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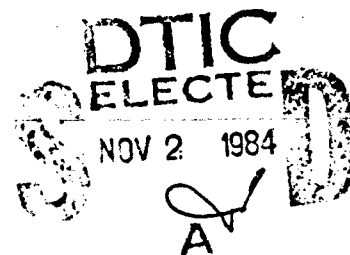
HUMAN FACTORS SURVEY: C-5 PILOTS

James S. Majors, Major, USAF, BSC

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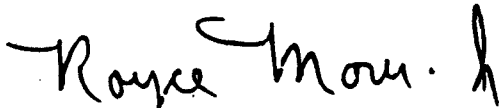
This report has been reviewed and is approved for publication.



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19. ABSTRACT (Continue on reverse if necessary and identify by block number) After two stall-related near-mishap incidents involving C-5 aircraft, a human factors consultation was requested. The purpose of this study was to conduct a broad preliminary human-factors survey of MAC C-5 pilots. Questionnaire and interview data were collected from 34 C-5 pilots (volunteers); with anonymity guaranteed. Study results are grouped under demographic, mission, physical, physiological, psychological, psychosocial, and pathological categories. Potential human-factors problem areas within the C-5 pilot population are suggested by the sample-group findings. The chronic problem of airlift-crew fatigue is apparent. Nearly 56% of the survey pilots reported significant levels of fatigue during a typical leg of their most recent strategic airlift missions. Also, a majority of them indicated various problems (probably fatigue related) with attention--such as distractions during critical phases of flight, boredom/complacency during the cruise portion, and fixated/channelized attention. Many pilots reported life-event changes and stresses--including a variety of family/marital problems, recent separation/divorce, financial crisis, nonselection for promotion, and other career dissatisfactions.			
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19. ABSTRACT (continued)

These stressors may increase mishap potential by decreasing personal capacity to cope with environmental demands. A significant portion of the pilots reported difficulties (again, possibly fatigue related) involving procedural recall, instrument cross-check, radio calls, missed checklist items, task saturation, and flying proficiency in general during the reference flight. The findings, including interrelationships, are discussed.

These results appear consistent with reports being submitted by crewmembers to the HQ MAC/IGFF Accident Waiting To Happen (AWTH) near-mishap reporting program. The findings of this study are recommended for use by MAC's operational planners and managers. The fatigue-associated results suggest review of policies on alert/takeoff scheduling, crew duty day, and crew rest pertaining to long overseas missions. Coordinated follow-on research of a more focused and problem-solving nature, zeroing in on the human factors areas found by this study to be potentially significant, is also recommended.

SUMMARY

The aim of this study was to conduct a broad human-factors survey of MAC C-5 pilots in response to a request for human factors technical consultation. The request for assistance followed two stall-related near-mishap incidents involving C-5s.

Questionnaire and supplemental interview data were gathered from 34 C-5 pilots who volunteered to take part in the study. Anonymity was assured to the participants.

Survey results are presented in terms of specific demographic, sortie/mission, physical, physiological, psychological, psychosocial, and pathological findings; elucidative comments are included. Potential human-factors problem areas within the C-5 pilot population are inferred from the following sample findings. Moderate-to-extreme fatigue level during typical leg of most recent strategic airlift mission was reported by 55.9% of the sample pilots; problems with various cognitive skills or information processing, 23.5%; significant anomalies of attention, 55.9%; recent significant changes in moods/emotions, 20.6%; dissatisfaction with career choice, 20.6%, and career progression, 26.5%; and recent significant life events/changes, 50%. Furthermore, 35.3% of the respondents indicated a family history of cardiovascular disease; and 17.6% reported a personal history of significant changes or problems with behavior, cognitive processes, feelings/emotions, or interpersonal relationships. Statistical interrelationship of the preceding items is discussed.

This study's findings appear essentially in agreement with reports submitted by crewmembers to HQ MAC/Flight Safety's Accident Waiting To Happen (AWTH) near-mishap reporting program (being jointly conducted with this office). The results of this survey are also generally consistent with previous human-factors-related research with military airlift crews.

I recommend that MAC's operational decision-makers incorporate the findings of this investigation, along with other germane sources (e.g., AWTH-related research), as human-factor input regarding their management process. I also recommend follow-on research of a more focused and problem-solving nature, zeroing in on the human factors areas found by this study to be potentially significant.

PREFACE

I am grateful to the C-5 pilots who volunteered to participate in this survey.

I also want to express appreciation to Donald J. Cosgrove, Data Sciences Division, and Sue Bensinger, Medical Editing, USAF School of Aerospace Medicine, Brooks Air Force Base, Texas, for their invaluable assistance.

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HUMAN FACTORS SURVEY: C-5 PILOTS

INTRODUCTION

In response to a request for human-factors technical consultation, a preliminary general human-factors survey of C-5 pilots was conducted. The study request was precipitated by two C-5 stall-related near-mishap incidents within the previous 5-month period. In both instances the autopilot was being used, with the altitude-hold function engaged. The pilot in control was distracted by radio calls and/or frequency changes during the landing approach, and other crewmembers failed to detect decreasing airspeed. The result was an actual departure from controlled flight and consequent altitude loss of approximately 792 m (2600 ft) in one case and a near-stall situation in the other. Both incidents occurred during day-VMC conditions. There were also noteworthy differences between the two scenarios. The stallmeters were inoperative in one case but fully functioning in the second. Fatigue apparently was a significant factor in only one of the incidents; likewise, a distracting inflight emergency was involved in only one. Finally, one approach, but not the other, was to an unfamiliar airfield.

METHOD

Thirty-four C-5 pilots from two airlift squadrons responded to a request for volunteers and participated in this study. A brief demographic description of the survey sample group is included in the Results section of this report.

Along with supplemental interviewing, my primary data-gathering approach was the Aircraft Nonmishap Human Factors Questionnaire, a comprehensive, recently developed 86-item instrument based on the Human Factors Mishap Investigation Checklist of the Human Factors Mishap Analysis Function, USAF School of Aerospace Medicine, Brooks AFB, TX. The Checklist was designed to provide an important source for a human-factors-mishap data base as well as a pragmatic, comprehensive, and extensive aid to the human factors investigator, serving as a Safety Investigation Board technical advisor/consultant, who assesses potentially significant human (and pertinent environmental) aspects of a class A aircraft mishap. Both the Checklist and Questionnaire sample the broad, complex human-factors domain in terms of physical, physiological, psychological, psychosocial, and pathological characteristics and limitations, along with interrelated environmental factors. The Checklist and Questionnaire are both currently undergoing in-house research and development, with eventual extensive operational implementation anticipated, as part of the Human Oriented Mishap Reduction/Integrated Mishap Prevention Program (HOMR). HOMR is a recently initiated contractual effort, with in-house supplemental support, aimed at software development and prototype demonstration of a computerized human-factors information management/transfer system using an aircraft-mishap data base (including actual-, near-, and non-mishap data); a systems (human, aircraft, and environmental) parameters data base; and an existing (ameliorative) technologies data base. An advanced development and implementation

follow-on program (Achilles) to HOMR is proposed to eventually provide pertinent human factors information to a variety of potential Air Force-wide/DOD users, e.g., operations, plans, safety, R&D.

The Questionnaire was developed primarily for use in compiling a pilot-provided human-factors data base regarding nonmishap/accident-free sorties to serve as a basis for comparison with actual-mishap (and even near-mishap) data. The comparative use of such a data base could facilitate detection, clarification, and amelioration of specific human factors associated with accident occurrence. This study represented the first field use of the Questionnaire, which seemed like a very appropriate means of gathering germane information.

The survey participants, either individually or in small groups, filled out the Questionnaires in my presence. Discussion and questions regarding the Questionnaire were encouraged, as was candidness. Anonymity was assured. With few exceptions, the respondents took 35-50 min to complete the Questionnaire. Regarding sortie-specific items, the pilots were asked to respond in terms of their most recent strategic airlift mission (as opposed to a local training sortie).

In addition to collecting Questionnaire and interview data, I had the opportunity to observe a 4-h C-5 air-refueling training sortie and a 2-h simulator sortie (the latter devoted primarily to emergency procedures).

STATISTICAL RESULTS¹

Demographic Data

The 34 MAC C-5 pilots who participated in this study were Caucasian males and ranged in grade from junior captain to senior lieutenant colonel.

	Range		Mean
	Minimum	Maximum	
Age	26.5	42.5	34.03
Flying time (h): Total	1300	6550	3062.5
First pilot (FP)	200	3500	1260.3
Instructor pilot (IP)	0	1850	601.1
C-5	30	4000	1028
FP C-5	0	1800	470.3
IP C-5	0	1000	49.6
FP/IP last 30 d	0	60	13.93
60 d	0	100	31.6
90 d	0	150	56.22
Flying time (h); most recent airlift mission plus preceding 48 h	4	45	14.01
Amount of duty day consumed (h); typical sortie/leg, most recent airlift mission	7	24	16.19
Flying time (h); typical sortie/leg, most recent airlift mission	4	15.5	9.52
Number of sorties/legs flown; typical duty day, most recent airlift mission	1	3	1.4
Number of reportable aircraft incidents/mishaps; flying career	0	14	1.9
Months since last reportable flying-related incident/mishap	1	72	11.7
	<u>N</u>	<u>%</u>	
Aeronautical rating: Pilot	11	32.4	
Senior pilot	20	58.8	
Command pilot	3	8.8	
Familiarity with most recent airlift mission:			
Extreme	5	14.7	
More than average	14	41.2	
Average	11	32.4	
Less than average	4	11.8	
Nil	0		
Type of last reportable incident/mishap:			
None	18	52.9	
Class A	1	2.9	
Class B	0		
Class C	6	17.6	
Class D	1	2.9	
Other	8	23.5	

¹ Percentages for each questionnaire item do not all add to 100% because of rounding or, for some items (*), option of selecting more than one response.

Sortie Information

Reported takeoff times for typical sortie/leg of most recent airlift mission ranged from 0200 to 2400L, with 57.5% within 4 h of midnight (i.e., 2000 to 0400).

	Range		Mean
	Minimum	Maximum	
Duration (h) of typical leg of the mission	4	15.5	8.43
Number of passengers	5	96	27
	N	Z	
Crew position of interviewees:			
Copilot (CP)	21	61.8	
Aircraft commander (AC)	11	32.4	
Flight-examiner aircraft commander (FEAC)	1	2.9	
Auxiliary pilot (AP)	1	2.9	

Physical Data

	Range		Mean
	Minimum	Maximum	
Height (cm/in)	168/66	196/77	180/70.87
Weight (kg/lb)	65/145	99/220	79.6/175.7
	N	Z	
Self-ratings of build/physique:			
Slender	6	17.6	
Average	19	55.9	
Muscular	5	14.7	
Heavy	4	11.8	
Physical condition/typical activity level/life style:			
Athletic	5	14.7	
Above average	13	38.2	
Average	15	44.1	
Below average	0		
Sedentary	1	2.9	
Physical fatigue level; typical leg, most recent mission:			
Extreme	4	11.8	
Moderate	15	44.1	
Mild	8	23.5	
Minimal	7	20.6	
Physical tasking/task saturation level:			
Extreme	1	2.9	
Moderate	19	55.9	
Mild	12	35.3	
Minimal	2	5.9	
General physical coordination/motor skills:			
Deft	2	5.9	
Above average	21	61.8	
Average	10	29.4	
Below average	1	2.9	
Awkward	0		

Physiological Data

		<u>N</u>	<u>%</u>
Vestibular/equilibrium illusions or problems; most recent airlift mission:	No	32	94.1
	Yes	2	5.9
Visual illusions or problems:	No	31	91.2
	Yes	3	8.8
Formal spatial disorientation training; preceding 6 months:	No	25	73.5
	Yes	9	26.5
Medical waiver in effect; last airlift mission:	No	28	82.4
	Yes	6	17.6
Weight-loss diet; last mission:	No	30	88.2
	Yes	4	11.8
Estimated level of dehydration; typical leg; most recent airlift mission:	Severe	0	
	Moderate	5	14.7
	Mild	19	55.9
	Minimal or none	10	29.4
*Psychophysiological state; reference leg:	Apprehensive	7	20.6
	Confused	1	2.9
	Panicked	0	
	Frustrated	1	2.9
	Angry	2	5.9
	Bored	4	11.8
	Unremarkable	23	67.6
	Other	3	8.8
Nap(s) between last sleep period and reference flight:	No	27	79.4
	Yes	7	20.6
Activity level between last sleep period and flight:	Extreme	0	
	Moderate, prolonged duration	9	26.5
	Moderate, brief	12	35.3
	Low	10	29.4
	Minimal/inactive	3	8.8
Indications of hypoxia, hyperventilation, acceleration/G effects, decompression sickness, trapped gas effects, or motion sickness; reference flight:	No	34	100
	Yes	0	
		Range	
		<u>Minimum</u>	<u>Maximum</u>
Time (h) between last full meal and reference leg		1.5	18
Number of time zones transited; reference leg and preceding 48 h		3	12
Hours of sleep (excluding naps) last sleep period prior to reference leg		1.5	8
			6.59

	Range		Mean
	Minimum	Maximum	
Hours since last sleep period (excluding naps) prior to reference flight	4	29	12.7
Hours of usual/nonmission sleep period	6.5	9	7.51
Duty hours, 7-d period prior to reference flight	0	70	34.8
Hours of sleep, 7-d prior to flight	40	60	49.8
Number of days since last ordinary leave	5	420	77.1
Number of months since last formal physiological training/altitude chamber course	0.5	34	15.31

Psychological Data

		<u>N</u>	<u>Z</u>
Problems regarding cognitive skills (e.g., memory, procedural knowledge) or information processing (e.g., judgment, decision making, task saturation); reference sortie/leg, most recent airlift mission:	No	26	76.5
	Yes	8	23.5
Problems regarding attention (e.g., general or selective inattentiveness, channelized/fixated attention, external or internal distraction, habit pattern interference/substitution, boredom, complacency/overconfidence, inappropriate perceptual/attitudinal set); reference flight:	No	15	44.1
	Yes	19	55.9
*Mood/emotional state just prior to reference flight:	Stable	15	44.1
	Content	9	26.5
	Confident	13	38.2
	Happy/elated	7	20.6
	Sad/depressed	1	2.9
	Frustrated/angry	2	5.9
	Apprehensive/anxious	7	20.6
	Other	4	11.8
Recent significant changes in moods/emotions:	No	27	79.4
	Yes	7	20.6

	<u>Mean</u>
Personality-trait self-assessment on 7-point rating scale (with 4.0 the midpoint of the continuum between each opposing pair of traits):	
Outgoing vs. withdrawn	3.3
Grouchy vs. good natured	5.3
Adaptable vs. inflexible	2.3
Impetuous vs. deliberate	4.7
Stable vs. vacillating	2.9
Excitable vs. calm	4.6
Modest vs. boastful	3.2

	<u>Mean</u>
Uptight/tense vs. easygoing/relaxed	5.0
Innovative vs. routine	3.7
Matter-of-fact vs. complex	3.7
Conscientious vs. careless	2.4
Immature vs. mature	5.4
Persevering vs. defeatist	2.8
Fickle vs. loyal	5.8
Frank vs. secretive	2.9
Coldhearted vs. compassionate	5.3
Practical vs. abstract	2.5
Risk-taking vs. cautious	4.8
Proud vs. unassuming	3.5
Competitive vs. cooperative	4.1
Team player vs. loner	3.5
Unsure vs. confident	4.8
Self-disciplined vs. impulsive	3.0
Follower vs. leader	4.6
Punctual vs. late	2.3
Uninvestigative vs. inquiring	5.3
Active vs. passive	2.7
Intolerant vs. tolerant	5.1
Aggressive vs. yielding	3.6
Defensive vs. open	4.4
Dominant vs. submissive	3.3
Exhibitionistic vs. shy	4.3
Playful vs. serious	3.7
Dull vs. bright	5.1
Independent vs. dependent	2.6
Liberal vs. conventional	4.9
Complacent vs. aspiring	5.0
Assertive vs. conforming	3.5
Disorganized vs. organized/orderly	4.6
Tactful vs. tactless	3.1
Gloomy vs. cheerful	5.2
Sedate vs. boisterous	3.6

Psychosocial Data

		<u>N</u>	<u>Z</u>
Primary duty position:	Operations officer	1	2.9
	Stan/eval	1	2.9
	Instructor pilot	2	5.9
	Flight commander	2	5.9
	Squadron pilot	26	76.5
	Other (flying safety officer)	2	5.9
Additional duties:	Safety officer	4	11.8
	Scheduling officer	8	23.5
	Other	18	52.9
	None	4	11.8

		<u>N</u>	<u>%</u>
Usual degree of sensitivity/acquiescence to supervisory influence/pressure:	High	4	11.8
	More than average	12	35.3
	Average	14	41.2
	Less than average	4	11.8
	Minimal/none	0	
Usual degree of sensitivity/acquiescence to peer influence/pressure:	High	1	2.9
	More than average	5	14.7
	Average	19	55.9
	Less than average	8	23.5
	Minimal/none	1	2.9
Usual circle of friends:	Supervisors	3	8.8
	Peers/co-workers	16	47.1
	Subordinates	1	2.9
	Nonmilitary	12	35.3
	Other (family)	2	5.9
Satisfied with career choice:	No	7	20.6
	Yes	25	73.5
	Undecided	2	5.9
Satisfied with career progression:	No	9	26.5
	Yes	23	67.6
	Undecided	2	5.9
Estimation of flying skills relative to peers:			
	76-99 percentile	17	50.0
	51-75	14	41.2
	26-50	2	5.9
Estimation of general leadership skills relative to peers:			
	76-99 percentile	16	47.1
	51-75	14	41.2
	26-50	2	5.9
Estimation of level of unit morale:			
	High	3	8.8
	Above average	8	23.5
	Average	13	38.2
Violation of any rules, regulations, or established procedures; reference flight:	Below average	7	20.6
	Low	3	8.8
	No	29	85.3
	Yes	5	14.7

	<u>N</u>	<u>%</u>
*Reason(s) for becoming a pilot:		
Love of flying	23	67.6
Family expectations	2	5.9
Financial considerations	4	11.8
Image/prestige/status	17	50.0
Other	6	17.6
*Current significant interpersonal problems/conflicts with:		
Spouse	6	17.6
Lady friend	1	2.9
Children	2	5.9
Parents	0	
Supervisor	2	5.9
Peers/co-workers	1	2.9
Subordinates	2	5.9
Other	4	11.8
None	20	58.8
Recent significant life events/changes (e.g., death/serious illness or injury in family, divorce/separation, marriage, change in financial status, job change, PCS):		
No	17	50.0
Yes	17	50.0
Self-assessment of predominant, underlying motivation:		
Self-actualization/self-realization	18	52.9
Prestige/power	2	5.9
Peer respect/affection	6	17.6
Safety/security	5	14.7
Survival	1	2.9
Other	2	5.9
Average number of packs of cigarettes smoked daily:		
More than 2	1	2.9
1-2	0	
Less than 1	2	5.9
None	31	91.2
Average number of alcohol drinks (e.g., beers/mixed drinks/ glasses of wine) consumed daily:		
More than 6	0	
5-6	0	
3-4	1	2.9
1-2	21	61.8
None	12	35.3
Number of alcohol drinks consumed within 24 h of last flight:		
More than 6	1	2.9
5-6	1	2.9
3-4	1	2.9
1-2	10	29.4
None	21	61.8

	<u>N</u>	<u>%</u>
*Recent significant changes in routine activities:		
Drinking	2	5.9
Smoking	1	2.9
Eating	4	11.8
Sleeping	4	11.8
Work related	9	26.5
Socializing	1	2.9
Recreational	2	5.9
Other (increase in physical exercise)	2	5.9
None	18	52.9

Pathological Data

	<u>N</u>	<u>%</u>
Use of prescription or nonprescription medicine/drug whose intended or unintended effect was probably present; reference flight:		
No	32	94.1
Yes (aspirin)	2	5.9
Physical illness/disease or injury which may have impaired performance; reference flight:		
No	31	91.2
Yes	3	8.8
Family history of heart disease, stroke, or seizures:		
No	22	64.7
Yes	12	35.3
Personal history of significant changes or problems with behavior, cognitive processes, feelings/emotions, or interpersonal relations:		
No	28	82.4
Yes	6	17.6

PARTICIPANTS' COMMENTS

Demographic Data

The type of last reportable flying-related incident ($n = 8$), other than class A-D, involved such things as flight-control malfunction, engine shutdown due to oil system problem, vaporized hydraulic system, and cut tire incurred by running over taxiway light.

Physiological Data

Vestibular/equilibrium problems ($n = 2$) during reference flight consisted of "some vertigo" experienced during airborne refueling rendezvous in marginal weather and "very slight dizziness" during normal aircraft maneuvering while the pilot was resting "in navigator's seat." Visual problems reported ($n = 3$) involved the vertigo experience above; an "unplanned 30-degree bank and extreme vertigo" during night instrument approach in hazy, moonless conditions without outside horizon reference; and eye irritation due to "heavy" concentration of cigarette smoke in the flight deck area. Medical waivers ($n = 6$) were primarily for vision, but anemia and abnormal EKG were also reported. Weight-loss diets ($n = 4$) consisted of reduced caloric intake, usually in conjunction with increased activity/exercise. Comments regarding psychophysiological state ($n = 3$) during reference sortie included "ennervated (sic) and confident"; "mild excitement" associated with first C-5 mission; "cautious" (checkride).

Psychological Data

Comments ($n = 8$) regarding problems with cognitive skills or information processing during reference flight included difficulties with procedural knowledge, instrument cross-check, radio calls, missed checklist items, task saturation, and flying proficiency in general associated with such factors as fatigue and low currency in overseas airlift missions. Indications of problems with various aspects of attention ($n = 19$) included distractions during critical phases of flight (e.g., interphone chatter); boredom, complacency, low concentration/alertness level during long over-water cruise phases of flight; fatigue due to long duty days and insufficient crew rest; channelized/fixated attention; and overconfidence in safety of C-5. Comments regarding mood/emotional state just prior to reference flight ($n = 4$) primarily involved fatigue along with irritability and mild excitement. Recent significant changes in moods/emotions ($n = 7$) were noted by "My moods seem to be much more unstable now than in previous assignments. I vary between elation/confidence and depression very quickly and much more often than formerly"; "more ups and downs than normal because I am more emotional than average"; ambivalence regarding move to wing-level job "in order to improve promotion chances"; "apprehension caused by being part of an office full of inexperience"; family-related stress; irritability secondary to stopping smoking; "ups and downs" after a recent C-5 incident/near-mishap.

Psychosocial Data

Additional duties (n = 18), other than safety and scheduling, included such jobs as plans, intelligence, mobility, executive officer, OER/APR monitor, ground and flying training, supply, maintenance control, wing staff, simulator IP, and stan/eval. Most of the voiced career-choice dissatisfaction (n = 7) involved perceived difficulty in getting promoted while holding primarily a cockpit assignment, regardless of demonstrated expertise as a professional aviator. PCS/TDY, additional duty, and low flying time complaints were also mentioned. Dissatisfaction with career progression (n = 9) centered on complaints regarding promotion/OER policy. Violations (n = 5) during reference flight included "Bending/violating regs in the pursuit of 'mission reliability' is commonplace in my Command." "Other" reason(s) for becoming a pilot (n = 6) reflected patriotism and sense of duty, career progression, something to do after college, and draft avoidance. Current significant interpersonal problems/conflicts (n = 4) other than with spouse, sweetheart, children, supervisor, peers, or subordinates involved internal affairs of church, the commander, and concern regarding career progression and family stress. Recent significant life events/changes (n = 17) included birth of a child, marriage, PCS, job change, serious illness within family, nonselection for promotion, noncompetitive OER, family adjustment problems, pending career decisions, family separation associated with PCS/TDY, financial problems, involvement in C-5 near-mishap, and predivorce separation from wife. "Other" self-assessments (n = 2) of predominant underlying motivation were financial and "to do the will of God."

Pathological Data

Physical illness or injury that may have impaired performance capacity during the reference flight (n = 3) was indicated as muscle spasm in lower back and cold symptoms. Comments regarding family history of heart problems or stroke (n = 12) primarily cited heart attacks, typically involving the respondent's father. Personal history of significant changes or problems with behavior, cognitive processes, feelings/emotions, or interpersonal relations (n = 6) included primarily family/marital-related stress and career dissatisfaction.

Additional Comments

Most of the comments (n = 20) added at the end of the Questionnaire tended to emphasize such related issues as fatigue, scheduling, 24-h (augmented) crew duty days, crew rest, and mission alert procedures. Typical comment: "The normal takeoff time of MAC missions ranges from 2300 to 0600L. This creates a severe physical constraint on individuals due to normal daily routine prior to the flight. Normal notification for a flight is 1 to 2 days prior to initial predeparture crew rest. With family [demands] and the normal work-sleep cycle, it is next to impossible to obtain the necessary rest prior to a mission. After the mission is airborne, average mission length is from 8 to 20 hours depending on stops in between home station and final destination in Europe or the Mid-East. This could make the average nonsleeping time a total of 40 hours. Little sleep (1 to 3 hours) can be obtained during flight. Couple the lack of sleep with [such situational demands as] air-refueling,

poor weather at destination, and foreign air traffic controllers, and the possible mishap potential increases significantly." Other comments dealt with communications equipment ("radios not able to work on all common-use frequencies; have to continually switch radios; get extra transmissions overriding primary frequency during approach"); low C-5 flying time causing problems achieving/maintaining proficiency; command and control ("command supervision considers 'on-time reliability' to be the bottom line, at the expense of safe judgement and decision making"); and poor nutritional quality of inflight meals ("junk food").

DISCUSSION AND CONCLUSIONS

Perusal of the results of this survey suggests nine items worthy of further emphasis, as pertains to inferring (from sample findings) probable human-factors problem areas within the C-5 pilot population. At least some of the findings of this study were probably players in the near-mishap incidents that precipitated the study. Central to this discussion is an implied mishap model involving the primary (and fluctuating) variables of pilot capability (level of functioning, capacity to cope, etc.) and environmental demands (aircraft, mission, etc.). The closer the latter is to exceeding the former, the greater the mishap potential.

Within the Physical area, moderate to extreme fatigue was apparent (55.9%) during a typical leg of most recent strategic airlift mission.

The following items were selected from the Psychological category. Problems, during reference sortie/leg of most recent mission, regarding cognitive skills (e.g., memory, procedural knowledge) or information processing (e.g., judgment, decision making, task saturation) were indicated by 23.5%; and problems regarding aspects of attention (e.g., general or selective inattentiveness, channelized/fixated attention, external or internal distraction, habit pattern interference/substitution, boredom, complacency/overconfidence, and inappropriate perceptual/attitudinal set) by 55.9%. Recent significant changes in moods/emotions were indicated by 20.6%.

Apparent Psychosocial problem areas included dissatisfaction with career choice (20.6%) and career progression (26.5%); and recent significant life events/changes, e.g., death/serious illness or injury in family, divorce/separation, marriage, change in financial situation, job change, PCS (50%).

Under the Pathological rubric, 35.3% of the respondents reported a family history of heart disease, stroke, or seizures; and 17.6% indicated personal history of significant changes or problems with behavior, cognitive processes, feelings/emotions, or interpersonal relations.

Chi-square data analysis via paired comparisons of the responses to these nine Questionnaire items indicates statistically significant ($p < .05$) relationships (more than would be expected due to chance alone) between several pairs of the items. The reported physical fatigue item (Physical rubric) is significantly related to the items regarding problems with cognitive skills/information processing and anomalies of attention (Psychological). Likewise, the item dealing with personal history of changes/problems with behavior, thinking, feelings, and/or interacting with others (Pathological) is associated with the

items on family history of heart disease (Pathological) and recent significant changes in moods/emotions (Psychological).

Such analysis does not deal with causality but does indicate significant tendencies apparently existing among the C-5 pilot population. Based on the responses of this study's sample, an increase in mission/flying-related fatigue level appears to be related to mission/flying-related problems regarding cognitive skills/information processing and anomalies of attention. Also, a personal history of significant changes/problems in general adjustment/adaptation/level-of-functioning appears to be associated with a family history of cardiovascular disease and with recent significant changes in moods/emotions.

The findings of this study are generally consistent with those of previous transport-crew studies related to human factors (see References) and appear to be quite consistent with anonymous reports submitted by crewmembers to the MAC-wide Accident Waiting To Happen (AWTH)/near-mishap reporting program. Among other factors, AWTH reports cite job dissatisfaction and perceived limitations to crew performance capacity as being associated with fatigue, scheduling/planning (alert, takeoffs, etc.), crew rest facilities, duty day length, and nonflying jobs/duties seen as necessary for career advancement.

Although few of the problems highlighted by this survey are likely to come as much of a surprise to military strategic airlift commanders, continued or renewed attention is warranted. Personnel, and indirectly their families, are the most important asset of the military. The criticality of technologically sophisticated (and astronomically expensive) hardware notwithstanding, our readiness and mission effectiveness ultimately depend on the people who operate and maintain the combat and support equipment.

I recommend that MAC operational planners and managers seriously consider the findings of this investigation, along with other relevant sources such as AWTH-generated research, as human-factor input to their decision-making processes. I also recommend more focused, in-depth, follow-on research, concentrating on the human factors areas highlighted by the present survey and aimed at suggesting appropriate remedial steps. Such additional research could be included within the purview of the developing HOMR/Achilles program and coordinated with anticipated AWTH-related empirical analyses.

I anticipate that MAC's healthy self-evaluative initiative and mishap-prevention stance will facilitate a continuation of an impressive record of high mission accomplishment/high safety standards, while also serving as a model for the other Commands.

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