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EVALUATION OF A TV MARKER FOR RADAR HANDOFF

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EVALUATION OF A TV MARKER FOR RADAR HANDOFF

SUMMARY

In order to expedite radar departure transfers, or handoffs, between control towers and Air Route Traffic Control Centers, a television marker for radar handoff developed at the Technical Development Center was installed in the Indianapolis Control Tower and Indianapolis Air Route Traffic Control Center for evaluation. The marker, consisting of an electronically generated circle, was displayed on scan-converted radar monitors operated from the control tower ASR-2 radar, and was movable over the entire radar display by the departure controller. One of the ASR-2 monitors remoted to the Air Route Traffic Control Center, and mounted in the vicinity of the Center's horizontal ARSR-1 radar monitor, showed the position of the television handoff marker and enabled Center controllers to transpose the radar target being handed off from the ASR-2 monitor to their en route horizontal ARSR-1 display

The television handoff marker was in use for over three months, and both tower and Center controllers agreed that it expedites the handing off of departure aircraft and reduces materially the possibility of traffic conflictions due to errors in identification. These opinions are borne out by time studies made during the evaluation, and by a subjective questionnaire submitted to controllers who were qualified to use the system

It is recommended that the television handoff marker be adopted as a standard radar coordination device, and that it be evaluated further as an intra-facility coordination device.

INTRODUCTION

The operational manual[1] used for radar procedures states, "Where the identity of an aircraft is being transferred from one radar scope to another, the controller . ... shall specify the distance and bearing from a known fix .. .. together with the observed track of the target being transferred " The manual also points out that in the event two or more aircraft are observed in the same vicinity, following the same tracks, additional means of identification shall be performed. Such additional identification usually involves an identifying turn. Obviously, the verbal transfer of a target from one scope to another can be time-consuming unless the two scopes are located side by side.

[1]United States Standard Manual of Radar Air Traffic Control Procedures, par. 1.5.5.

In a previous report,[2] a light-gun marker, which was developed for use as a radar transfer or handoff device, is described. The light-gun marker was used with conventional radar displays. The television (TV) handoff marker device is analogous to the light-gun marker except that it is used in conjunction with scan-converted radar equipment. The marker is inserted on the reading side of the scan-converter. A detailed technical description of the TV handoff marker may be found in another report.[3]

The TV handoff marker shown in Fig. 2 is an electronically generated circle approximately 1/2-inch in diameter, when viewed on a 17-inch monitor, and it may be displayed on one or more scan-converted radar monitors simultaneously. However, all monitors using the same marker system must utilize common horizontal and vertical synchronizing pulses, which results in synchronized rasters. This ensures that the marker will be in the same position on each monitor.

Positioning of the marker is accomplished by means of a joystick-type control, also shown in Fig. 2, located in the vicinity of the tower departure controller's monitor. In the system evaluated, the position of the marker was determined by the position of the joystick at all times, and when the system was not in use, the marker was moved to a position within a small rectangle at the lower right-hand corner of the display, as indicated in Fig. 2.

In use, the tower departure controller positions the marker until it encircles the aircraft target to be handed off to another control position. The Center controller then notes the position of the encircled target, transposes this target from the Center ASR-2 monitor to the horizontal en route display, and advises the tower controller of radar contact. The tower controller then moves the marker to the lower right-hand corner of the ASR display.

A switch located on the control box, shown in Fig. 2, enables the tower departure controller to operate the marker in either a steady or flashing mode. The flashing mode normally is used to alert the Center controller that a handoff procedure is to be undertaken. Marker intensity is adjustable by tower maintenance personnel.

OPERATIONAL TESTS

Shortly before the TV handoff marker was installed in the Air Route Traffic Control (ARTC) Center and tower, a series of time tests were conducted in the Airways Operations Evaluation Center (AOEC) to

[2]Lawrence B. Ii, "A Light Gun for Radar Handoff of Aircraft Between Air Traffic Controllers," Technical Development Report No. 384, January 1959.

[3]Lawrence B. Ii, "Television Electronic Marker for Radar Handoffs," Technical Development Report No. 391, March 1959.

determine the difference, if any, between the time required for radar handoffs using purely verbal coordination and those using the marker. Four groups, A, B, C, and D, each composed of one Indianapolis ARTC Center controller and one Indianapolis Tower controller, made 10 to 12 simulated radar handoffs from tower to Center under each of four different conditions. Condition I was a verbal handoff accepted by the Center controller on the ARSR-1 horizontal display; condition II, also verbal, was accepted on the Center's ASR-2 monitor; condition III was the same as condition II except that the TV handoff marker was used in lieu of verbal coordination; and condition IV was the same as condition III, except that the Center controller was required to transpose the aircraft target from the Center's ASR-2 monitor, on which the marker was displayed, to the horizontal ARSR-1 scope.

The results of these time tests are presented graphically in Figs. 3A and 3B. Individual group averages showing the time necessary per handoff are listed in Table I

TABLE I

TIME REQUIRED TO COMPLETE HANDOFF PROCEDURES

Group	Condition I (sec.)	Condition II (sec.)	Condition III (sec.)	Condition IV (sec.)
A	25.5	23.7	8.9	6.9
B	16.8	16.1	13 9	11.7
C	15.7	14.2	10.2	12.0
D	18.8	17.6	7.7	14.6

Average of all groups under each condition:

Condition I - 19.2 seconds
Condition II - 17.9 seconds
Condition III - 10.1 seconds
Condition IV - 11.3 seconds

These figures indicate that, in every instance, less time was required to accomplish a radar handoff when the TV handoff marker was utilized.

QUESTIONNAIRE STUDY

Approximately three months after the TV handoff marker had been installed, a questionnaire was prepared and distributed to those tower and Center controllers who were qualified to use radar in the control of air traffic. A total of 44 completed questionnaires (21 Center, 23 tower) was returned, revealing the following information·

1. The marker was a faster and more positive method of radar transfer.

2. In general, the marker operating controls were found to be adequate and satisfactory. Most controllers felt that marker intensity should be adjustable by operating personnel.

3. Controller attitude toward the flashing feature of the marker was somewhat divided; however, the majority felt that a selection of either steady or flashing mode was a desirable feature.

4. The marker is about the correct size.

5. Controllers feel that one marker is satisfactory, in general, and that the present circular configuration is preferable to other shapes.

6. Center personnel felt that it would be highly desirable to display the marker simultaneously on the horizontal ARSR-1 monitor, thus eliminating the necessity of transposing each handoff from the ASR-2 monitor.

7. The location of the ASR-2 monitor at the Center was controversial. Some controllers felt that the monitor was satisfactorily located; however, a slight majority would have preferred that the monitor be located closer to the horizontal ARSR-1 scope.

8. The majority of controllers felt that one or more intra-facility markers would be highly desirable. A few stated that additional markers might tend to be confusing.

9. Operating personnel agreed almost unanimously that the TV handoff marker system was relatively trouble-free.

Written comments, in general, were confined to marker shape in the event that multiple markers were incorporated into the system. Several controllers suggested that different colors be used to identify markers; others suggested different shapes, rectangular, triangular, polygonal, and so forth.

A detailed summary of the results of the questionnaire study is included in the Appendix I.

CONCLUSIONS

It is concluded that:

1. The TV handoff marker expedites the transfer of aircraft targets between scopes considerably and reduces the possibility of traffic conflictions due to errors in identification.

2. The necessity of transposing a transferred target from one monitor to another reduces the effectiveness of the system.

3. Preferred marker intensity varies from controller to controller.

4. Portability is not a desirable feature of the marker operating controls.

RECOMMENDATIONS

It is recommended that:

1. The TV handoff marker be inaugurated as a standard radar coordination device.

2. Marker operating controls be permanently mounted in close proximity to the departure radar scope.

3. A marker intensity control be made available to operations personnel.

4. Circuitry be developed to translate the marker from one TV system to another with acceptable accuracy.

5. Intra-facility potentials of the marker be evaluated.

APPENDIX I

FEDERAL AVIATION AGENCY
TECHNICAL DEVELOPMENT CENTER
P. O. Box 5767
Indianapolis 21, Indiana

DATE_____

QUESTIONNAIRE

TV MARKER

Center Controller_____ Tower Controller_____

The following questions are all multiple choice; however, in some instances space is left for individual comments. Check as many blocks opposite each question as you feel necessary to adequately express your opinion of the TV marker. If you wish to make additional comments, use the reverse side of this questionnaire.

A "T" in the left margin indicates that the question is applicable to tower personnel only, and a "C" indicates that the question applies to center personnel. Both tower and center personnel answer questions indicated by "T.C.".

			TOWER (Percentage of Replies)	CENTER	AVERAGE
T.C.	1.	The TV marker, when used for tower-center radar handoffs, is:			
		(a) A faster method than pure verbal coordination.	100	86	93
		(b) Slower than verbal coordination.	-	-	-
		(c) Less apt to introduce traffic conflictions through errors in identification.	87	76	82
		(d) More apt to produce errors in identification.	-	-	-
		(e) Some other method of radar handoff would be better than the TV marker (explain).	4	5	5
T.	2.	The operating controls for the TV marker are:			
		(a) Adequate and satisfactory.	83		
		(b) Awkward to use.	-		

		TOWER	CENTER	AVERAGE
		(Percentage of Replies)		
	(c) Need improving (explain).	39		
T.C. 3.	Regarding the flashing feature of the TV marker:			
	(a) The flashing mode is preferable to the steady mode of operation.	4	38	20
	(b) The flashing mode is not necessary.	30	38	34
	(c) Both modes are desirable, for use in different circumstances.	65	24	45
	(d) The flashing rate should be changed (explain).	-	-	-
T.C. 4.	Regarding marker brightness:			
	(a) The TV marker should be less bright than the radar target.	13	29	20
	(b) The marker should be brighter than the target.	35	14	25
	(c) The marker should be approximately the same brightness as the target.	22	14	18
	(d) Marker brightness should be adjustable by operating personnel.	48	57	54
T.C. 5.	Marker size:			
	(a) The marker is too large.	-	-	-
	(b) The marker is about the right size.	96	100	98
	(c) The marker is too small.	4		2
T.C. 6.	Number of markers:			
	(a) One marker is sufficient.	70	76	73
	(b) There should be several tower-to-center markers.	13	14	14
	(c) There should be one or more center-tower markers.	22	10	16

			TOWER	CENTER	AVERAGE (Percentage of Replies)
T.C.	7.	Marker shape:			
		(a) The circular marker is satisfactory.	87	86	86
		(b) Some other shape would be preferable (explain).		10	5
		(c) If several markers were used, a marker in the form of a letter of the alphabet would be desirable.	9	10	9
		(d) If several markers were used, the circular form should be retained, and some other form of identifying each marker used.	48	14	31
C.	8.	Regarding the necessity of transposing radar targets from the tower (ASR) to the center (ARSR) monitors during radar handoffs utilizing the TV marker (before answering this question, reread question 1.):			
		(a) Transposing targets from one scope to another is extremely time-consuming, and seriously reduces the effectiveness of the TV marker as a handoff device. Purely verbal coordination is preferable.	5		
		(b) The necessity of transposing targets is undesirable, but it does not reduce materially the effectiveness of the TV marker.		33	
		(c) It would be highly desirable to display the TV marker simultaneously on the center radar (ARSR) monitor, thus eliminating the necessity of transposing targets from one scope to another.	76		
		(d) Transposing targets from one scope to another presents no problem whatsoever.		19	
C.	9.	Regarding the device whereby the tower radar (ASR) display may be superimposed on the center radar monitor:			
		(a) This device is highly desirable, and will solve any of the problems mentioned in question 8, above.		19	

		TOWER	CENTER	AVERAGE
		(Percentage of Replies)		
	(b) A superimposed display is confusing, and tends to complicate transposing targets.		14	
	(c) Will neither expedite nor hinder the operation of the TV marker during radar handoffs.		33	
	(d) Have not used the device.		29	
C. 10.	Regarding the tower radar (ASR) monitor in the center·			
	(a) The monitor is satisfactorily located.		52	
	(b) The monitor is too far from the center radar display.		19	
	(c) The size of the monitor could be reduced without altering the effectiveness of the TV marker handoff system.		10	
	(d) The monitor should be mounted (explain).		52	
T.C.11.	Regarding additional TV markers for use within each facility:			
	(a) One or more markers would be desirable for use between different positions within the facility; for example, tower to IFR room; center sector-to-sector.	78	67	73
	(b) Such markers would be likely to create confusion.	17	24	20
T. 12.	Maintenance of the TV marker:			
	(a) Maintenance-wise, the TV marker itself has been no problem. It has operated as reliably as any other comparable piece of electronic gear.	96		
	(b) The TV marker has required a large amount of work by maintenance personnel.	-		

FIG. 1 TV HANDOFF MARKER AND POSITIONING CONTROLS

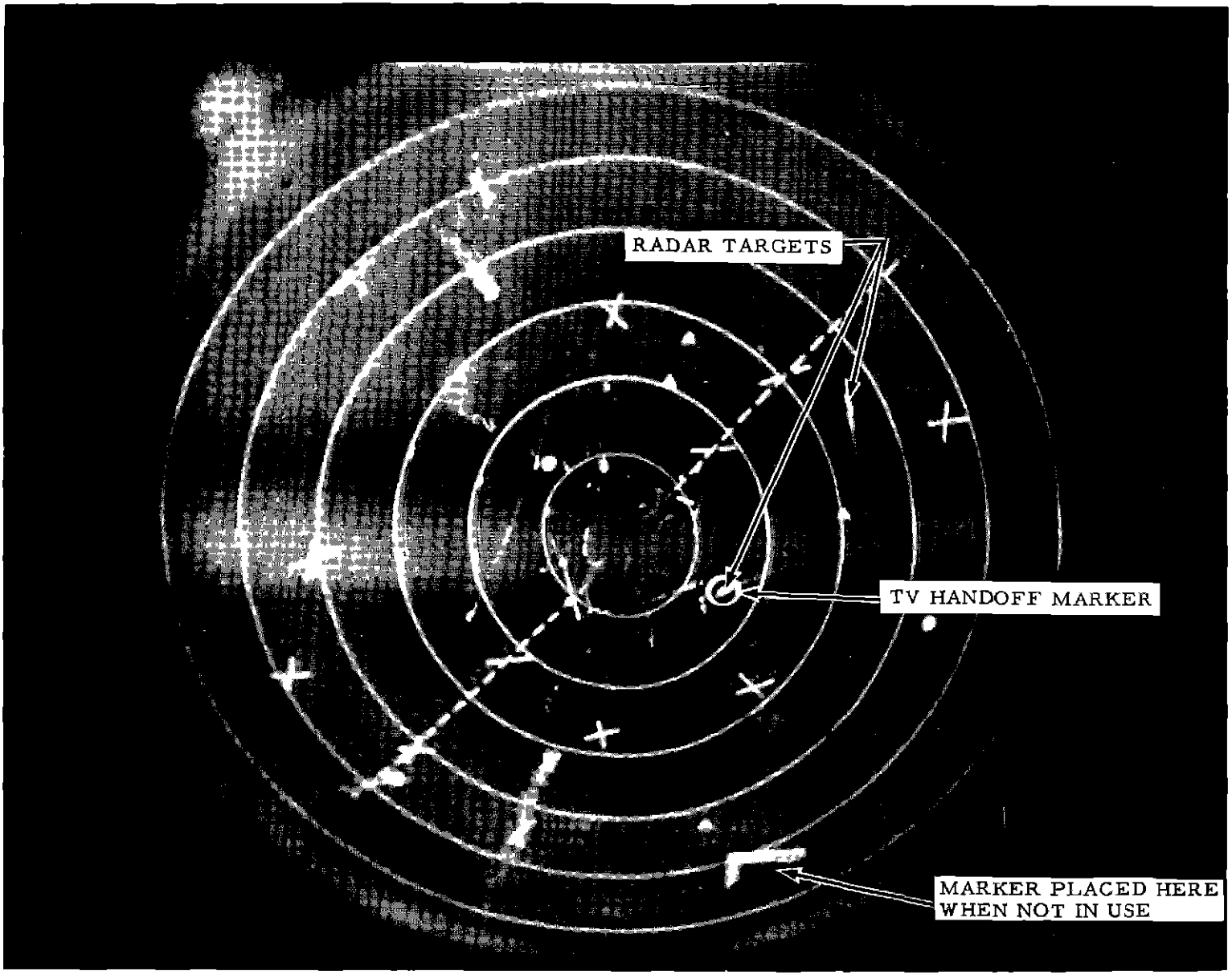

FIG. 2 CLOSE-UP VIEW OF MONITOR

CONDITION I - VERBAL, TOWER ASR-2 TO CENTER ARSR-1
CONDITION II - VERBAL, TOWER ASR-2 TO CENTER ASR-2.
CONDITION III - MARKER, TOWER ASR-2 TO CENTER ASR-2.
CONDITION IV - MARKER, TOWER ASR-2 TO CENTER ASR-2, THEN TO CENTER ARSR-1

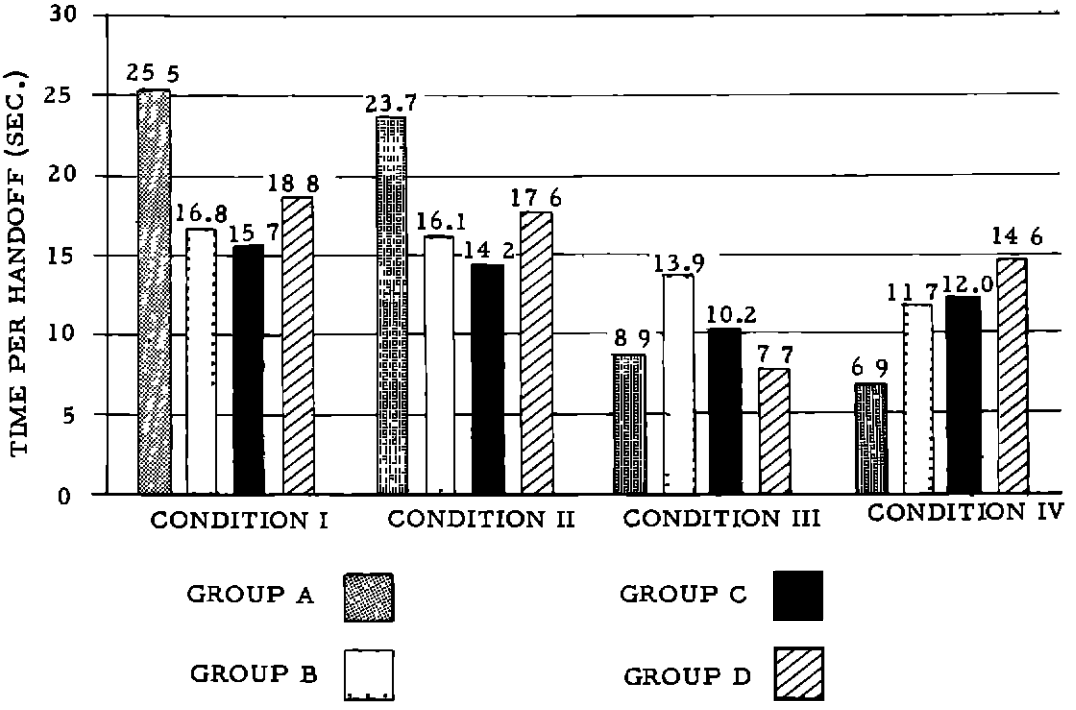

FIG. 3A AVERAGE HANDOFF TIME BY GROUPS

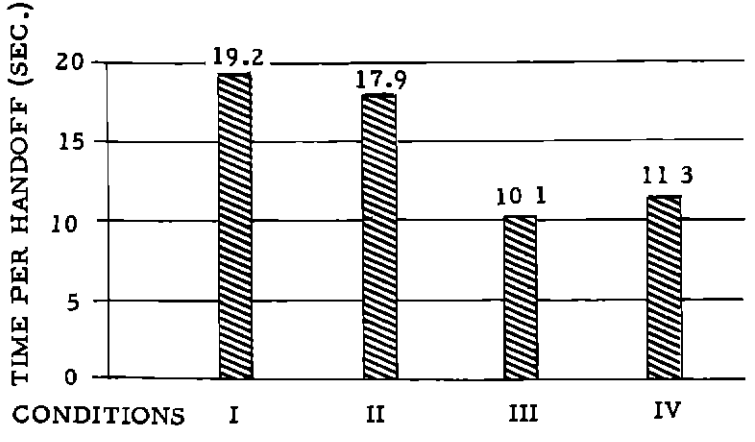

FIG. 3B AVERAGE HANDOFF TIME (ALL GROUPS)