence at simulator control was achieved.

The collision avoidance task required subjects to detect and avoid target aircraft having a head-on aspect and bearings between 355 degrees (5 degrees left) and 005 degrees (5 degrees right) in one-degree increments. The avoidance maneuver was to consist of a turn to one side of the established flight path. Upon termination of the 2-second duration stimulus (a Cessna 177 silhouette) subjects were to return the simulator to a level flight attitude. Static targets were used because little or no relative motion is present in an actual collision approach.

Stimuli were presented in a predetermined random order with randomly selected interstimulus intervals ranging from 8 through 14 seconds. Five presentations occurred at each bearing with the exception of 0^{o} where ten presentations occurred. Center presentations were balanced such that half were preceded by left-of-center targets and half by right-of-center targets. The targets were positive contrast silhouettes superposed, at the horizon, upon a rear-projected horizon display showing blue sky and green ground. The targets subtended approximately 2 degrees of visual arc which corresponded to an apparent distance of 350 yards. Pitch angle, bank angle, and stimulus event were recorded by a two-channel paper strip chart recorder. Pilot experience variables (flight time, ratings, recency) were assessed by post-test questionnaire.

Results

A two-way analysis of variance was conducted on the scores representing frequency of a left turn. Effects of both bearing ($p < .0001$, $F = 75.47$, $df = 10,330$) and group membership ($p = .01$, $F = 5.21$, $df = 2,33$) were significant. The interaction, however, was not. The median probability of a left turn increased from 0 at 3^{o} to 1 at 5^{o} fright for all groups (excepting the females who began at .1 and went to 1). Scheffe' post hoc comparisons at zero degrees bearing showed no reliable difference between the nonpilots but revealed that these groups combined exhibited a significantly different median probability of a left turn (males = .80, females = .60) than did the pilots (.25). Three pilots, however, exhibited a left-turn response bias. This confirmed an earlier finding (Beringer, 1971) which showed 25% of the pilot population exhibiting a left-turn bias.

Discussion

Education of pilots concerning the regulation which requires a right turn to avoid a head-on collision would appear to be less than 100% effective. Although all pilots sampled indicated correct knowledge of the regulation, the actual response selection appeared influenced to some extent by the nonpilot stereotypic left-turn response.

Study II

The second phase of experimentation expanded bearing values to cover from 20 degrees left to 20 degrees right in five-degree increments. Values of aspect were paired with bearing to obtain 7 values of collision index (bearing minus aspect). A collision index value of zero degrees indicated a collision course. Increasing values paralleled increasing divergence of the target from a collision path.

Although some presentations represented noncollision approaches they did represent near misses. The close target proximity, small divergence angles, and requirement for immediate response suggested that a static presentation would suffice for the limits of the study.

Twenty-four pilots participated in the second study. The tasks and data measures were the same as in Study I with the exceptions just noted. A warning tone of 3500 Hz at 8 beeps per second was added to the stimulus presentation to indicate the presence of a target and thus reduce the probability of a missed detection. For this phase the targets were silhouettes of a Cessna 150.

Results

Three possible strategies of response were developed based upon bearing, aspect, or collision index. For the bearing strategy all targets left of centerline would produce p(left) = 0 and those right of centerline would produce p(left) = 1. The aspect strategy would produce p(left) = 0 for all right aspects (target nose to observer's left) and p(left) = 1 for all left aspects (target nose to observer's right). A collision-index strategy would produce p(left) = 0 for pass-left values and p(left) = 1 for pass right values. A zero value for any of the above variables should produce p(left) = .5 for its respective strategy (response ambiguity).

Matching by covariance allowed subjects to be grouped by response pattern. This method uncovered two groups of nine subjects each. Data from each group was plotted against the curves predicted by each of the three response strategies. Very close matching was obtained for the bearing and aspect strategies. Linear regression slopes were nearly identical while the intercepts were of lower value for the obtained data than for the predictions. This reflected the general tendency of pilots to turn right in head-on approaches. One of the six subjects remaining appeared to use the collision index strategy. The other five were unclassified (mixed strategies).

Control reversals were restricted primarily to the group which was aspect oriented. The location and type of reversals suggested that bearing was competing with aspect. These results implied that bearing was the more immediate determiner of response while aspect evaluation might occur at a later stage.

Although a large number of pilot experience variables were examined in the questionnaire, none appeared to have any reliability as a predictor of performance. A further examination of other individual differences might be warranted.

Summary and Conclusions

It is clear that the nonpilot left-turn response stereotype conflicts with the Federal Aviation Regulation right-turn requirement. The small likelihood of regulation modification suggests an intensification of training and education to counteract the initial population response bias. The nonuniformity of pilot response to variations in aspect and bearing suggests further research to more clearly define the processes underlying approach evaluation in the absence of motion cues. Relative motion, when available, remains as the best cue for determining whether or not a collision approach is present.

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PERFORMANCE CORRELATES OF ANTHROPOMETRIC VARIABLES

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Performance in a task which simulated elements of air combat flying was analyzed to determine if differences existed as a function of whether or not cockpit man-machine geometry incorporated the effects of variables such as postural slouch and displacement caused by items of aviators' personal equipment and actual restraint systems used in military flight operations. Results revealed significant performance differences between historically used cockpit design-eye-position criterion and criterion proposed as a result of this research. This investigation was conducted during doctoral research at Texas Tech University.

This study involved a comparative analysis of simulated tactical flight performance (a night intercept and attack mission featuring display monitoring, target classification, and weapon firing). The comparative element of the research was based on performance scores resultant from cockpit configurations derived from anthropometric design criteria specified via: (a) previous methods of criterion establishment ("historical" standard anthropometric chair techniques), and (b) current methods which include realistic postural variables. It was hypothesized that significant differences in measured psychomotor performance as correlates of anthropometric variables would occur.

Earlier anthropometric research by Gregoire and Benta (1974) identified dimensional differences between (a) traditional anthropometric measurement data which is typically used as aircrew station design criteria (MIL-STD 1333), and (b) more realistic data which includes variables of posture slouch, body displacement due to items of aviators' clothing and equipment, and variances which are a function of lap belt and shoulder harness restraint systems typical of tactical military jet airplanes. A critical item specifid by MIL-STD-1333A is the location of the design-eye-position (DEP). The DEP is the source point from which engineers work when designing a cockpit. Controls, displays, ejection systems, and other man-machine interfaces within cockpits are based on the relative orientation to the "standard" DEP. The design dimension for the DEP specified from the historical Naval Aviator Anthropometric Dimensions is 80.01 cm (31.5 in.) above the neutral seat reference point (NSRP). This dimension represents the eye position of the 50th percentile aviator (Gifford, Provost, & Lazo, 1964), as measured while sitting in a standard 90° seat/back anthropometric chair

without wearing the aviator's clothing and equipment actually worn during flight. The hypothesis that significant differences existed between DEP data derived from a more realistic setting (actual torso restraint system and ejection seat) was confirmed in that the average in-flight eye position for the subjects previously researched was 3.94 cm (approximately 1.5 in.) lower in the cockpit environment than that measured by traditional methods.

METHOD

Subjects

The number of subjects required to determine a difference of .25 standard deviations between means (at the .05 level of significance) 80% of the time was computed to be fifty. The subjects were 40 undergraduate and graduate students as well as 10 pilot trainees from an Air Force flying training base. The college students were anthropometrically screened to meet flight training physical requirements.

This study sought to determine if differences in cockpit design criterion relative to the design-eye-position would result in performance differences during simulated flying tasks. The construction of a full scale mock-up of the actual measurement environment, a tactical military jet cockpit, provided the realistic framework within which to analyze this particular anthropometric human factors design problem. Such a mock-up provided the necessary ancillary variables such as the restraint system, pilot-control juxtaposition, and physical accouterments which limit dynamic anthropometric freedom in actual flight operations. Additionally, this investigation involved the design of an electro-optical head-up display (HUD) representative of those devices typically found in military tactical jet aircraft currently being developed.

As impressive as HUD technology is relative to combat aviation, there are also problems inherent in its application. One important problem concerns focusing limitations. Due to the combining-glass properties of HUDs, the entire field of view on a HUD focuses or "funnels" from the entire display surface down to a small area ("keyhole") between 3.81 and 11.54 cm in diameter at the pilot's eye location. In the experimental mock-up apparatus, an adjustable aperture device was designed to "funnel" display vision and control viewing height. Due to the complexity of aircraft HUDs and other types of electro-optical displays, the keyhole cannot be adjusted to various sitting-eye heights; the keyhole location must remain stationary. Thus, with the advent of sophisticated electro-optical devices and higher performance tactical military aircraft in the near future, it becomes more critical than ever to accurately analyze and define the sitting eye height dimension and Design Eye Position to serve as a criterion for human engineering design applications.

Procedure

To use the apparatus as a performance evaluation tool, the subject's task consisted of simulated night combat flights. While completely attired in actual flight clothing and equipment and being secured to an ejection seat via a locked torso restraint system, the subject tracked, identified and fired upon targets by using the aircraft control stick, weapon trigger, and electro-optical display device. The dependent variable was the number of "kills" scored per mission.

The treatment conditions included: (1) viewing a display from an eye position based on traditional measuring techniques (erect); (2) viewing the display from the same position as (1) with the exception that supports were used to prevent or relieve fatigue (supported) and (3) viewing the display from a position 3.81 cm lower than (1) to accommodate the postural displacement resulting from: (a) wearing aviator's equipment, (b) torso restraint body retention, and (c) normal upper body slouch which is common in sitting positions.

Results

Actual results indicated that the mean performance scores in the actual condition were significantly better than either the supported or erect conditions. The untransformed data is presented in Table 1.

TABLE 1

UNTRANSFORMED DATA DESCRIPTION

Treatments	Mean Kill Scores	S.D.	Variance	Standard Error
Erect	30.68	17.26	297.23	2.44
Supported	23.54	16.86	284.37	2.38
Actual	41.04	17.51	306.45	2.48

A randomized block factorial analysis of variance as outlined by Kirk (1968) was then applied to the kill scores (Table 2) to analyze performance over time. The time span of each trial condition was blocked into fourths such that each 12 minute treatment condition was analyzed in 3 minute segments. Post hoc power was found to be .79 for an effect size of .26.

TABLE 2

RANDOMIZED BLOCK FACTORIAL ANALYSIS OF VARIANCE
SOURCE TABLE KILL SCORES

Source	SS	DF	MS	F
B Time	4.51	3	1.50	1.01
A Treatments	726.49	2	363.25	243.95*
AB	8.81	6	1.47	.99
Residual	802.60	539	1.49	
Total	11822.32	599		

*$p < .001$.

A comparison of paired means utilizing Tukey's multiple comparison test (HSD) demonstrated that there were significant differences between the erect and actual as well as between the supported and actual treatment conditions at $p < .91$.

The absence of significant performance differences over time independent of treatment condition suggests the posture/position variable as the most plausible explanation of the performance differences which resulted as a function of treatment condition. The rationale for such an explanation is straightforward; it is typically difficult for people to sit perfectly erect (at a 90^{0} angle from seat and back surfaces). People usually exhibit a degree of slouch when sitting, regardless of whether the task is working at a desk, driving a car, eating a meal, flying an aircraft, etc. The majority of chairs and other seating devices incorporate a nonvertical back surface. Generally, the upper portion of seat backs slant to the rear approximately 15^{0} to accommodate support of the spinal column in a nonvertical position. With the above considerations in mind, it is suggested that although slouch generally has a negative connotation, it is probably a more common (normal?) condition than is a perfectly erect posture.

The hypothesis that decrement results from the misapplication of anthropometric data in particular human engineering designs is indicated in this research relative to the design eye position which is critical in tactical military aircrewstations.

It is suggested that a more realistic approach be employed in the use of basic anthropometric data in human engineering applications. The multitude of psychological and physical variables which influence and alter performance in man-machine interactions should certainly include anthropometric differences in humans as well as equipment designs which influence those anthropometric characteristics.

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THE EFFECTS OF MODERATE NOISE LEVELS, ANXIETY, AND TASK DIFFICULTY ON BEHAVIORAL AND PHYSIOLOGICAL RESPONSE INDICANTS

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Seventy-three male upperclassmen were dichotomized into either High or Low Anxiety groups. Each subject experienced a household noise profile under a quiet (50 dBA), intermittent (84 dBA), and continuous (84 dBA) noise condition, while performing either an easy or difficult pursuit tracking task. Each subject performed two successive tracking tasks. Heart rate, electromyographic potentials, and tracking error responses were evaluated. Results for the first tracking task indicated task difficulty, noise condition, and anxiety level accounted for a significant proportion of the variance in tracking error, but not in heart rate or EMG change. In the second task, only EMG changes reflected significant relationships with task difficulty and noise condition. There were also significant interactions between noise and anxiety; task sequence, noise conditon, and anxiety; task sequence and noise.

An examination of recent research on noise as a public health problem reveals great controversy and disparate results. One likely reason for the lack of consistency in research findings is the wide range of variables which interact with noise in producing behavioral effects. For example, sex (Kumar and Mathur, 1969), age (Mathur, 1972), and social class (Anderson, 1973) can all modify noise effects.

Despite the controversy surrounding noise as a stressor, the effects of extreme noise envioronments on threshold shift and hearing loss are well established. However, there seems to be little appreciation for the effects of moderate noise on non-auditory physiological responses and behavior. Bull (1973) noted decreased tolerance for ambiguity in such a noise environment. Edsell (1973) observed an increase in negative perception of others. Glass and Singer (1973) discovered that frustration tolerance decreases. These studies indicate that the organism pays a psychological price for exposure to ordinary noise levels. Perhaps this psychological deficit is accompanied by physiological changes as well.

The above considerations indicate the effects of noise, especially at moderate levels, are elusive and depend, at least to some extent, on other factors. With this in mind, the current research was conducted to: (1) specifically assess a moderate noise profile to which a large proportion of both urban and suburban dwellers are exposed on a daily basis; (2) examine these effects on a relatively homogeneous sample; and (3) provide more adequate control, in terms of research design, of individual differences which could potentially contribute to between group differences in noise response.

Method

Subjects

Seventy-three male junior and senior Air Force Academy Cadets from upper division Behavioral Science and Life Science classes volunteered as subjects. The subjects were dichotomized based on the Institute for Personality Ability Testing "Anxiety Scale Questionnaire" as High Anxiety (above the median score) or Low Anxiety (below the median score). Each subject was then assigned to one of four task sequence groups resulting initially in eight cells of ten subjects each. Seven subjects failed to complete all trials.

Design

A 2 X 3 X 4 factorial design was employed. Forty subjects served under each of the two anxiety conditions (High, Low). Ten subjects served under each of four task sequence conditions (Easy-Easy, Easy-Difficult, Difficult-Easy, Difficult-Difficult) within each anxiety condition. Each cell of ten subjects experienced the three noise conditions (Quiet, Intermittent, Continuous) in a counterbalanced, repeated measures sequence.

Apparatus

Ventilated, audiometric examination booths provided a controlled acoustic environment. Each chamber was equipped with a dual trace oscilloscope which displayed a randomly moving horizontal "target" line and a subject "controlled" line. The subject's task was to superimpose the "controlled" line, by means of a gimballed joystick, over the target line. A digital multimeter provided real-time cumulative tracking error feedback to the subject. A white noise generator provided 50 dBA of acoustic masking. The experimental variable noise was introduced via AR2-AX speakers using Crown high fidelity amplifiers and tape recorder. An intercom provided communication with the subject.

The audio input consisted of a combination of magnetically recorded pink noise and narrow band gaussian noise which was real-time 1/3-octave band shaped and amplified. The profile represented 84 dBA of typical suburban household noises. Primary spectral energy content centered between 200 and 3000 Hz, with a peak at 400 Hz. The final audio profile was verified by real-time 1/3-octave band analysis in the sound chamber at subject ear level.

Subject tracking error was determined by an analog computer and then magnetically recorded on an FM instrumentation recorder. Electrocardiograph (EKG) signals were processed through a Biomedical-Tachometer Coupler and magnetically recorded. Electromyograph (EMG) signals from the frontalis muscle group were also recorded. The subsequent analog data were processed and digitally analyzed.

Procedures

Subjects were seated in the chamber and the EMG and EKG electrodes were attached. Subjects were instructed to relax and cautioned against extraneous movements. One minute of baseline physiological data was recorded [illegible]

min after the chamber was closed. Two min of taped instructions followed. After a brief question and answer period, subjects were exposed to two 5-min experimental periods with a 1 min rest between periods. During the first 4 min of each 5-min period, the subject received tracking error feedback via the digital multimeter. During the last minute the multimeter was turned off and EKG, EMG, and tracking data were recorded. Tracking task difficulty was manipulated between the two periods as described previously and remained the same for a given subject. Each subject served under each of the 3 noise conditions on different days.

Results

Multiple stepwise regression analysis was used to evaluate the contribution of the independent variables to the dependent variables. Coefficients of determination were compared using an F test.

In the first tracking task, the three independent variables account for a significant ($F = 12.20$; $df = 3, 156$; $p < .01$) but relatively small ($R^2 = .19$) proportion of the tracking error variance. The contribution of task sequence alone ($R^2 = .16$) represents the difference between the easy and difficult tracking tasks. Comparison of group means using the Newman-Kuhls procedure showed that in all conditions tracking error was significantly ($p < .05$) higher for the difficult task. The three independent variables were not significantly related to either heart rate or EMG. There were no significant interactions for the first tracking task.

In the second tracking task regression analysis revealed no significant effects of the independent variables on tracking error. However, multiple analysis of variance reflected a significant main effect for task sequence ($F = 28.20$; $df = 3,130$; $p < .001$). The easy to difficult transfer resulted in the most debilitating effects for all noise groups but was most pronounced for the intermittent and quiet groups. Intermittent noise proved most debilitating for the high anxiety group but low anxiety subjects performed most poorly under the quiet condition. There was also a significant ($F = 2.56$; $df = 2,130$; $p < .10$) main effect for noise condition on tracking error. Newman-Kuhls comparisons of column means showed significant ($p < .05$) differences for: high anxiety intermittent noise versus high anxiety continuous noise; high anxiety quiet versus high anxiety intermittent noise; high anxiety intermittent noise versus low anxiety intermittent noise; and high anxiety intermittent noise versus low anxiety continuous noise. There were significant interactions for task sequence X noise condition ($F = 3.57$; $df = 6, 130$; $p < .01$), noise condition X anxiety ($F = 4.85$; $df = 2,130$; $p < .01$), and noise condition X task sequence X anxiety ($F = 3.53$; $df = 6,130$; $p < .01$).

There were no significant relationships with heart rate for the independent variables. Regression analysis revealed that the independent variables were significantly related to EMG changes ($F = 3.09$; $df = 3,150$; $p < .05$).

Discussion

Results of this study support previous research findings with respect to the importance of considering personality variables when attempting to explain noise effects on motor skill performance. The present results also attest to the interactive nature of noise effects. The general absence of mean

differences on both heart rate and EMG as a function of noise indicates a lack of utility of these measures as indicants of noise stress. The complicated nature of noise interactions with other variables calls for further analysis of the current data and further research before attempting to subsume the results under a general theory of noise effects.

The practical implications of these results are many. For example, perhaps more care should be taken in designing appliances, heating systems, etc. to attenuate even moderate noise. This could improve the psychological well being of those exposed to such noise. We should investigate the possibility that moderate airplane noise leads to deterioration of pilot psychomotor performance, even as moderate noise influenced performance in the present study. Other implications may be evident to the reader.

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MIXED-FACTORS CENTRAL-COMPOSITE DESIGNS IN HUMAN PERFORMANCE RESEARCH

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A hypothetical problem is used to illustrate the construction of two mixed-factors central-composite designs (CCD). Subsequently, the two designs are compared with respect to experiment size, redundancy, subject requirements, appropriate data analyses, design efficiency, and coefficient biases. In addition, a series of visual target detection studies, using time-compressed displays, provide data to compare the predictive validities associated with second-order polynomial models fitted to data collected in accordance with each of the two designs. Given the aim of developing a complete second-order prediction equation of acceptable validity, both theoretical and empirical comparisons indicate that the more economical of the two mixed-factors CCDs is the preferable way to incorporate within-subject and between-subjects factors into a single study.

A common assumption in human performance investigations is that a particular function, or response surface, exists that describes the "true" relationship between some specified performance and a set of system parameters. One particularly economical experimental design that human performance investigators have borrowed from chemical research to explore response surfaces is Box and Wilson's (1951) second-order central-composite design (CCD). Since the CCD was first incorporated in human performance research, the original design has been variously modified to make it more appropriate for research involving human subjects (Clark and Williges, 1973). The current paper discusses two recent CCD modifications that permit joint consideration of within-subject and between-subjects factors. These two mixed-factors CCDs are compared on both theoretical and empirical grounds to determine if either design is a preferable way to incorporate both factor types in a single study.

Theoretical Comparisons

Suppose one wants to determine a complete second-order polynomial equation that expresses the level of some performance as a function of s = 3 within-subject and t = 1 between-subjects factors. An appropriate Version 1 mixed-factors CCD (introduced by Clark, Scanlan, and Williges, 1973) is constructed by first determining a basic three-factor CCD involving the within-subject factors (Clark and Williges, 1972). The 15 unique conditions so determined are then completely crossed with five levels of the between-subjects factor, resulting in a total of 75 unique conditions. Different subjects are assigned to the set of $(2^s + 2s + 1)$ or 15 conditions occurring at each of the 5^t or 5 between-subjects factor levels. Version 2 is constructed by initially disregarding the within-subject or between-subjects status of all factors and by determining experimental conditions strictly in accordance with a K-factor CCD, where K = s + t. Subjects are assigned to the resulting $(2^K + 2K + 1)$ or 25 unique conditions such that no subject experiences more than one level of the between-subjects factor(s).

The most immediate benefit of Version 2 over Version 1 is the marked reduction in experiment size, from 75 to 25 unique conditions for the hypothetical problem stated earlier. In general, as the number of between-subjects factors

increases beyond one, Version 1 data requirements are discouraging at any level of K. Furthermore, for t > 1 Version 1 requires more subjects than Version 2, provided the designs are replicated equally.

Given data collected in accordance with either Version 1 or 2, a complete second-order polynomial model can be fit to the data according to a least squares criterion. In general, for a K-factor design this requires the separate estimate of (K + 2)!/K!2! predictor coefficients including the intercept. Because Version 1 always designates more data points, it is characterized by a larger, less desirable redundancy ratio, where redundancy (Box and Behnken, 1960) is defined as the ratio of the total number of experimental trials to the number of predictor coefficients to be estimated separately in fitting the model.

Regardless of the source of the data, an analysis of variance (ANOVA) is conducted to determine how well the derived equation and the model on which it is based describe the real world. In addition to establishing the proportion of the variation in observed performance that is explained by the equation, the ANOVA tests the reliability of each predictor, of intersubject variability in the case of Version 1, and of lack of fit; a reliable lack of fit indicates that a higher-order equation is required to account for the data adequately.

Unlike Version 2, Version 1 allows one to distinguish between pure experimental error and the effect of nested intersubject variability. Consequently, one can derive more refined estimates of error against which to test the reliabilities of individual terms in the fitted model. In the presence of significant intersubject variability, reliability tests of within-subject terms are generally less conservative than if experimental error were pooled with the subject effect in forming the F-ratio; therefore, the tests are more likely to detect any variation in performance that could be accounted for by a particular within-subject term. Conversely, using the isolated subject effect as the error term against which between-subjects terms are tested results in more conservative reliability tests in the presence of significant intersubject variability. If nested intersubject variability is negligible, the effect on reliability tests of pooling the subject effect and pure experimental error, as necessitated by Version 2, is of little consequence.

Given Version 1, one can also test the reliabilities of the contributions to regression sum of squares of within-subject terms as an aggregate and of between-subjects terms as an aggregate separate; reliability tests of analogous lack of fit aggregates are also possible. However, this kind of breakdown is of dubious worth. Attending to these aggregate effects appears to provide not only less specific information than is already available, but can also provide misleading information.

Versions 1 and 2 mixed-factors CCDs appropriate to the previous example can be orthogonalized and compared with respect to two criteria introduced by Myers (1971): (1) design efficiency, a criterion that considers both the precision with which coefficients are estimated and the required number of experimental trials; and (2) coefficient biases, present in the event that an improper model is chosen to represent the real world. Orthogonal Version 2 is more efficient with respect to estimating the pure quadratic term involving the between-subjects factor; otherwise, orthogonal Versions 1 and 2 exhibit comparable efficiency with respect to estimating the predictor coefficients

in a complete second-order polynomial model. Likewise, under a hypothetically "true" condition which includes pure third-order effects of within-subject factors, orthogonal Versions 1 and 2 are characterized by comparable coefficient biases. Both these observations are specific to the comparison between orthogonal Versions 1 and 2 and should not be generalized to other (nonorthogonal) comparisons of the two versions under other conditions.

Empirical Comparisons

A series of visual target detection studies provided data to compare the predictive validities associated with second-order prediction equations derived from data collected in accordance with each of the two mixed-factors CCDs. Double cross validation analyses were conducted, using data from each design, to obtain empirical estimates of the shrinkage in multiple correlation coefficients (R) that occurs when an equation derived from one sample is used to predict performance in a second, comparable sample. These cross-validated R values were compared with Lord and Nicholson's formula estimate of shrunken R. The predictive validities of the derived equations were alternatively compared in terms of the associated mean square errors. These empirical comparisons indicated that both designs sampled the experimental space sufficiently to permit derivation of comparably valid second-order prediction equations. This conclusion held for prediction across the experimental space, including conditions not experienced by the derivation samples.

As a result of the more voluminous data required by Version 1, the standard errors of prediction are smaller relative to Version 2 for a given population variance, yielding greater precision of estimation. The comparison of mean square error of prediction across the two versions could be considered a test of whether that difference in standard errors is statistically reliable. For the particular case of three within-subject and one between-subjects factors, that difference is not reliable. However, as the total number of factors or of between-subjects factors increases, the data demands of Version 1 increase rapidly relative to Version 2. As this occurs, reliable differences in precision of estimate may appear in favor of Version 1. However, those results must be weighed against the excessively heavy data demands of Version 1 under those conditions.

Conclusions

Given the aim of developing a complete second-order prediction equation of acceptable validity, both theoretical and empirical comparisons indicate the more economical Version 2 mixed-factors CCD is the preferable way to incorporate between-subjects and within-subject factors into a single study, unless there is reason to anticipate substantial variability in performance across subjects. Only Version 1 provides for distinguishing (and testing) a subject effect from pure experimental error. The target detection studies did not reveal any reduction in predictive validity for second-order equations derived from Version 2 versus Version 1 data, despite the sparser sampling of the experimental space.

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PERFORMANCE EVALUATION OF DATA ENTRY DEVICES

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A comparative performance evaluation of four digital message entry devices (DMEDs) was conducted. The DMEDs employed markedly different display technologies and operating procedures. Twelve Marine Corps communications specialists were tested on each of the devices. Time and error scores were obtained for different operations and subjective responses were recorded. The data were analyzed by conventional parametric and nonparametric statistical techniques. The results indicated consistent, but slight, differences in performance times and error rates for the different devices. The equivalence of performance on the DMEDs examined indicates that decisions on selection of one of these DMEDs should be based on other factors such as cost, durability and maintainability.

Digital message entry devices (DMEDs) are an attempt to improve communication between a forward observer and the fire control center. The message information is entered in a fixed format and, when the message is completed, it is transmitted in a "burst" lasting from a fraction of a second to several seconds (depending on bit rate and keying tone length). The improvement in communication occurs with the stability of message content assured by the fixed format of the message and with the inability of the enemy to detect or act on the information transmitted in the burst.

It is anticipated that digital message entry devices will be widely utilized by the military for forward field observers and fire control centers, and may ultimately have an equally large, or larger, market for other military and civilian purposes. The evaluation of operator performance on the different devices would permit knowledgeable decisions to be made about the purchase of DMED systems; specifically, the evaluation would indicate whether a particular system was sufficient for requirements and whether the increased cost of one DMED as opposed to another resulted in commensurate improvements in operator performance.

DMED Designs

There is a growing number of different designs for DMEDs. All are characterized by utilizing a fixed format entry procedure and a burst transmission. The fixed format is essential to any DMED design. The message is composed of elements, each of which has several options that may be entered in the message by a single action (as in selecting an encoded option, e.g., East) or it may require several actions (as in entering a set of four digits for time).

The essential features of a DMED are a display (which presents the options for different message formats, and, within a format, the options for the different elements of a message) and a keyboard or switch panel (by which the operator selects which of the options to incorporate in a message). Four DMEDs, each of which employed markedly different technologies for the display and entry of a message, were examined in this study. Some of the characteristics of the different DMEDs examined are indicated in Table 1.

The marked difference in operating procedures and in the technologies employed by the four devices examined in this study made it necessary to conduct a comparative performance evaluation to provide a basis for making decisions about the possible acquisition of DMED systems.

Experimental Design

Performance on the four DMEDs was determined under laboratory conditions simulating, in a controlled setting, operations under two lighting conditions (light or dark with a red-filtered flashlight) and two input modes (voice-told or written message).

Each subject was tested on each of the devices under all of the experimental conditions. Data were entered into the DMEDs using five standard Army TACFIRE formats. Randomization and counterbalancing techniques assured an equitable basis for comparison of operator performance on the different devices.

Twelve Marine Corps communications specialists were used as subjects. Each subject participated in the testing for one week.

Table 1. Display and Operational Characteristics of DMEDs.

DMED	Display	Operations
1	Alphanumerics spell message options in windows. Options appear written in 5x7 LED characters.	Keyboard integrated with display. Press button below window in which desired option appears.
2	Mylar overlay contains matrix with options printed in each cell. LED illuminates to indicate option selected.	Keyboard integrated with display. Press printed overlay at the cell containing the option desired.
3	Alphanumerics spell message options and keying code on display panel. Options appear in plasma characters.	Keyboard associated with display. Press button on keyboard corresponding to key code for option.
4	Scroll contains matrix with options printed in each cell. Liquid crystal windows expose printed options.	Keyboard integrated with display. Press panel at the cell overlying the option desired.

On the first day, the subject was given an introduction to the study, an explanation of how the different devices operated, and two sets of practice sessions with each device.

On the subsequent four days, the subject was rotated from device to device, spending one day with each DMED. A predetermined schedule of operation was employed so that equal numbers of subjects operated the devices on different days. The sequence in which one subject was rotated was not repeated by others. This was done to ensure that there would be no fixed bias given to the results by learning effects or by transference from one device to another.

Data Collection and Analysis

Test measures were of time and error scores. The time scores were taken for the major discernible operations performed in entering a message into a DMED: format selection, data entry, and review of the message. Times were obtained for each of these events under each of the four experimental conditions. A fourth major operation, for which times were taken only in the light, voice-told condition, was correction of pre-established, simulated message entry errors.

Error scores were obtained for three categories of errors: errors in data entry (the subject entered data incorrectly), errors in review (the subject failed to call back an element of the message), and errors in operating procedure (the subject made a time-consuming error which required a restart of timing)

The results obtained from this study were analyzed by a variety of procedures employing conventional, parametric statistics and distribution-free, nonparametric statistics. Combined scores were obtained for each subject by using the actual scores (the time in average number of seconds and the total numbers of errors) and the relative ranking of the subject's performance on the different devices (by disregarding the actual amplitude of the scores and regarding only the comparative rank order of performance on the different devices). For most analyses, these two statistical procedures led to identical results.

Results and Discussion

The results indicated that although there were consistent differences in operator performance on the four devices, these differences were slight. For example, for the combined data entry plus review times (the types of operations most frequently performed in field situations) the average scores on the different devices were 57, 60, 64, and 67 seconds.

The rankings of performance on the four devices differed for the various operations required in using a DMED. One per-

formed best for data entry, whereas another performed best for review, while still another performed best for the combined data entry plus review times. The rankings of the different devices did not change with shifts of experimental conditions between light and dark levels of illumination nor between voice-told and written message inputs.

When the performances of the four fastest, the four average, and the four slowest subjects were compared, the same slight differences in the ranking of the four devices were obtained. This means that there is no device which is especially better or worse for operators of given levels of ability. If a fast operator performs best with one device, a slow operator is also likely to show the same performance preference.

Of greater importance than the variations in the average performance on the devices (a difference of 10 seconds for the combined data entry plus review times) were the variations in the abilities of the subjects to operate the devices. When, for each subject, the times for the combined data entry plus review operations for all four devices were averaged, the fastest subject had an average time of 47 seconds whereas the slowest had an average of 85 seconds. These considerable differences in performance between operators reflected differences in their capabilities which could not be related to their scores on the Army General Classification Test (AGCT). These differences were not due to the level of training or to the order of testing. Generally, if a subject was slower than the others in operating one device, he would also be slower than average in operating all the other devices.

The magnitude of the differences in the average scores of the different subjects, when viewed against the slight average differences between performances on the different devices, suggests that the most cost-effective procedure for improving performance on DMEDs may be through improved operator selection rather than through improved hardware efforts.

In terms of operator preference for the different devices, one device was clearly most preferred and another one was clearly leastpreferred. Yet, despite the strong feeling of the subjects, most felt that they could operate effectively with any one of the devices, and operational data supported this belief.

This study showed that from the standpoint of operator performance, no one of the devices examined was substantially more effective than the others, although considerable differences in display technologies and operating procedures used by these units existed. Decisions on selection of one of these four DMEDs examined may, therefore, be based on other factors such as actual field testing, cost, durability and maintainability, and size and weight considerations.

PANEL DISCUSSIONS

SESSION I

Applications of Organizational Development in DoD

Chairman: James C. Metsala

AN OVERVIEW OF ORGANIZATION DEVELOPMENT

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Organization Development, often abbreviated as OD, is a process of planned change processes designed to bring about improvement in the performance of a group. The critieria for this performance increment can be specified in effectiveness, efficiency, or satisfaction. Any or all of the preceding might give evidence as to the improved performance as a result of Organization Development. While there is no intent to play semantic games, other processes can perform the same function and might be labeled as Organization Renewal, Organization Improvement, Work Group Dynamics, and so forth. The main objective is to perform some of the following:

1. To improve communications, trust, and support among group and organizational members.

2. To enhance the ability to meet organizational problems rather than to hide or defer them.

3. To open up an organization so that the level of satisfaction and personal enthusiasm can be increased.

4. To improve the operational climate and environment, especially by increasing the level of responsibility of individuals and groups as they display increased commitment and contributions to the group and organizational effort.

These kind of objectives naturally make some assumptions about people who operate in organizations and groups which are seeking to improve. These kinds of assumptions can be highlighted as:

1. Individual persons have a need for growth and development and are capable and interested in making greater contributions to organization goals and environment and conditions usually support.

2. Groups contain people who would like to be accepted and to cooperate with each other, recognizing the leadership function that does exist with the accompanying responsibilities for work performance. It is assumed that people would prefer to work together as a team under satisfying conditions than to be a nominal member of a work group.

3. People and organizations recognize that there are interdependencies and interactions among decisions and operations in organizations. It is recognized that cooperation, support, and trust in organizations usually are lower than is desirable and that win-lose strategies between people in groups are common occurences but not conducive to the long-run interests of organizations or participants.

While the actual techniques used in developing organizations might vary, common steps usually emerge in any model of Organization Development, which closely resemble the classic action-research model as follows:

1. Diagnosis of problems as sensed or felt by participants of the work group or organization.

2. Data gathering which elaborates on the problem. The data are generated and processed by the group as that data includes problems which exist and the location and suspected source of problems as people see them. Data gathering is more specific than the diagnosis, which is concerned with the expressed needs of individuals for change or organization improvement.

3. Feedback would involve nonjudgmental observations of behavior for the improvement of the organization.

4. Data discussion and work on feedback provided to generate new perspectives for change. This is an understanding and analysis study.

5. Action planning provides some work objectives as to organization improvement and some steps as to how to reach those objectives. Team building is a technique commonly used in this step as a process of flexing the potential of people to work as a team and to plan a strategy for improvement.

6. Action for change will involve implementation of the steps previously planned.

The strategy for Organizational Development is cyclical and continuous in its best utilization, which means that data might be continually generated about the operation of the organization, the reaction of people to each other within the work group, the reaction of outside persons, as their perceptions of the work group are mirrored back, as well as further analysis and processing of data being generated.

Organization Development is commonly engaged with the assistance of external or internal consultants who understand group dynamics and the operational nature of the work group. This individual can serve as a process consultant as to the dynamics of the situation and may also help provide mediating or interpretation capabilities. The selection and use of external consultants is extremely important, as well as the training of internal coordinators to facilitate the functional growth of the work

group and members of that work group. This development function is commonly related to leadership, but because of existing and historic relationships, the use of an external consultant becomes very important, whether that consultant is a practicing expert or a mediating person who comes in from another segment of the organization and can provide the fresh perspective on organizational processes in the subject work group.

The benefits of Organization Development usually consist of:

1. Individuals who are more aware of their own reactions and their impact on other persons, as well as the impact of other persons on themselves. Individuals generally display changed attitudes with a greater tolerance and commitment to work organizations and the tasks that are accepted by those organizations.

2. Interpersonal competence is generally increased by the satisfaction of building productive and rewarding relationships with persons in the organization.

3. Organizations and work groups improve chiefly through the team building process where persons forge together as a unified, committed work group, rather than a "bunch of people who happen to work in the same area or do the same kind of job." The benefits of Organization Development usually require some pressure for improvement from within and from without the organization, as well as guidance of persons who are knowledgeable and expert in the process who serve as consultants or group leaders, as well as the cooperation and goodwill of members of the organization.

In the long run, successful Organization Development amounts to a systemic process. The organization and work group undergoes a program

of planned change, not a stopgap temporary vantage or organizational panacea. The Organizational Development program is intended to develop the resources of the organization to meet the needs of the present and any changes for the future. The ultimate benefit occurs in the realization and development of the potential of the individual, as well as the improved capability of the organization to adapt to situational demands as well as to cope with change as appropriate.

ORGANIZATIONAL EFFECTIVENESS (OE): ACTIVITIES AND TRAINING IN THE UNITED STATES ARMY

Frank Burns

Headquarters, Department of the Army

This paper contains excerpts from a Department of the Army letter entitled "Organizational Effectiveness (OE): Activities and Training" which was distributed during the panel discussion on "OD in the DoD" by Major Frank Burns, policy coordinator for OD in the Army and OD consultant for the Army Staff at Headquarters, Department of the Army, Pentagon. These excerpts outline the basis for use of OD in the Army as discussed by Major Burns.

EXPLANATION OF TERMS.

a. Military Personnel Management. The process of planning, organizing, directing, coordinating, and controlling the procurement, training/education, utilization, separation/retirement, development and motivation of military personnel to assist in the successful accomplishment of the organizational mission. It includes all procedures related to: military job analysis and evaluation; position classification; personnel classification, assignment and utilization; maintenance of an adequate system of records and reports required for successful operation of the Army personnel system; Human Resources Development activities, to include: development of individual potential; and development of an organizational climate that enhances the attitude, motivation, commitment and sense of well-being of soldiers and their families.

b. Organization Development (OD). A technology which involves the combined application of behavioral and management science methods: (1) to understand more clearly how persons in an organization communicate with each other and how they affect and are affected by the structures, procedures, and work environments of the organization; and (2) to use this knowledge and understanding to reinforce organizational strengths and make practical and systematic improvements in the way the organization functions.

c. Organizational Effectiveness (OE). A systematic adaptation of OD by the Army for the purpose of strengthening the chain of command, increasing individual and unit effectiveness, and improving the quality of life in an Army community. OE is implemented as a phased process that is tailored to the unique requirements of a particular Army unit, controlled by that unit's leader or commander, and normally supported by an Organizational Effectiveness Staff Officer. The primary steps of OE include:

(1) Assessment of organizational processes.

(2) Chain of command action planning.

(3) Implementation of planned actions.

(4) Evaluation and follow-up.

d. Organizational Effectiveness Staff Officer. (OESO). A personnel management staff officer (SSI 41A, ASI 5Z), qualified through training at the U.S. Army Organizational Effectiveness Training Center (USAOETC), who performs an advisory and assistance function for improving organizational effectiveness through the systematic military application of OD and related advanced management and behavioral science skills and techniques.

BACKGROUND.

a. The Army is committed to improving the effectiveness of its organizations by adopting any proven management practice which is consistent with basic Army missions, requirements, and policies, provided it can be supported from reasonably available resources and training, and provided it supports the basic dignity, values, and traditional standards of the Army and its members.

b. In 1972, Headquarters, Department of the Army decided to accomplish the following: (1) broaden the concepts and doctrine for military personnel management and leadership by capitalizing on behavioral science knowledge, (2) initiate a three year experimental program in a variety of Army organizations to determine the utility of systematically applying advanced management and behavioral science techniques to increase individual and organizational effectiveness, (3) educate and train personnel management staff officers to implement concepts and techniques determined to be useful, and (4) orient and educate commanders on the applicability of advanced management and behavioral science technology.

c. The experimental program was conducted from June 1972 through June 1975 and was titled MOTIVATIONAL DEVELOPMENT. The program consisted of pilot projects in MILPERCEN, USAREUR, and at Forts Ord, Bliss and Benning. The results of the pilot projects indicated that:

(1) Many of the advanced management and behavioral science techniques collectively referred to as Organization Development (OD) are adaptable to the Army.

(2) When adapted and implemented as a systematic and integrated process, these techniques are capable of assisting Army commanders make substantial improvements in the effectiveness of their organizations.

(3) To be effective, this integrated process needs to be applied in a decentralized manner that is tailored to suit the local situation and requirements of a particular organization.

(4) Implementation of these techniques should support the plans and objectives of the chain of command.

(5) Although responsibility for implementing these techniques must remain with the commander, specialized staff assistance is required.

(6) The staff officer providing this assistance must possess a high degree of technical expertise in the applied behavioral and management sciences. This expertise is gained by intensive skill-oriented training which stresses the practical application of the technology within Army organizations.

(7) This staff expertise should be developed initially within the personnel management specialty.

d. The experimental Motivational Development Program was formally terminated in June 1975. By that time, most of the pilot projects had been incorporated into operational and educational activities in HQDA, FORSCOM, USAREUR, and TRADOC. The expanded application of these management techniques, and the integration of these activities with existing managment practices, will be introduced selectively in Army organizations in accordance with the guidance contained in the following paragraphs.

IMPLEMENTATION OF OE ACTIVITIES.

a. The responsibility for conducting OE activities and utilizing OESO's is decentralized to the commands to which OESO's are assigned. As a regular member of the S1, G1, DPCA, or DCSPER staff, the OESO provides technical support to unit leaders. Specifically, the OESO assists leaders in their efforts to strengthen their chain of command, and foster an organizational climate in which unit personnel are actively involved in improving the unit's performance.

b. OE activities require the direct involvement and full voluntary support of the unit's chain of command. At no time should an OESO attempt to impose his or her assistance upon a unit or its leader.

c. The OE process is designed to improve a unit rather than to evaluate it. Any information collected and analyzed by the OESO will be furnished only to the commander or leader he or she is assisting unless that commander or leader specifically authorizes its release to others. The OESO must protect the confidentiality of unit assessment data with the unconditional support of senior commanders in the chain of command.

QUO VADIS: THE NAVY AND ORGANIZATION DEVELOPMENT

Raymond L. Forbes, Jr.*

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The United States Navy became involved with Organization Development system wide basis in the early 1970's. The impact of accelerating technological and social changes occurring in the larger culture of the country appeared to be the main precipitating factors. From a pilot program begun by the Chief of Naval Operations in 1971, the Navy effort in Organization Development has expanded into a world wide program principally aimed at improving the effectiveness of the operating forces. This planned change effort has proceeded through a recognizable series of growth stages to reach its present proportions.

The present approach called, "Survey Guided Development," is seen to contain elements of major strategies previously identified by organizational theorists for changing human systems. The Navy developmental program calls for a chronologically sequenced series of discrete steps designed to assist individual units in producing and implementing individual action plans. The process uses human resource management specialists acting in the role of consultant to the individual unit's commanding officer.

These consultant specialists are especially trained, active-duty, Navy men and women who operate in small teams. They are administered from centers located in areas of major concentration of fleet units. Units are scheduled for the full program, known as the "Human Resource Management Cycle," on a non-voluntary basis as part of the routine operational scheduling process.

Significant among the present problems of the Navy program is the measurement of results in ways that indicate visible impact on the traditionally used criteria of organizational effectiveness. Some initial attempts at measurement show promise of correlating survey results with operational mission effectiveness yardsticks. Long term future support of this Navy developmental program appears to be keyed to its ability to demonstrate its worth in cost effectiveness terms. Continuation of the present effort into the near term future seems to be related to its ability to successfully compete for the required survival resources in the light of an increasing cost consciousness and an overall decrease in organizational size.

*The author is a faculty member at the Naval Postgraduate School, Monterey, California. The remarks contained herein are condensed from a paper which Lieutenant Commander Forbes presented as a panel member on "Organization Development in the DoD." Copies of the entire 33 page paper should be requested of the author.

QUO VADIS: THE FUTURE

The Navy's OD effort is beginning to work with increasingly higher levels in the organizational hierarchy. The use of aggregated survey data to provide "big picture" information to commanders at the squadron, type, and fleet levels is growing in demand. Pressures continue to mount on Human Resource Management Cycles (HRMC's) to develop broader scale analytical capacities and apply the principles of operations analysis to summarized survey data.

The employment of trend information as a diagnostic tool for the Navy as a macro-system is a distinct possibility in the near term future. The identification and utilization of a realistic set of evaluation standards keyed to survey difference values is also considered a probable future imperative directly related to program survival. There is a growing movement for more standardization of HRM Cycle events between all the HRMC's and (HRMD's) that would appear to support the efficiency of such an evaluation effort.

User units are becoming increasingly more sophisticated in their ability to utilize the available consultant services and to meaningfully interpret survey data. This sophistication is becoming ever more apparent as individuals and commands go through a second HRM cycle. A likely consequence of this second experience movement is a greater base of understanding and acceptance of the Navy OD process at the "grass-roots" level.

The HRM cycle will, in all likelihood, continue to undergo evolutionary revision and improvement. One particularly promising improvement area is the joining of the discipline of Educational Technology with Organization Development (Forbes and Nickols, 1974).

As operational experience continues to mount, some consulting procedures are seen to be generally more effective than others. This growing body of experience, along with the almost paramount need for acceptable evaluative criteria, should result in increased intra-Navy, cross-service and cross-institution cooperation. This enhanced cooperation is likely to expand toward joint military service OD projects. Other possible outcomes are the establishment of mechanisms for the sharing of resources and for the use of accumulated knowledge.

A more effective feedback loop between the OD training system and the processes that are actually employed in the field will be required for the future. More advanced educational opportunities in the Navy OD field at the postgraduate level should soon become available. A Master's Degree program in Human Resource Management is now initially staffed and funded at the Naval Postgraduate School awaiting only final approval to be implemented.

The research data bank containing accumulated survey information should provide a rich source of future Navy organizational analysis studies. Realization of current data bank special projects is likely although its potential is still largely untapped and, as yet, not well understood.

Projects for special interest groups now underway and probable to continue include (Spruance, 1976):

1. The Chief of Naval Information has evaluated internal information sources.

2. The Judge Advocate General is evaluating the Uniform Code of Military Justice and non-judical punishment.

3. The Commander in Chief Pacific Fleet is analyzing personnel retention data.

4. The Chief of Naval Education and Training is evaluating the effectiveness of his leadership and management training, and

5. A safety analysis is soon to be conducted for the Naval Safety Center.

New data-derived, empirically-based tools are needed to help the Navy Commanding Officer to do his job more effectively. The link between research and practice will require further strengthening.

The future should also move Navy OD practitioners and their sponsors to a more careful scrutiny of their roles vis-a-vis the organization they service. This introspection may likely produce greater efforts to provide a more self-sustaining OD capability within each Navy unit with the eventual aim of moving the practitioner out of a job. Until that time comes, practical dilemmas remain to be worked through to help OD continue to help the Navy.

Many of these dilemmas seem to be common to OD efforts everywhere. It is the writer's hypothesis that as each organization seeks to clarify its stance relative to each dilemma, it helps to define the particular direction and meaning of the developmental process that is unique to that organization. Some of these key dilemmas that have been identified thus far are (Forbes, 1976):

1. Confidentiality vs disclosure. (Who can get to see what information?)

2. Marketing vs being asked. (Active or passive related to possible clientele?)

3. External vs internal direction. (Outside versus inside control of the effort?)

4. Top management participation vs top management approval, (What level of top support is necessary to success?)

5. Individual change focus vs organizational change focus, (Aim at the person or the system?)

6. Voluntary vs mandatory involvement. (Free choice or forced participation.)

7. Repair (maintenance) vs development. (Go for the short or long range payoff?)

8. Focus on people vs structure vs technology. (Where should the developmental emphasis be placed?)

9. Starting only at the top vs starting anywhere. (Where to begin?)

10. Planned vs emergent design. (Rationally structure the effort in advance or just let it happen naturally?)

11. Meeting organizational needs vs meeting consultant needs. (Who is the real client?)

12. Organization values vs consultant values. (Is the organization's value structure consistent with the desired change goals?)

13. Line vs staff program management. (Who owns the program?)

14. "Buy it" vs "build it" OD capability. (Start from scratch or go with a "proven" product?)

15. Balance of consultant credibility vs skill. (What does an effective OD person look like?)

16. Focus on problems vs focus on opportunity. (Negative on positive developmental emphasis?)

17. "Soft" vs "hard" evaluation effort. (Subjective or objective basis for assessing results?)

EPILOG

This condensed paper has attempted to look into the future of the United States Navy's Organization Development programs. The initial developmental effort was seen to be mainly connected to the accelerating pace of technological and social change. The Navy, in common with other large institutions, has attempted to become responsive to both external and internally felt pressures.

Through the efforts of the top Navy leadership a pilot effort in human resource management was begun in 1971. The outgrowth of this effort was the "Command Development" program featuring a seven step approach

to organization development. This approach was modified in 1973 into the Human Resource Management Cycle. The cycle incorporated many "lessons learned" from the previous program.

Portents for the future of the Navy OD effort were listed and discussed. A series of organization development dilemmas were posed along with the hypothesis that their resolution defines OD for a particular organization.

Returning to the question posed at the outset by the title of this paper regarding where the Navy is going in Organization Development, this writer would like to conclude with a summary comment made by a former Superintendent of the United States Naval Academy. Vice Admiral Calvert's words, written more than ten years ago, relating to the Navy's ultimate objectives seem equally suited to what the OD effort is really trying to accomplish today (Calvert, 1965).

> The Navy is an instrument of the United States; it exists to provide one of the means of attaining its national objectives. What are these objectives? Of the many possible answers, these few seem to me basic:
>
> 1. To maintain our way of life--particularly as it regards the dignity and freedom of the individual.
>
> 2. To maintain and, if possible, to improve our standard of living by taking intelligent steps to broaden the base and increase the vigor of our economy.
>
> 3. To maintain peace and create, insofar as possible, an atmosphere in which all nations may work together for the eventual achievement of a world in which individual nations need not maintain armed forces.

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ORGANIZATIONAL DEVELOPMENT IN THE USAF

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The Air Force has been involved with Organizational Development (OD) in a variety of ways and at many different levels. The purpose of this presentation is to describe two micro-level OD projects that are currently being undertaken by the Air Force. The two projects are similar in that they both employ the OD technique of job redesign and the intervention is at the lowest organizational level - the work force itself. In other respects, the two projects are quite different.

The first work redesign project was begun in 1974 at an Air Force Logistics Command (AFLC) Air Logistics Center (ALC) through the initiative of the Center Commander. His problem was one that we are all facing in the military - how to improve productivity and quality in the face of continued reductions of funds and personnel. In addition, the commander was concerned with the motivation, job satisfaction and quality of work life of his military and civilian work force.

An outside well known civilian consultant was employed to design and implement a pilot orthodox job enrichment program. Representatives from each of the ALC's five directorates were selected as "key men" for their particular organization and underwent three weeks of formal, academic training in work motivation and job enrichment processes. The keymen then returned to their own organization and underwent three weeks of formal, academic training in work motivation and job enrichment processes. The keymen then returned to their own organization where they acted as internal consultants and coordinators for job enrichment training. Initially, the keymen, with the assistance of middle managers, selected pilot projects in their organization that offered the most potential for job enrichment. In their respective areas, the keymen formed two committees and trained the members of those committees on job enrichment. The implementing committee was made up of lower level supervisors who actually identified changes that could result in better jobs. The coordinating committee consisted of middle managers who reviewed the proposed changes and approved those they considered feasible.

The number of active job enrichment projects has increased from 11 to approximately 50. Although not all the projects have been completely successful, the overall results are impressive. Estimates for savings as a result of the work redesign are in excess of $300,000 annually. Workers report being more satisfied with their work and management is pleased with the increased productivity and quality of work.

The second Air Force work redesign project that I am going to describe differs from the first project considerably.*

*Information on this project was provided by Major James Metsala, USAFA representative to the Air Staff Job Enrichment Task Team.

As a result of recent study accomplished by the Air Force Management Improvement Group, a pilot project was initiated at the Air Staff level to improve the quality of life in the Security Police career field. After a preliminary diagnosis, it was determined that job redesign theory might be useful in this career field. Strategic Air Command appeared very interested in improving the satisfaction and performance in their security police. Air Staff brought together representatives from the Air Force Academy (USAFA), Air University (AU), and Strategic Air Command Headquarters to plan a program. The Job Diagnostic Survey (Hackman and Oldham, 1974) was used as a diagnostic tool. The data received from this survey and interviews at the unit were used as a base for a 12 day workshop involving all levels of the unit. Motivation and job enrichment theory was provided next. Then a green light brainstorming session was conducted. This produced over 2400 ideas on how to change the job. Consolidation of these ideas resulted in present staffing of approximately 126 proposals in which job redesign is proposed. Implementation will be followed by further attitudinal and performance measurement. This project has special significance in several ways:

1. This job redesign project is using Air Force resources (blue suit) as consultants.

2. This project is in an operational command versus a support command. The job is distinctly military rather than a mixture of military and civilian as in AFLC.

3. The workers took part in the identification of job redesign.

4. The project was designed with operational requirements in mind. The objective was to keep it uncomplicated. However, test and control groups are being watched in regard to attitudinal and performance data. This will allow future groups to better plan and design OD efforts with the data available from this endeavor.

5. The mere fact that this project is being undertaken, shows the progressiveness of Air Force leaders to try behavioral science techniques in improving work motivation.

The projects just described are only two of may OD programs that are going on in the Air Force. OD is no more of a cure-all for organizational problems in the military than it is for other organizations. However, with proper diagnosis, intervention and implementation, OD offers a means for improving military members affective responses to their jobs in terms of improved organizational outcomes of performance, work attendance, and desired personal outcomes of increased work motivation and job satisfaction.

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PANEL DISCUSSIONS

SESSION II

Women in DoD

Chairman: Dirk C. Prather

WOMEN IN DOD PANEL PRESENTATION
by

Brigadier General Chris C. Mann, USAF
Deputy Director, Personnel Plans for Human Resources Development

As my introduction indicated, I am responsible for directing human resources development in the Air Force - a function charged with improving personnel areas such as quality control, motivation, productivity, equal opportunity, and quality of life...both on and off duty. Quite frankly, most of our concern is driven by economics because over the years human costs have continuously increased. Today, nearly half of the AF budget pays for people... and with a shrinking force, we simply can't afford to waste human resources -- this includes enlisted and officer... Reserve and Air Guard...men and women because we are concerned with the development of all human resources.

Now it might appear inappropriate that I begin this paper by talking total force management when the subject is women...but in so doing there is a point to be made. Management advances in the Air Force have been so rapid and pervasive in recent years that we no longer think of the force as consisting of men with a small number of token women standing on the side lines. We think in terms of a force of people -- men and women who contribute jointly to overall mission accomplishment.

There are many factors that have forced an updating of management policies and one of those factors is the growing number of women in the Air Force.

Today we have over 34,000 Air Force women on active duty and almost 7,300 in the reserves. In recent years the number of women has more than quadrupled, and further increases are programmed. In 1970, there were 10,000 women on EAD. Today, the strength is 34,000 and projected to be 48,000 by the end of FY 78. The same dramatic changes are also happening in the reserve forces. Today's strength of 7,300 is projected to be 13,000 by the end of FY 78.

As human resources become a high cost item and the number of women in the force increases, AF planners and programmers are becoming increasingly aware of the necessity for total force management.

Unfortunately, our planners have not always possessed this sensitivity. In previous years the numbers of Air Force women were relatively small... a phenonomen that was driven by congressional limitations and the belief that women were simply not competitive in a predominantly male military force. While retention was cited as one fact to prove the point, separation policy forced pregnant women out so that it became a self-fulfilling prophecy. Women who acquired teenage children under 18 years of age through marriage, were also forced to exit, and special considerations, applicable to women only, made an enlistment contract less binding for a

woman than a man. In general, past procurement policy was driven to a large extent by the belief that women were not cost effective and the programmers and planners cited retention rates as proof of the pudding.

In 1972, outside pressures mounted for the military services to take aggressive action to insure women their rightful place in the armed forces. At that time, I had the opportunity to head a working group that took a hard, objective look at both procurement and utilization of military women. And that look surfaced an amazing fact.

We found that women did not cost more than men, quite to the contrary, they were proven cost effective and in some instances they even cost less than men.

1972 was also a banner year for AF women with regard to utilization. Up to that point, less than 50% of the enlisted jobs were open. In the summer of '72 that was changed to 98% so that today women are able to compete for every job with the exception of a very few that are closely related to combat.

Until the summer of '72 women had been concentrated in jobs that society had come to recognize as "women's work"... nursing, administration, clerical jobs. As women sought to break out of the narrow confines of society's stereotypes, AF recognized that the traditional utilization patterns were no longer relevant. In recent months even greater advances have been made in utilization. This year twenty women will enter a test program for undergraduate pilot training. They will meet the same physical and mental standards as their male counterparts and be assigned to aircraft that have a noncombat wartime mission and, as you know, women will enter the AFA for the first time.

On the enlisted side of the house, we are also making new advances. 100 women volunteers are being recruited for assignment in security police. This test, which will run approximately one year, will provide training in security specialist and combat skills in order to evaluate women's ability to withstand the rigors of security duties under a wide range of conditions.

However, changing the classification system - i.e., opening more jobs to women is only part of the equation. We found out some years earlier, that if the jobs open, women do not necessarily "free flow" into them. To achieve full utilization of women across a wide range of jobs, percentage goals were set by skill and recruiters were tasked to find women either already qualified for assignment in industrial jobs or capable of and interested in being trained to do them. We have never failed to meet our goals.

Today, the total force concept starts with the recruiter. There are for the most part parallel entrance standards for men and women. Age, mental, and educational criterion are the same and, with the

recent standardization of height tables, physical requirements are essentially the same too.

From my experience as a recruiting group commander, I can tell you that the reasons women join the AF are essentially the same as for men. They seek the training and education to prepare themselves for gainful employment. They seek to develop their abilities and realize success through their endeavors.

Today's Air Force is training women in almost every job in the inventory and assigning them around the globe against a set of rules that are the same for men and women. They must be assigned duties and perform them where and when needed. There are no special considerations for women only based on family responsibilities, (humanitarian considerations apply equally to both sexes). Today 42% of the women in the Air Force are married and many have small children. Prolonged separation brought about by overseas duty can present real hardships for many, all of which leads us to the inevitable question of retention and cost effectiveness in a force with growing numbers of women.

As I mentioned earlier, the '72 study established that women are cost effective and that fact has not changed. In some areas their cost effectiveness can even exceed that of their male peers. As an example, the BMT discharge rate has changed radically in the last four years. In 1971 it was 8% for women and 1% for men. Today it is 6% for women and 8% for men. In early FY 73 the female attrition rate dropped below the male attrition rate and has remained below since.

The annual turnover rates have also decreased since FT 71. At that time, the rate was over a third higher for women. In the past few years the gap has been closing and today the two rates are almost the same. And while we are talking about success stories, I would like to tell you about ROTC. Air Force began testing coeducational AFROTC at four universities in the Fall of 1969. In the spring of 1970 the decision was made to offer the program to all schools with AFROTC. Currently, there are 2,400 women in AFROTC and 9,600 women in JROTC. 104 women are enrolled in the scolarship program.

While all of this progress is certainly encouraging, I must acknowledge that we still have problems to solve. Women continue to be victims of sex stereotyping - a condition that exists in both the civilian sector and the military. Women are not always accepted as qualified workers in jobs for which they were recruited and trained. Many male supervisors employ paternalism rather than objectivity in managing female resources. I refer to such practices as limiting the female motor vehicle operator to duty in the dispatch office, or assigning women aircraft mechanics to the typewriter rather than the aircraft.

The Air Force must respond to this problem. If for no other reason, we have a large investment in military women, and mission accomplishment

demands that they reach their full potential. This is a job for all managers -- from the general officer commander to the E-5 supervisor. I believe that all of our leaders are professional, dedicated military people who will take affirmative action in managing female resources if they are given clear direction and the tools necessary to do the job.

To further assist the field commander, we at the Air Staff are working to insure the Air Force Equal Opportunity Affirmative Actions Plan contains objectives and milestones designed to erode old persistent patterns of discrimination. While the plan is new and in the process of gaining credibility we have reason to believe that it represents a giant step forward in achieving equal opportunity for all people. Because the plan has high level support as indicated in the Chief of Staff's letter directing its implementation, commanders are forced to give it more than lip service.

The attitudes of managers toward women in all career fields - especially the more physically demanding career fields - have a tremendous impact on the morale, effectiveness, and productivity of women. For this reason, the upcoming Phase III, Human Relations Education will have a concentrated block of sexism, its effects, and its costs in terms of productivity. The approach will be open to discussion of management practices in certain work situations that lead to less than optimum utilization. The course will be mandatory for all supervisors, military and civilian.

At the Air Staff we also monitor and track the career progression of women. Personnel indicators such as performance ratings, promotions, selection for professional military education, and attrition rates are followed. If they indicate negative trends, agencies responsible for working the problems are notified. In the fall of 1975 an attitude study was conducted which provides a base line against which future measurements of sex discrimination perceptions can be computed. The attitude study will be repeated within the next twelve months to determine the effectiveness of our efforts.

In addition to surveys, there are other indicators of attitude change. There is growing evidence that some commanders have moved out dramatically in identifying problem areas and on working to eliminate them. Recently the Commander-in-Chief of SAC published an open letter on the utilization of Air Force women. I will quote a portion of it that portrays womens' new role, not only in SAC, but throughout the Air Force today.

"SAC's women - Air Force women - have surprised many by proving themselves a valuable source of competent and professional technicians in many of our so-called nontraditional career fields. In SAC we are 'rediscovering the wheel' daily. We are recognizing just how productive our women can be in many of these areas which we have long thought as the sole province of our men."

Top Air Force managers have made a strong commitment and taken positive action to eliminate discrimination against women throughout the force - but perhaps even more important than action the Air Force is taking, is the action women are taking. They are beginning to realize that they must take the initiative in developing their own potential, in guiding their destinies. They are moving out with confidence and direction in making their own unique contribution to a better world - a world in which their success will be determined by their own ability, motivation, and achievement.

WOMEN IN DOD PANEL PRESENTATION
by

Colonel Edith M. Hinton
Deputy Director, WAC

The changing role of women in the Army parallels in general that of the other services, although differences do exist. It's instructive to look to the past to place the matter of women's status in proper perspective.

In 1942, a Women's Army Auxiliary Corps was established for service with the Army of the United States. The "Auxiliary" status, which many believed to be infeasible from the outset, was dropped in 1943 and thus WAC personnel could serve in rather than with the Army.

During World War II, the WAC strength peaked at approximately 100,000. The jobs of these women ran the gamut from traditional medical and clerical tasks to such male oriented jobs as mechanics and truck driving. They did not have direct combat roles, although they served in the various combat theaters of operations.

After World War II, the WAC strength dropped to some 9,000 and varied little until the WAC expansion effort began in 1972. Too, at the war's end, women returned in general to the desk, the typewriter, and the hospital ward. Although our country was involved in two major conflicts in the intervening period, there was no real effort to increase the WAC strength or to change the WAC role until the early 1970's. In fact, serious questions were raised as to the need for women soldiers. Public Law 625, enacted in 1948, was a positive response, establishing the WAC as a component of the regular Army and the Army Reserve. This law, however, imposed numerous restrictions on the WAC. Provisions were made for only one colonel -- that is, the Director, WAC. The law also limited the numbers of women to two percent of the military strength and dictated earlier mandatory retirement for women.

Another law enacted in 1967 removed the restrictions just mentioned, setting the stage for changes of the 1970's.

Two major factors brought about the changing WAC role -- that is, the all-volunteer force and women's movement. Both factors were critical, in my judgement, to the results which have accrued.

Now to briefly highlight some of the changes which have occurred:

-- Job specialties open to women have increased significantly. Enlisted women may serve in 92 percent of the Army's MOS, in contrast to about 25 percent in 1971. The closed MOS involve combat or close combat support.

Open positions have also shown a marked increase. The exclusions include positions in category I units -- units whose primary mission is fighting the enemy -- and to various positions which involve closed MOS.

-- Assignment limitations have been liberalized extensively. Some examples:

Women may command other than WAC units.

Women may drive vehicles larger than the 2-1/2 ton truck.

Women may serve as military police.

Married women may enlist.

Involuntary discharge for pregnancy/parenthood has been discontinued.

Women are generally billeted with their units of assignment, rather than separate WAC units.

-- Training and courses of instruction for which women are eligible generally have been integrated.

Effective this summer, men and women ROTC cadets will undergo a common basic training program with exceptions limited to those required because of physiological differences. Parenthetically, the first women are to be commissioned from ROTC this May.

Women cadets will enter the military Academy this summer. Modifications to accommodate women at the Academy will also be limited to those required because of physiological differences.

Separate basic training programs for enlisted men and women still apply although there is an increasing degree of commonality in their programs of instruction. As an example, weapons qualification training with the M-16 rifle applies to both men and women.

Under the impetus of increased opportunities, there has been a marked increase in the WAC strength. The active Army WAC strength has more than tripled since 1972 -- to almost 44,000. Sharp increases are reflected in the reserve components as well.

We are steadily moving toward the active Army goal of 50,400 enlisted women by 1978 and are now taking multiple initiatives with respect to women's utilization. Specifically, the Army has formed a women in the Army study group to revalidate the program for the expanded utilization of women in the Army to assure it provides for full and effective employment and is consistent with the current and future needs of the Army. Let me touch briefly on the objectives and status of some study group tasks.

-- One task involves attitude surveys to determine opinions of military personnel concerning utilization of women in various roles. Thus far, the effort has concentrated on a review of existing surveys. These surveys tend to show that women are more liberal on the issue than men -- younger people are more liberal than old -- combat categories are more conservative than combat support and combat service support personnel. Parenthetically, the Defense Advisory Committee on Women in the Services recently recommended that OSD initiate and coordinate a survey of military personnel as to the desired role and participation of servicewomen in combat and combat-related assignments. OSD responded that the suggestion is under review for costs and benefits and that a final decision will be made following this review.

-- Other study group tasks include the following:

A survey of major Army commanders for their assessment of the utilization of women in the Army, to include comments on tasks being addressed by the study group.

Also, a review of physiological, psychological and sociological factors is underway. This review will look at the results of various projects - e.g., the Military Academy's project 60 which utilizes high school girls in the development of physical aptitude examinations. Additionally, the group will be looking at ROTC cadet training, police experience, WAC basic training, etc., and will obtain data on psychological and sociological factors from various sources.

Another task involves collecting and analyzing data on the utilization of women in foreign armies.

There will also be an interface with the Army research institute and its projects which have an impact on the study effort. An example is what we informally call the max WAC study. This study involves field tests to validate recommendations as to maximum percentages of enlisted women who can be assigned to various units without detriment to mission capability.

Pregnancy/parenthood is another issue being addressed. This includes collection and analysis of data regarding the impact of current policies on the readiness and deployability of units.

Training issues primarily pertain to basic training and MOS training. The Army Chief of Staff has authorized testing of a core basic training curriculum for both enlisted men and enlisted women. Tests are to begin about September of this year. MOS training is being reviewed to assure that critical skills are being taught and that men and women are being prepared properly to assume the duties for their MOS.

Another task, that of MOS reviews, is being conducted to validate the appropriateness of job specialties available to women. As a result of this review, some MOS may be opened and some closed.

The remaining tasks include a review of women officer policies and programs and refinement of the WAC enlisted strength model. The enlisted strength model and a parallel officer model analyze the force structure and various considerations to arrive at a rational structure for women. Considerations which limit the WAC strength include the combat constraint and provisions for equitable rotation of men and women between CONUS and overseas areas. Additionally, the Training and Doctrine Command is conducting a doctrinal analysis with respect to the optimal women officer content on various Army units. This generally parallels the max enlisted WAC study mentioned earlier.

The study group will make its report in July, recognizing that many actions will not be complete by that date and that a continuum of effort will be required for a sustained period of time.

Another significant action is underway -- in this connection, plans are being developed to disestablish the office of the Director, WAC anticipating repeal of the law which established the Women's Army Corps as a separate entity. This should occur within two or three years. There is foreseen, however, a continued need for a senior woman officer to advise on women's matters.

Ladies and gentlemen, this has been a broad overview of the changed and changing role of women in the Army. The Army recognizes a continued need to test, to evaluate, and to further refine women's role in the defense structure.

WOMEN IN DOD PANEL PRESENTATION
by

Captain Mary A. Gore, U. S. Navy
Director, Recruiting Support Department
Commander, Navy Recruiting Command

It is a great pleasure for me to be here at the Air Force Academy to participate in the Fifth Psychology in the Air Force Forum. I am particularly pleased to represent the United States Navy in panel discussions here today about the role of women in the Department of Defense.

My remarks will be restricted to enlisted Navy women and Naval officers of the line though there are some 2200 in the healing arts (2100 Nurses) and 74 in the various staff corps, 5 being Chaplains.

The Navy's utilization of women has been somewhat varied. During World War II, when there were some 86,000 on active duty, they were assigned to many "non-traditional" jobs. For instance, 80 women officers were designated Naval Air Navigators and were the first women in the U. S. Armed Forces to perform duties as part of a military air crew in a non-combat type aircraft. Enlisted women repaired planes, taught gunnery and instructed in the Link-Trainer.

Though women became an integral part of the Navy in 1948, they served from the end of World War II until 1972, when Admiral Zumwalt opened all ratings, in the most traditional of jobs, such as personnel, communications and administrative fields for officers, and mostly clerical and medical ratings for enlisted women. Until 1967, the highest permanent rank a woman officer could hold was Commander. Now the normal promotion pattern goes to Captain with a woman Admiral being appointed only by the Secretary of the Navy.

If Congress enacts the Defense Officer Personnel Management Act (DOPMA), it will standardize the management of the officer communities in all services in addition to equalizing statutory provisions for men and women. DOPMA will not change Section 6015 of Title 10, U. S. Code which reads in part "Women may not be assigned to duty in aircraft that are engaged in combat missions nor may they be assigned to duty on vessels of the Navy other than hospital ships and transports." The present Juudge Advocate General's opinion is that women may be assigned to small harbor craft and tug boats as long as they do not deploy to the high seas. A modification to Section 6015 to permit the temporary assignment of women to ships is presently under review but it is unlikely that any change to permit permanent assignment will be made in the near future. The important effect of DOPMA is that it will eliminate separate provisions for women dealing with procurement, appointment, promotion, authority, command, separation and retirement.

The management and distribution of enlisted women is important when you consider the dramatic increase in the number of enlisted women ---

5,000 in 1971 to 18,000 at present. The maximum goal of 20 thousand should be reached by October 1976. The goal is the number of women who can be effectively utilized without negatively impacting on sea to shore rotation for men.

Because of the rapid expansion, the percentages of women in each paygrade is unbalanced. For example, over 30 percent of all enlisted women are in the combined paygrades of E-7, 8 and 9. For the sake of comparison, fifteen percent of all Navy men are in paygrade E-3 while 6.3 percent are in the combined paygrades of E-7, 8 and 9. Eighty-nine percent of enlisted women are E-4 or below in comparison with 58 percent of men in the same paygrades. I expect that the distribution of women will become more balanced through normal promotional opportunities and advancements.

For first term women, although their eligibility population is smaller than the men, their reenlistment rate is higher so that the first term are comparable. Since 1971 there has been an increase in the percentage of women eligible to reenlist. It is expected that trend will continue and there will be a higher percentage of first term women eligible to reenlist. In the career reenlistment comparison, the retention percentages for men and women are compared favorably with 76 percent for men and 68 percent for women.

To effectively control the assignment and distribution of enlisted women, the Chief of Naval Personnel initiated a number of management actions. These include establishment of an enlisted women's coordinator in the Bureau of Naval Personnel, who is concerned with numbers of women in specific ratings and in the three basic Navy groups, which are seaman, airman, and fireman, for which goals were established. He also established goals for the assignment of women to "A" Schools, the Navy specialized training schools, and developed career rotational patterns for women.

Several variables in computing rating goals for Navy women are mandatory. Planning must consider sea to shore rotation billet base, upward mobility for women, sea duty professional requirements (practical factors), and sea to shore rotation for men. A controversial issue from the male perspective continues to be the impact of women on sea to shore rotation opportunity. Consequently, a paramount consideration was the requirement to ensure that the significant population of women would not negatively impact the male shore rotation opportunity, while simultaneously ensuring continued upward mobility for enlisted women. As a result, fifteen of the more than 60 enlisted ratings were closed to women. These are sea going ratings. All other enlisted ratings now have defined limits or goals for women. There are now ratings where large numbers of women can be accepted. For example, in the Air Controlman ratings, the goal for women is 386 and there are only 279 in that rating.

Looking next at the unrestricted line community, the 1200 women line officers on active duty represent approximately 4 percent

of the unrestricted naval officer community. The goal is to increase the total women line officer strength to 2000 by 1985. By 1980, the major accession sources for women officers will be Officer Candidate School, the NROTC program and the Naval Academy. Total anticipated accessions are 245 per year. The Navy is planning to accept 80 women at the Naval Academy in 1976. Allowing for the numbers who will be dedicated to the Marine Corps and for attrition, it is expected that 43 women will be commissioned in the Navy from the class of 1980.

Approximately 35 percent of all women officers are ensigns, 8 percent are lieutenant commanders and 3 percent are in the combined grades of commander and captain. At the same time, approximately 18 percent of the men in the unrestricted line are ensigns, 22 percent are lieutenant commanders and 15.9 percent of male unrestricted line officers are in the combined grades of commander and captain. It is immediately apparent that a concentration of women in the junior officer ranks has resulted from significantly increased accession rates during the past five years. Presently, 89 percent of women line officers are lieutenants or below, while 62 percent of all male unrestricted line officers are lieutenants or below. In time, routine promotions will cause the women's distribution pattern to more closely parallel the men's.

Navy policy for women officers is to provide maximum opportunity for leadership assignments and subspeciality development. A career progression plan for women with an 1100 designator would be:

a. Basic management level (1-10 years); an ensign would first be assigned at a field activity followed by duty as a division officer and finally general subspecialty development. A lieutenant (jg) could expect selection for post graduate education and a lieutenant would serve as a department head. In the middle management phase (11-15 years) a lieutenant commander might attend a junior service college followed by a Washington headquarters tour and consideration for a proven subspecialist designator. Finally, a senior lieutenant commander in the middle management phase would normally be screened for assignment as an executive officer. The upper management phase (16-21 years) would have a commander attend a senior service college, followed by duty at a major fleet or Joint Staff and screening for duty as a commanding officer of a shore establishment. In the key management phase, (22-30 years), a woman captain may serve at a senior position on a major fleet or joint staff followed by a senior Washington headquarters billet. She could then expect duty as a project manager followed by command of a major shore establishment. To remain promotionally competitive, women officers must progress through levels of responsibility and authority essentially equivalent to those experienced by male warfare specialists.

There are now six designated women naval aviators with seven more in training and eight more to enter this fall. The Chief of Naval Personnel has approved a policy change which now permits women to enter the restricted line where they will compete with other women officers.

Last year for the first time, women lieutenant commanders and commanders were screened for executive officer and commanding officer shore billets. The types of billets to which selectees will be assigned include Recruiting Districts, Naval Facilities and stations, military sealift command offices, communications stations and units, recruit training command, NROTC Units, and service schools.

The Navy is committed to a policy which will provide Navy women with a real opportunity to rise to as high a level of responsibility as possible, dependent upon individual ability and within the bounds of national law. Current concerns that are presently viewed as short term include an excessively high percentage of non-rated enlisted women and junior officers; and concurrently, too few senior enlisted women petty officers and senior officers - facts that increase the urgent need to fully integrate Navy women throughout the command structure, while ensuring the effective utilization of their talent and ability. Phase II program of our human resources management effort will soon include a workshop on women in the Navy principally designed to assist commanding officers and middle management in the full integration and utilization of the Navy women in commands to which they are assigned. Legislative initiatives are in progress to remove the last of all remaining inequities in law that can possibly be removed under the non-combat constraint.

WOMEN IN DOD PANEL PRESENTATION
by

Colonel Margaret A. Brewer, USMC
Director of Women Marines

The Marine Corps was one of the first services to enlist women for jobs other than in the medical fields. This was during World War I when approximately 305 women enlisted in the Marine Corps. The majority served in clerical jobs in Washington. After the war, however, they were all released from active duty and it wasn't until 1943 that women again served in the Marine Corps.

During World War II there were approximately 20,000 women in the Corps and they performed a great variety of jobs. However, despite their valuable service, there still wasn't any serious consideration given to a continuing role for women in the military during peacetime except in medical fields. Since all medical services for the Marine Corps are provided by the Navy, this left a very limited opportunity for women in the Marine Corps and only 100 women remained on active duty after the war to provide a trained nucleus in the event it was ever necessary to mobilize again.

Today there are approximately 3500 women in the Marine Corps which is the highest total strength since World War II. Our official strength goal is approximately 4100 by FY 80 which would be approximately 2-1/2% of the total strength. However, there are some studies being conducted which might result in an increase to this strength goal.

The Marine Corps as the Nation's Force-In-Readiness maintains a uniquely high ratio of operating forces or combat forces to general support forces -- approximately 60% combat forces to 40% support forces. As a highly mobile and ready combat force, the Marine Corps maintains a Division and Aircraft Wing team in the Pacific area comprised of male Marines on one year unaccompanied tours, without their dependents. Since this is a combat ready unit, women have been excluded from the rotation base for the Fleet Marine Force unit. However, within the last year we have begun to assign women routinely to Divisions, Aircraft Wings, Force Troops and Force Service Regiment headquarters to those Marine Force units located in the continental United States. This represented a significant policy change for the Marine Corps. In the past, women had not been assigned to Fleet Marine Force units other than the two Force headquarters.

Since the Fleet Marine Force units are combat forces, there are some constraints on the assignment of women to these units. At this time, women are limited to the headquarters of these major commands and to subordinate nondeployable units in rear echelon billets requiring service

support, aviation support, or communication occupational specialties that would not require them to deploy with the assault echelon of the unit if a contingency should arise.

All occupational fields have been opened to women with the exception of four. These four are infantry, field artillery, tank/amphibian tractor, and pilots/naval flight officer. However, there are some management constraints that have been placed on the number of women to be classified in each occupational field. This was based on an analysis taking into consideration such factors as the number of deployable and nondeployable billets, equitable promotion opportunity for men and women, and maintaining an equitable rotation base for male Marines.

Admittedly, most of the women are still assigned to traditional occupational specialities. However, ever increasing numbers are being assigned to nontraditional occupational fields. There are, however, a variety of attitudes toward the assignment of women to nontraditional jobs; for example, some men and some women consider nontraditional jobs, especially those that involve manual labor as inappropriate for women.

Another area of concern in the assignment of women to certain nontraditional technical jobs is the physical requirements for some of the jobs. If the work required by a certain job does, in fact, require that the worker possess certain physical strength or stamina, then definitive performance standards should be established so that no one, male or female, who could not meet the requirement standards would be assigned the MOS (Military Occupational Specialty).

When given the opportunity, women have generally been performing well in nontraditional jobs. Their abilities as students in Marine Corps and interservice schools are a matter of record. For example, three enlisted women students in a welding course recently finished within the top four class positions. The honor graduate was a male Marine who had previous experience as a welder. Women officers are also performing well in nontraditional jobs. For example, the first woman officer in the Marine Corps to be assigned as an engineer was the honor graduate of the engineer course that she attended earlier this year. How well the women perform on the job, however, can depend on the attitudes of their supervisors. If they are relegated to routine jobs not consistent with their training and abilities, then that is not effective personnel management.

There are still some legal restrictions which limit opportunities for women. There is the combat limitation which you hear and read about frequently. However, there are also some other limitations such as the legal prohibition against the appointment of women as limited duty officers. There is also the legal limitations on the promotion of women officers to flag and general officer rank in the Navy and Marine Corps; and the differences in criteria for the involuntary separation of male and female officers who are not selected for promotion. The law also

precludes female commissioned officers in the Marine Corps from competing for promotion with their male counterparts.

Legislation that would change these legal limitations has been included in DOPMA (Defense Officer Personnel Management Act). This is DoD sponsored legislation designed to revise laws pertaining to appointment, promotion, separation, and retirement of officers in all the services. However, until such time as the laws may be changed, they continue to constrain, to a varying degree, the assignment and utilization of women in the Marine Corps as well as in the other services.

The decade which has passed has been a time of change and transition in the role of service women, especially during the past few years when there have been a number of changes in laws, policies, and regulations affecting the assignment and utilization of military women. As we move toward the more complete integration of women in the Marine Corps, and increased numbers of women are integrated into organizational units and work sections that have previously been all male environments, it is probably inevitable that there will be some attitudinal problems that will create a special leadership challenge. Military leadership has traditionally been oriented toward the leadership of men by men. There are, of course, many leadership principles that are the same whether the leaders and followers are men or women. However, in some cases there may be some differences since women as a distinct minority within the Armed Services are still affected by legal restrictions, societal/cultural attitudes and vestiges of past legal and policy restrictions. As unnecessary differences in the assignment and utilization of women are eliminated, care must be taken to ensure that the transition is orderly and that the requirements and needs of women as a minority in the Armed Services aren't overlooked or minimized.

Good leadership which recognizes the needs of all members of the command is essential to any organization. When the Marine Corps Human Relations Program was first established some years ago, the primary emphasis was minorities. As time has gone by, the program has evolved and this year we are transitioning from a separate Human Relations Training Program which will combine elements of both human relations training and traditional military leadership training.

For some time it has been recognized that information regarding the role of women in the Marine Corps was somewhat limited in the Human Relations Training Program. Continuing efforts have been made to include additional materials. However, these efforts have been hampered to some degree by the lack of readily available research material regarding the changing role of women in our society today. There are many unanswered questions and there is still much research work that must be done. Perhaps some of the papers presented at this symposium will help to answer some of the questions -- questions which must be addressed and resolved as the Marine Corps and the other services continue to move steadily toward the more complete integration of women in the Armed Services.

WOMEN IN DOD PANEL PRESENTATION
by

Captain Dorothy Jeanne Gleason
U. S. Coast Guard Reserve

It is a privilege to be here this morning and talk about the women in the Coast Guard. Our numbers may not be large, but some of the current happenings are quite impressive.

--Women entered on military duty in the Coast Guard Reserve in November 1942 (known as SPARS), and eventually reached a maximum strength of 1,000 officers and 10,000 enlisted. Practically all were released by 30 June 1946. Emergency Coast Guard legislation, which terminated in July 1947, included termination of the authority for women reservists and all women officers and enlisted were discharged.

--It was not until November 1949 that new legislation was enacted to reestablish the women's branch of the Coast Guard Reserve. Women officers whose commissions were in effect at the time of the terminated legislation were invited to reaffiliate with their prior date of rank. Former enlisted women were given an opportunity to re-enlist. Approximately 300 women responded. Volunteer reserve units and correspondence courses were the only training opportunities available. (This also applied to the male reservists.) There was no active recruiting to increase numbers, or to replace those lost by attrition.

--Beginning in the early 50's, women could be enlisted in an inactive status for assignment to reserve units. A few former enlisted women who attained degrees were given direct commissions as were a limited number of other women for assignment to units.

--During the Korean conflict some 35-40 women, officers and enlisted, returned to active duty, and 8 of these officers were permitted to remain on active duty to complete 20 years of active duty service. A few enlisted women also remained on active duty following the Korean Conflict.

--Commencing about 1962 and continuing for several years, enlisted women were brought on active duty, on an average of 40 each year, to fill medical and administrative positions (HM, SK and YN).

--Meanwhile, attrition continued to thin the ranks to the extent that by the end of FY 71, only 2 officers and 25 enlisted women were on extended active duty, all of whom were reservists. In all other reserve categories--selected reserve, ready and standby reserve--there were 96 officers and 43 enlisted.

--In 1972 a board was convened to develop a program to utilize women. As a result of the recommendations of this board, action was initiated to open the way for an expanded reserve program and for women to enter the regular Coast Guard.

--In January 1973, the Coast Guard assigned women to OCS class--to provide leadership prior to enlistment of women. Significant in this assignment is that it was the first time women were totally integrated into an officer candidate program on a par with their male counterparts--selected on the same factors--berthed in the same barracks (with female roommates and separate bath facilities)--curriculum identical except for some changes in physical education--they march with heavy M-1 rifles as their preference over dummy rifles. Two or three women consistently qualify for the honor platoon and many qualify as small arms experts and marksmen.

--Later in 1973, enlistment of women was authorized in the Coast Guard Reserve with a call to active duty for four years. The ratings were limited to administrative types--yeomen, storekeeper, hospitalman, personnel, dental technician and musicians. During this same period women were given direct commissions for assignments to reserve units and petty officer programs brought in enlisted women for the units.

--In December 1973 a major action was taken as the result of Coast Guard initiated legislation: The restriction that women could only be in the reserve was abolished thus permitting enlistment into the regular Coast Guard. Women on active duty were given their choice of enlisting in the regular service or completing their reserve enlistment. Other ratings continued to be open to women, including all aviation ratings. Two women who had been on active duty for some time, a Lieutenant and a Chief Warrant Officer, integrated into the regular service. OCS continued to produce 15-20 women officers per year, and a few women received direct commissions as legal specialists.

--Additionally, beginning in FY 1973, a reserve inactive duty direct petty officer program was initiated and by the end of that year there were 414 enlisted women in the selected reserve.

--Officers on active duty are performing a wide variety of duties and are eligible for assignment to any and all Coast Guard units except floating units and isolated duty stations. They are serving at groups, bases, district offices, training commands, headquarters, and two are assigned to flight school at Pensacola-- one is already on board and one will report within a short time. These women will undergo flight training in an unrestricted status-- fixed wing and/or rotary--and upon completion will be assigned just as their male counterparts to any operational aviation command in an unrestricted flying status.

--OCS graduates serve their first three years at their initial duty station. Integration into the regular service is possible after this initial tour of duty. Enlisted women are currently serving at district offices, headquarters, air stations, marine inspection offices and bases where appropriate barracks space or S&Q entitlement exists.

--Numbers as of this time:

--Officers on active duty include two regulars and 42 reservists, four of whom are direct commission lawyers with the rank of Lieutenant, and the others are Lieutenant junior grade and ensigns, the current OCS class has nine women. There are 400 enlisted women on board. In the inactive group as of December 1975 there are 26 officers and 948 enlisted.

--Inactive duty women are assigned to practically every reserve unit throughout the country, and perform duties commensurate with their rank or rating. Enlisted women in such ratings as port security, boatswain mate, engineman, data processing, subsistence specialist, as well as the more usual ratings for women--yeomen, storekeeper, photo journalist, hospital corpsman, etc.

--Enlisted women--regular and reserve-- are in coed companies at basic training, entering the program weekly. It is anticipated that two hundred women will be enlisted in FY 76 for active duty--one out of every 28 recruits is a female--just as the officers, aside from berths and bath facilities and physical fitness, they have the same program as the male.

CADETS: The Academy will admit women cadets for the first time this summer -- I am more than a little proud that the Coast Guard was the first of the armed services to open its academic doors to women. The cadet program will not be changed except for some modifications in the physical fitness program -- the academic and military training portions will be identical with the men -- women will make the summer practice cruises on the sailing barque EAGLE where 18 berths have been added, and on the high endurance cutters where facilities are available. Women cadets will be full participants in the military indoctrination system, including that portion conducted in the barracks -- women will live in the wings occupied by their platoons and companies and distributed throughout the cadet corps-- they will have female roommates and separate bath facilities. Of 10,000 applicants for the current class, 7% -- 700 -- were women. We anticipate the percentage of the class of 1980 who are women will be 7%. The class size is 325 -- 20-25 will be females.

Defininte actions have been taken to grant opportunities to women co-equal with the men in the Coast Guard to the greatest extent possible. It is the policy to assign married couples to duty at either the same station (if large enough to accommodate) or in the same area so that they may live together. Pregnant women are permitted to remain on active duty providing the command certifies that child care provisions will not interfere with job performances. Pre - and post-natal sick leave as medically

indicated are now routine entitlements, as opposed to requiring the use of annual leave for part of the absence.

There is no "women's program" -- there is no parallel administrative organization to handle women. Assignments, except for floating units, are made on a basis co-equal to male counterparts in the same ranks and ratings. The question of assigning them afloat or to isolated units is one which will require further consideration by the commandant and will be resolved before the Academy class of 1980 graduates. We are training OCS candidates and plans are being made for Academy cadets to serve afloat on our newer classes of vessels and the EAGLE. In addition female officers are going to sea on operational patrols for familiarization purposes for periods of two weeks or more -- so far no problems and the women perform well.

A general observation based on reports from the field indicates there may be a tendency on the part of some commands to initially assign women to administrative and less physically demanding positions. Women generally object to this, assert themselves, and work into all aspects of the unit. There are no quotas or particular billets that are designated for women only. We attempt to keep at least one female officer some place on the staff of training commands, but there is no rule that requires this. By utilizing assignment preferences and service needs, female officers are distributed throughout the service rather than concentrating them in any one place. This approach seems to be the most realistic in terms of satisfying command preferences, assisting in image development and recruiting, and it helps to facilitate attitude changes among the male members.

There is an extreme imbalance between regular and reserve commissioned females. This will correct itself during the next five years as women are integrated into the regular service and graduate from the Academy.

In November 1975, the Commandant approved a new uniform for women -- designed by Miss Edith Head, Hollywood fashion expert, Paramount Pictures-- which is now in production system and projected to be available for all women by October 1977.

Admiral Owen Siler, Commandant of the Coast Guard, stated:

"Women in the Coast Guard have a long and proud record of service that dates back to lighthouse keeper days. Today, the opportunities for women are greater than ever .... We have fully integrated women into the regular service....Old barriers to women serving in certain rating specialities have all but disappeared. Only those ratings with very poor sea/shore duty rotations are closed to women since our present policy restricts women from serving afloat or on isolated stations." and in speaking to the male cadets at the Academy, Admiral Siler said: "I am sure the cadet corps will welcome the first women with open arms -- figuratively speaking, of course, and I see no problem with you men competing with women as equals just as you would at any non-military

college or university. Judging from our experience with women at OCS and enlisted training, I expect you will find women cadets will offer strong competition in many fields. But aside from a few bruises to your ego, I see only minor problems which can be settled by Admiral Jenkins (Superintendent of the Academy) and his staff -- such as whether to address women cadets as Mister or Sister."

Let me end on a personal note -- a point of privilege for serving 33 years in the Coast Guard Reserve. What a challenging time to be a woman in the service with all the opportunities for an exciting and rewarding career. My best wishes and good luck to all who are serving-- regardless of the branch of service -- and to say that I am truly envious that I do not have their opportunities.

LIST OF ATTENDEES
FIFTH ANNUAL PSYCHOLOGY IN THE AIR FORCE SYMPOSIUM

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