AN INITIAL MINI-STUDY OF DISPLAY SYMBOLOGY FOR FAAD-C2I DISPLAYS

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LIST OF ACRONYMS AND ABBREVIATIONS

BN	Battalion
C^2I	Command, Control and Intelligence
DOD	Department of Defense
FAAD	Forward Area Air Defense
FAAD-C^2I	Forward Area Air Defense Command, Control and Intelligence
FOG-M	Fiber Optic Guided Missile
LOS-F	Line-of-Sight Forward
LOS-R	Line-of-Sight Rear
MMI	Man-Machine Interface
MMI/SIM	Man-Machine Interface Simulation
NLOS	Non-Line-of-Sight
SIM	Simulation
SPEC	Specification
STD	Standard

I. BACKGROUND FOR THE MINI-STUDY

In the use of graphics displays to facilitate the man-machine interface (MMI), instant display clarity and transfer of required information must be the goal of symbology and display design. During the development of the FAAD-C^{2}I ABMOC display on the SYMBOLICS 3670, it became obvious that the symbology set as prescribed in DOD-STD-1477 and the FAAD-C^{2}I System Specification causes excessive screen clutter. This observed clutter creates a confusion factor and excessive loading on the operator. Seconds lost and misinterpretation of data could be significant factors in the intense real-time air defense environment.

As a result a small effort was undertaken to examine what, if anything, could be done to reduce screen clutter by redesigning the air defense artillery symbology.

II. FOUR SYMBOLOGY SETS FOR THE MINI-STUDY

The task compared four sets of symbology; one of which was the FAAD-C^{2}I specification symbology as defined in the System Specification for Forward Area Air Defense Command, Control, and Intelligence (FAAD-C^{2}I). The other three trial symbology sets were designed based on two underlying principles: (1) reduce screen clutter; and (2) allow instant transmission and identification of vital information (further defined as unit location, designation and weapon type for fire units). Table 1 summarizes the four sets of display symbology.

As previously stated, version 1 (Baseline) represents the current standard. Since an exact size for the symbols is not specified, a size consistent with the scale of the screen display was selected.

All four versions use the same rectangular battalion and battery symbols. However, version 2 replaces the fire unit symbol with a series of icons representing the fire unit's weapon type. Icons were also developed for the ground and aerial FAAD-C^{2}I sensors - information which could be vital to the battalion commander. The sensor icons remain constant in versions 3 and 4.

TABLE 1. FAAD-C^{2}I SYMBOLOGY MATRIX

	VERSION 1		VERSION 2	VERSION 3	VERSION 4
	BASELINE (SPEC)				
BATTALION COMMAND POST	BN		BN	BN	BN
BATTERY COMMAND POST	B		B	B	B
FIRE UNITS	D66	LOS-F	F07	F07	B31
		NLOS	N01	N01	A46
		LOS-R	R10	R10	D65
SENSORS		GROUND	4001	4001	4001
		AERIAL	1021	1021	1021

Version 3 uses symbology for the fire units similar to that used in recent "draft" tactical literature received from Ft. Bliss. These symbols are small in size, which should reduce screen clutter, but readily identify weapon system type.

Version 4 symbology uses one of the smallest geometric shapes - a circle. The circle is then augmented by a variety of lines to identify weapon types. The cross represents missile fins of the Line-of-Sight Forward (LOS-F) missile; the vertical arrow symbolizes the vertical launch of a Non-Line-of-Sight (NLOS) FOG-M missile; and the diagonal line represents the firing angle of the Line-of-Sight Rear (LOS-R) weapon.

III. STUDY RESULTS

These four trial symbology sets were then exercised in a typical division scenario on the SYMBOLICS 3670 in a prototype ABMOC display. Snapshots of the four displays are shown in Figures 1 through 4.

On the displays, the black arrows identify three problem areas. The upper arrow identifies an area where clutter is not excessive but symbol discrimination is difficult. The hostile rotary wing aircraft is difficult to recognize. In fact, in version 3 the protruding ground symbol line coincides with the upper bar of the aircraft symbol, making it impossible to identify the hostile aircraft as a rotary wing.

The middle-center arrow focuses on an area of extreme aircraft clutter, which makes fire unit recognition especially difficult. Because of its size and uniqueness, the version 2 fire unit symbology provides the best identification in this environment.

The last arrow (the lower one) points to an area of extreme ground and air unit clutter. For this situation, in all four symbology cases it is impossible to clearly recognize the identity of the symbol at the ABMOC division display.

Because of this extreme screen clutter, the sets were rerun with the aircraft designation filtered out. This data could be provided in a suitable tabular display. Figures 5 through 8 show the resulting displays.

As expected, with aircraft designations removed the screen clutter is reduced, but still not to the degree needed to eliminate the problems identified in the base case.

The last symbology case, shown in Figures 9 through 12, filters out both the fire unit designation and the aircraft identification. Again, such data, especially at the battalion display level, could be provided in a suitable tabular display. With this filtering, all display symbology versions become relatively uncluttered. Versions 1 and 2 provide the best discrimination between symbols. However, the specification fire unit symbology provides no information on the fire unit other than its present location. The circle-based symbology, versions 3 and 4, continues to cause confusion in identification in a friendly aircraft environment.

Obviously, even in this low intensity air defense battle, it is apparent from the analysis that screen clutter and information transfer is an ABMOC display problem. All selected symbols caused screen clutter to varying degrees. As expected, the larger the area occupied by the symbol the more clutter present.

The analysis also showed that confusion can exist for symbology derived from the same geometric base - hostile aircraft with versions 3 and 4 symbols, and possible friendly aircraft with baseline symbols. Use of icons eliminates symbol confusion in a medium density environment but provides no solution to clutter in heavy density. In heavy density environments, the use of another dimension of symbology rather than just geometrical shape is indicated. For example, replacement of closely packed symbols for the same class of object with a single group symbol, and the use of different colors to aid object class differentiation, are excellent candidates. The analysis also pointed out that the current specification symbology set provides no direct indication as to the fire unit weapon type.

Filtering out data or deferring data to tabular displays will definitely reduce screen clutter. For example, should fire unit designation be a continuous display data requirement for the ABMOC display? If it is not needed in the heat of battle, it can be deferred to a tabular display, displayed only in a zoom or hooked fire unit environment, displayed only upon operator selection, etc. Without fire unit designation, clutter was reduced for all symbology sets. However, confusion between fire unit symbols and geometrically similar symbols on the battlefield remained and the present FAAD-C^2I specification symbology is of questionable value in a cluttered display environment.

Lastly, although not presented pictorially in this paper, effectiveness of using color to enhance clarity and to reduce clutter was vividly demonstrated on the SYMBOLICS 3670 color display. Color was a great aid in discriminating among various "look alike" symbols.

IV. SUMMARY

In summary, clutter will be a problem for all symbols if the ABMOC display is required to display both fire units and unit designations. As expected, symbols small in area reduce screen clutter. However, symbols of geometrically similar shapes cause operator delay and confusion, particularly as the density of the symbols increases. Removing data from the screen via filtering, tabular displays and/or zoom capability will reduce clutter and symbol confusion. And lastly, the use of color would seem to be a must for division level air defense displays of the ABMOC type.

V. CONCLUSION

This mini-analysis has definitely uncovered the need for further display and symbology analysis and prototyping prior to finalization of the system software specification.

VI. RECOMMENDATION

It is recommended that a study be initiated on the MMI/SIM SYMBOLICS 3670, in coordination with the materiel developer, the combat developer, and human engineering personnel, to definitize FAAD-C^2I display symbology requirements.

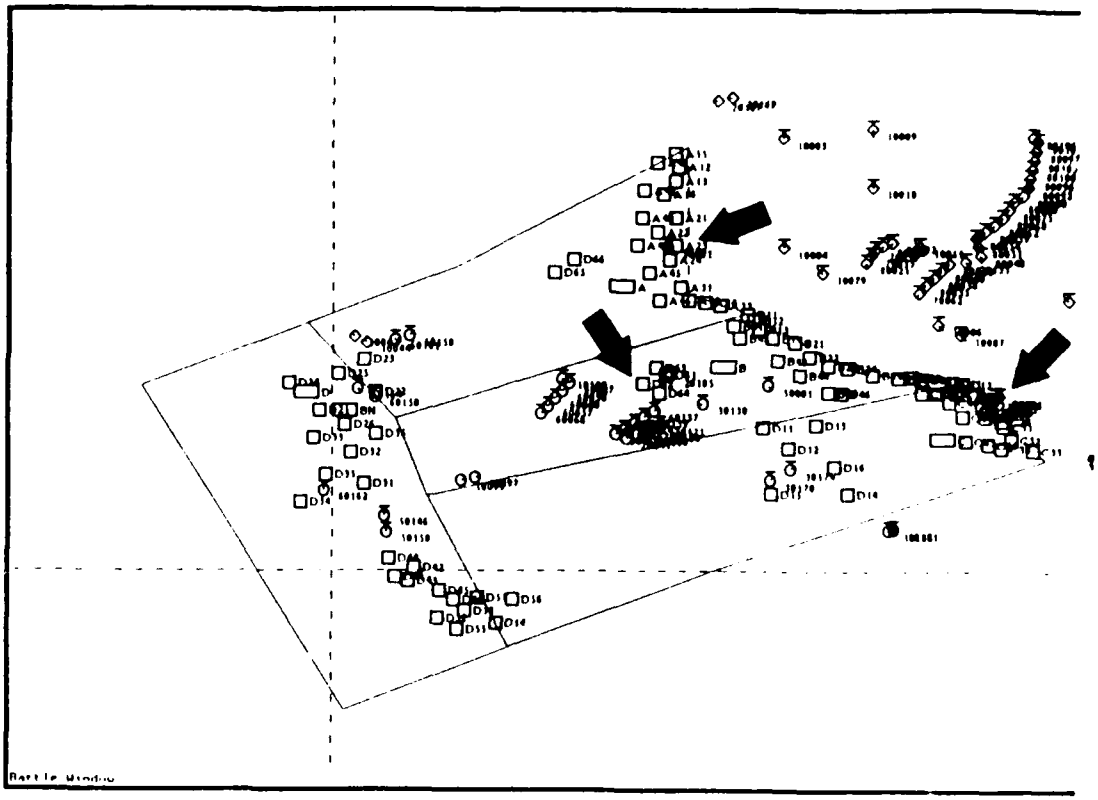

Figure 1. Baseline symbology.

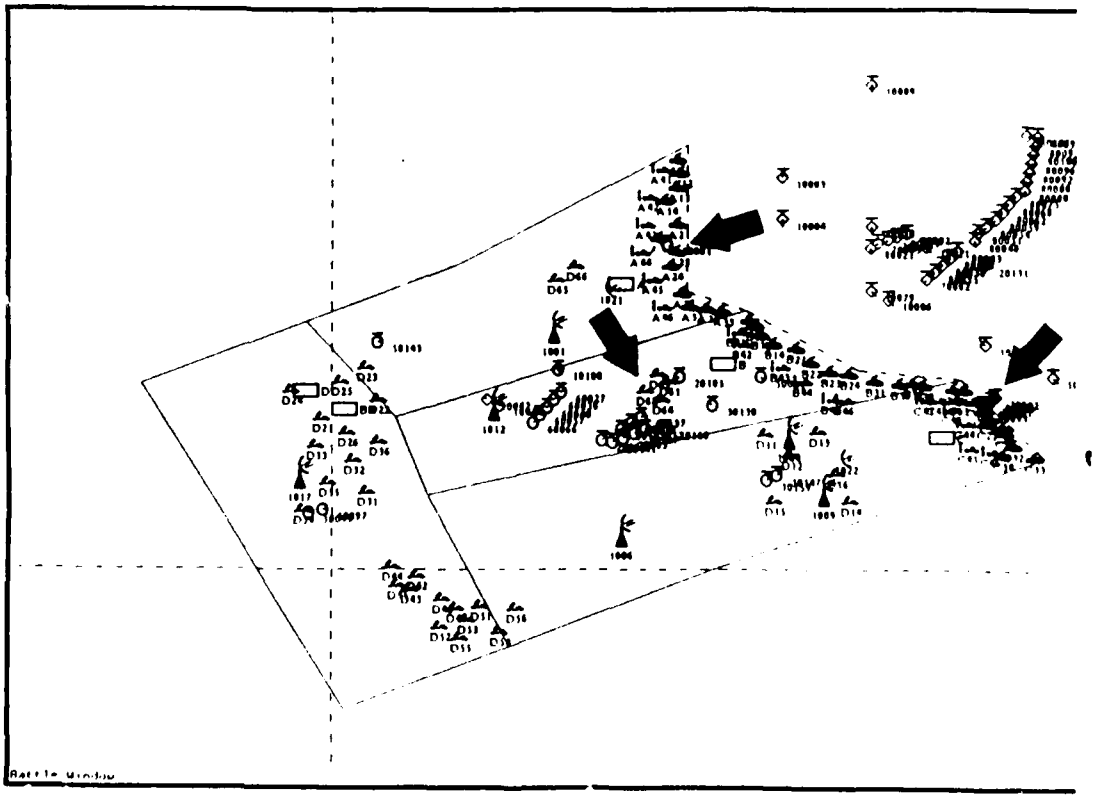

Figure 2. Version 2 symbology.

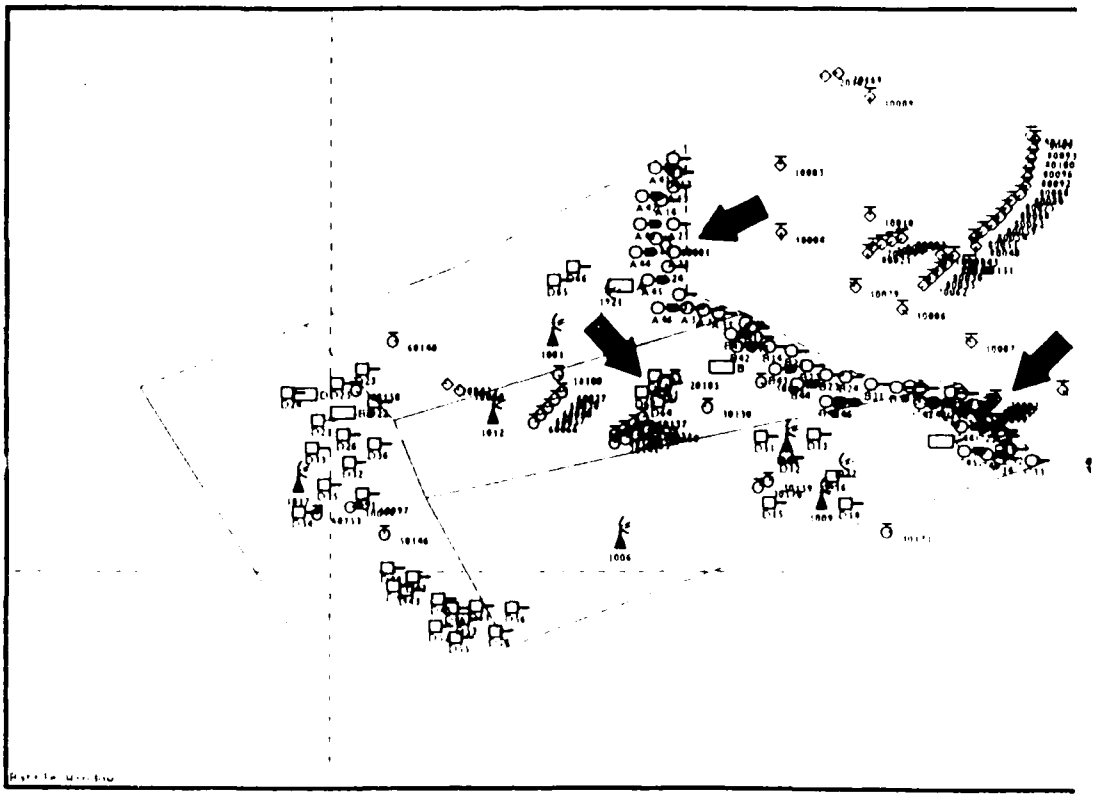

Figure 3. Version 3 symbology.

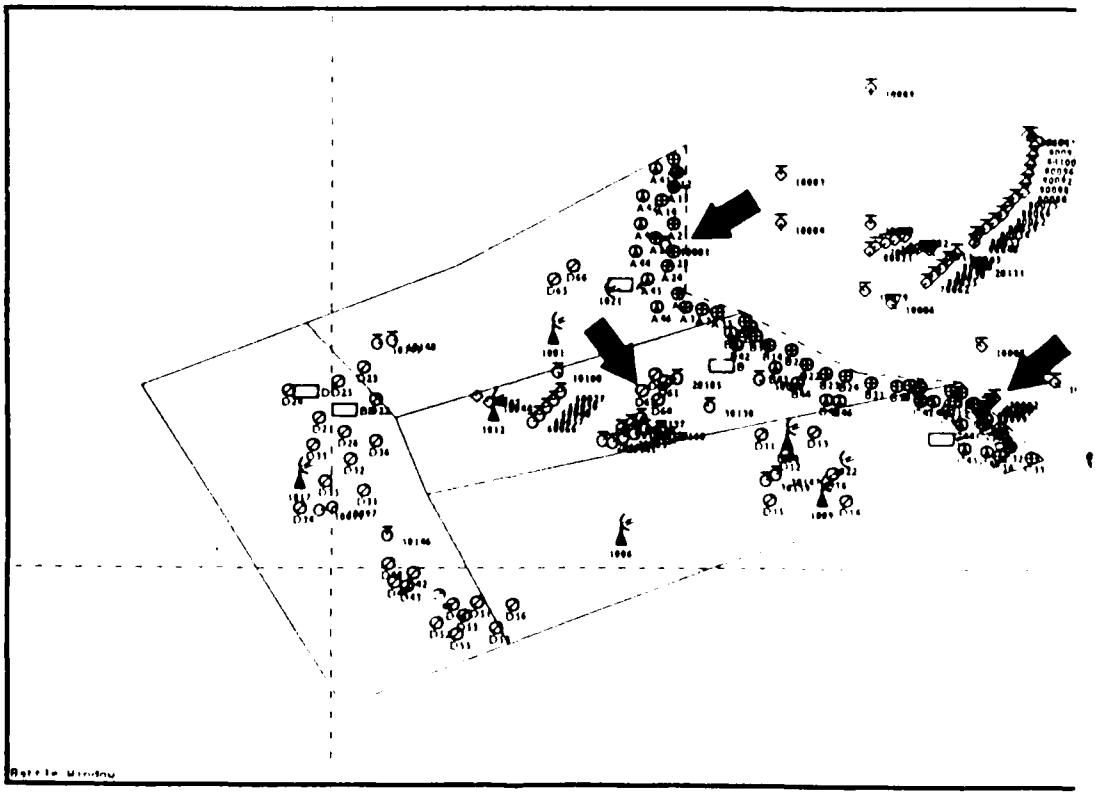

Figure 4. Version 4 symbology.

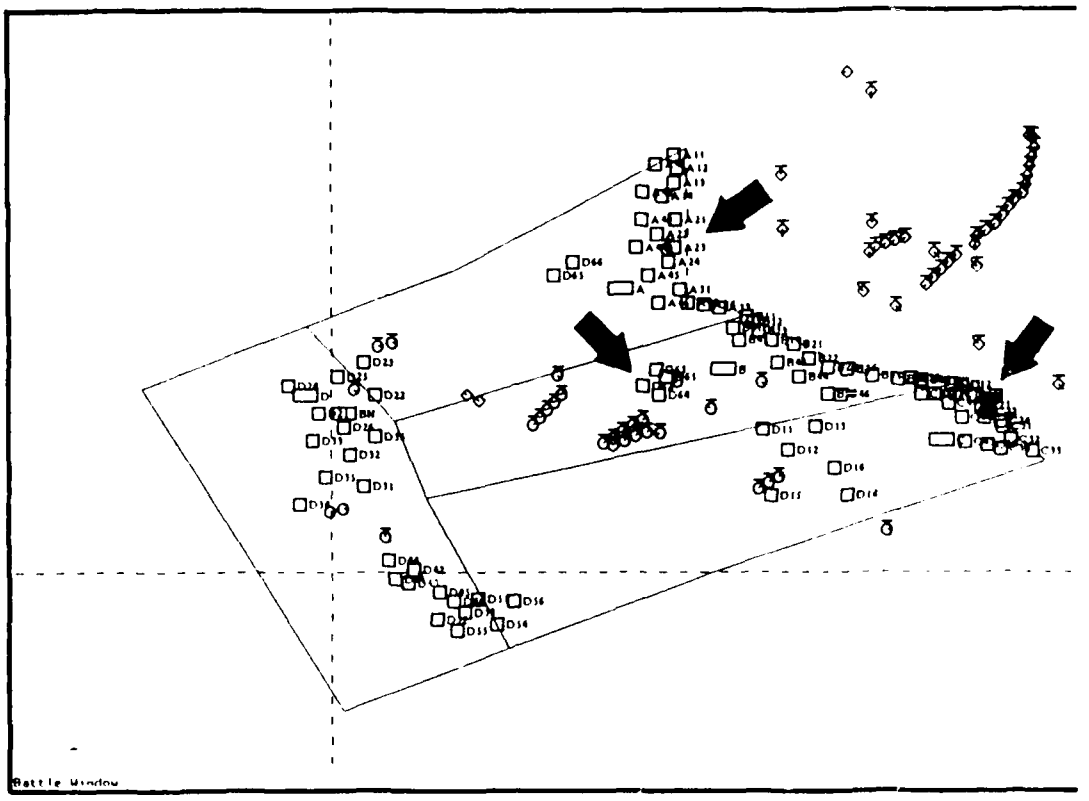

Figure 5. Baseline symbology without aircraft designation.

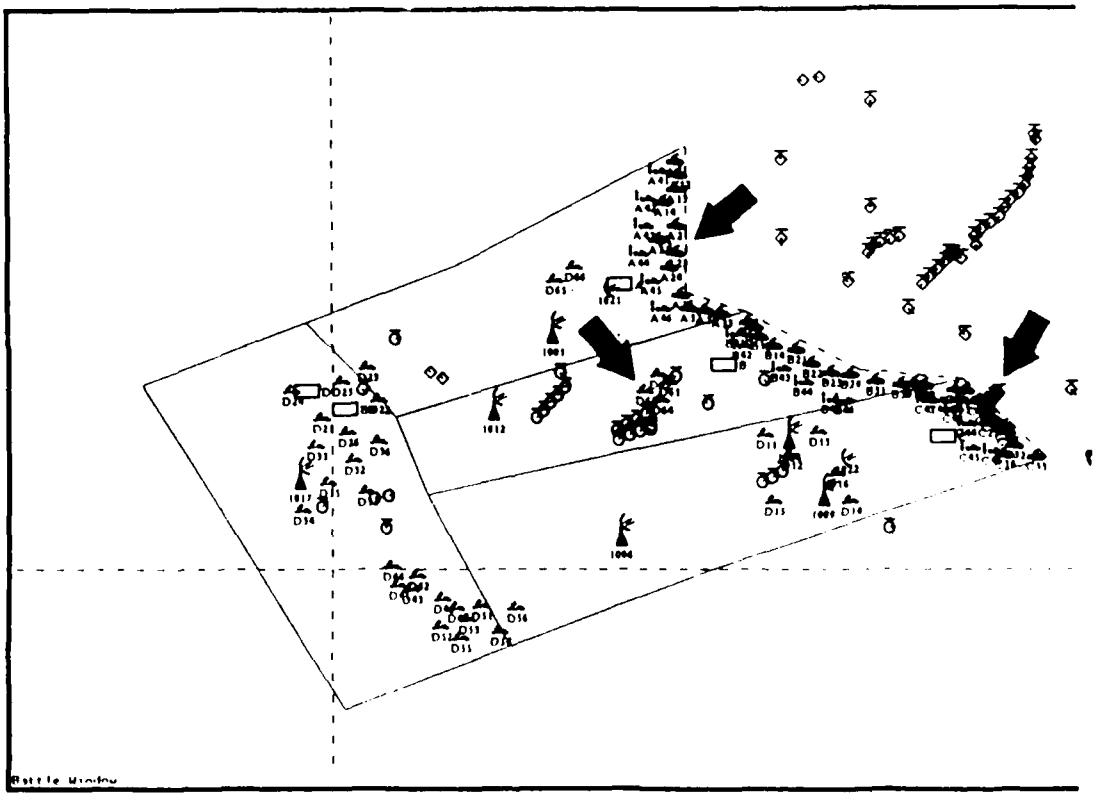

Figure 6. Version 2 symbology without aircraft designation.

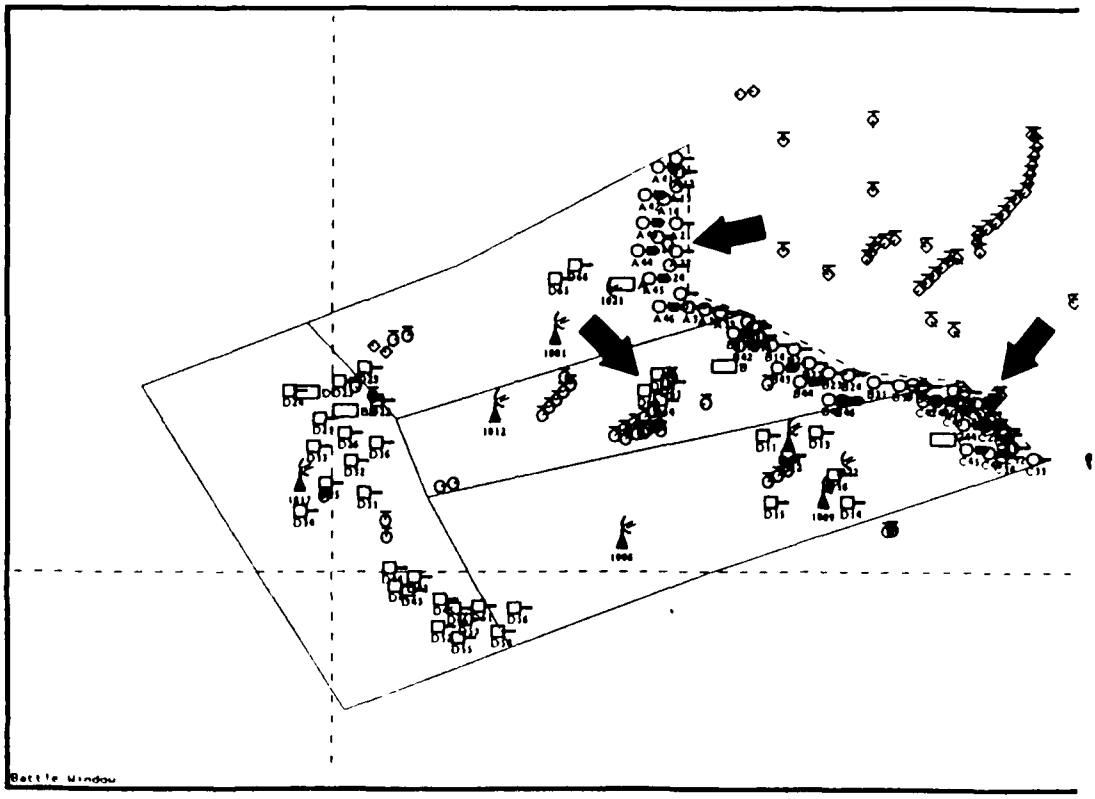

Figure 7. Version 3 symbology without aircraft designation.

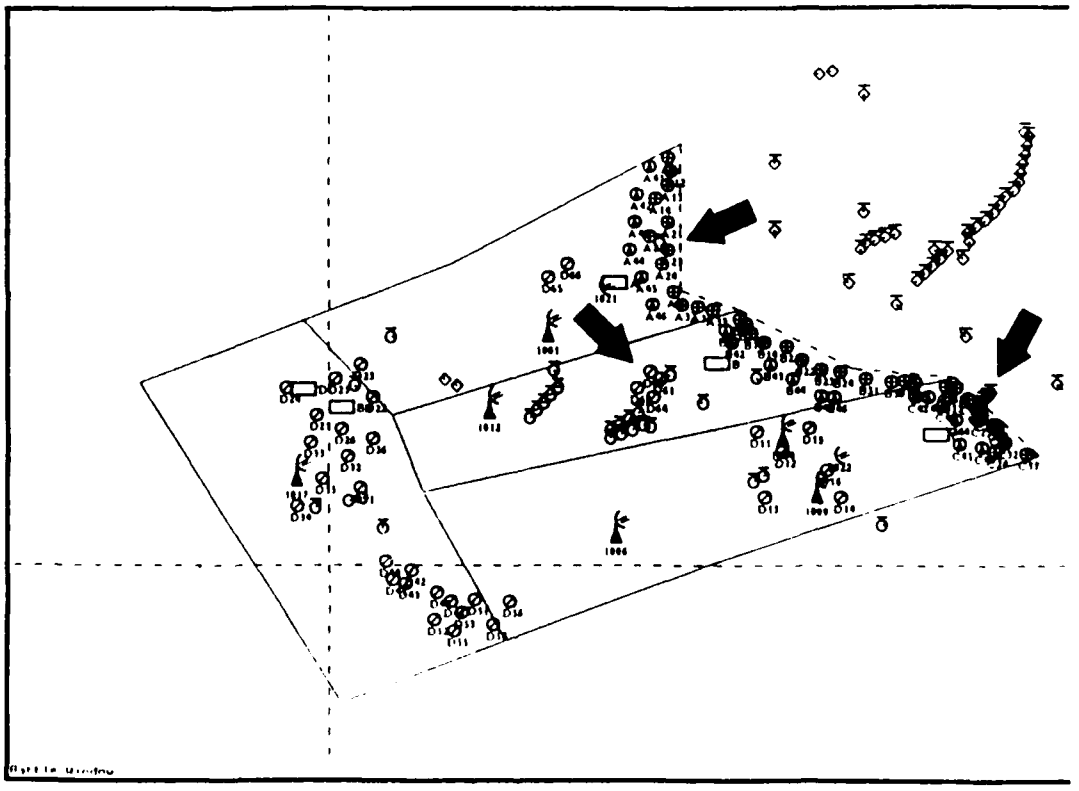

Figure 8. Version 4 symbology without aircraft designation.

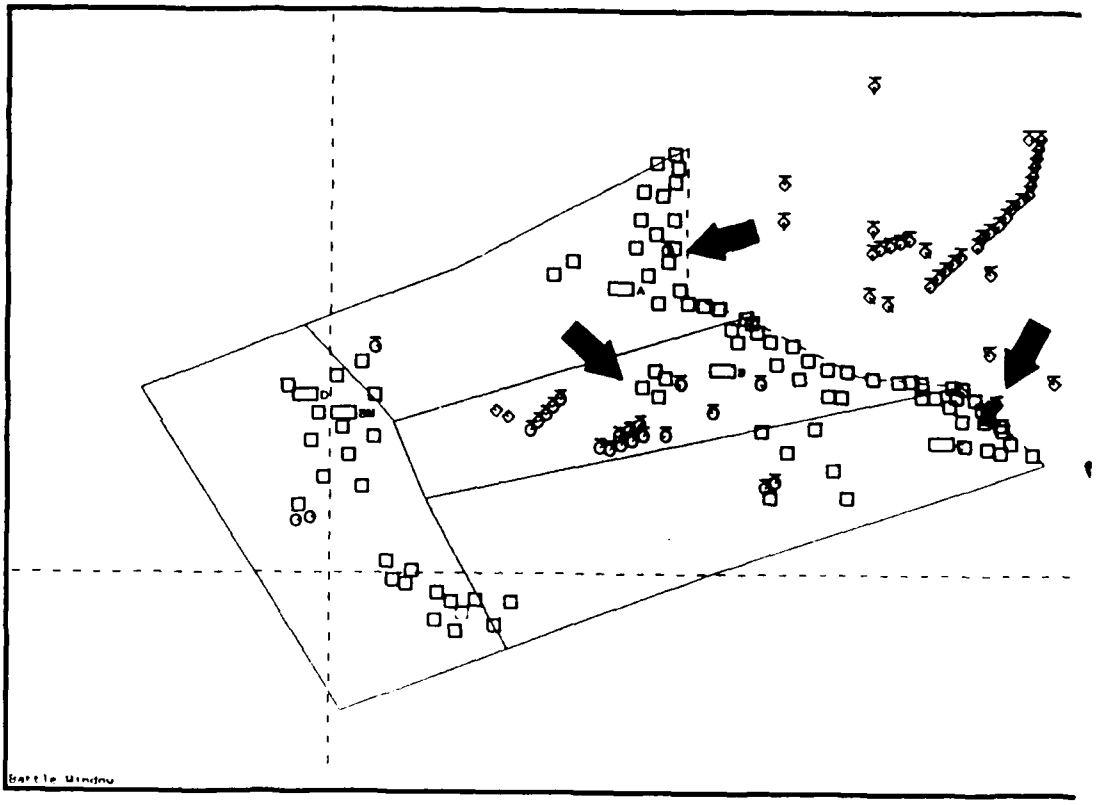

Figure 9. Baseline symbology without fire unit designation.

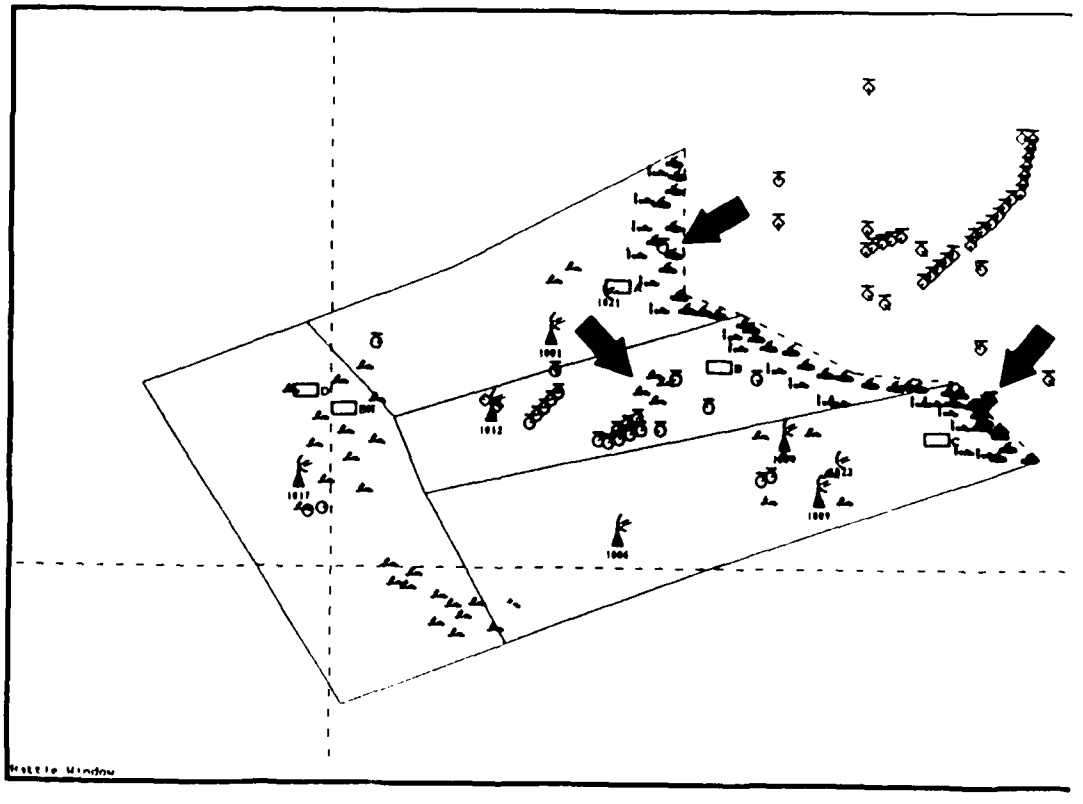

Figure 10. Version 2 symbology without fire unit designation.

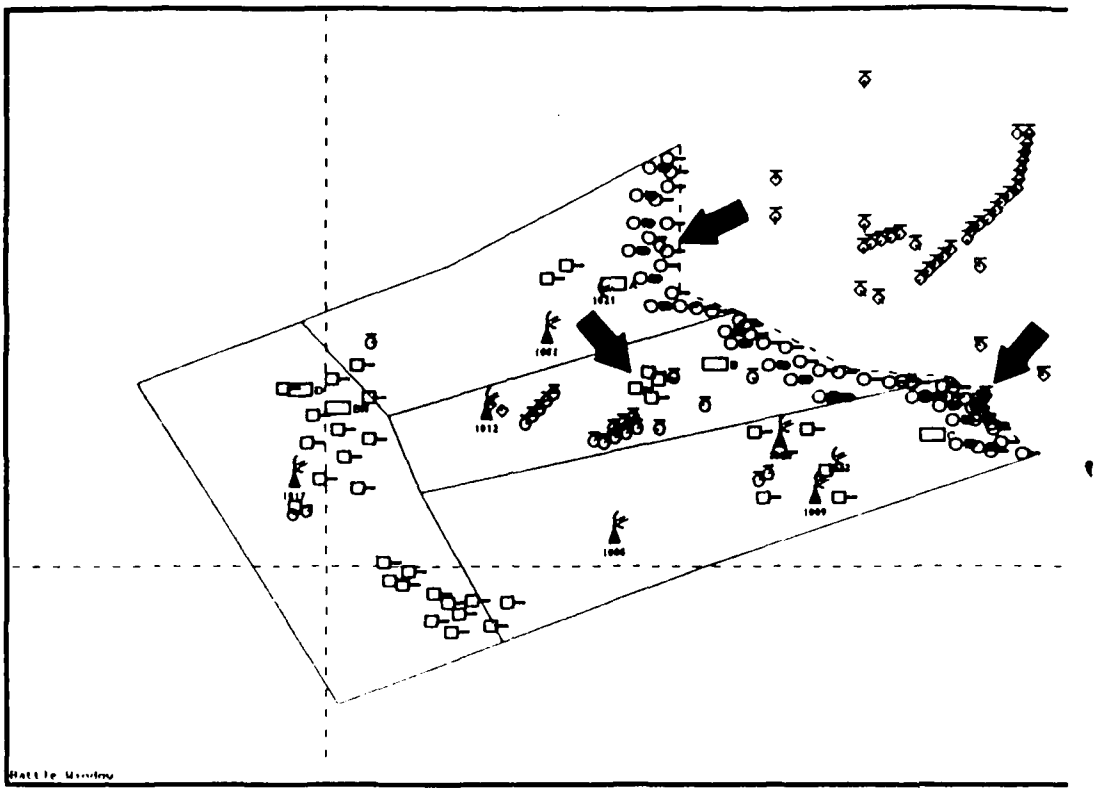

Figure 11. Version 3 symbology without fire unit designation.

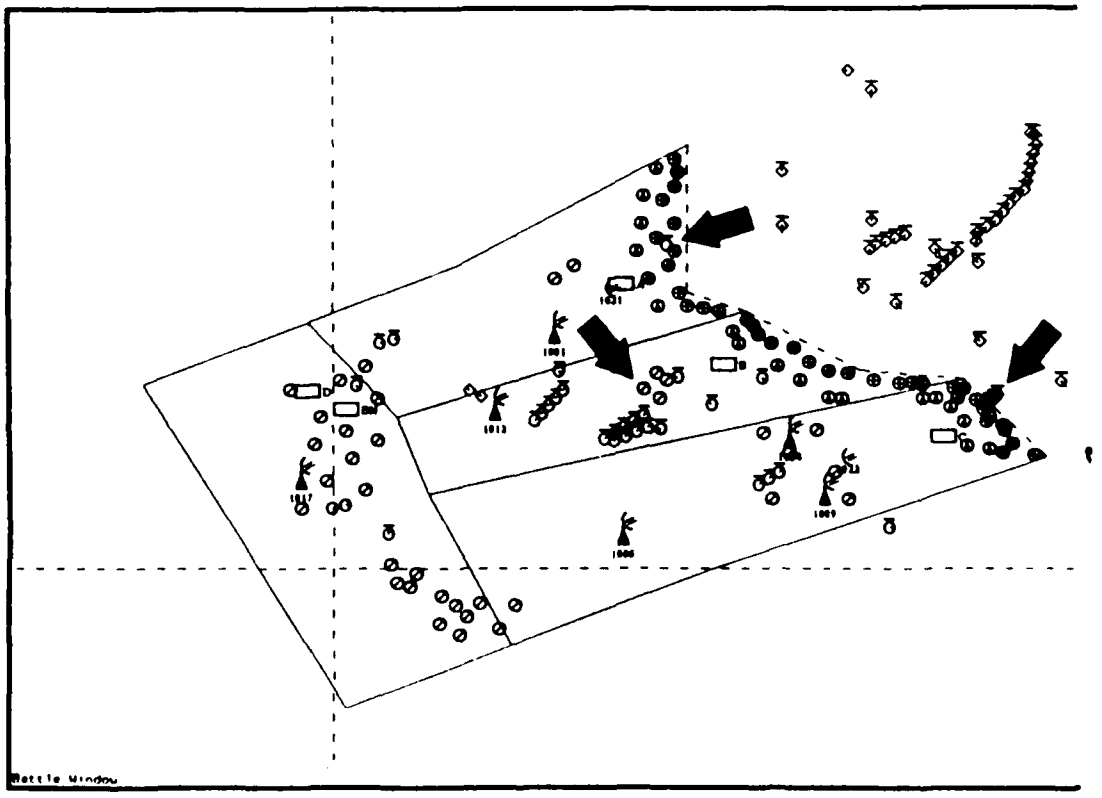

Figure 12. Version 4 symbology without fire unit designation.