HUMAN FLIGHT BEHAVIOR IN GROUPS

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An intrinsic aspect of human behavior in flight is that it involves the behavior of persons as members of organized groups, in which there is some division of labor and differentiation of roles. As a result each individual must depend on other individuals, to some extent, for the over-all accomplishment of his tasks. The in-flight interdependence of the crew members of bombardment, refueling, and transport aircraft is readily apparent. Similarly the coordination required among the solo-flying pilots of fighter-interceptor flights, with each other and with control stations on the ground, is easily recognized. The coordination network is greatly extended, however, by the participation of many specialized support agencies — such as maintenance, weather, airways and air traffic control, and others — when the operation is viewed in its totality. This thought was neatly expressed by an Air National Guard jet pilot (25) in the words, "You can't set a record by yourself," after a record-shattering F-86-F flight from Los Angeles to New York in 1954.

In recognition of the interdependence of human behavior in organized, group situations, terms such as *teamwork, leadership, morale,* and *coordination* have high status as desired values in human affairs. However, systematic understanding of the behavior processes by which they may be achieved has been slowly acquired and is as yet meager. It is gratifying that a vast amount of research effort is currently being directed at these problems and that some substantial results can be reported at this time. In selecting material for this report, precedence has been given to research actually concerned with the behavior of flight personnel in flight operations. As a result, only a few other references have been made to the substantial and growing research literature on group behavior or to the broader aspects of coordination involved in the operation of the over-all flight organization. Those desiring general references in these fields should consult works such as Cartwright and Zander's

Group Dynamics (4), Lindzey's *Handbook of Social Psychology* (23), and McFarland's *Human Factors in Air Transportation* (24). The Office of Naval Research has recently issued a bibliography of unclassified research reports in group psychology (26).

With this limitation, let us consider first some semantic problems related to research in this field and a frame of reference to assist in organizing and interpreting the material to be presented.

SEMANTIC PROBLEMS

A great deal of confusion has resulted from the imprecise and often misleading use of terms related to group behavior, as for example, *leadership* and *morale*. One problem is related to their functional purposes. Such terms can have systematic explanatory meaning only when they refer to dimensions of group functioning, but they are often used to describe specific behaviors of individual group members.

Leadership, in an organized group, is the general function of facilitating the movement of the group toward the accomplishment of its designated goals; that is, of expediting group effectiveness. The behaviors of various designated individuals, in this respect, must depend on the nature of the task, the people involved and the goals. Thus the leadership behaviors required of an aircraft commander, a squadron commander and, say, a hospital commander, may be quite different, and may also vary under different task conditions.

Similarly, *morale* represents attitudes associated with membership in a group, which reflect the cumulative satisfaction of group members derived from their participation in the group. It should not be confused with other concepts, such as general level of individual adjustment, although these are related. And, it cannot be specified by a particular list of behaviors, but rather depends on the relation of individual behaviors to the status of functioning of the group. Thus people in an organization might be happy, but they might be mission oriented and effective, or not; and the evaluation of morale would be quite different in these cases.

If a recent report by Fruchter et al. (11) were taken at face value, one would conclude that leadership is highly, but negatively related to B-47 crew effectiveness, as rated by superiors and wing standard-ization boards. It is of interest that in this study the ratings of *leadership* were based on specified behaviors, principally of aircraft commanders, such as putting other crew members at their ease, making crew membership more enjoyable, and accepting responsibility. The authors themselves questioned the appropriateness of

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such behavior by a bomber commander to his military mission and cited similar results of a study of B-29 crews in combat, by Halpin (13). However, Halpin used the more appropriate term, *consideration,* for the same behavior, which he, too, found to be negatively related to effectiveness ratings of aircraft commanders by their superiors. Halpin properly referred to this finding as a "dilemma of leadership" since the more the commander pleased his crew, the lower he tended to be rated in effectiveness by his superiors.

A similar finding was reported by Smith (36) in a study of B-17 groups based in England in World War II, whose mission involved the bombardment of heavily defended targets in Germany. Smith compared groups selected as highly effective and highly ineffective in terms of bombing results and found that *morale,* defined as feelings of well-being and cohesion reflecting enjoyment of group participation, was low in the effective groups and high in the ineffective groups. On the other hand, in the most successful groups, cohesion was found, but it was centered around the mission, emphasizing military combat duties, rather than social and recreational activities. They were welded together with a common purpose, but this was to get their job done, and get home. Group cohesion did not appear as an end in itself, and other purposes incompatible with the mission, such as safety and survival, were kept in check.

Smith concluded that superior performance in a combat bombardment group is more likely to be achieved if the designated leader (a) stresses mission objective over all other considerations, (b) is not himself overly identified with the personnel of the group to the point where this identification interferes with the mission, and (c) achieves a high degree of cohesion, confidence, and cooperation, but not necessarily "morale" in the sense of well-being. This ruthless emphasis on the mission was truly a "dilemma of leadership" which many combat commanders found too difficult to accept. It was dramatically portrayed in the play *Command Decision.*

The work of Fiedler (8), supported by the Office of Naval Research, throws further light on these problems. Fiedler's research, based on groups as diverse as high school basketball teams, student engineer surveying crews, and B-29 bomber crews, produced a number of consistent results. One of them related the group's perception of its mission to the attitudes of group members toward each other. For example, basketball teams that were high in league standing and competing for top honors, tended to prize competency

ahead of social participation, while low standing teams placed more emphasis on "being a good fellow." These variations, which correspond with those observed by Smith, with respect to "morale" attitudes of B-17 groups, illustrate the importance of situational specifications in the study of morale.

With respect to superior-subordinate relationships, Fiedler emphasized the importance of the interaction between the two in relation to effectiveness. If the superior is outgoing and approachable and tends to get too friendly with his subordinates (i.e., identify with them too much), he may find himself unable to make clear-cut decisions. However, if the organization has rigid barriers between ranks, and is part of a highly disciplined system, such a superior may be more effective. In contrast, an aloof superior, who isolates himself from his subordinates, may lose touch with the group. Such a superior, however, may be more effective in a situation where rank barriers are relaxed. Hence the relation of *consideration,* as a variable describing superiors' behavior, to group effectiveness, should be expected to depend not only on the requirements of the mission, but also on the nature of the group membership and group structure, as reflected in attitudes of group members toward each other.

The principal lesson in semantics that we can draw from this discussion is that in the study of group behavior a distinction must be made between terms used to describe human behavior, such as consideration, identification, cooperation, and terms used to describe group functions, which are essentially abstractions, such as leadership, morale, and group effectiveness. The task for psychologists and social scientists, with reference to the goal of clarifying the principles of group behavior, is to relate behavioral concepts to the abstractions of group function. Since the problem is to explain group function in terms of behavioral data, it is essential that concepts of group function — such as leadership, morale, and group effectiveness — be employed to define criteria, while the predictions are based entirely on behavioral data.

Another important semantic point concerns the use of words to represent particular aspects of behavior. Throughout the literature in this field, terms are assigned to represent particular attitude, role, and behavior scales, which are necessary for communication purposes, but often imperfect symbols of the behavior described. Until a standardized taxonomy of behavior description is achieved, which at this time is certainly not imminent, extreme caution must be exercised in the comparison of results of different studies on

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the basis of the verbal symbols only, without reference to the supporting behavior descriptions.

A FRAME OF REFERENCE FOR THE STUDY OF GROUP BEHAVIOR

All behavior represents the interaction of the individual and the environment, in which significant variance can be attributed both to the abilities, habits, and dispositions of the individual and the pressures and forces exercised on him by the environment. In group behavior, many of the significant environmental forces are derived from the structure of the group as it channels communication of information to various individuals, defines prestige, power, and influence, and determines the roles that individuals play in the concerted effort of the group.

The practical application of psychologic principles of group behavior in flying activities lies in the understanding of factors in organization and interpersonal relations which may be used to increase group effectiveness. From this point of view it becomes necessary to consider not only the characteristics of the individuals who comprise group membership, and the various aspects of group structure, but also the purpose, goals, or mission of the group, on which the concept of effectiveness depends.

There are, then, three dimensions of group functioning which interact and must be considered in interrelation in the study of human behavior in organized groups. Keeping in mind the practical application aspect, these dimensions may be regarded as subject to external control by top management and this is reflected in the following terms which will organize the balance of this discussion: (a) *group goals* define the mission in terms of the task objectives set for the group and the priorities and cost limitations under which they are to be accomplished; (b) *group staffing* defines the constitution of group personnel and therefore the upper and lower limits of their potentiality, in terms of the abilities and capabilities of the individual members; and (c) *group utilization of personnel* refers to the nature of the work environment provided for the group and hence it defines the extent to which the potentiality of the group may be realized.

The interrelation of these factors is illustrated in a very impressive report by Paterson (27), who, although a radar control officer, was assigned by his station commander to attack the problem of a dreadful and destructive accident rate at an RAF fighter station during World War II. Available evidence suggested that the accidents represented careless errors of judgment rather than accident

proneness, and Paterson approached the problem by efforts to increase group cohesion and to achieve a group norm of "good flying" for pressure to conform. After observing and analyzing conversations among pilots and other personnel, he decided that it was frustration of the desire to get into battle that was responsible for the prevalent irritability, carelessness, and lack of team spirit and that this might be overcome by giving the pilots something to fight, symbolic of the enemy. Since constant bad weather prevented the pilots from engaging the enemy in battle, the weather was on the side of the enemy and could be made symbolic of the enemy. The station might fight the enemy by fighting the weather.

The account of how he identified the respected, influential members of each group, whom he called *exemplars,* and working tactfully and unobtrusively through them, set in motion group interactions which gradually affected everyone on the station with a common purpose, is one of the thrilling anecdotes of the war. In addition, in discussion of his successful efforts to reduce aircraft accidents, which have since been tested as well in industrial situations, Paterson made a number of important theoretic observations. With reference to team spirit and teamwork, he emphasized the importance of *morale,* based on appreciation of the common purpose and knowledge that everyone, in his role, is "doing his bit." Teamwork, the coordination of the various functions, depends on the development of such morale, although "leaders or experts" are necessary to that coordination. But it is not alone necessary to have one person tell others how to perform their functions. They must also know something of the way in which their functions are coordinated, which is the background to the popular interest of *communication* and *liaison.*

On *group structure* and *roles* he pointed out that, "not only was appreciation of functional coordination necessary, but also appreciation of the persons performing these functions; that is, estimation of role. ... Function, hence role, has no meaning unless it is one of a structure of functions necessary to achieve the purpose of a group.... If a man performs no function of significance to a group, he cannot be a member of that group.... Thus at Bogfield, there could be no room for one who did not perform a function which helped in some way to put an aircraft and its pilot into battle with the enemy.... If the word 'work' is taken to be synonymous with 'job,' then work may be said to refer to what a man does when what he does has functional significance, his contribution to the group activity. A man working fills a role. He and his

role are identified and in this he becomes a meaning to society. . . .
Unless there is a structure of functions work is not meaningful. . . .
For a sense of belongingness, role, hence structure, is essential. . . . Belongingness gives security."

Thus we can see that behavior of individuals as members of groups and their collective behavior in groups reflects the complex interaction of many variables which we have grouped logically in the three categories: group goals, staffing, and utilization. The research to be summarized in the remainder of this discussion will illustrate a number of variables related to staffing and utilization. However, in each case, the results must be interpreted with reference to the established goals of the particular group and the particular perceptions of them found among the members of the group, as well as with reference to all other conditions of staffing and utilization not specifically isolated for study. The fact that relevant variables are not always taken into account by investigators does not alter their relevance or effectiveness.

MEASUREMENT OF GROUP PERFORMANCE:
THE PROBLEM OF CRITERIA

One of the most baffling and elusive problems in personnel research has been the development of appropriate, reliable criteria of performance. Measurement of group performance is necessary to evaluate the effects of various factors presumed to account for group performance.

Research, primarily with B-29 crews by the Combat Crew Training Research Laboratory at Randolph Air Force Base, has given a rather discouraging picture of a number of *objective* indicators of bomber crew performance. For example, Forgays and Irwin (9), who studied 600 B-29, student crews in training, reported results such as the following:

a. Radar bombing circular errors obtained by the Radar Bomb System (RBS) showed a corrected odd-even mission reliability of .33. Attempts to increase reliability by correcting for target and mission differences, presence of instructors, and condition of radar set were unsuccessful.

b. Mean circular errors on the ultrasonic (ground) trainer had a reliability of .47, and questionable validity in relation to radar bombing scores in flight.

c. Target identification scores on simulated visual bombing missions ("visual camera" scores) had a reliability of .20, which was believed to be inflated by instructor estimates in scoring. Circular errors in actual visual bomb drops had a reliability of .18.

d. Average errors in making good control times showed a reliability of .49, with some indications requiring verification, that these errors relate meaningfully to mission difficulty and stage of training.

e. Ground school written examination had relatively high Kuder-Richardson reliabilities (.60 to .91) in the cases examined, but these failed to correlate meaningfully with objective in-flight measures.

These results are representative of efforts to obtain satisfactory objective measures of flight crew performance. On the other hand, ratings of crews by superior officers and by standardization boards have proved reliable in a number of studies, although not related to objective measures. Knoell et al. (20), for example, obtained several types of ratings on combat performance in the Far East for 108 B-29 crews which had trained initially at Randolph Air Force Base. Their results showed:

a. That ratings by squadron commanders and, in some cases, wing officers, were satisfactory as to inter-rater agreement; however, although nine dimensions were rated, factor analyses revealed that they were accounted for by one general factor.

b. That similar ratings of individual performance were most satisfactory for aircraft commanders, navigators, radar operators, and flight engineers; ratings of copilots, bombardiers, radio operators, and gunners did not reach satisfactory levels of agreement.

c. That ratings of flight crews by ground crews assigned to their aircraft offer a reliable source of rating information, although these ratings did not correlate significantly with anything else.

In view of their demonstrated reliability and authoritative status in the operating affairs of the organization, *superiors' ratings* have in one form or another been used in most of the research known. However, this is probably more expedient than satisfactory and the criterion problem remains an important and challenging area for continuing investigation.

RESEARCH ON STAFFING PROBLEMS

Technical competence

The most important single factor controlling the assignment of personnel to any flight crew is technical competence. Although, from the standpoint of crew effectiveness, the possession of a minimum standard of technical competence may be regarded as a necessary rather than sufficient requirement, the study of Fruchter et al. (11) reported a positive, linear correlation of .43 between crew members' ratings of each other on this factor and the superiors' rating criterion. These ratings were based on such items as

frequency of errors in the air, competence and interest in technical specialty, satisfaction with performance in both air and ground activities, and consistency of performance.

There is some impressive evidence, from another study of B-47 crews, that crew members' approval of the technical competence of other crew members is not entirely a matter of individual proficiency but depends also to a substantial degree on their experience in working together. Hood and his associates (18) found that crew agreement on "who does what when" in flight, which is highly correlated with superiors' ratings, is a direct function of crew members' experience in flying *together;* the important factor is neither flying experience nor even multi-jet time per se, but experience together as a team. The importance of operational training to supplement initial crew assembly is clearly indicated and neatly illustrates the interdependence of staffing and utilization measures.

Crew assembly

The problem of rational crew assembly has received considerable research attention and yielded useful results. Rational approaches imply that some combinations of personalities, backgrounds, skills, and other individual characteristics may be more compatible and adaptable to effective task performance than others. The literature on interpersonal attraction and selection of mates and work partners is relevant and has contributed to approaches which have been investigated. A comprehensive review by Haythorn (16) cited a number of generalizations as well supported by experimental evidence:

a. Research on crew composition and efforts to assemble crews for optimal performance has confirmed that variations in crew effectiveness can be accounted for by variations in the particular combinations of individuals composing the groups (32).

b. The most successful method of assembling crews thus far has been that of self-selection, in which crew members express their own choices of preferred crew mates. The improved effectiveness obtained by such methods is apparently a result of increased crew compatibility observed in crews composed by these methods. A limitation of self-selection methods has been their feasibility, but this is less of a problem with smaller crews such as in the B-47 and B-52 type aircraft, as compared with the much larger B-29 and B-36 crews. To accomplish self-selection, it is necessary to give potential crew members an opportunity to become acquainted with those from whom they are expected to choose. The more extensive this acquaintance, the more effective the assembly procedure

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is likely to be. Practical procedures for setting up contact situations have been described by Roby and Rosenberg (29, 33).

c. One of the most important determiners of compatibility among crew members is similarity of values regarding issues relevant to group performance. Hence, compatibility and resulting efficiency can be improved by assembling in the same crews individuals whose values and attitudes on mission and work-related issues are alike. The more relevant the issue, the more important this sharing of values becomes.

An as yet unpublished study by Sells and Templeton (34), which was concerned with the problem of reducing attrition in primary flight training by compatible matching of students with flight instructors, showed also how individual needs may influence choice. When asked for preferences with reference to their choices of students, the instructor's replies included such statements as, "I prefer to have no students taller than 5 feet 6," and "I would prefer noncollege graduates." Among the students' replies were preferences for "older, more patient, and fatherly" instructors and for instructors "who don't chew you out on the radio." It was not clear whether the satisfaction of such expressed choices or increased compatibility resulting from it was effective in the significant reduction of attrition accomplished in this study.

In a related study using basic airmen as subjects, French (10) studied the influence of achievement and affiliation needs, measured by psychologic tests, on work partner selection. She assumed that the behavior of a person making a choice between a work partner who was a competent nonfriend and one who was a less competent friend could be predicted by the relative strength of these two kinds of motivation. The results were in accordance with the hypothesis, although subjects low in both achievement and affiliation showed no patterning. In addition, the achievement motivation mean scores showed a significant increase and the affiliation a significant decrease from subjects who chose a friend, through those who chose both the friend and the competent person, to those who chose the competent person only.

The accomplishments of research on crew assembly problems warrant further support of effort in this direction, as well as practical application of technics already available. Refined technics using proficiency measures and personality test profiles, following up promising beginnings referred to above, and the use of mathematical models (6, 7) need to be investigated. The methods developed in this field will also have application to the development of other significant work groups in aircraft and missile operations.

RESEARCH ON UTILIZATION PROBLEMS

The challenge to top levels of control in an organization is not only to obtain the best talent for the required tasks, but also to make the most effective use of it. This is the strategy of the term *utilization*, which implies the exploitation of all possible relevant factors in the work environment which may contribute to group effectiveness. Of course, there must be a balance between goals, capabilities, and facilities. If the goals are unrealistically high or low in relation to the other two, certain problems will arise. Or, if either the personnel or facilities are inappropriate to the goals, there will be other problems. However, a commonly overlooked problem is that of an organization in being, with qualified personnel and generally reasonable goals, which falls short of optimal effectiveness and has room for considerable improvement. Let us examine the relevant factors for improvement of utilization.

Aircrews and other organizations have been approached by different investigators in terms of several different conceptual viewpoints. One approach, which has been used more in relation to larger groups — such as squadron, wing, and larger administrative units — is concerned with organizational structure, lines of authority, communication channels, span of control, pay, promotions, and other formal, structural aspects of the system. This may be called the *structural approach*. A second approach views a crew or other group as a social group, which is part of a social system. The sociocultural background provides a common set of symbols to which the members respond. The members are differentiated in terms of roles, status, power, and various patterns of interrelation, which affect and are affected by the attitudes, inter-individual compatibility, cooperation, and performance of the others. The emphasis here is on *group dynamics*. Finally, the third approach looks at an aircrew as a *man-machine system*. It is task-oriented and involves a flow of communications in relation to group (actually system) work output.

Although each of these approaches has been productive, no one is alone sufficient to the total problem. Indeed, there is no reason to expect that the picture of an organization from the viewpoint of group dynamics, the analysis of formal structure, and the man-machine system need be consistent. Whether the effects of different aspects are complementary or contradictory may be important in many cases. The interplay of various factors can only be evaluated by a comprehensive, integrated approach. However, at present we must be content to consider the contributions of the separate approaches.

The structural approach

Important contributions from this approach have come from the Ohio State leadership studies, which have received support from the Office of Naval Research and the Air Force. The profound importance of the formal structure and its implications for the behavior of organized groups was graphically analyzed by Stogdill (38). The act of organization involves specification of jobs and their functions in the over-all division of labor. The specification of a job constitutes definition of *responsibility to whom, for what functions,* and incidentally *at what level* of prestige, status, and power. Thus the official lines of authority and communication, power and status hierarchies, and the basic prescriptions of roles in the group are specified by the formal structure of the organization. They may contribute positively to effective operation or they may interfere.

However, responsibility can never be spelled out in complete detail nor is this desirable. A proper balance must be struck between the dangers of ambiguity at one extreme and of excessive restraint and red tape, at the other. Behavior within the organization occurs according to *expectations,* resulting partly from custom and tradition and partly from interactions between superiors and subordinates within the organization. *Conforming expectations* reflect favorable goals, formal structure, and personnel capabilities, reinforced by effective discipline and exemplary behavior by superiors; *deviant expectations* and *noncomformity,* which impede and may undermine the organization, may result from unfavorable conditions or lax discipline and deviant examples by superiors and high status persons. To the extent that superiors are conscientious about influencing conformity with organizational patterns, their own freedom of behavior is sharply restricted.

Conformity with expected behavior of a particular job, or *assumption of expected role* in accordance with the prescribed formal structure, often produces unintended behavioral results of far-reaching significance. The traditional unpopularity of the inspector and of the comptroller in large organizations is virtually written into their job descriptions and intensified when conscientiously followed. Departmental rivalries, "empire building," budget padding, and similar bureaucratic institutions can be shown, to a large extent, to be inherent in the basic formal structure of an organization, just as cheating on tax returns and expense accounts is encouraged by inherently unwise regulations and laws.

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Research on role behavior of members of aircrews (2, 12, 14) has generally confirmed these principles in both student and operational B-29 crews, both with respect to the interaction of aircraft commander behavior with crew interpersonal relations and expectations, and in relation to crew proficiency and combat effectiveness ratings. Torrance (40) has shown the influence of power position on group decision making in B-26 crews, and his results, like those of Hood (18) in the B-47 study mentioned earlier, have emphasized the importance of training together in supporting and solidifying a "crew norm" of operating procedure.

Another important contribution from the Ohio State group is Hemphill's (17) development of a taxonomy of situational factors in group situations which have behavioral implications and which can be measured by his "Group Dimensions Description Questionnaire." Examples of his dimensions are *group autonomy*, *control over activities of members*, *flexibility* of procedures, *stratification* by rank, authority, prestige, *stability* of personnel, assignments, and organizational structure, *affect* associated with membership, and a number of others.

The group dynamics approach

Although the formal structure of an organization has a profound influence on roles, attitudes, and behavior, this influence is exercised through the reactions and interactions of people in the group. In addition, many interactions occur, in the form of group pressures and group standards, reflecting patterns of cohesiveness and communication among group members, which are not directly related to the formal structure. Actually, the formal structure may be considered as a plan, whether spelled out in detail or implied, and an organization in operation seldom corresponds with the organization model as charted (4, 38).

Group dynamics is reflected by the intervention of human social factors interacting with the formal plans and other influences in the situation. The resulting work performance, attitudes, and relationships among members reflect the organization in operation. In his efforts to make the actual organization conform to the formal plan, the appointed leader is continually confronted with the task of reconciling discrepancies between what should be done and what is done, between the needs of the organization and the needs of individual members, and between prescribed and actual lines of communication. Many of the most important decisions he faces involve compromises between maximum goal achievement and the costs they imply in terms of risks of jeopardizing the organization

by impairment of the welfare, motivation, and capabilities of its members.

In their introduction to the problems of group pressures and group standards, Cartwright and Zander (4) quoted Bill Mauldin's book *Up Front* in which he stated that combat outfits "have a sort of family complex"; that is, the men know what is expected of them and readily accept group pressures to behave in a certain way while they are group members. Mauldin stated, "Combat people are an exclusive set, and if they want to be that way it is their privilege. They certainly earn it. New men in outfits have to work their way in slowly, but they are eventually accepted. Sometimes they have to change their way of living. An introvert or a recluse is not going to last long in combat without friends, so he learns to come out of his shell. Once he has 'arrived' he is pretty proud of his clique, and he in turn is chilly to outsiders."

This quotation illustrates identification. One of the concomitants of identification involves acceptance of group norms which function as pressures to conform. This is part of the explanation of the importance of communality of values in a cohesive group. However, except in the relative isolation and intensified stress of the combat group, where situational pressures and survival needs may obscure other affiliations, most people affiliate with many groups which exercise various pressures on those who identify with them. Religious, social, political, and other group memberships not only represent basic values, but also styles of living, likes and dislikes concerning a wide range of activities, and prestige, and resulting power and influence among associates.

Some of these, which have equally important civilian parts, are illustrated by military status categories such (flag, field grade, company grade, warrant, NCO, and e type of aircrew rating, regular vs. reserve, and academy gr vs. other. The importance of such status categories is cle shown by the many symbols of status that are displayed and coveted, such as insignia, distinctive wings, flags, badges, parking spaces, office furniture, rugs, desk-sets, private dining rooms, cars, clubs, and the like. These are not merely utilitarian conveniences, but also means of reinforcing and displaying evidence of power, prestige, and status, which have implications for the behavior of their owners and their associates.

In a formal organization in which authority is hierarchical, cooperation is enhanced when the various dimensions of status are consistent. Therefore it is desirable that the commander be the

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highest rank and that rank, prestige, and formal status be consistent throughout the organization. Top management of an organization might well investigate many of its existing status conventions, if it is desired to exploit fully these informal forces within the group. For example, Lanzetta and Haythorn (21) in a study of B-29 instructor-crew influence on student attitudes and performance, found a decided lack of prestige attached to instructor status. In view of the well-known influence of prestige persons on attitudes of their associates, and of the demonstrated relations of crew attitudes to crew effectiveness (5, 14, 19), the possibility of positively affecting attitude development among student crews by improving the prestige status of instructors appears as a worthwhile problem.

The effects of various forms of *interaction among aircrew members* have been studied in relation to crew effectiveness. DeGaugh and Knoell (5) found a significant relation between a factor which they called "pride-in-work-group" and superiors' ratings of 89 B-29 groups in combat. The items which identified this factor were chiefly related to liking for the members of one's crew, satisfaction with the accomplishments of the crew, and a sense of safety in flying with the crew. Haythorn (14) reported significant correlations for 103 B-29 crews which indicated that crew mean sociometric scores covary with crew mean attitude scores, particularly on the same dimension of pride-in-crew, and with combat ratings of the crew by superior officers. In a later study of 42 B-29 crews which remained together from training into combat in the Korean War, Knoell (19) reported that crew attitudes measured in training and also in combat are significantly correlated with the crews' rated combat performance. The same interpersonal factors as reported in earlier studies — namely, pride-in-crew, acceptance of Air Force goals, and sense of well-being in the Air Force — which reflect group acceptance of the same task-oriented values, were reported by Knoell as criterion related.

The relations between superiors and subordinates, particularly between the aircraft commander and the combat crew, which have been studied most in the flight situation, are significant in achieving the attitudes which are most compatible with effective performance. These relations are subtly dependent on the nature of the task and the mission. Although no empirical data are available, it is likely that the negative relation to effectiveness of *consideration* and *nurturance* by the aircraft commander, among combat crews, as reported by Fruchter, Halpin and others, might

be positive among commercial aircrews whose duties are less hazardous and stressful. In his role as chief officer of the crew, the aircraft commander is the source of information which affects the performance of his subordinates and their sense of individual security on the job. He must keep his crew informed, but the nature and purposes of his communications will be conditioned by the requirements of the situation.

Research on group dynamics has repeatedly emphasized the importance of *communication of information* necessary to the group, for feelings of individual well-being and effective performance (3, 35). For example, Riecken (28) described a work camp group where the behavior code prohibited criticism or aggression of any kind. As a result, the usual minor antagonisms and conflicts enlarged, since they could not be discussed, until the entire group lost its cohesiveness and effectiveness. Cartwright and Zander (4) pointed out that both international conferences and workers at noisy jobs suffer loss of effectiveness and cohesiveness due to communication difficulties unless compensatory mechanisms for communication can be obtained. Taylor (39) found a highly effective functioning communication system in an Air Force squadron which was independently rated outstanding.

In an extensive study of a mental hospital, Stanton and Schwartz (37) noted the formal organization structure, and from it constructed a chart of the "formal expectation of the transmission of information," which carried a small but vital part of the communications among the staff to higher administrative levels. They repeatedly observed the causes and effects of the "blocking" of this type of information: Blocking was usually due to the overloading of these formal channels or to changes desired or not desired in hospital procedures. The effect was the setting up of informal channels to carry needed facts. The informal channels usually were slower, less accurate, and more misleading, but eventually a needed bit of information reached the person who needed it, although frequently too late or too inaccurately for effective action.

Stanton and Schwartz also found that the informal channels could be roughly predicted from a chart of the formal expectation of communication, once the location of the block of formal channels was known. Furthermore, the informal channels were unstable because of their excessive length and unreliability. They would form, then break up, then reform repeatedly until the blocked formal channel was reopened. The persons used as intermediates in the informal channels became noticeably tense without realizing why,

while the two primary persons concerned were constantly seeking newer and better informal channels. Whenever a block in the formally expected line of communication between staff members was removed, considerably improved behavior was noted in patients dependent upon the persons involved, although these patients had not been directly concerned.

These authors caution against confusing lines of formal authority with the formally expected channels of communication. Forcing the use of the former for all formal communication quickly leads to blocking due to channel overloading, and this in turn leads to the establishment of informal or even *sub rosa* channels, which are much less effective methods of communication. Thus communication should not follow but actually reinforce the formal organization through a network of expected communication derived from formal job descriptions. This conclusion is supported by centuries of combat history; men in actual combat must communicate not only with their superiors to the rear but also with the groups on their flanks.

The more that existing channels of information support the formal organization, the more they reinforce the positions of the leaders and decision-makers, and the less likely will there be discrepancies between formal and informal power structure.

The man-machine system approach

It is possible, as some investigators have shown, to ignore structure, status, roles, and interpersonal problems, and to regard an aircrew or other task group as a man-machine system. Viewed thus, crew members and equipment are perceived as linked in a unitary system in which information must flow efficiently to enable decisions and responses in appropriate sequence and timing. This approach is concerned with discovering the most efficient arrangements for information flow for various types of group and task.

A simple model illustrating this problem is given in a study by Bavelas (1), who demonstrated experimentally that different forms of communication structure have differential effectiveness in group performance. He arranged five cubicles into each of several geometric configurations (such as a star, a fork, a circle, and a straight line) and then placed a person in each cubicle. Each was given a bit of information, which together with the other four bits of information given the others constituted solution of the problem. The geometric pattern markedly affected the assembling of the bits of information; highly centralized figures, such as the star and fork, organized faster, were more stable from problem to problem and

test group to test group, solved problems faster, and evolved as leader the centrally placed persons. The flow of information could thus be seen to be an important resultant and determinant of how well a group functions.

Roby and Lanzetta (22, 30, 31) investigated task performance in the laboratory under four different conditions of communication structure, ranging from that in which control agents had direct access to none of the information required to operate their own controls to that in which control agents had direct access to information for all but one of their controls. They found that differences in team performance are associated with task communication structures even within the comparatively narrow range of the structures studied. Performance efficiency increased as the structure permitted more direct transmission of information and less dispersion. Learning was more rapid with an easy communication system than with a difficult one, and replacing an interphone circuit with a telephone circuit resulted in wider differences in performance and an increase in errors.

These and related studies have suggested a number of principles of job structure to maximize group performance in a man-machine system.[1] These are (a) *load-balancing*, wherein each member of a team is equally occupied in attaining the goal, regardless of the importance or magnitude of the contribution or of variations in type of activity; (b) *autonomy of function*, which implies that jobs are self-contained with reference to information necessary for their performance; and (c) *homogeneity of function*, wherein the functions performed by each job have a high degree of homogeneity with respect to information handled.

These principles have implications for technical competence and therefore for the content of selection and training programs, as well as structure of the organization. The Roby and Lanzetta studies have shown that when they are violated to various degrees by varying the proportions of information-giving and relaying requirements, decrements of performance resulted.

In a study by Voiers (41) of factors involved in bombing accuracy in B-29 crews, it was found that the aircraft commander and radar observer were directly dependent on each other for effective expression of their respective proficiencies. The proficiency of each member (as measured in ground school) correlated most highly with

the bombing criteria under conditions of higher-than-average-proficiency in the other member. High proficiency in the navigator appeared to compensate in some degree for lack of proficiency in the aircraft commander and radar observer, in that the navigator's proficiency appeared most highly correlated with the criteria under conditions of low proficiency in these members. The results for bombardiers were inconclusive. Voiers interpreted the relationship between bombing accuracy and the proficiency structure of the bomb team by means of a crude electrical analogy in which the proficiencies and performances of the aircraft commander and radar observer were represented as being "in series" with one another and collectively "in parallel" with the proficiency-performance of the navigator. These observations fit in nicely with the principles of load balancing, autonomy, and homogeneity of function.

SUMMARY

This paper has presented a survey of research on group behavior oriented to problems of aircrew proficiency. A common semantic problem was clarified which involves the distinction between terms descriptive of behavior and those descriptive of group functioning. This was illustrated with reference to the terms *leadership* and *morale*. The survey was organized in terms of a frame of reference within which top management levels might consider application of principles of group behavior to increase group effectiveness. The concept of effectiveness depends on the specification of group mission or goals, which is necessary in order to define criteria of performance. Group performance in relation to goals depends both on staffing and utilization of personnel. Staffing refers to capabilities of group members and hence the group potentiality. Methods of crew assembly were reviewed under this heading. Utilization refers to the work environment provided by management for the group, and therefore reflects the extent of realization of potentiality. Approaches to utilization considered were the structural approach, group dynamics, and the group as a man-machine system. Each of these provides a partial view of the total problem and although substantial insights have been reported from each approach, their integration into a comprehensive analytic system is required. The profound influence of group behavior factors in aircrew effectiveness recommends that both military and civilian authorities consider the immediate application of the program and the continued support of research.

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