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**Development and Use of Mark Sense Record Cards
For Recording Medical Data on Pilots
Subjected to Acceleration Stress**

CAPTAIN HARALD A. SMEDAL, USN, MC and C. DEWEY HAVILL

Development and Use of Mark Sense Record Cards For Recording Medical Data on Pilots Subjected to Acceleration Stress

CAPTAIN HARALD A. SMEDAL, USN, MC and C. DEWEY HAVILL

A TIME-HONORED system of recording medical histories and the data obtained on physical and laboratory examination has been that of writing the information on record sheets that go into a folder for each patient. In order to have information which would be more readily retrieved, a program was initiated in 1952 by the U. S. Naval School of Aviation Medicine in connection with their "Care of the Flyer" study to place this information on machine record cards. In 1958, a machine record card method was developed for recording medical data in connection with the astronaut selection program. Machine record cards were also developed by the Aero Medical Laboratory, Wright-Patterson AFB, Ohio, and the Aviation Medical Acceleration Laboratory, Naval Air Development Center, Johnsville, Pennsylvania, for use in connection with a variety of tests including acceleration stress.¹ Therefore, a variety of systems resulted in which data of a medical nature could easily be recalled.

During the NASA, Ames Research Center centrifuge studies,^{2,3} the pilot subjects were interviewed after each centrifuge run, or series of runs, and subjective information was recorded in a log book by the usual history taking methods referred to above. After the methods were reviewed, it was recognized that a card system would be very useful in recording data from our pilots after they had been exposed to acceleration stress. Since the acceleration stress cards already developed did not meet our require-

ments, it was decided a different card was needed.

DESIGN

The regular machine record card with its coded information punched does not have the capability of yielding information directly from the card unless the person using the card is very familiar with the code. This disadvantage is overcome by the mark sense card method described by others.¹ On the mark sense card, the questions are written in abbreviated form. The answers are marked with an electrographic pencil in an adjacent oval-shaped space. The space used will indicate the correct answer either in the form of a specifically provided choice of answers or a Yes or No answer. An example of this card is shown in Figure 1.

An IBM card layout form for an inclined mark sense card (Fig. 2) gives maximum space for writing and printing. This form can present all the information desired for one pilot during one run or a series of runs on a single card. Through our past experience with subjective complaints during and after acceleration stress, we were able to compile a list of the most common items that occur. Visual symptoms that are of interest during the acceleration include blurring, changes in visual field, loss of vision, and pain about the eyes. Other general symptoms of interest are chest pain, headache, dizziness, nausea, abdominal pain, difficulty in breathing, and pain in the extremities. We were also interested in information as to whether or not any of these symptoms persisted after the exposure to acceleration.

Another card layout was made in order to have a history type card which could be filled once a year at the time of the annual physical

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NAME - LAST, FIRST, MIDDLE INITIAL				SERIAL NO.				CASE OR HOSP NO.				S	RANK	R-S	M	E	C	SERV.	BORN	AGE	GA	NO	YR	DATE OF EXAM
1 HAS PATIENT EVER HAD ? <i>** If you do not understand a question ask the doctor or nurse **</i>																								
SHADED AREA - STAFF USE ONLY												SHADED AREA - STAFF USE ONLY												
												Significant General History				Significant Ear History								
Measles Any Kind	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Blood Poisoning Severe Infection	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Loss of Consciousness Any Cause	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Lived in Foreign Countries Over 1 Year	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Earaches	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Chicken Pox	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Intestinal Parasites	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Severe Headaches	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tuberculosis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Draining Ears	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Mumps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Undulant (Milk) Fever	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Diabetes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Rheumatism Any Kind	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Buzzing or Ringing In Ears	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Whooping Cough	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Poisoning Other Than Food	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tumors of Any Kind	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Arthritis Any Kind	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Temporary Hearing Loss	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Influenza Any Kind	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Encephalitis (Brain Fever)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Major Operation Any Type See Card 1 - 8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Hepatitis (Liver Infection)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Permanent Hearing Loss	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Strep Throat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Mononucleosis (Glandular Fever)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Recent Significant Weight Gains	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	X-ray or Radiation Therapy For Any Purpose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Pain in Ears From Flying	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Serious Accident	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Penicillin or Other Drug Reaction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Recent Weight Loss	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Non-specific Urethritis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ever Worn Hearing Aid	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Accident Prone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Immunization or Serum Reaction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Is Diet Necessary to Control Weight	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Frequent Colds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unusual Hearing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Diphtheria	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Malaria	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Tropical Disease	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	On Pension or Disability Insurance Any Purpose	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Other Ear Problems	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Fig. 1. General medical history mark sense record card (Lovelace Foundation).

MARK SENSE RECORD CARDS—SMEDAL AND HAVILL

↑
STAFF MARK HERE
IF COMMENTS ARE MADE
ON BACK OF CARD

October, 1962

IBM SUPPLIES DIVISION

IBM CARD LAYOUT FORM - INCLINED MARK SENSE

FORM X74-6259-1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
																C0	C0	C0	C0	C0	C0	C0																																																									
																C1	C1	C1	C1	C1	C1	C1																																																									
																C2	C2	C2	C2	C2	C2	C2																																																									
																C3	C3	C3	C3	C3	C3	C3																																																									
																C4	C4	C4	C4	C4	C4	C4																																																									
																C5	C5	C5	C5	C5	C5	C5																																																									
																C6	C6	C6	C6	C6	C6	C6																																																									
																C7	C7	C7	C7	C7	C7	C7																																																									
																C8	C8	C8	C8	C8	C8	C8																																																									
																C9	C9	C9	C9	C9	C9	C9																																																									

18-19-IBM PRINTERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
60-PRINTERS INTERPRETERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
40-298-PRINTERS & INT.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80

TYPE SPACING 18-19-IBM PRINTERS 60-PRINTERS INTERPRETERS 40-298-PRINTERS & INT.		COLUMN GUIDE FOR MARK SENSING 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80	
<p align="center">COMPLETE THESE SECTIONS FOR ALL LAYOUTS</p>			
BRANCH OFFICE NAME _____ CUSTOMER NAME _____ CUSTOMER REFERENCE AND DATE _____ MAIL PROOFS TO _____		TRANSMITTAL NO. _____ CUSTOMER NO. _____ PROOFS REQUIRED? YES <input type="checkbox"/> NO <input type="checkbox"/>	
Is this a revision of, or replacement for, an existing IBM card form? YES <input type="checkbox"/> NO <input type="checkbox"/>		If (YES), indicate present IBM card form no. _____	
May the existing printing plate be scrapped? YES <input type="checkbox"/> NO <input type="checkbox"/>		If (YES), indicate authority for scrapping: _____	
LAYOUT PREPARED BY _____ DATE _____		AUTHORITY _____ DATE _____	
<p align="center">COMPLETE THESE SECTIONS WHEN APPLICABLE</p>			
CORNERS TO BE CUT NONE <input type="checkbox"/> UPPER <input type="checkbox"/> LEFT <input type="checkbox"/> RIGHT <input type="checkbox"/> LOWER <input type="checkbox"/>		INTERPRETATION NONE <input type="checkbox"/> 45 PER. INT. <input type="checkbox"/> 60 MEDICAL <input type="checkbox"/> 552 <input type="checkbox"/> 557 <input type="checkbox"/> BILL FEED <input type="checkbox"/> END PRINTING STRIP <input type="checkbox"/> SPEC. <input type="checkbox"/> TYPEWRITER <input type="checkbox"/> LINE <input type="checkbox"/> 18-19-IBM <input type="checkbox"/> LINE <input type="checkbox"/>	
REQUIREMENTS SCORING <input type="checkbox"/> PRENUMBERING <input type="checkbox"/> (INDICATE ON THE LAYOUT THE LOCATION OF EACH FEATURE SPECIFIED ABOVE.) STOR <input type="checkbox"/> PAD <input type="checkbox"/> CONTINUOUS <input type="checkbox"/> IF CARD IS TO BE PRINTED ON BOTH SIDES, INDICATE <input type="checkbox"/> BOOK <input type="checkbox"/> TUMBLE <input type="checkbox"/>		FOR MARK SENSING CARDS, INDICATE STYLE See for notation using or printing <input type="checkbox"/> <input type="checkbox"/> Not recommended for cards requiring printing or printing between H. & P. <input type="checkbox"/> <input type="checkbox"/> 	
POINTERS FOR SHORT CARD LAYOUTS } 1) DETERMINE SHORT CARD COLUMN NUMBERS BY REFERRING TO GUIDE AND COLUMNS PRINTED BELOW. USABLE COLUMN RANGE IS ESTABLISHED BY THE CAPACITY LOCATION ON EACH SIDE OF GUIDE, E. G., ON A 31-COLUMN CARD, USABLE COLUMNS ARE 15-45.			
2) CUT OUT THE STRIP OF COLUMN NUMBERS. 3) PASTE THE STRIP ON THE LAYOUT FORM IN DESIRED LOCATION FOR THE SHORT CARD. 4) RULE ENDS OF SHORT CARD 2 1/2 COLUMNS BEYOND THE STRIP OF COLUMN NUMBERS.			
<p align="center">SHORT CARD COLUMN GUIDE</p> <p align="center">← 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 80 →</p>			
5) DETERMINE MARK SENSE POSITIONS, IF ANY, BY ASSOCIATING STRIP NUMBERS WITH CARD LAYOUT POSITIONS, E. G., ON A 31-COLUMN CARD, M. S. POSITIONS 4-22 ARE USABLE.			
CUT-OUTS FOR PASTING 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80		SCALE: APPROX. DOUBLE SIZE. ACTUAL CARD SIZE: 3 1/4" X 7 3/8"	

Fig. 2.

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MARK SENSE RECORD CARDS—SMEDAL AND HAVILL.

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MARK SENSE RECORD CARDS—SMEDAL AND HAYILL

NAME		AGE		DATE		SIMULATOR LOCATION											SERIES CARD	
TYPE OF SIMULATOR	TYPE OF ACCELERATION ANGULAR LINEAR VIBRATORY IMPACT	SIMULATOR TIME COVERED BY THIS CARD		TYPE OF ACCELERATION I O D		DID YOU HAVE ANY OF THE FOLLOWING SYMPTOMS DURING OR SUBSEQUENT TO THE SIMULATOR TIME COVERED BY THIS CARD											COMMENTS	
1	MOST IMPORTANT COMPONENT	0000000000		0000000000		SYMPTOMS DURING SIMULATOR OPERATION		SYMPTOMS DURING, OR SUBSEQUENT TO SIMULATOR OPERATION						COMMENTS				
2	SECOND	1001001000		1001001000		BLURRED VISION YES NO	HEADACHE YES NO	DURING SIMULATOR OPERATION	SUBSEQUENT TO SIMULATOR OPERATION		INTERMITTENT SUBSEQUENT SYMPTOMS (COMMENT ON YES ANSWERS)	COMMENTS						
3	THIRD	2002002000		2002002000					LESS THAN 8 HRS	MORE THAN 8 HRS		YES	NO	YES	NO	COMMENTS		
4	FOURTH	3003003000		3003003000					YES	NO		YES	NO	YES	NO	COMMENTS		
5	IS THIS CARD FOR A SINGLE RUN OR ONE SERIES OF RUNS	4004004000		4004004000				CHANGES IN VISUAL FIELD	YES NO	PAIN IN OR ABOUT THE EYES	YES NO	NO	YES	YES	YES	NO		
6		5005005000		5005005000				LOSS OF VISION	YES NO	DIZZINESS	YES NO	NO	YES	YES	YES	NO		
		6006006000		6006006000				CHEST PAIN	YES NO	NAUSEA	YES NO	NO	YES	YES	YES	NO		
		7007007000		7007007000		DIFFICULTY IN BREATHING	YES NO	ABDOMINAL PAIN	YES NO	NO	YES	YES	YES	NO				
	OTHER (COMMENT)	8008008000		8008008000		LOSS OF CONSCIOUSNESS	YES NO	PAIN IN THE EXTREMITIES	YES NO	NO	YES	YES	YES	NO				
		9009009000		9009009000		OTHER (COMMENT IF YES)	YES NO	OTHER (COMMENT IF YES)	YES NO	NO	YES	YES	YES	NO				

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
IBM LB4013

Fig. 3. Ames mark sense record card (series card).

OCTOBER, 1962

NAME - LAST, FIRST, MIDDLE INITIAL				SERIAL NO.	CASE OR NOSP. NO.	S	RANK	R-S	M	E	C	SERV	BORN	AGE	DA	MO	YR	DATE OF EXAM	
SPECIAL AVIATION HISTORY	1	C 0 C 0 C 0 C 0	C 0 C 0 C 0 C 0	TYPE OF ACCELERATION ANGULAR LINEAR VIBRATORY IMPACT MOST IMPORTANT COMPONENT SECOND THIRD FOURTH	DID YOU HAVE ANY OF THE FOLLOWING SYMPTOMS DURING OR SUBSEQUENT TO YOUR SIMULATOR WORK														COMMENTS YES
	2	C 1 C 1 C 1 C 1	C 1 C 1 C 1 C 1		SYMPTOMS DURING SIMULATOR OPERATIONS		SYMPTOMS DURING OR SUBSEQUENT TO SIMULATOR OPERATIONS												
	3	C 2 C 2 C 2 C 2	C 2 C 2 C 2 C 2				DURING SIMULATOR OPERATION		SUBSEQUENT TO SIMULATOR OPERATION LESS THAN 24 HOURS		MORE THAN 24 HOURS		INTERMITTENT SUBSEQUENT SYMPTOMS						
	4	C 3 C 3 C 3 C 3	C 3 C 3 C 3 C 3		BLURRED VISION	YES	NO	HEADACHE	YES	NO	NO	YES	YES	YES	NO				
	5	C 4 C 4 C 4 C 4	C 4 C 4 C 4 C 4		CHANGE IN VISUAL FIELD	YES	NO	PAIN IN OR ABOUT THE EYES	YES	NO	NO	YES	YES	YES	NO				
	6	C 5 C 5 C 5 C 5	C 5 C 5 C 5 C 5		LOSS OF VISION	YES	NO	DIZZINESS	YES	NO	NO	YES	YES	YES	NO				
	7	C 6 C 6 C 6 C 6	C 6 C 6 C 6 C 6		CHEST PAIN	YES	NO	NAUSEA	YES	NO	NO	YES	YES	YES	NO				
	8	C 7 C 7 C 7 C 7	C 7 C 7 C 7 C 7		DIFFICULTY IN BREATHING	YES	NO	ABDOMINAL PAIN	YES	NO	NO	YES	YES	YES	NO				
	9	C 8 C 8 C 8 C 8	C 8 C 8 C 8 C 8		LOSS OF CONSCIOUSNESS	YES	NO	PAIN IN THE EXTREMITIES	YES	NO	NO	YES	YES	YES	NO				
	10	C 9 C 9 C 9 C 9	C 9 C 9 C 9 C 9		OTHER	YES	NO	OTHER	YES	NO	NO	YES	YES	YES	NO				

IBM L54014

Fig. 4. Ames mark sense record card (history card).

MARK SENSE RECORD CARDS—SMEDAL AND HAVILL.

examination of the pilot. This allows the examiner to keep a year-to-year record of the total acceleration stress encountered over the year, both as to total time as well as type of acceleration, i.e., linear, angular, impact, or vibratory. It also permits the evaluation of any sign or symptom that might be accumulative and related to repeated acceleration stress.

A final example of the two cards, one called the series card, and the other called the history card, is shown in Figure 3 and Figure 4, respectively.

RESULTS AND DISCUSSION

The series cards were used in collecting data on 22 test pilots used as subjects during a centrifuge program conducted at the Naval Air Development Center, Aviation Medical Acceleration Laboratory, Johnsville, Pennsylvania, during the months of March, April, and May of 1961. The cards proved to be readily understood and easily filled out by the pilots. A few items were found to be unsatisfactory in the first form of the sense card. For example, the simulator time columns which were three in number were found to be one too many since the time resulting from any one run or a series of runs was always less than 9 minutes, and two columns which would show the time in nine or fewer minutes plus a question were all that was required. It was also found that with a series of runs it was difficult to relate the symptoms to a specific run. The vector of the applied g often differed in each of the runs in a series and the pilot would not leave the cockpit. As a result, he was unable to fill out a card after each different run in the series. In general, however, the sense card when used for the single run was quite adequate. Modifications of these cards will be made from time to time as is found necessary.

The history cards have been forwarded to the Lovelace Foundation where they are currently

being used as a part of their large series of cards that cover test pilot type examinations.

SUMMARY

This report presents the design format of two machine record cards of the mark sense card type which have been developed for use in connection with recording medical data on test pilots who are subjected to various acceleration stresses. One is a series card used to record subjective data from pilots after a single or a series of runs on a motion simulator during which acceleration stress is encountered. The other is a history card intended for use once a year at the time of the pilot's annual physical examination. The history card is intended to provide information regarding accumulative effects of repeated acceleration stress on the pilot. The series card has been used during one centrifuge program conducted by the NASA, Ames Research Center at the Naval Air Development Center, Aviation Medical Acceleration Laboratory, Johnsville, Pennsylvania, during March, April, and May of 1961, and has proved very successful. Although the population group was small and so not ideally suited for mark sense card data acquisition, some valuable accurate subjective information was obtained, particularly in regard to vision. This information would not have been obtained by simply keeping a log.

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