How SAS® has Impacted History
or
A 25 Year Affair with the Semi-colon

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ABSTRACT

My relationship with SAS® (and the fickle semi-colon) began in 1972. I was looking for a statistical package that could handle ANOVA with unbalanced data and missing cells. I found the answer to this and more. A verbal and visual collage will show history-making events in pharmaceuticals in the early 1970's with FDA (SAS® pre and post PROC GLM), in aluminum plate for aerospace and defense during the early 1980's (SAS/GRAPH®), computer design and customer satisfaction analysis (SAS/AF® and SAS/FSP®). Examples will include how SAS® changed the way NASA looked at the display of quality data for the space shuttle and aircraft aluminum (PROC G3D) including how aluminum plate was shown NOT at fault early in the Challenger disaster investigations. Additionally, a history of data mining for predicting student performance during the early 1970's, for revolutionizing the rolling of aluminum for beverage cans during the early 1980's and beer production in the 1990's.

INTRODUCTION

In 1972 I was working as a biostatistician at Abbot Laboratories in No. Chicago, IL. We had an opening for another person and interviewed a recent graduate from North Carolina State University. During the course of the interview the discussion led to the analysis of linear models with unbalanced data and missing cells. Unbalanced data is very common in clinical trials. I expressed my desire to find a statistical package that handled these situations well. He told me about a package called SAS®. I requested my computer department to investigate the software. We received the demo tape, circulated the hard copy examples and the rest is history.

PHARMACEUTICALS (The 1970's)

Implementation of SAS® from the very beginning was quite simple. The computer department fell in love with concept of one package that "did it all." We integrated SAS® into pre-clinical as well as clinical investigations. SAS® contributed to the introduction of several new drugs, but the most impressive was radio-active fibrinogen for the detection of deep vein thrombosis. The project team for this new drug application designed all data collection, entry, analysis and presentation around the SAS® system. The question that would come from the investigating physicians was, "Can the computer do ...?" Invariably we could program the computer using the SAS® system to do whatever the physicians could think up.

Using the flexibility, versatility and power of SAS® we completed the studies and began crunching the data. The team tried to anticipate the questions that we would receive from a branch of the FDA called the Bureau of Biologics. We wrote the application for approval of the new diagnostic and included all of our analysis from SAS®. The application was submitted and we waited for questions. We knew there would be questions to answer and re-analysis because it always worked that way. We were shocked and pleasantly surprised to receive approval without any further work. The submission was so complete that it became the first application in history be approved on the first submission.

As generic pharmaceutical products entered the scene, the need for less expensive and sustained release formulations were needed to remain competitive. The power of SAS® allowed us to write macros to analyze bioavailability and bioequivalence data easily. This helped save time and improve consistency in the submission of applications for formulation changes. At the same time there were SAS® users working with FDA to have statistical analysis performed using the SAS® system accepted as accurate.

ALUMINUM (The 1980's)

During the late 1970's technology improved to the point that testing devices made available to determine the quality of heat-treated aluminum plate for aerospace and aircraft applications had significantly greater precision and accuracy. The new testing methods found that the heat-treating and quenching processes had deficiencies throughout the industry. Reynolds Aluminum introduced an automated conductivity testing system (ACTS) for the testing of heat-treated plate to determine the uniformity of the quality; i.e.; did soft spots exist. The computer controlled testing device not only moved the plate through the device for readings to be made, but also stored data from tests. It was designed as an elaborate GO/NO-GO gauge. There was a bigger vision that the stored data could be used to "draw pictures" of the quality. A data transfer mechanism was devised to move data from a mini-computer to a mainframe so that the data could be available for analysis and presentation with SAS®.

The original plan was to use line printer density plots to determine where harder and softer areas occurred on the plate, but then SAS/GRAPH® was introduced. Programs were written utilizing PROC G3D to show the variation of surface hardness across plate. Presentations were made to NASA, other defense agencies, and manufacturers of the space shuttle and combat aircraft using these computer generated 3-dimensional graphs. These graphs captured the attention of all the participants and led to an invitation from NASA to present this methodology to the Second Mission Assurance Conference on the space shuttle. Questions were raised as to the design of the heat-treating and quench equipment. All manufacturers of plate were asked to submit their products to ACTS testing and SAS/GRAPH® data presentation for evaluation.

The Challenger disaster raised questions as to the strength of the aluminum plate used in the large external fuel tank. Original speculation focused on a rupture in the external fuel tank, but SAS/GRAPH® output on the plate in question showed no such defects. As we know from the investigation, the O-rings seals failed and a flame burned through the tank like a huge blow torch. The investigation led to a proper solution more quickly since the aluminum plate was ruled out early as the failure mechanism.

Aerospace and defense weren't the only recipients of benefit from data analysis in SAS®. Data mining began on the process for rolling aluminum sheet for beverage cans. Computer systems stored data on every conceivable variable in the rolling process. As quality became a larger and larger focus during the 1980's a project was started to find predictor variables for quality measures. We began mining the data bases. The SAS® correlation procedure gave us information about variable relationships that we had never seen before. Some of the high correlations were totally dismissed by engineers and metallurgists as totally meaningless.

One of the more highest correlations was totally dismissed for nearly 2 years. Eventually a metallurgist took the time to study the process to put the "rantings" of the statisticians to rest. In the process of trying to disprove the statistical findings, the metallurgist found a new relationship between the aluminum and rolling lubricants in the production aluminum sheet for beverage cans. Statistical control charts were introduced into the process on the newly discovered "contributor variable" and quality measures improved significantly. With other plants manufacturing products for the automotive industry, the transfer of statistical knowledge helped other plants become preferred suppliers in the Ford Q-101 program.

These experiences led to the creation of an interactive statistical process control module using a combination of SAS® and ISPF® under TSO®. The power of SAS® facilitated the interactive application that utilized both the SAS® system and SAS/GRAPH® output options depending on the capability of the user. The application was made available corporate-wide through all computer terminals. This application was available before SAS/QC® was released and helped in the supplier certification efforts of several facilities. Control charts and process capability analysis were on-line.

COMPUTER MANUFACTURING (The 1990's)

SAS® for the personal computer was gaining momentum by this time and made the analysis of survey data quite easy. Customer satisfaction came to the forefront as a measure of success. The SAS/AF® and SAS/FSP® modules made data entry and formatting a simple task. Information that was never available to designers before could be gathered and analyzed in a short amount of time. This was the key. Computer design is a rapidly changing process what with the importance of being "first to the market" with a new concept. By using the SAS® system we were able to survey customers then enter the data, format the data and give meaningful analysis and feedback to researchers on a short cycle. Several changes were made to products during the design phase based on the quick turnaround of data. Potential customer dis-satisfiers were turned into customer satisfiers quite easily.

BEER PRODUCTION (The 1990's)

The taste of beer is important to the consumer and Anheuser-Busch believes that the fresher the beer, the better the taste. To continually produce the freshest beer possible, we monitor the quality of all of our processes from the receipt of the raw materials and packaging materials used for our beers to the brewing process and including the transportation times. The relationships among variables at all steps of beer production are monitored and data mining methods are being implemented to understand where the most critical control points exist. By better understanding where these critical control points are, we are able to more efficiently monitor the most important ones that affect the taste and freshness of our beer. The SAS® system is playing a major roll in the development of models to assist in more fully understanding even the subtleties in processes and critical control points.

For example, we are studying the malting process to completely understand all the nuances in steeping, germination, and kilning. Additionally, we are including transit time information related to the age of the materials as they are transported from location to location. By continually improving our knowledge we can ensure that we use only the highest quality materials. We continually use data from processes to bring our customers a product that always meets their expectations for quality and freshness.

CONCLUSION

The SAS® system, as a tool for individuals that need to make important decisions, has been important through recent history. There are probably many more examples that could be added to this short, but powerful list. To the programmers, we tip our hats as they reran code to insert that missing semi-colon. Today, point-and-click technology makes life easier and lets those of us who talk about the semi-colon look like dinosaurs. Regardless of the perspective, SAS® is a product whose time is always current and its impact profound.

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