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Computer-Controlled Videotape Display: An Innovation in Traffic Analysis

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Although videotape equipment has been available to traffic researchers and engineers for over a decade, its uses have been limited to routine applications. However, the recent development of microcomputers and interface equipment facilitate the use of videotape (and videodisc) in research applications. Current research under contract to the Iowa Department of Transportation is detailed where computer-videotape simulations of uncontrolled intersections elicit responses by a sample drawn from a public location. Data are presented to demonstrate (a) the efficacy of the videotape-computer research approach as well as (b) useful findings that suggest the presence of word-oriented versus symbol-oriented subgroups in the adult population, each having very different responses to various warning signs.

Television and videotape have been used as traffic engineering data-collection tools in a variety of ways within the past decade as portable camera-recorder systems became generally available (1-5). Some of these uses have included collecting data on the speed of vehicles; lane placement of vehicles; license-plate vehicle identification for monitoring vehicles through a portion of a system; accident surveillance on bridges, tunnels, and freeways; and emergency traffic operations coordination. Videotape is being commonly used in education and training activities. This use is not, however, as extensive as is commonly thought by persons outside of education. In this paper, we presume such use to be common knowledge. In a similar fashion, the general availability of small personal computers (32K-64K memory) for use in both traffic engineering and education activities is assumed to be common knowledge. What is new on the technological scene is an interface board to permit a microcomputer to control a new generation of video player-recorders. This combination provides a new analysis tool (6). This paper outlines how this new tool has been incorporated into an innovative analysis of rural road signing through some creative computer programming.

PROBLEMS IN SIGNING

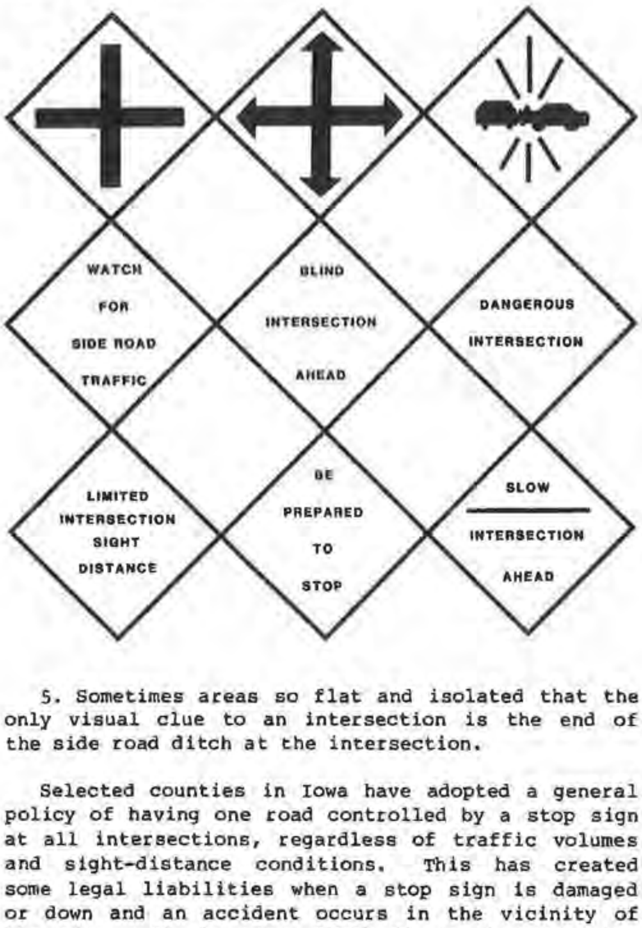
Several Iowa counties were frustrated in their attempts to communicate with people driving their extensive network of low-volume gravel rural roads. When these low-volume gravel roads intersect in the rolling Iowa terrain, a variety of factors interact to create seasonal (or sometimes continuously) hidden intersections. Some examples include the following:

1. Tall corn growing, planted to the very edge of the right-of-way (or perhaps in the right-of-way);
2. Trees at farmsteads in the corner quadrants of the intersecting roads;
3. Sharp curves within narrow cuts;
4. Densely wooded areas on curves; and

Table 1. General intersection site approach characteristics.

Site	Iowa County	Characteristic
1	Story	Cropland and pasture; intersection located at bottom of sharp sag vertical curve in all four directions
2	Boone	Cropland; intersection located at top of crest vertical curve in all four directions
3	Boone	Cropland and timber along stream; intersection is beyond short crest adjacent to a timber area
4	Boone	Timber, sharp curvature to road with steep grade; very hilly area along the Des Moines River; intersection is on curve in dense woods at end of sharp downgrade
5	Crawford	Grassland and cropland in sharp to rolling Missouri River region hills; intersection is at end of curving downgrade through cut in hill with crest location with respect to crossroad
6	Benton	Cropland in flat terrain; intersection is obscured by tall corn growing in fields adjacent to intersection approach

Figure 1. Array of signs in statistical design.



5. Sometimes areas so flat and isolated that the only visual clue to an intersection is the end of the side road ditch at the intersection.

Selected counties in Iowa have adopted a general policy of having one road controlled by a stop sign at all intersections, regardless of traffic volumes and sight-distance conditions. This has created some legal liabilities when a stop sign is damaged or down and an accident occurs in the vicinity of the sign. It is also difficult to justify stop signs that are not warranted by the Uniform Manual on Traffic Control Devices (MUTCD) (7) when litigation arises in court over accidents in the intersection.

One Iowa county has erected a warning sign with the legend Dangerous Intersection at a large number of low-volume rural roads in an attempt to communicate a need for increased attention to drivers who approach the intersection. Such a sign can very easily become a liability rather than an asset if a lawsuit erupts over an accident at an intersection that has this sign.

One county has experimented with using the standard crossroad sign (7, Section 2C-14) at low-volume rural road intersections for which drivers complain about near misses or potential collisions. Generally, these intersections do not warrant stop signs or are they amenable to expensive changes. Such use of the standard crossroad sign is also a potential liability problem since this sign is intended to be used on a through highway intersection approach, and it implies that drivers on one of the intersecting roadways will be required to stop.

In an effort to identify what the signing needs were at local uncontrolled road intersections and to establish some measure of what is effective sign communication, the Iowa Department of Transportation issued a contract to Iowa State University to investigate signing for these previously identified conditions. In order to develop a research design that would permit examination of these problem areas, videotape was combined with an interactive computer display to simulate approaching an intersection as a variety of signs are shown and respondent evaluation criteria are provided.

EXPERIMENTAL DESIGN FACTORS

A primary factor was the variation in terrain that produces regional variations in the topography that surrounds an obscured low-volume rural road intersection in Iowa. The original experimental design intent was to tape intersection approaches in the central part of Iowa (which tends to be flat to rolling cropland), in the northeastern part of Iowa (which tends to have sharp hills with dense woods), in the western part of the state (which has sharp hills with grasslands), and in the southeastern part of Iowa (characterized by short, sharp rises and falls in terrain in a strip-mining region). Careful selection of intersection approaches permitted use of four intersections within a 20-mile radius to represent four very different terrain conditions. Table 1 lists the general characteristics of each site.

A second factor involved our attempt to distinguish between the communication needs of the local driver (who would be familiar with the intersection) as opposed to the driver who might never have seen the intersection before. It was possible to simulate these two conditions by videotaping a fixed establishing shot of each intersection as well as a long-drive approach to the warning-sign location. The establishing shot provided the sample respondent with a close-up view of the intersection followed by a distant view of a vehicle traversing the intersection and turning. Thus, the respondent knew the intersection. The long-drive approach consisted of a 10- to 15-s tape segment filmed through the windshield and over the driver's right shoulder to show the view of the road that approaches the hidden intersection. When the warning-sign location is reached the camera pans across to the sign and zooms in to fill the field of view with a blank sign face. A respondent who represents the familiar driver sees both the establishing shot and the long-drive approach before responding to his or her first sign. A respondent who represents only unfamiliar drivers sees the long-drive approach only and begins sign responses.

Another control factor consisted of either the initial display of a symbol or word-legend sign. One-half of the sample is programmed to see a tape segment first ending with the crossroad sign and the other half first sees a Dangerous Intersection sign. The complete array of signs presented is shown in Figure 1. These two signs were selected for the initial variations of word versus symbol because they are currently being used to a limited degree to warn drivers who approach low-volume intersections that have potential traffic problems. The selection of the remaining signs was based on a pretest among a sample of engineers and social scientists that considered both a hypothetical and an actual variety of legends already in use.

After each sign is shown on the television screen the computer halts the tape player in the pause mode, returns control of the television screen to the computer, and presents a display on the screen that asks for an evaluation of the sign presented. The respondent is asked to evaluate the sign as

1. Very good,
2. Good,
3. Cannot decide or no opinion,
4. Bad, or
5. Very bad.

The computer then moves the tape back into the play mode in order to show a very short (3-5 s) portion of the driving approach to the hidden intersection followed by another sign. This process continues until each respondent has examined all nine signs for one intersection site.

After the respondent has completed the rating of each of the nine signs, the computer flashes a question that asks the person to select the best sign from among those shown, which are as follows:

1. Plus,
2. Arrows,
3. Crashing cars,
4. Watch for Side Road Traffic,
5. Blind Intersection Ahead,
6. Dangerous Intersection Ahead,
7. Limited Intersection Sight Distance,
8. Be Prepared to Stop, or
9. Slow - Intersection Ahead.

The computer informs the subject that an attendant has a set of signs should they wish to refresh their memory. After the respondent has selected the best sign, the computer asks each person to select the worst sign. These ratings permit weighting of the individual evaluation given each sign as it is presented.

At this point, the computer asks the person to decide whether, in their estimation, the intersection actually should have a sign to be safe. The possible responses offered are

1. Definitely needs a sign;
2. Probably needs a sign;
3. Don't know, no opinion, don't care;
4. Probably does not need a sign; and
5. Definitely does not need a sign.

Since one-half of the respondents see the establishing shot at the beginning and one-half at the end of each intersection site sequence, this question, which relates to the need for the sign, will permit weighting the sign responses according to perceived need. In a limited pretest exercise, one person responded that a particular sign was good and that it was the best of the nine signs but that in his opinion the intersection did not need a sign at all. Preference studies must have a mechanism by which preferences can be related to some normalizing scale to estimate salience of the performance.

STATISTICAL ASPECTS OF PRESENTATION

Twenty-four separate displays were created through the combination of computer control of the videotape player and videotape editing. Each site tape (there were six) was edited to have an establishing shot, then a long-drive approach to the intersection, then a symbol-sign presentation (crossroad sign), then a word-sign presentation (Dangerous Intersection sign). Then a fixed sequence of other signs is presented (each site has a different sequence of the same signs), then the crossroad sign, then the Dangerous Intersection sign, then the establishing shot. The computer is programmed to display to the sample respondents the following:

1. Respondent 1: Establishing shot, long drive up, crossroad sign, site 1 sequence for seven signs, Dangerous Intersection.
2. Respondents 2-6: Same as 1 except that each site (2-6) has a different sequence to the seven signs.
3. Respondents 7-12: Establishing shot, long drive up, Dangerous Intersection sign, site sequence for seven signs, crossroad sign.
4. Respondents 13-18: Long drive up, crossroad sign, site sequence for seven signs, Dangerous Intersection sign, establishing shot.
5. Respondents 19-24: Long drive up, Dangerous Intersection sign, site sequence for seven signs, Dangerous Intersection sign, establishing shot.

The pattern began again with respondent 25. This permitted control of a wide variety of factors.

The original research intent was to participate in a number of local county festivals and fairs across the State of Iowa. However, an opportunity was created for our participation in the Iowa Department of Transportation display at the 1981 Iowa State Fair in Des Moines. Respondents were obtained from adult drivers between the ages of 14 and 99 who visited the fair display.

A total sample of 405 persons was obtained. Seventy percent of the respondents were male, 24 percent were female, and six percent of the responses were made up of combined response from both a male and a female. The crossroad sign (symbol) was seen first on the tape display by 222 respondents while 183 saw the Dangerous Intersection (word) sign first. Each site represented from 15.8 to 17.5 percent of the responses. Sixty-six of the 99 Iowa counties were represented in the sample.

RESULTS

Table 2 illustrates that the sample respondents exhibited significant preferences for some signs over others. Since the crossroad sign and the Dangerous Intersection sign were given more positive ratings, the possibility existed that seeing a sign first or last implied to a respondent a researcher preference. When the mean scores for each sign were analyzed, controlling for whether a word or a symbol sign was seen first and whether or not the establishing shot was seen first, no statistically significant differences were to be found among the mean rating scores.

Table 3 contains the results of the forced choice as to the best and the worst sign for the intersection as seen on tape. The grouping of the data around conflicting preferences leads to the hypothesis that the respondent sample contained both word and symbol persons. A pattern of choice responses was created by using best-on-symbol/worst-on-word ratings (and vice versa) with corresponding highly favorable rating of the crossroad sign (and inversely a highly unfavorable rating of the Dangerous Intersection sign) to select consistent preference persons. The selection process resulted in 40 word persons and 49 symbol persons being identified.

Table 2. Mean ratings for signs by site used.

Site	No. of Respondents	Sign Shown: Crossroad		Watch for Side Road Traffic		Blind Intersection Ahead[a]		Limited Intersection Sight Distance[b]		Be Prepared to Stop[c]		Slow Intersection Ahead[d]		Arrows[e]		Crashing Cars[f]		Dangerous Intersection[g]	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	73	2.23	1	2.95	6	2.38	2	3.37	8	2.86	5	2.41	3	3.17	7	3.87	9	2.54	4
2	67	2.26	1.5	3.37	8	2.50	4	3.40	8	2.62	5	2.37	3	3.11	7	2.26	1.5	2.79	6
3	71	2.60	2	3.01	7	2.63	3.5	2.90	5	3.59	9	2.63	3.5	2.94	6	3.40	8	2.12	1
4	64	2.46	3	3.37	8	2.82	5	2.37	1	3.56	9	2.95	6	2.57	4	3.32	7	2.40	2
5	66	2.19	1	3.00	6	2.36	3	3.72	9	2.95	5	2.31	2	3.37	8	3.01	7	2.57	4
6	64	2.20	1	3.18	6.5	3.46	8	2.53	4	2.81	5	3.67	9	2.23	2	3.18	6.5	2.29	3
Rank			1		9		3		5.5		7		4		5.5		8		2

Note: For mean ratings, 5 = most disliked, 1 = most liked.

[a]Statistical significance: $F = 7.53 < 0.001$. [b]$F = 17.47 < 0.001$. [c]$F = 6.78 < 0.001$. [d]$F = 14.48 < 0.001$. [e]$F = 7.45 < 0.001$. [f]$F = 12.78 < 0.001$. [g]$F = 3.07 < 0.001$.

Table 3. Respondent rating of best and worst signs.

Sign	Rating (%): Best	Worst
Crossroad (symbol)	26.4	6.2
Arrows (symbol)	10.9	11.4
Crashing cars (symbol)	8.4	34.3
Watch for Side Road Traffic	3.0	2.5
Blind Intersection	17.0	1.2
Dangerous Intersection	19.3	1.0
Limited Intersection Sight Distance	1.2	36.5
Be Prepared to Stop	7.7	4.0
Slow – Intersection Ahead	6.2	3.0

Given that both groups represent about 10 percent of the sample, it was hypothesized that they represent the tails of a normal distribution of communication modal preference. Traffic engineers now have available a method to determine the degree of communication between driver and signs without actually endangering lives or generating legal hazards through field testing.

CONCLUSIONS

The research reported in this paper demonstrates that this method is effective in providing driver evaluation of proposed traffic-control changes. Since the concept has been under development for over five years, it is gratifying to conclude that the method does indeed work.

Data analysis results of this research indicate the presence of word-oriented and symbol-oriented persons among the driving population. It is concluded that further analysis of this behavioral and perceptual character of drivers will be a future critical issue in making standard traffic signing and signal displays more effective.

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