LEVEL II

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THE DETECTION RANGES OF FEATURES OF ARMORED VEHICLES

by

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Reduced-scale techniques were used to determine the actual ranges at which various features of vehicles can be recognized. The principal findings were:

A number of recognition features stressed in current training programs were not seen until the observer was very close to the target (number of road wheels and gun tubes, sprocket location, and number of rollers, for example).

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20. (continued)

The determination of turret shape, a major recognition feature, occurred earlier for the bowl shaped turrets than for other shapes. This type of turret is used more often on Soviet type vehicles than on NATO vehicles.

The only features seen at scaled distances greater than 1200 meters were (a) tracked vs. wheeled, (b) presence of a turret, and (c) turret location. All other features were seen at closer distances.

The detection ranges for features did not appear to be related to amount of prior experience, but seemed to depend on the observer's risk-taking propensity.

FOREWORD

The Fort Hood Field Unit of the Army Research Institute for the Behavioral and Social Sciences (ARI) provides support to Headquarters, TCATA (TRADOC Combined Arms Test Activity; formerly called MASSTER--Modern Army Selected Systems Test Evaluation and Review). This support is provided by assessing human performance aspects in field evaluations of man/weapons systems.

This report presents the results of an experiment designed to obtain estimates of the detection distances for the recognition features of armored vehicles. It provides baseline data for evaluating the effects of other factors which may influence vehicle identification.

ARI research in this area is conducted as an in-house effort, and as joint efforts with organizations possessing unique capabilities for human factors research. The research described in this report was done by personnel of the Human Resources Research Organizaiton (HumRRO), under contract DAHC19-75-C-0025, monitored by personnel from the ARI Fort Hood Field Unit. This research is responsive to the special requirements of TCATA, the 6th US Cavalry Brigade (Air Combat), and the objectives of RDTE Project 2Q763743A775, "Human Performance in Field Assessment," FY 77 Work Program.

THE DETECTION RANGES OF FEATURES OF ARMORED VEHICLES

BRIEF

Requirement:

This study was conducted in response to a Human Resources Need (HRN) statement prepared by the 6th U.S. Cavalry Brigade (Air Combat), Fort Hood, Texas. The overall requirement concerned target identification by helicopter crewmen. More specifically, the Brigade was concerned about the adequacy of the current training methods used for training vehicle identification.

A review of existing training programs indicated that, generally, these programs concentrate on teaching the recognition of the features that can be used to distinguish among various armored vehicles, irrespective of the visibility of such features at different distances. In fact, the results of a pilot test conducted at Fort Hood indicated that many targets are incorrectly named because the presence of a specific recognition feature could not be discerned. It was apparent that there is a need for valid information concerning the distances at which the recognition features of armored vehciles can be detected under a wide variety of viewing and environmental conditions. An an initial step a limited experiment was conducted to obtain measures of the detection ranges for vehicular features under optimum conditions.

Procedure:

Models of 20 armored vehicles were presented to observers who moved toward the targets from a maximum scaled distance of 4000 meters to a minimum scaled distance of 100 meters. As the observers approached the scale models, they reported when detection of the various recognition features occurred. The observers were not required to name the vehicle. The models were oriented at an angle of 45 degrees with respect ot the observer and included two wheeled and 18 tracked vehicles. All observations were made with unaided vision (that is, without optical aids).

Principal Findings:

- A number of the recognition features stressed in current training programs were not seen until the observer was very close to the target (number of road wheels and gun tubes, sprocket location, and number of rollers, for example).

- The determination of turret shape, a major recognition feature, occurred earlier for the bowl shaped turrets than for other shapes. This type of turret is used more often on Soviet type vehicles than on NATO vehicles.

- The only features seen at scaled distances greater than 1200 M were (a) tracked vs. wheeled, (b) presence of a turret, and (c) turret location. All other features were seen at closer distances.

- The detection ranges for features did not appear to be related to amount of prior experience, but seemed to depend on the observer's risk-taking propensity.

Utilization of Findings:

The data obtained in this study provides a basis for evaluating the effects of other variables which may influence vehicle identification. This data also should be of immediate utility for training developers and military intelligence personnel. Although additional studies are needed to find out which features are most significant for vehicle identification, units can use these results in the conduct of vehicle identification training.

CONTENTS

BACKGROUND

MILITARY PROBLEM

In any future conflict in central Europe, US Army personnel can expect to see a wide variety of armored vehicles. Friendly forces will be using vehicles which have been developed by the US and, in addition, considerable numbers of vehicles developed by several other NATO nations. It is expected that in any future war the enemy will employ large masses of troops and vehicles. The initial phases of battle are expected to be extremely intense. The battlefield will be much more fluid than in the past. Under these circumstances the fixed boundaries between opposing forces will disappear. It will not be possible to assume that a vehicle is either friendly or hostile simply on the basis of its location on the battlefield.

Current Soviet doctrine stresses closing with the enemy in order to prevent the enemy from employing nuclear weapons against them. Therefore, US forces must be able to identify targets accurately to ensure that they do not engage friendly vehicles. They must also be able to identify targets rapidly to neutralize the enemy as soon as possible, thereby minimizing friendly losses. This requirement for rapid and accurate identification is virtually Army-wide, but is especially critical for artillery FOs, armor crewmen, airborne crewmen, and personnel manning ground-based antitank systems such as the TOW and Dragon. Therefore, the need for systematic and effective training in target identification is obvious.

TRAINING METHODS

At the present time, there is no standard Army-wide training program in ground vehicle identification. Some units have developed their own training programs. However, the different programs are quite varied in their content, instructional approach, and length. This circumstance appears to be due, at least in part, to the fact that the developers had no reliable information to guide them as to what should be taught. Therefore, they could be guided only by intuition and their personal biases.

One such program has been examined in some detail. Instructional materials included drawings, photographs, and even scale models where available. The general approach was to teach the recognition of individual features which might be employed to distinguish between the various armored vehicles which would likely be encountered on a central European battlefield. Typical features included the number of road wheels, the spacing between road wheels, the location and number of hatches, the presence or absence of items such as cupolas, idler wheels, skirts, and searchlights, and the presence/absence and location of bore evacuators. Unfortunately, the training developers had no data to help them decide at what ranges and under what conditions these cues might be useful.

A pilot test conducted with scale models at scaled tactical ranges under relatively ideal viewing conditions indicated that many of these cues simply could not be perceived by observers at distant ranges. Several of the personnel tested had recently completed two weeks of training in vehicle identification, yet were able to classify targets as friendly or threat with only 60% accuracy, and were able to correctly name the targets only a third of the time. However, with additional training at these tactical ranges, their accuracy approached 100%. Posttest debriefings indicated that many targets were incorrectly classified or named because the presence (or absence) of particular identifying features could not be discerned. However, the personnel responsible for the training and associated instructional materials should not be faulted. The necessary information required for maximizing training effectiveness was, and still is, largely lacking.

The need for valid information to guide training developers in designing programs specific to their needs is obvious. For example, there is little need to stress a recognition feature which cannot be discerned at ranges over 500 meters to crewmen on a weapons system designed to engage at no less than 1000 meters. However, personnel operating systems designed for closer ranges should receive extensive training on such features, as they can be used to identify vehicles within the effective ranges of their weapons. This does not mean that less useful cues should not be taught at all. The identification of potential targets by soldiers in the field could be very useful intelligence data, even though the personnel making the identifications are unable to engage at the time. What is implied is that the major emphasis should be placed on teaching those specific features most useful to the individual soldier in his particular circumstances. Logically, the greatest effort should be placed on training a crewman to identify vehicles at or just beyond the maximum effective range of his weapon, thereby optimizing his engagement possibilities.

At the present time, no data exists on the ranges at which various features can be discerned or distinguished. A considerable research effort is required in this area, as data are needed on the effects of factors such as illumination, camouflage, partial obscuration, vehicle aspect angle, atmospheric degradation, and vehicle background. As a first step, a small-scale experiment was conducted to determine the ranges at which various potentially useful features become visually available under optimum conditions. This research effort was intended to establish the outer limits at which particular features could be detected under relatively optimum conditions. The study employed a variety of scale models of both friendly and threat vehicles which might be seen in the forward areas of a central European battlefield.

METHOD

TEST PROCEDURE: INDOORS

Observers

The observers were US Army personnel obtained from the 66th Military Intelligence Detachment and Squadron 1 of the 3rd Armored Cavalry Regiment, and military and civilian personnel associated with the ARI Unit at Fort Bliss. Observers, both military and civilian, had varying amounts of armor experience, ranging from none to extensive. The observers ranged in age between 20 and 45 years old, but most were in their early twenties. All observers were required to have good vision. Before each testing session each test subject was briefed on the nature of the test and the various vehicles features of interest. The features were described and pointed out on the models to avoid any confusion about the terms used in the test.

It was difficult to get the same personnel for more than two one-hour sessions so that only a few observers could be tested on all of the vehicles. Although 28 persons served as observers in this experiment, indoor data for the total sample of 20 vehicles could only be obtained for two persons. Complete outdoor data was obtained from eight observers. Only one observer completed all indoor and outdoor trials.

THE MODELS

Twenty HO scale model armored vehicles were selected for the test. Most of the models were fairly close to 1/87 scale. Three of the models appeared to be smaller, perhaps 1/100 scale. These slightly smaller models, the ZSU-57-2, the T-10 heavy tank, and the BTR-60P troop carrier were included because they were Russian vehicles that were not obtainable from other manufacturers. Table 1 lists the models used in the study.[1] Some of the models are of obsolete vehicles, but they were included because they contained features which were not available in more up-to-date models.

[1] Photographs of the models are presented in Appendix A.

The models were sprayed with a flat olive drab spray paint (PACTRA SM6) which was found to be a good match to the paint color used on US Army armored vehicles.

The models were grouped in pairs, as indicated by the A and B designations in Table 1. In most cases models of similar size, or with similar features, were paired. A test trial consisted of presenting a pair of models about 10 inches apart in the display box. In all test trials the models were oriented toward the observer at a 45° frontal angle. Vehicle turrets were oriented in the same direction as the vehicle and gun tubes were horizontal. The models were designated A and B by labels above the display box opening.

TEST ENVIRONMENT

The models were displayed singly or in pairs in a lighted display box. The observers viewed the model through a 8 1/2" x 32" opening in the box. The bottom of the opening was located at a height of 53 1/4" above the floor. The model was placed in the middle of the floor of the box about 10" behind the front of the opening. The box was 23" deep and the floor and sides were painted a flat foliage green. The upper portion of the box above the opening which was not visible to the observer, contained two 500 watt photoflood lamps and was lined with white poster board to provide a more diffuse light.

The observers walked toward the display box along a masking tape line on the floor. The tape on the floor was marked in 100 meter increments based on the 1/87th scale of the models. The display box was located in one corner of a large room, and the tape was placed diagonally across the room to a maximum scaled distance of 1500 meters.

The illumination in the box was 1550 foot candles at the position of the model. Due to the 3200°K color temperature of the lights, the olive drab models appeared slightly more brownish in color than when viewed by daylight.

Trial Procedures

For each test trial the observer started at the 1500 M position and indicated whatever features he/she could see as the person moved toward the models. The test monitor marked down the range at which each feature was recognized. The monitor had a separate check list for each vehicle that contained the items that were important in recognizing that vehicle. For example, Table 2 gives the list of items used for the M-48 tank.

As the observer moved closer to the models the test monitor would ask if certain features could be detected. If the observer responded that the feature could be seen he/she was asked to describe the feature. For example, if the observer indicated that a bore evacuator on a gun tube was seen its location had to be described. A recognition range was only recorded when the observer correctly identified a feature. In a few instances range data on erroneous features was recorded, such as, a response of two barrels on the four barrel Panzer IV.

Each observer was tested for an hour. It was found that only 4 pairs of vehicles could be tested in an hour long session.

TABLE 1

VEHICLES USED IN TESTING

1A	M-48 Patton Medium Tank	US
1B	M-60A1 Battle Tank	US
2A	M-551 Sheridan Light Tank	US
2B	JS-3 Heavy Tank	USSR
3A	ZSU-57-2 57mm Antiaircraft System	USSR
3B	M-108 105mm Self Propelled Howitzer	US
4A	Chieftain Main Battle Tank	Uk
4B	Leopard I Main Battle Tank	Federal German
5A	M-113 Armored Personnel Carrier	US
5B	Panzerspahwagen 234/3 WW II Armored Car	German
6A	Panzer IV WW II 4 barrel Antiaircraft System	German
6B	M-10 "Sherman" type hull	US
7A	Scorpion Combat Reconnaisance Vehicle	Uk
7B	Roland I Self Propelled Missile Launcher	Fr
8A	AMX-30 Main Battle Tank	Fr
8B	T-54 Main Battle Tank	USSR
9A	M-42 40mm Self propelled Antiaircraft System	US
9B	Gepard 35mm Self Propelled Antiaircraft System	Federal German
10A	BTR-60P Armored Personnel Carrier	USSR
10B	T-10 Heavy Tank	USSR

TABLE 2

RECOGNITION FEATURE CHECKLIST FOR THE M-48 TANK

RANGE	FEATURE	RESPONSE
______	Correct Identification	M-48
______	Tracked?	Yes
______	Turret?	Yes
______	Turret Location	Mid
______	Turret Shape	Rounded Bowl
______	Cupola or Hatch	Right Rear Cupola
______	Length of Main Gun	Average
______	Muzzle Brake	Yes
______	Secondary Armament	Cupola M.G.
______	Suspension Type	Torsion Bar
______	Roadwheels? Evenly Gapped?	No
______	No. of Roadwheels	6
______	Support Rollers?	Yes
______	No. of Rollers	5
______	Drive Sprocket	Rear
______	Front Slope (Glacis)	Rounded Point
______	Skirts	None
______	Fenders	Curved
______	Sponson Boxes?	Yes

VIEWING CONDITIONS

All observations utilized unaided vision. Optical aids were not employed for two reasons. First, if aided vision was involved the maximum scaled ranges would have exceeded the physical space available for indoor testing. Second, preliminary pre-test trials, using 3 and 7 power optics, indicated that it was not possible to obtain optical focus at a distance of less than 30 feet or approximately 800 meters full scale.

Although the resulting data should provide relatively accurate estimates for unaided vision, it seems likely to establish a transfer function for this data if full scale data for optically aided observers could be obtained for several of the vehicles used in this test. Such full scale testing was beyond the established scope of work and the logistical support available for this experimentation.

TEST PROCEDURE: OUTDOORS

Early in the conduct of the testing, it was found that the indoor test area was not long enough to determine the maximum range limit for some of the larger features. Since the discrimination of turrets and tracks and some guns was often made at the 1500 M distance it was decided to set up an outdoor test range to collect data for these features.

A 30 inch wide platform was made for use outdoors. It included a vertical background and was painted the same color green as the indoor range. The course was laid out using white engineer tape marked in scaled 100 meter increments as in the indoor test range. The maximum length of the outdoor range represented a 1/87 scaled 4000 meter distance.

In order to speed up the outdoor data collection, five vehicle models were placed on the platform at once. The models were all placed at a 45° angle to the observer as in the indoor test. A sign beneath the model platform designated the models A,B,C,D, and E. Four 5-model groupings could easily be completed in an hour's time. These groupings are given in Table 3. The outdoor model groupings contain those models for which responses occurred

TABLE 3

OUTDOOR TEST MODEL GROUPINGS

Group	A	B	C	D	E
I	Shop Van Truck	M-60	ZSU-57-2	Armored Car	JSIII
II	Chieftain	M-113	M-48	Leopard	M-551
III	Panzer IV	Half-track	AMX-30	M-10	T-54/55
IV	M-42	Gepard	BTR-60P	Scorpion	T-10

at 1500 M indoors and a few models not used indoors such as the truck and half-track. These two models were used in an attempt to increase the difficulty of the wheeled vs. tracked discrimination, however the truck was identified at 3000 M by its unique shape before any discrimination of wheels vs. tracks could be made. No data is presented for the half-track vehicle because most of the observers were unfamiliar with its hybrid type of suspension.

Outdoor data was collected only on features for which numerous 1500 M responses were obtained indoors. These features were as follows:

1. Is the vehicle tracked or wheeled?
2. Does the vehicle have a turret and if so, where?
3. Does the vehicle have a main gun and how long is it?
4. Do any of the vehicles have skirts?

The outdoor lighting conditions varied substantially from those of the indoor test. Most of the outdoor data was collected under bright sun conditions where the brightness was measured at 9000-9500 ft. candles. Two test subjects were run on a cloudy day when the brightness was measured as 1800 ft. candles or approximately the same as the indoor test.

An effort was made to keep the sun angle roughly the same for all of the outdoor test sessions. The testing range was oriented so that the sun position was located between about 10°- 60° to the left rear of the test subject as he faced the models. This resulted in the long sides of the models being directly illuminated by the sun. This intense sunlight provided higher contrasts for detecting vehicle features than did the indoor lighting.

RESULTS

DATA ANALYSIS

The amount of data collected for a particular feature depended upon the number of vehicles that contained the feature. For example, only ten data points were collected on the Volute suspension feature since only one vehicle contained that feature. In contrast, a total of 175 data points were collected concerning road wheel spacing, since all vehicles shared this feature in common.

The data did not tend to group around a particular distance, but tended to be spread due to many factors, such as the observer's experience, or willingness to risk making a judgment about the target. For this reason, it was decided that the data would best be described by computing the median and interquartile range for each feature since these measures are not influenced by extremely high or low values. The median, Q_2, represents the range value at which half of the responses occurred; Q_1 represents that range at which the initial 25% of the responses occurred and Q_3 is the range at which 75% of the responses occurred; and the interquartile range, $Q_3 - Q_1$, represents the distance over which the middle 50% of the responses occurred. For example, the values of Q_1, Q_2, and Q_3 for the detection of machine guns were found to be 750, 500, and 350 meters, respectively. Therefore, one fourth of the responses occurred by the range of 750 meters from the target. The median, Q_2, was 500 meters and is the midpoint of the range data for machine gun detections. Three-fourths of the responses had occurred by 350 meters. The interquartile range is 750-350 or 350 meters. Since the test observers always walked in on the target, the value of Q_1 will always be the largest range.

The data was collected by moving the observer in 100 meter increments between 1000 and 100 meters, 200 meter increments between 2000 and 1000 meters, and 300 meter increments between 3000 and 2000 meters. Most of the data was collected at ranges of less than 1500 meters and the resulting values of Q_1, Q_2, and Q_3 were rounded to the nearest 50 meters.

The resulting data is given in Table 4 together with the number of observations for the larger vehicle features of interest.[2] This data is also shown graphically in Figure 1. The lines plotted in Fig. 1 represent the interquartile range. The lowest range dot corresponds to Q_3 and the highest range dot to Q_1. The middle dot gives the value of the median, Q_2. Most of the data shown in Figure 1 was obtained from the indoor testings. The outdoor testing data is labeled as such.

[2] The median detection ranges for the features specific to each of the vehicles is presented in Appendix B.

FIGURE 1

DETECTION RANGES FOR VEHICLE FEATURES

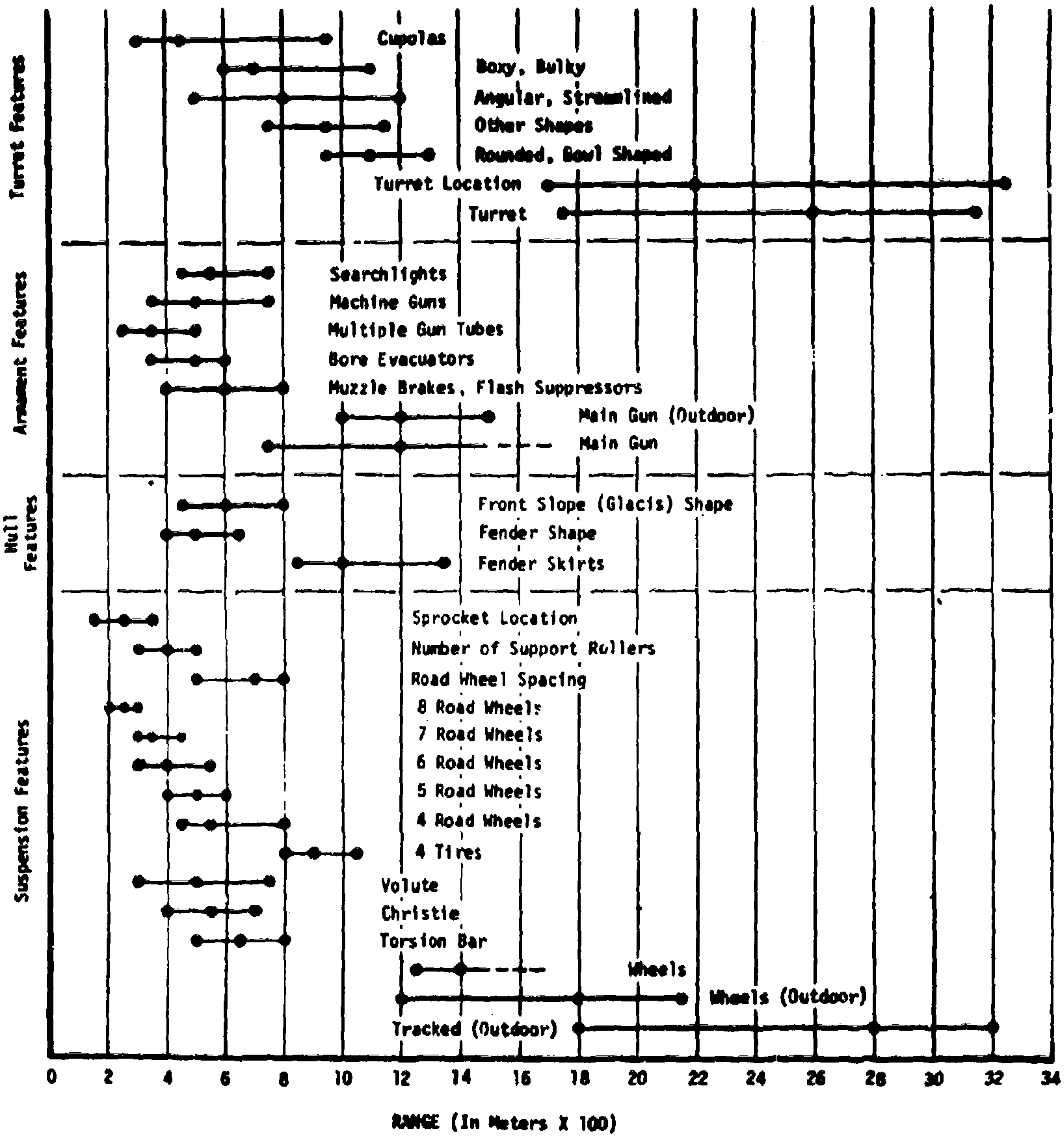


TABLE 4

MEDIAN and INTERQUARTILE POINTS FOR RECOGNITION FEATURES

	Q_1	Q_2	Q_3	n
Tracked (Outdoor)*	3200	2800	1800	162
Turret (Outdoor)	3150	2600	1750	164
Turret Loc. (Outdoor)	3250	2200	1800	114
Suspension:				
Wheels (Outdoor)	2150	1800	1200	20
Wheels	1500+	1400	1250	19
Torsion Bar	800	650	500	80
Christie	700	550	400	52
Volute	750	500	350	10
No. of Road Wheels:				
Tired 4	1050	900	800	19
Tracked 4	800	550	450	11
" 5	600	500	400	58
" 6	550	400	300	59
" 7	450	350	300	38
" 8	300	250	200	9
Road Wheel Spacing	800	700	500	175
No. of Rollers	500	400	300	77
Sprocket Location	350	250	150	139
Skirts	1350	1000	850	38
Front Slope	800	600	450	168
Fenders	650	500	400	155
Main Gun	1500+	1200	750	158
Bore Evacuator	600	500	350	52
Flash Sup./Muzzle Brake	800	600	400	62
Multiple Gun Tubes	500	350	250	47
Machine Guns	750	500	350	112
Searchlight	750	550	450	29
Turret Shape:				
Boxy/Bulky	1100	700	600	22
Angular/Streamlined	1200	800	500	32
Others	1150	950	750	37
Rounded/Bowl	1300	1100	950	48
Cupola	950	450	300	34

* Unless otherwise noted, all data was obtained in the indoor environment.

SUSPENSION FEATURES

The lower portion of Figure 1 shows the interquartile ranges associated with the suspension features of the models. The bottom two lines show the recognition ranges associated with the determination of whether the vehicles were tracked or wheeled. These data resulted from the outdoor test and it can be seen that the median value of the tracked designation occurred at 2800 M while the median value for the wheeled designation occurred at 1800 M. The interquartile range for the tracked designation is quite broad, extending from 1800 M to 3200 M. The data for this feature was quite spread out due to the fact that some observers based their response on overall vehicle shape and other, more cautious, observers waited until they could begin to see road wheels re they responded. The data for the indoor "wheeled" response is also shown, but has an undetermined upper limit due to the limiting size of the room.

The recognition range data for the three basic track suspension types is shown next. Above these data are the interquartile ranges related to the observers ability to determine the number of road wheels on the vehicles. This determination is based not only on the number of road wheels, but also on the size of the road wheels, the size of the spaces between the wheels, and the presence or absence of fender skirts.

The interquartile range based on road wheel spacing gives the data for the determination of whether the road wheels are evenly spaced or have some uneven gaps between them. This distinction is important in recognizing some of the Soviet tanks such as the T-54/55 and the T-62.

Track support rollers are probably the best criteria for determining the torsion bar suspension system. The number of rollers on the models used varied between 3 and 5. The observers were able to correctly count the rollers at a distance of about 400 M from the target.

The final suspension feature shown is the sprocket location. The observers were instructed to determine the drive sprocket location by being able to detect either the teeth on the drive sprocket or the smooth surface of the idler wheel. Obviously there are vehicles where the drive sprocket location may be inferred at much greater distances due to the observer being able to assume that (a) if the vehicle has a front or rear mounted turret then (b) the engine and drive sprocket must be located at the other end. Some of the observers also tried to infer a sprocket location determination based on the observation that one end of the track appeared higher than the other end. These observers said that the higher end held the sprocket. It is not known how reliable this method of determining sprocket location may be.

HULL FEATURES

The presence of fender skirts was detected about 1000 M from the target. The ranges associated with fender shape discrimination occurred much closer to the target. The observers were asked to describe the shape of the front edge of the fenders. The fenders could be classified as three types: rounded or curved over, angled straight down, or flat.

One of the hardest features to accurately describe was the front slope or front glacis plate. This feature may be a straight slope, rounded, pointed, blunt, or a combination of these. Observers tended to change their descriptions of the front slope as they approached it, more so than for any other feature. The angle of the target also seemed to have a great effect upon making a correct judgment. Often the pointed and rounded front slopes would be described as straight across until the observer was within a few hundred (scaled) meters of the target.

ARMAMENT FEATURES

The medians for the indoor and outdoor detections of the main gun both occurred at 1200 M. The interquartile ranges vary somewhat. This indicates that, at least for this feature, the indoor and outdoor results are comparable despite the wide differences between indoor and outdoor illumination.

The muzzle brakes and flash suppressors were detected somewhat before bore evacuators. Multiple gun tubes were very difficult to detect since the tubes were level and viewed obliquely. The multiple tubes would have been easier to detect if they had been elevated. The detection of machine guns and searchlights occurred at about the same ranges as multiple gun tubes and the gun tube features.

TURRET FEATURES

Turret detections and turret location tended to occur at about the same ranges as the detection of tracks. The turret detection response means "yes there is a turret." The turret location response means that the observer could correctly indicate whether the turret was mounted on the front, middle, or rear of the vehicle. Some tanks such as the M-48, AMX-30, T-54, JSIII, and T-10 have turrets that are rounded and bowl shape while others such as the ZSU-57-2 and M-108 have bulky, boxy turrets. Tanks such as the M-551, Chieftan, M-10, and Leopard have angular-streamlined turrets. Vehicles such as the M-60 Armored Car, Panzer IV, and Scorpion have turret shapes that do not fall into any of the other three classes. These turrets may have features of all the other classes or may be cluttered due to external storage etc. The detection ranges for turret shapes shown in Fig. 1 indicated that the rounded bowl shaped turrets (such as used on Warsaw Pact vehicles) may be recognized slightly before the other types.

The data related to the detection of cupolas is shown at the top of Fig. 1. This data applies only to the cupola detections for the M-48, M-60, M-551, and Leopard tanks. Other vehicles were not included because the detection of a cupola or hatch feature would require that the observer approach the vehicle from a higher elevation than that used in this experiment. It should be noted that this experiment did not control for the elevation angle of the observers eyes with respect to the height of the tank model, so that tall observers would be able to detect features on top of turrets before the shorter observers.

When the data shown in Fig. 1 is interpreted it must be remembered that this data applies only to the group of 20 vehicles used in the experiment and not necessarily to all armored vehicles. This data applies only to vehicles seen at a 45° frontal angle with turrets aligned with the hull and all guns level. Variations in lighting, background, visibility conditions, camouflaging, target movement, and observer experience could change the results greatly.

ADDITIONAL SPECIAL FEATURES

Some of the vehicles used in the test had unique structural features that might allow them to be more easily identified. The vehicles, the features, and the median detection ranges are given in Table 5.

Several of the vehicles had sponson mounted storage boxes that were detected at 250-400 M. The JS III tank had 2 large cylindrical storage tanks mounted along each side of the hull. This feature could be detected at ranges of 1000 M or greater, but could not be identified as two cylindrical tanks until a median range of 400 M.

The M-108 has a large rear-mounted boxy turret that could be seen from a great distance, but many observers were reluctant to call it a turret because the separation between the turret and the hull was not apparent until about 600 M.

Two of the vehicles, the Roland and the Gepard have radar dishes. Each vehicle had a large acquisition radar dish that was detected from distances of 800-1000 M. Each vehicle also had a smaller tracking radar mounted between the gun tubes or missile launchers. The smaller radars were not seen until 200-300 M.

Both the Leopard and the Gepard share the same chassis and differ only in the type of turret. Therefore both of these vehicles have the same fender skirt with its unique wavy lower edge. This feature was detected at 600 M. These hulls also have the same exhaust grill configuration which was detected at 400-500 M.

TABLE 5

SPECIAL FEATURES

Vehicle	Feature	Median Detection Range (Meters)
M-48	Sponson Boxes	400
M-60	Sponson Boxes	250
JS 3	Cylindrical Storage Tanks	400
M-[illegible]	Turret	600
Leopard	Exhaust Grills	400
"	Wavy Lower Fender Skirt Edge	600
Roland	Missile Launchers	500
"	Big Radar Dish	800
"	Smaller Radar Dish	200
AMX 30	Large Hatch	300
T-54	Sponson Boxes	300
M-42	Sponson Boxes	400
Gepard	Big Radar	1000
"	Small Radar	300
"	Side Mounted Gun Tubes	300
"	Wavy Lower Fender Skirt Edge	600
"	Exhaust Grills	500

EFFECT OF OBSERVER EXPERIENCE

Although only a small number of observers participated in this study, the results suggest that the detection ranges for vehicle features were not solely dependent upon the observer's prior experience with military vehicles. Although the ability to name, or identify a vehicle is undoubtedly dependent upon training and prior experience, the visual abilities and "guessing" propensities of the observers seemed to be more important determinants of the ranges at which vehicle features were reported. Some relatively inexperienced observers were willing to venture an opinion about a vehicle feature at a great distance based on very little visual information, while some tank identification "experts" were very conservative in their judgments, being unwilling to make a decision until they were much closer to the target. This variation in observer behavior probably contributes more to the large variations in detection range data than differences in visual abilities.

Another source of variation in the detection range arises from uncertainty about how to describe a feature. Some features such as the main gun or the spacing of the road wheels seem to suddenly appear to the observer as he approaches the target. Other features such as turret shape or front slope shape seem to take form very slowly as the observer approaches the target. These larger features may gradually take shape over long distances as the observer approaches. If they are not well defined shapes to start with, the observer has a difficult time deciding just what they are. For example, the turret features of the Gepard Antiaircraft system were quite confusing to many observers. The turret has no easily defined basic shape and is cluttered with two radar systems and two side mounted gun tubes. The observer must sort out all of these component shapes before he can determine the basic turret shape. The observers also found front slopes difficult to describe.

CONCLUSIONS

The variability in the individuals' detection of the different recognition features varied considerably. This variation was directly related to the physical size of the feature, such as number of road wheels (small variation) to type of vehicle (large variation).

A number of the recognition features emphasized in current training literature were not detected until the observer was very close to the vehicle (number of road wheels and gun tubes, sprocket location, and number of rollers).

The detection ranges for features did not appear to be directly related to prior experience, but seemed to be quite dependent upon the "risk taking propensity" or willingness of the observer to venture a detection response based on limited visual information.

The determination of turret shape, a major recognition feature occurred earlier for the rounded bowl shaped turret than for the other turret shapes. This type of turret is used on Soviet-type tanks more often than on NATO vehicles.

Under the conditions of this experiment (45° frontal target angle and unaided vision) the only features with median detection ranges in excess of 1200 M were:

(1) Tracks vs. wheels

(2) Turret

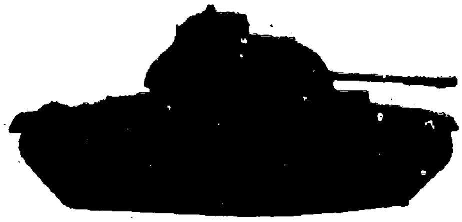
(3) Turret location

All other features were detected at median ranges of less than 1200 M.

Some features such as turrets and front glacis plates (front slopes) can have complex shapes that may result in large variations in detection range depending upon the amount of previous experience the observer has had with the particular feature. Other simpler features such as the number of road wheels or the length of the main gun pose simpler detection tasks and result in a narrower spread of detection ranges.

TECHNICAL APPENDIX A

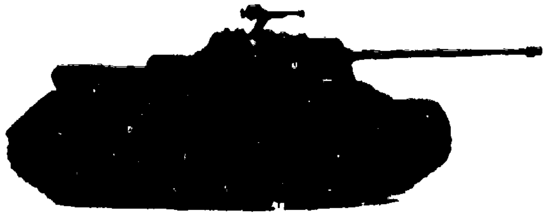
PHOTOGRAPHS OF THE MODELS USED IN THE EXPERIMENT



M-48

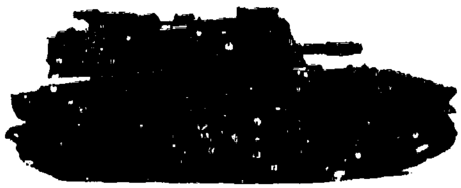
M-60

M-551



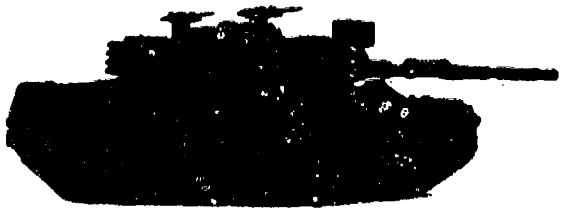
JS-3

ZSU-57-2



M-108

Chieftain

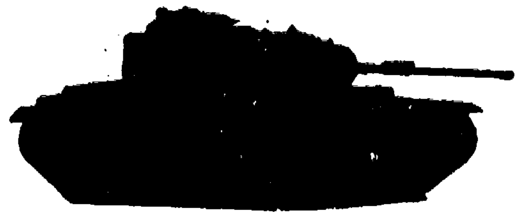


Leopard I

TECHNICAL APPENDIX A

PHOTOGRAPHS OF THE MODELS USED IN THE EXPERIMENT

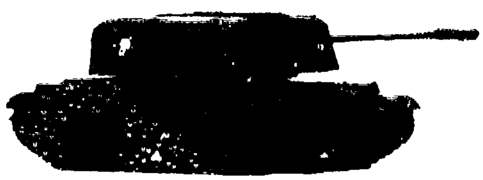
M-48



M-60

M-551

JS-3

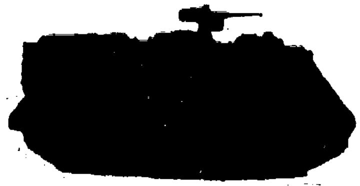


ZSU-57-2

M-108

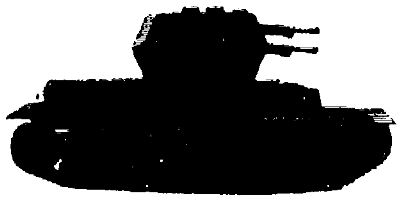
Chieftain

Leopard I

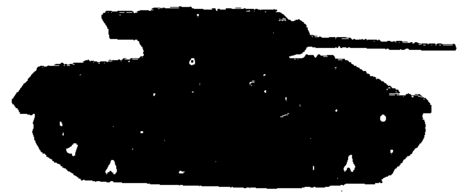


M-113

Armored Car (WWII)



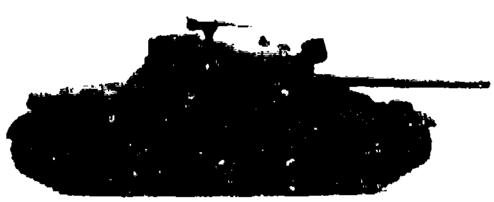
Panzer IV (WWII)



M-10

Scorpion

Roland I



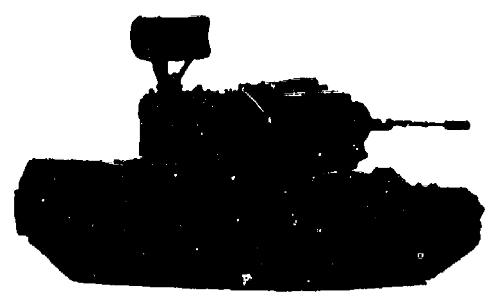
AMX-30

T-54

BTR-60P

T-10

M-42



Gepard

APPENDIX B

MEDIAN DETECTION RANGES (METERS) FOR FEATURES OF EACH VEHICLE

VEHICLE	TRACKED	WHEELS	SUSPENSION TYPE	NUMBER OF ROAD WHEELS	ROAD WHEEL SPACING	NUMBER OF SUP-PORT ROLLERS	SPROCKET LOCATION	FENDER SKIRTS	FENDER SHAPE	FRONT SLOPE (GLACIS)
M-48	3400	-	700	400	400	400	300	-	600	550
M-60	3000	-	800	400	700	500	400	-	600	400
M-551	2600	-	500	600	700	-	100	-	500	700
JSIII	2800	-	600	400	700	500	200	-	550	550
ZSU-57-2	1100	-	600	500	750	-	150	-	500	650
M-108	950	-	400	300	500	-	200	-	400	500
Chieftain	3200	-	[2]	200	350	-	200	900	300	300
Leopard I	3000	-	[2]	300	450	-	[2]	900	400	250
M-113	1150	-	[2]	400	400	-	100	1100	-	900
Armored Car (WWII)	-	1800	-	900	800	-	[2]	-	500	400
Panzer IV (WWII)	2000	-	500	200	550	200	150	-	500	350
M-10 (WWII)	2600	-	400	500	-	-	100	-	500	500
Scorpion	1050	-	250	400	500	-	-	-	350	650
Roland I	1200	-	300	300	600	200	200	-	300	600
AMX-30	2600	-	500	400	700	200	200	-	300	500
T-54/55	3000	-	500	450	700	-	100	-	500	900
M-42	2450	-	600	500	600	300	250	-	350	450
Gepard	2600	-	[2]	250	500	-	150	1150	600	600
BTR-60P	-	1300	-	800	800	-	-	-	-	650
T-10	2700	-	500	400	600	400	200	-	450	[4]

(1) Any median range in excess of 1500 M is made up of outdoor data.

(2) Fender skirts obscure suspension type and sprocket.

(3) Sometimes the turret location response occurred before the observer would say that the feature was really a turret.

VEHICLE	MAIN GUN	MUZZLE BRAKE FLASH SUP.	BORE EVACUATOR	MULTIPLE GUN TUBES	MACHINE GUNS	SEARCH LIGHTS	TURRET?	TURRET LOCATION	TURRET SHAPE	CUPOLAS
M-48	1200	500	-	-	300	-	3600	2900	1600	700
M-60	1300	-	500	-	300	-	2600	1950	1100	700
M-551	650	-	-	-	700	300	2300	1300	700	300
JSIII	1250	600	-	-	550	-	2200	1200	1100	-
ZSU-57-2	1000	650	-	300	-	-	2200	1600	700	-
M-108	750	-	200	-	-	-	600	1250[3]	600	-
Chieftain	1400	-	450	-	400	-	1800	2200[3]	750	-
Leopard I	1300	-	550	-	300	700	2950	2100	700	200
M-113	-	-	-	-	950	-	-	-	-	-
Armored Car (WWII)	900	250	-	-	-	-	1200	1300	900	-
Panzer IV (WWII)	700	200	-	300	-	-	3000	2900	1100	-
M-10 (WWII)	1100	-	-	-	-	-	2200	2550	950	-
Scorpion	700	-	-	-	-	-	1300	2900[3]	700	-
Roland I	500	-	-	400	-	-	-	-	-	-
AMX-30	1100	-	-	-	500	500	2900	1900	1000	300
T-54/55	1300	-	500	-	400	-	2300	1800	1100	-
M-42	800	-	-	150	-	-	2500	3000[3]	1150	-
Gepard	950	600	-	400	-	-	3000	3000	-[5]	-
BTR-60P	700	-	-	-	400	-	-	-	-	-
T-10	1200	700	-	-	500	-	2100	2350[3]	1000	-

(4) The front slope of this vehicle is slightly pointed, but this feature was not correctly detected due to the observer's angle of view.

(5) No data was collected on the turret shape of the Gepard due to the complexity of the turret shape caused by the presence of two radar systems and side mounted guns.