# Using SAS® to Catch White Collar Criminals: A Collusion Detection System

Susan Schwartz, Info Tech, Inc., Gainesville, FL
Randy Lawton, Info Tech, Inc., Gainesville, FL

## ABSTRACT

Info Tech developed SENTRY™, a Collusion Detection System, to help investigators determine the likelihood of collusive bidrigging behavior in the sealed bid marketplace. The sealed bids are used by public agencies to purchase many commodities or services.

SENTRY is a PC application. Analysis takes place on the desktop, with minimal or no outside assistance from expert consultants, at least during the preliminary phase of an investigation.

SENTRY was developed entirely in SAS and is available in Microsoft® Windows NT™ and Windows® 95 versions.

## INTRODUCTION

Info Tech has been in the business of developing "high tech" collusion detection tools since its very inception when its founders, Drs. Jim McClave and Tom Rothrock, assisted the Florida Attorney General's office in an investigation of highway construction bidrigging in the early 1980s. The computerized tools they developed helped to identify the markets and the contractors involved in collusive activities, and ultimately the Florida Attorney General recovered $29 million from the contractors. This marked the first case in which computerized tools were used to detect collusive behavior in a market where no direct evidence of antitrust violations existed prior to computerized econometric analysis.

Info Tech assisted a number of other state attorneys general in highway investigations, including the City of Atlanta's Hartsfield Airport runway and tarmac paving case. The total recoveries to date exceed $300 million.

## HIGHWAY SYSTEMS

Because of these successes, Info Tech developed generic software to enable state highway departments to monitor the bidding behavior of their contractors. This software was named BAMS™ (Bid Analysis and Monitoring System) and its license was purchased by the American Association of State Highway and Transportation Officials (AASHTO) in 1985 for use by its member state highway departments. The collusion detection component of BAMS is known as BAMS/DSS™ and is currently licensed by 31 states.

BAMS/DSS was written entirely in SAS and is available on IBM/MVS®, VAX or AXP/VMS®, and Client/Server (Solaris™/Windows) platforms. A Windows NT Workstation version was released in August, 1996.

While BAMS/DSS has proven to be a highly effective tool in detecting collusive behavior, it was built for mainframe computers and was designed specifically for highway construction projects. It was not designed for use in investigating bidrigging in other contracting processes.

## THE SENTRY SYSTEM

Info Tech saw the need for a system that could capture and analyze data for any commodity or service. SENTRY was developed to address this need.

The PC desktop had become the environment of choice in the 15 years since BAMS/DSS had been developed, and needed to be the environment for SENTRY for it to be well received. Info Tech also determined that its user market had other critical requirements for SENTRY, and that these requirements were:

- **DATABASE**: The database had to be able to handle any commodity or service in the bid market.

- **USER EXPERIENCE**: SENTRY needed to be easy enough for the computer novice to use effectively, and still be sophisticated enough for someone experienced in antitrust investigations.

- **SECURITY and CONFIDENTIALITY**: SENTRY needed to run on an investigator's desktop PC, with minimal or no support from computer personnel or outside assistance from expert consultants.

- **IMPORT / EXPORT**: SENTRY needed to be able to import data created in standard PC formats, such as spreadsheets, and also be able to generate files that could be imported into other PC applications.

- **STANDARD ANALYSIS**: SENTRY needed to offer a standard set of bid collusion investigative tools. This set makes extensive use of statistical algorithms and iterative computations.

- **"WHAT IF" ANALYSIS**: SENTRY needed to offer the ability to collapse and expand data ranges as well as to zoom to specific areas of graphical displays.

- **BUSINESS NEED**: SENTRY had to offer the basic framework needed to support a dynamic set of bid collusion tools.

## THE SOFTWARE CHOICE

SAS for the Desktop offered the best toolkit for SENTRY's development and ongoing support, as well as the best desktop for investigators to use SENTRY.

## THE SENTRY DESIGN

Info Tech did not want SENTRY to be a traditional system in which there was a menu of reports and graphs, with little interaction between the investigator and the desktop. In that type of system, an investigator would be presented with a choice of analyses, would choose *Market Shares* Analysis, and would submit the job for batch processing.

This was the approach used when BAMS/DSS was developed. Although it was appropriate at the time, mainly because of the toolset available, the toolset had matured and we wanted SENTRY to be a more dynamic system in which the user retained more control.

Specifically, we wanted the investigator to be able to specify *what* data were to be included and *how* they were to be displayed on the desktop. We also wanted all of the investigator's interaction with SENTRY to be interactive.

SENTRY provides the tools to allow an investigator to build a custom analysis such as the one shown in Figure 1:
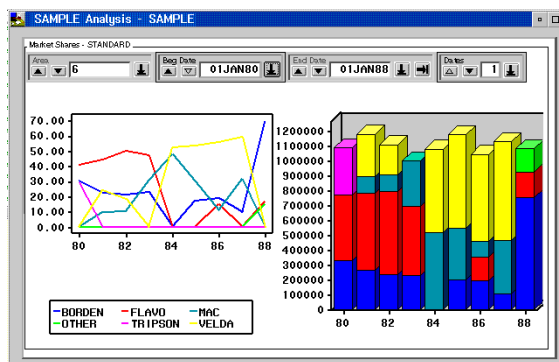


**Figure 1**

SAS/AF® FRAME was the tool we chose to build the interactive part of SENTRY. Not only did it allow us to offer the investigator a dynamic and adaptive environment, it also offered all the advantages of Object-Oriented Programming.

Perhaps the most important of these advantages, at least as far as SENTRY was concerned, was support of a graphical desktop. Because much of collusion detection is done visually, it is imperative that investigators be able to look at data visually, as well as mathematically.

Object-Oriented Programming has several advantages in addition to its support of the graphical desktop. Among them are:

- Easy manipulation of objects allows rapid prototyping of systems.

- Functionality is built into icon classes and does not have to developed from scratch.

- Program modules are re-usable and accessible by multiple FRAME entries.

- Standard attributes can be assigned to a class, and the class then assigned to multiple objects.

SAS/AF FRAME has several desktop features, in addition to support of Object-Oriented Programming, that were incorporated into SENTRY. These features are the Work Area and its widgets, Inter-Widget Communications, the Toolbar, and the Drag and Drop facility.

## WORK AREA AND WIDGETS

All interaction with SENTRY takes place in Work Areas:

- **Work Areas** are scrollable frames used to display one or more widgets.

- **Widgets** are any component of the graphical desktop that displays information or accepts user input.

- **Pop-Up Menus** display the choice of available widgets. The pop-up menu is activated with the right mouse key.

The first thing an investigator does when building a custom analysis is to place a Work Area on the desktop. Just as in the example shown in Figure 1, the investigator is doing a *Market Shares* analysis, and starts by placing a Work Area for the analysis on the desktop (Figure 2).
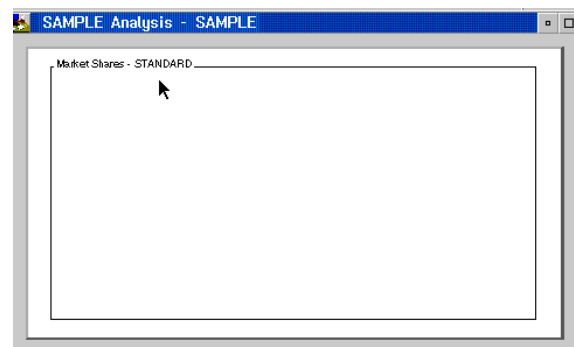


**Figure 2**

Pressing the right mouse key displays a pop-up menu that has choices relating to graphics, data filtering, data tables, etc. These choices are specific to the analysis type. Figure 3 shows the choices defined to Market Shares.
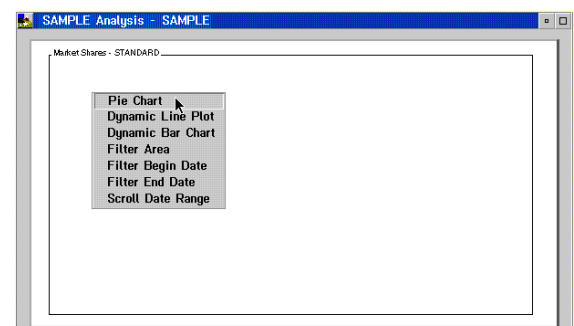


**Figure 3**

Choosing an object from the pop-up menu places a widget for that object on the Work Area.  Figure 4 shows the result of choosing the option *Pie Chart*.
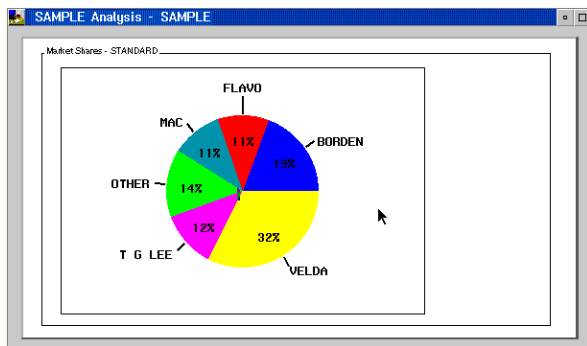


**Figure 4**

The investigator is free to tailor the Pie Chart object to meet his/her requirements and tastes by pressing the right mouse key (Figure 5).
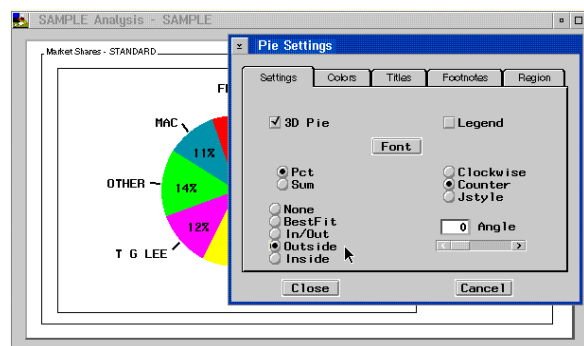


**Figure 5**

The Pie Chart is changed from a 2-dimensional figure to a 3-dimensional figure, and the share percentages are displayed outside the pie chart instead of inside (Figure 6).
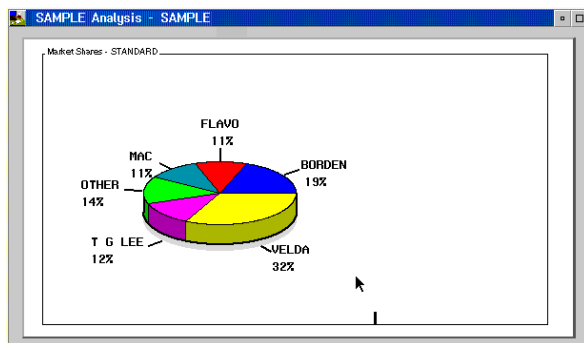


**Figure 6**

This is a simple example of how the investigator is able to control *how* data are displayed in SENTRY.  Providing the ability to control *what* data are included is handled by SENTRY's use of inter-widget communications.

## INTER—WIDGET COMMUNICATIONS

SAS/AF has two methods to handle communications between widgets: the broadcast-and-receive method and the event-handling method.  SENTRY uses both.

The broadcast-and-receive method:

- enables one sender to broadcast a message to multiples receivers with just one call

- enables receivers to filter (or ignore) broadcast messages

- is useful in cases where two widgets are closely coupled and need to work cooperatively

- takes place between two widgets

The event-handling method:

- uses a distinct object ("the event handler") for communications

- maps each event handler to its own set of receivers

- allows the sender to deliver a message to the event handler, and the event handler takes care of delivering the message to its receivers

- is useful in cases where widgets are loosely coupled

- takes place outside the widgets

One of the more common ways to subset data in bidrigging analyses is to "filter" the data.  Looking at only one area of a market is an example of filtering the data.

Consider again the graph displayed in Figure 6 and suppose the investigator wanted to include only those data in Market Area 6.  Pressing the right mouse key displays a pop-up menu (Figure 7).
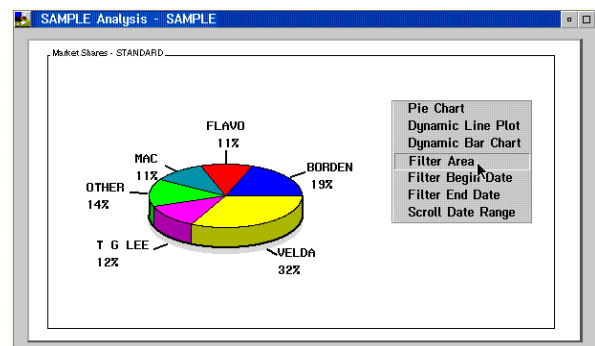


**Figure 7**

Selecting *Filter Area* places a filtering widget on the Work Area.  Note that the initial value is OVERALL.  The investigator selects Market Area 6 (Figure 8).
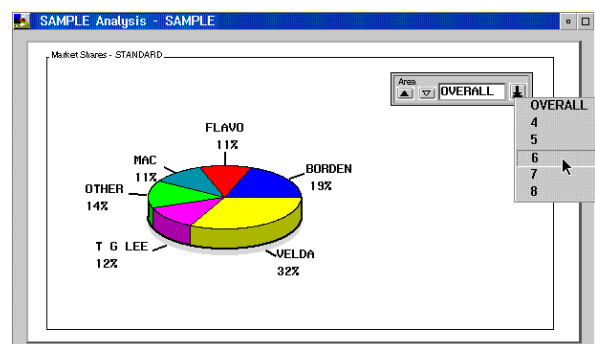


**Figure 8**

3

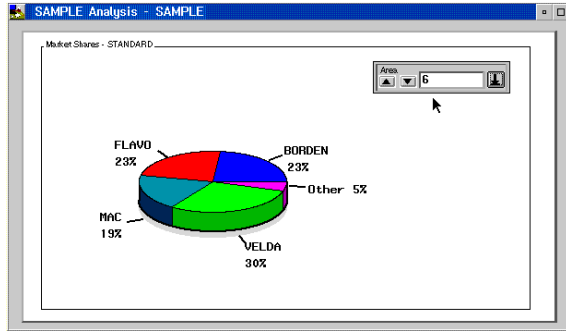The graph automatically refreshes itself (Figure 9).



**Figure 9**

Thus the widget for the Market Area filter has "communicated" with the widget for the pie chart, telling it to redraw itself to reflect only the data in Market Area 6.

## COMPOSITE WIDGETS

The Filter Area object is an example of a composite widget; i.e. a widget made up of two or more widgets (Figure 10).



**Figure 10**

This composite widget is actually five discrete widgets joined into one (Figure 11):
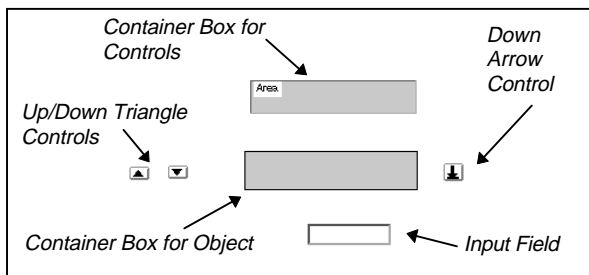


**Figure 11**

The composite widget is more than just a graphic. Like other (pre-defined) widgets, it needs an attribute to tell it how to behave and methods to tell it what to do. Unlike pre-defined widgets, however, both must be explicitly assigned.

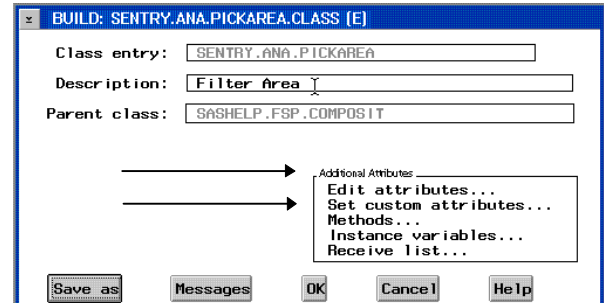Both attributes and methods are accessed from the class build menu (Figure 12).



**Figure 12**

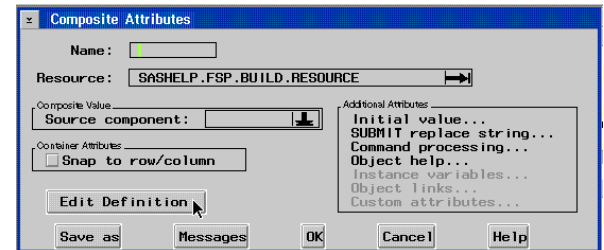Selecting Edit Attributes displays the screen in Figure 13.



**Figure 13**

Selecting Methods displays the screen in Figure 14.

Methods can be defined in one of three ways: by using an existing method, by enhancing an existing method with SCL code, or via user-written code stored in an SCL library.

AREA_GET_TEXT is an example of the first. It uses the method, GET_TEXT, to instruct the input field to get a value for the variable AREA.
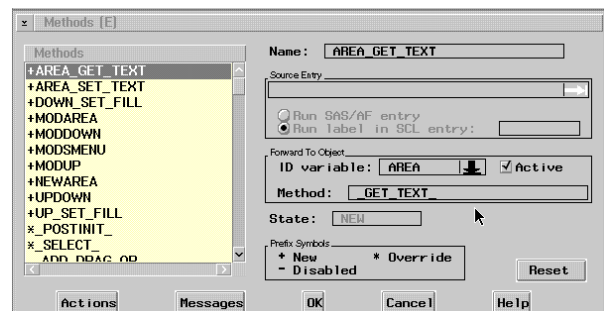


**Figure 14**

4

NEWAREA (Figure 15) is an example of using SCL code to define a new method. This approach is necessary when no existing method provides needed functionality.
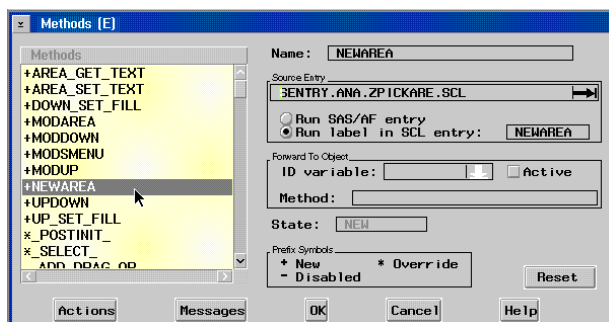

**Figure 15**

NEWAREA also sets up the event handler, builds a validation list for values of AREA, and initializes each of the widgets that make up the composite widget.

## TOOLBAR

The Toolbar in SAS/AF is the same as it is in every Windows application. SENTRY's toolbar contains entries for SENTRY's most common functions (Help, System SetUp, Print, Undo, etc.) The investigator can customize the Toolbar.

## DRAG AND DROP

Objects can be defined as "drag sites" and "drop sites." Consider a SENTRY generated graph that is defined as a "drag site." An investigator can e-mail the graph by dragging it to an e-mail "drop site," or save it for later retrieval by dragging the graph to a catalog "drop site."

## DATABASE

SENTRY's database was designed to accommodate fields common to every contract analysis, as well as those specific to the commodity or service under investigation.

Every contract analysis effort requires information about the bid (and the contract when awarded), and information about all bidders on the contract. The SENTRY database contains a standard set of fields for bid information and for each bidder.

Investigators can add fields relevant to their analyses (either bid fields or bidder fields) using SENTRY's database function.

## USER EXPERIENCE

SENTRY was designed with both the novice and the experienced antitrust investigator in mind. It is a true GUI[*] system that runs in Windows environments. It

employs a "Point and Click" approach wherever possible, and it contains help on every screen.

The novice investigator can begin to use SENTRY as soon as it is installed. SENTRY comes with pre-defined analyses already on the Work Area. The more experienced investigator can customize the Work Area as desired.

## SECURITY AND CONFIDENTIALITY

SENTRY runs on an investigator's desktop PC, and needs little or no support from computer experts. Investigators have the option to encrypt and password protect their SENTRY database.

SENTRY works in tandem with another InfoTech product, InterLock™. InterLock is a private network accessible only by state and national investigating professionals. It is a secure "Internet like" network delivered over the Advantis SecureIP Network.

InterLock allows everyone working on an investigation to communicate electronically amongst themselves, without concern of breaching confidentiality. They can share messages, analysis, and data with other members of their investigating team, whether in their state or across the country.

## IMPORT / EXPORT

SENTRY can import data created in standard PC formats, such as spreadsheets, and can generate files for import into other PC applications. SENTRY can also access Lotus and Excel spreadsheets directly using SAS/ACCESS® software.

## STANDARD ANALYSIS

SENTRY contains a standard set of investigative tools used in all collusion detection investigations. These tools have been developed over the past twenty years by Info Tech, and are now available in SENTRY.

First, there are programs to define "groups":

**Market Area**
Group contiguous geographic areas, such as counties, into areas representing markets for analysis.

**Vendor Affiliation**
Group vendors together to form a vendor group that can then be treated as one vendor during analysis.

Second, there are programs to select those data with common attributes:

**Contract Selection**
Identify contracts with certain attributes to be included or excluded from analysis.

---

[*] Graphical User Interface

**Item Selection**

Identify items with certain attributes to be included or excluded from analysis.

And third, there are the analysis programs:

### Market Share Analysis
Determine the percentage of an economic market area controlled by each vendor or vendor group by item quantities or item dollars.

### Vendor Competition Analysis
Determine the level of competition in an economic market area.

### Pricing Analysis
Analyze the historical behavior of unit prices of an item across time, economic market area, or other pertinent variable.

## "WHAT IF" ANALYSIS

In addition to the filtering and grouping available as part of SENTRY's standard analyses, the investigator can access the SENTRY database directly, and can store programs in SENTRY's user library.

## BUSINESS NEED

SENTRY contains the tools necessary to help an investigator determine the likelihood of collusive bidrigging behavior in the market of any commodity or any service.

SENTRY has the "look and feel" of a true GUI system, allows investigations to take place in a secure environment, and contains the standard set of investigative tools used in all collusion detection investigations.

SENTRY provides the basic framework needed to support collusion detection investigations.

## REFERENCES

SAS Institute Inc., (1995) *The SAS System Release 6.11: The Orlando Release,* Cary, NC: SAS Institute Inc.

SAS Institute Inc., (1995) *SAS/AF Software: FRAME Application Development Concepts, Version 6, First Edition,* Cary, NC: SAS Institute Inc.

## ACKNOWLEDGMENTS

The authors would like to thank the following Info Tech staff members for their help in the preparation of this paper:

| | |
|---|---|
| Michael Dempsey | Dr. James McClave |
| Ragan Gilbert | Scott Pooser |
| Roy Johnstone | Dr. Tom Rothrock |
| Kathy Yellé | |

## AUTHOR CONTACT

Comments, suggestions, and questions are welcome. The authors may be contacted at the following address:

Susan Schwartz
Randy Lawton

Info Tech, Inc.
5700 SW 34th Street, Suite 1235
Gainesville, FL 32608-5371

Phone:  (352) 375-7624
Fax:     (352) 373-9586

e-mail:  susan.schwartz@InfoTechFL.com
         randy.lawton@InfoTechFL.com