# Evaluation of SIVAS: A System for Simulating Graphic Driving Situations in the Context of Teaching Road Safety

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## Characteristics and objectives of the system

Traffic accidents are among the main problems affecting the most advanced societies and whose economic and human consequences are enormous. One way to reduce this problem is by carrying out an optimal education program for future drivers in order to equate them with the risks that are involved while driving a vehicle. In Spain a network of private driving schools exists to accomplish this purpose. Driver education deals with two aspects of driving: Theoretical, which includes knowledge of the legal code, signs, manoeuvres, etc. and practical, that deals with driving a car in real situations. In order to obtain a driver's licence, applicants must pass two exams, each of them dealing with one of these aspects.

Teaching of the theoretical component possesses a specific problem. Since many of the contents which must be explained are based on relatively sophisticated graphics representations, the teachers need to find methods that enable the students to visualise these situations. Instructional tools exist which fulfil this objective, such as transparencies, blackboard, video, photographs, models, and of course, gestures and good intentions. All of these methods offer advantages and disadvantages, but instructors are of the opinion that none of them sufficiently accomplish what is needed in the learning situation.

Our research group has designed [Bayarri et al. 1996a] tools to allow the simulation of driving situations. The use of this tool in a teaching environment was considered possible and probably beneficial.

Before designing this tool a study was carried out in order to determine precisely what were the weaknesses of the traditional instructional tools. This study consisted of the driving instructors filming their sessions of instruction. These films were subsequently analysed using tools for observational data analysis [Sanderson & Fisher 1994]. By way of example we will comment on some of the inconveniences that were found using a video to present traffic situations: (1) it presents a sequence of contents which is found to be too rigid when planning and developing the classroom sessions, (2) it is difficult to attend to individual differences

among students -previous knowledge, attitudes toward traffic and interests-, (3) it offers little flexibility for moving through the tape in order to show the critical moments in each situation, (4) it presents only one perspective and does not allow modifications in order to view the situation from other vehicles that are involved, (5) it does not provide more than one viewpoint at a time (e.g. the view is either from inside the vehicle or a general aerial view).
The system which is presented in this paper attempts to improve upon these limitations, and is directed toward (1) the creation, editing and presentation of complex traffic situations that are of didactic interest for teaching the concepts, rules and behaviours which are relevant in road safety education (schools) and driving (driving schools), (2) to be incorporated into the curriculum and to be used in the daily teaching sessions [Chipman 1993] and (3) designed in order to facilitate the selection, organisation and development of the classroom sessions in an interactive manner.
The SIVAS system requires a compatible personal computer with a Pentium or later processor. 32 Mbytes of memory are suggested. Presently SIVAS works with WindowsNT 3.51, but it has also been shown to run with Windows95 and WindowsNT 4.0. These operative systems include the OpenGL 3D graphics library, so only the graphics card drivers have to be added.


**Figure 1-** Example of the view that appears at the start of an instructional situation

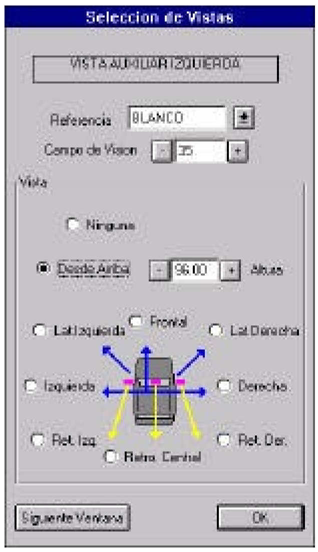


**Figure 2.-** The window for configuring perspectives

The system consists of three modules that allow it to be operated by different types of users in different stages [Bayarri et al 1996 1997]: (a) A program to model geometric-topological scenes, which offers editing functions for modifying the geometry and visual aspects of the road and surroundings to be incorporated in the situation to be used; (b) a program to design the didactic situations based on the scenes created by the previous program, permits the selection of the vehicles involved in the situation as well as the parameters that describe their movement and (c) a program for planning and presenting the lessons to be used by the instructor which will be described in more detail in the following section. By using this third module, and the instructional situations based on real time 3D animation, which are included in its data base, the instructor can select the situations to be used in each session, their order of presentation and their configuration relying on those that are offered by default in the program. During the classroom session, the instructor can modify the way these didactic situations unfold, the configuration of the points of view which are presented or quickly jump to the key moments in the scene.

**The lesson presentation program.**

By making a double click on the lesson's first situation the instructor brings up the visual scene (fig. 1). The initial scene is previously defined by default but can also be modified by the teacher. The controls that are used are similar to those of a video player and the scroll bar allows the teacher to move quickly through the sequence. There are also controls which allow the situations to be viewed from different vehicles and perspectives (frontal, lateral, aerial) and/or with auxiliary windows that provide additional perspectives simultaneously (fig. 1 presents the general aerial view and an auxiliary frontal window in a passing situation). Figure 2 shows the window used to configure the views in the visualisation windows.

**Evaluation of the system**

No instructional tool can aspire to completely take the place of those already in existence. A much more reasonable goal is to change the way that teaching is actually done in an appropriate direction. In our case, the intended change was to increase the use of visual explanations in the classroom. We think this change is positive as it improves the quality of the explanations of teachers. We also think that SIVAS will be able to produce this change because it is more teacher friendly that previous technologies or devices used for that purpose. We need to mention that the evaluation we carried out is basically exploratory, as at this stage we were more interested on improvement of SIVAS than in providing definitive proofs of its benefits. We think that it is probably too soon to attempt such enterprise without having a more definitive product. However, we expected that this evaluation will provide us with a deeper insight of the device we had developed.

## Method

This evaluation was carried out by videotaping a group of 6 instructors using SIVAS. This group was different from the one of 5 teachers not using SIVAS considered previously. Then, tapes for both sets of instructors were analyzed. The analysis consisted mainly in calculating the time that teachers used visual explanations versus verbal explanations, such as showing an overhead to help their lessons. Other aspects of their teaching were also recorded as described below. This analysis is very time consuming. About a month was devoted by a person to analyze the tapes from the dozen of teachers involved in the evaluation. This analysis was accomplished using MacShapa, a software tool for video analysis described in Sanderson (1994). This software tool allows to mark the onset and offset of different behaviors in videotapes. Then, it provides summaries of the different categories recorded as well as other more sophisticated analysis.

The features we recorded in the tapes were the following:

- Time with no tool: Teachers just explain the things using words or gestures.
- Time with a Graphical Static aid: This corresponds to time that teachers used in explanations using a photograph or the blackboard in the condition without SIVAS. In the condition with SIVAS this refers to time with a static view of an scenario.
- Time with a Graphical Dynamic aid: In this case, the explanation uses a graphical aid that represents a dynamic scenario, such as a sequence of drawings in the blackboard, a videotape or using the Play button in SIVAS.
- Time Wasted: Time without any productive explanation. This includes time devoted to manipulate the videos, or SIVAS or whatever. More time wasted means a worse product.
- Contents: A list of contents in the lesson for overtaking was identified. The time devoted to the contents mentioned by each teacher was examined in the tapes. However, because the lack of agreement between teachers on this matter, we decided just to count the number of different contents taught by each teacher. This is important because teachers normally explain many contents in each lesson, as the exam in Spain requires a very detailed knowledge of traffic regulations. We wanted to know whether the number of contents changed when using SIVAS with respect to not using it.

## Results

Tables 1 and 2 show the time devoted to each of the categories previously described for teachers in the conditions Without and With SIVAS. Visual inspection of these tables gives an impression of the consequences of using SIVAS for driving lessons.

It is quite remarkable that almost no time was wasted in the condition without SIVAS (only about a 6% of the time was devoted to manipulating the tapes, overheads or the other instructional tools they used). On the other hand, approximately the same amount of time was devoted to explain contents without using a tool than to static or dynamical graphical explanations. The mean number of contents in the list we developed was ____. This figure illustrates quite dramatically the high density of contents that teachers in Spanish driving schools attain in order to prepare students for the theoretical exam. On the other hand, considerable individual differences can be noticed in this table. Therefore, aggregated summaries should be interpreted cautiously.

| No Tool | Static | Dynamic | Wasted Time | Contents |
|---|---|---|---|---|
| 00:08:00 | 00:07:21 | 00:26:54 | 00:02:58 | 95 |
| 00:06:32 | 00:25:07 | 00:06:36 | 00:06:51 | 74 |
| 00:43:28 | 00:22:51 | 00:12:39 | 00:00:00 | 114 |
| 00:01:32 | 00:30:29 | 00:25:38 | 00:04:43 | 106 |
| 00:31:45 | 00:03:35 | 00:00:00 | 00:00:00 | 74 |
| 01:31:17 | 01:29:23 | 01:11:47 | 00:14:33 | Mean:95 |
| 35% | 32% | 27% | 6% | |

Table 1: Times devoted to different aspects for teachers not using SIVAS

Teachers spent almost half of the time doing visual static explanations in the condition with SIVAS. The time without tool was very reduced but the wasted time increased with respect to the condition with SIVAS. Again, several individual differences can be identified. This consideration and the need to make comparisons between subjects in different conditions led us to use a biplot based on principal components analysis to visualize more clearly the information in the two tables (Gabriel 1986). This biplot can be seen in figure 3. Only the first two principal components are shown, which explain about a 60% of the total variance. This was regarded as satisfactory for exploratory purposes.

A biplot can be interpreted attending to three aspects. First, relation among variables can be interpreted by looking to the length and direction of the lines associated with them. Short angles represent high correlation. In this case, Wasted time seems to correlate with teaching based on Static representations. Time Without tool is related to a higher number of Contents.

Angles approximately straight mean absence of correlation. This is the case of Wasted Time and -Dynamic representations. Finally, angles wider than straight indicates negative correlation. Therefore, figure 1 shows that the number of contents and the time without tool correlate negatively with the other three variables.

| No Tool | Static | Dynamic | Wasted Time | Contents |
|---|---|---|---|---|
| 00:00:00 | 00:39:17 | 00:04:20 | 00:22:00 | 22 |
| 00:00:00 | 00:19:30 | 00:06:57 | 00:09:03 | 39 |
| 00:00:00 | 00:17:48 | 00:07:35 | 00:20:00 | 17 |
| 00:02:39 | 00:26:34 | 00:10:49 | 00:14:38 | 26 |
| 00:07:21 | 00:29:29 | 00:05:09 | 00:10:00 | 38 |
| 00:00:00 | 00:25:24 | 00:05:29 | 00:07:20 | 32 |
| 00:10:00 | 02:38:02 | 00:40:19 | 01:23:01 | Mean:29 |
| 3% | 54% | 14% | 28% | |

Table 2: Times devoted to different aspects for teachers not using SIVAS

Second, individual points can be interpreted. Figure 1 shows that individuals using SIVAS (marked with a dot) clustered quite uniformly on a side of the plot. On the other hand, individuals without SIVAS (marked with a star) are spread along the plot. This means that individuals without SIVAS behave in quite different ways. Individuals with SIVAS had a much more homogeneous behaviour by comparison.

Third, points and lines (individuals and variables) can be interpreted simultaneously. Individuals with SIVAS had a bigger tendency to use more visual and dynamic explanations. However, they wasted more time dealing with the device. Also, fewer contents were explained by teachers using SIVAS. Individuals non using SIVAS but using graphical aids had the same behaviour. This indicates that the problem is not only a property of SIVAS but of any teacher trying to use this kind of material in the class-room. On the other hand, users not using any graphical aid managed to explain more contents and, of course, wasted less time dealing with videos or computers.

## Conclusions

As stated previously, no educational tool can aspire to fully substitute previous existing tools. A much more reasonable goal is to produce a new tool that can offer a richer educational environment. Very often, this new tool will bring both advantages and disadvantages. Therefore, only an adequate balance between them will yield a useful product.

SIVAS has shown that can be a useful tool when graphical aids are used in the classroom but the number of contents is not the most important issue. So, we think that if the teachers want to debrief scenarios of driving in the classroom, SIVAS can be very useful for them. Some more research comparing the advantages of SIVAS versus videos or overheads might be done, but comments from teachers suggest that our system has clear advantages. However, as the evaluation system in Spain at this moment is highly content-based teachers may find SIVAS too slow for that purpose and consequently not to use it. This extreme is still pending of further evaluations to be done in the future.

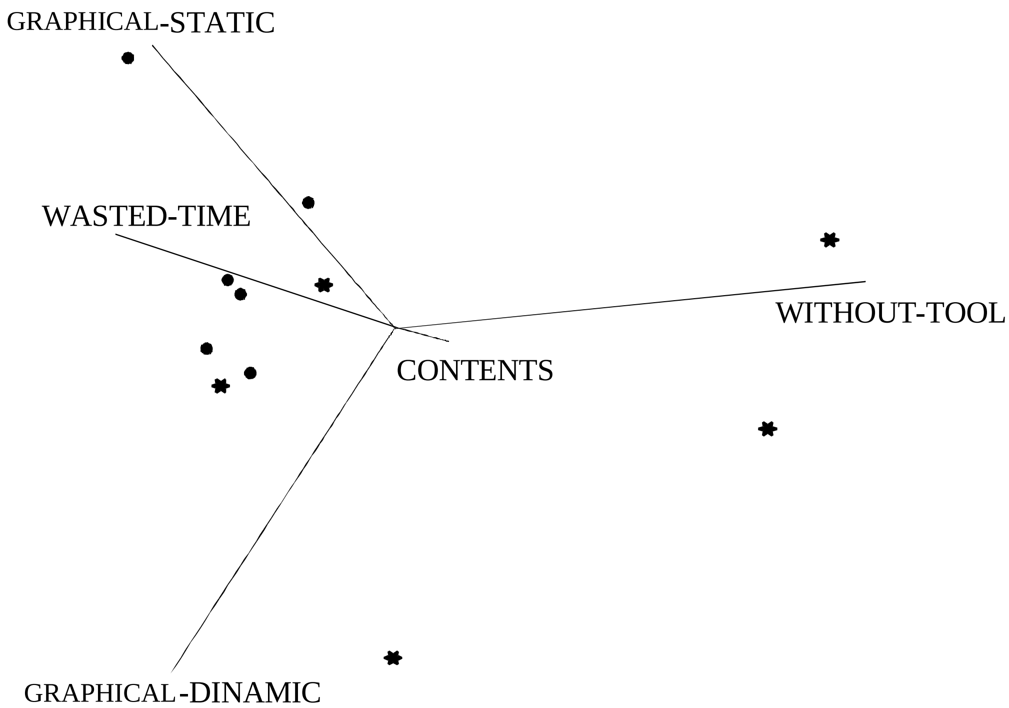


**Figure 3:** Biplot of times devoted to different types of teaching. Black dots represent individuals that used SIVAS. Stars represent individuals that did not.

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