

The SAS® System: From the Box to Production

Roger L. Chenoweth, SAS Institute Inc., Cary, NC

ABSTRACT

When a new release of the SAS System is installed it is natural to have concerns about the validity of the new software and its impact on your production applications. To allay these concerns this paper describes verification and validation of the SAS System performed at SAS Institute, how SAS Software sites can contribute to this process, and finally, steps SAS Software users can take to continue the validation process once the new release is installed. This paper also illustrates how the Management Information Systems (MIS) department puts the SAS System into production at the Institute.

INTRODUCTION

SAS Software sites depend on SAS Software to perform reliably and consistently from release to release, maintenance to maintenance. When you receive a new installation medium (tape or disk) you naturally have concerns about possible catastrophes that can occur to your production systems and applications if the new product fails for some reason.

SAS Institute staff understands these concerns because the Institute is also dependent on a safe, dependable production version of the SAS System. Everything at the Institute from sales tracking and contracts administration systems to personnel and payroll systems are SAS applications. In fact, 95 percent of the production systems in use at the Institute are SAS System applications. When the Management Information Systems (MIS) department upgrades a production version of SAS running on any of many hardware platforms, these production systems must continue to function reliably and accurately. Figuratively and literally, Institute paychecks depend on it.

The material in this presentation should allay your concerns about the validity of new production releases installed at your site. This paper presents five aspects of the validation of the SAS System:

- The Quality Assurance (QA) department at the Institute performs traditional system validation. This section includes descriptions of validation that you may find useful in validating the function of your SAS applications under a new release.
- Technical Support acts as your liaison to the Institute development team. Problems you report with current production or beta software products serves as direct input to the validation process.
- Beta releases of SAS software are part of the validation process.
- Quality Assurance (QA) performs a final inspection of the installation medium and monitors all phases of the production of the product package.
- The MIS department at the Institute performs installation and validation of production software at the Institute.

The final section of the paper provides validation steps you may perform when installing a new release at your site.

QUALITY ASSURANCE VALIDATION PROCESS

All SAS software users at the Institute are involved in product testing. SAS programming experts in MIS, Technical Support, Marketing, Development testing groups, QA, and so forth, represent millions of hours of SAS programming experience. When these resources are directed at new SAS releases under development, the programmers are alert to changes which affect the consistency of the software over time. All of these groups contribute to informal validation of the software.

Responsibility for the formal validation of the software falls to the Quality Assurance department. QA is the final authority on when a new release is ready for shipment. The department is comprised of nearly 100 analysts, organized into eight groups: a host testing group with expertise in all of the 25 different host environments supported by the SAS System, five application groups covering logical classes of the application-layer products, a tools and information services group, and a maintenance coordination group.

While the QA department is involved in all stages of the software development cycle at the Institute, the bulk of the QA system validation work occurs after all development has been frozen and the only changes accepted into the code are those made in response to defect correction.

The QA department's mission statement states: "... The Quality Assurance mission is to improve product quality as defined by the Institute and our user community. Recognizing that quality must be built into our products, we implement processes throughout the software life cycle to improve software reliability and optimize delivery schedules..." The bottom line, however, must be that each system the Institute delivers must be better than the one it replaces. This is the mainstay of the QA system validation phase of the software development life cycle.

A thorough review of the QA process is beyond the scope of this paper; therefore, the paper concentrates on regression testing. This is testing designed to catch situations where a feature that worked in the past fails in a new version. While much of Quality Assurance's work focuses on certifying that new versions deliver large gains to users, the emphasis is on those activities that minimize the potential for regressions that can impair your production applications.

When a new system passes through QA, the department performs over 70,000 unique batch tests. In addition, QA performs over 3500 documented manual interactive tests. If developers change code or correct defects while the system is in QA, many of these tests are repeated.

The results from the batch tests are automatically compared to benchmarks primarily originating from previous releases of the SAS System. Benchmarks take several forms. The most common forms are log and list files created by the tests. These files are stored with the test programs that produce them. In cases where precision differences among the various hardware platforms produce spurious difference detection, QA keeps host-specific benchmarks. An internally developed testing tool manages the submission of all batch tests and can automatically compare output generated by tests with multiple established host benchmarks until an exact match is found.

With this many tests, reduction of the number of insignificant differences is critical. One technique QA uses to reduce the number of difference files the department must visually inspect is to specify options controlling SAS output. These options include:

- **NONEWS** which prevents a site-specific information file from being written to the log.
- **NOSTIMER** which prevents printing of time-elapsed statistics after each DATA step and procedure. The times in these notes will change with system load during execution of the test stream and thus produce spurious differences.

- **LINESIZE=nn** which specifies the line size (printer line width) for the SAS log and SAS procedure output file. QA specifies a constant so benchmark files are not affected by changes to the system default.
- **NODATE** which prevents printing the date and time at the top of each page of the SAS log and any print files created by test programs.
- **NOCENTER** which specifies no centering of lines in the output file. This reduces differences when comparing output across hosts because centering is sensitive to how a particular platform rounds the decimal representation of 1/2.

Output files, generated on various host platforms, are returned to the HP-UX development network for comparison. For many test cases, spurious differences can be reduced by first processing the files with *sed* (a UNIX stream editor) to delete portions of the output that are not of interest.

Many QA tests of the SAS GUI (graphical user interface) are automated through the use of an internal capture-playback tool called the batch driver. This tool enables testers to capture a sequence of interactive events, such as selecting an item on a menu with a mouse, and then replay those events at a later time. The batch driver generates its own output file, which contains details about the graphical display that can be compared to established benchmarks just as the log and list files are compared to benchmarks.

Before an interactive test is captured by the batch driver a detailed script is written. This script describes every selection the tester should make and the expected result. A written script enables testers to reenact a series of events if the test needs to be recaptured. Some features of the SAS System, which are not captured adequately by the batch driver, are tested by hand using these scripts.

Graphics output is also benchmarked by the use of special internal device drivers that, rather than producing actual graphics, create output files containing information that uniquely identifies a picture. These output files are then compared to established benchmarks.

When any of these benchmark (log, list, batch driver, or graphic) comparisons produce a difference, a QA analyst examines that difference to determine if the difference is the result of a regression or an expected code change. All regressions or reported problems are tracked in an internal SAS application called DEFECTS.

QA uses the DEFECTS application to report problems and request changes. Depending on the severity of

the problem, developers may fix and test a solution and, under revision control, include the fixed code in the next host image for verification by QA. Trivial problems may be deferred for fixes in later releases of the software. High priority defects include those that cause system failure; produce incorrect, unreliable, or misleading results; result in the loss or corruption of data; or depart significantly from product function specified in user documentation. Lower priority defects can include nonfunctional cosmetic differences or problems for which there are convenient workarounds. Decisions regarding assignment of priorities to reported problems require the concurrence of QA. Often, QA consults with Technical Support representatives on the priority of a problem based on user experience.

During the final regression test, QA retests all areas affected by defect fixes, reruns 70,000 batch tests, completes all interactive tests in changed areas of the software, and reexamines all results.

TECHNICAL SUPPORT AS YOUR LIAISON TO THE INSTITUTE DEVELOPMENT TEAM

The Technical Support department at the Institute serves as the Institute's eyes and ears to the user community. Technical Support staff enter any problems reported about production software releases into the DEFECTS tracking system. There, the problems, are assigned a priority and treated in the same manner as those discovered by QA. In general, problems discovered by and affecting the user community receive a higher priority.

Technical Support also maintains the SAS Notes database. These notes are automatically distributed to all SAS software sites on all product installation tapes. They contain corrections to the documentation, known software defects, availability of fixes or circumventions, and common usage errors. All software defects documented in the SAS Notes database have a counterpart in the DEFECTS database.

DEFECTS manages directories of test cases that can be used to reproduce reported problems. If you supply such a test case to Technical Support, QA will likely incorporate it into the test suites the department executes.

You can provide test cases to Technical Support electronically via the Online Customer Support Facility (OCSF), Electronic Mail Interface to Technical Support (EMITS), or anonymous FTP. For more information on these facilities refer to Technical

Support document TS-301.

BETA RELEASES OF SAS SOFTWARE IN THE VALIDATION PROCESS

When a new release of the SAS System enters the formal QA validation process, it may also be shipped as a beta release to select customer sites. Beta versions of SAS Software can be made available to customers months prior to a production shipment. Beta releases can be closed (that is, limited to a number of sites) or open to all customers upon request.

Beta releases are an excellent opportunity for you to install a preproduction version of the software for validation by your user community. Generally, beta software supplied by the Institute is stable. At the Institute, pre beta versions of Release 6.07 running under MVS and CMS operating systems were installed as production systems long before they were offered to customers. This indicates the Institute's confidence in the integrity of the beta systems.

Beta sites are supported by the Institute's Technical Support Division. Technical Support's primary role for beta releases is to record customer-identified problems into DEFECTS and assist customers in resolving problems.

Serving as a beta test site gives you the chance to have an impact on the quality of the SAS System. If you are interested, contact your SAS Software sales representative on the availability of beta software for your platform. All beta sites should install the product immediately upon receipt to maximize the Institute's ability to respond to reported problems prior to the production release.

FINAL INSPECTION OF YOUR CUSTOMIZED INSTALLATION PACKAGE

Once all tests are completed and all requested fixes are implemented and tested, QA requests delivery of the the final installation package. This package is an actual customer tape (or disk) for QA to install, prepared by the Software Production Services (SPS) department.

QA completes the installation process and verifies that the software on the install medium (tape or disk) matches the tested images by performing a byte-for-byte comparison. The image shipped customers must be identical to the image QA tested. When satisfied, QA declares the products and the

installation process, production certified. Representatives from each of the QA product test groups, approve this final image, and initiate the trial-package process.

The trial-package process is a dry run of our actual customer tape production process. Individuals representing Technical Support, MIS, QA, and host development groups are designated recipients of trial packages. A list of these people is sent to the Contracts department who process the list as if it were actual customers orders. The software medium is produced, and a box complete with all instructions, documentation, and marketing information is prepared by SPS for delivery to these representatives.

Along with the box, SPS sends a Trial Package Authorization form that details the recipients responsibilities for reviewing and installing the package. These forms must be completed, signed, and returned to SPS. When all of the trial packages are successfully installed, SPS releases the software for customer shipment.

Once the software is authorized for shipment, the SAS Institute Data Center, using tools developed by SPS, prepares the medium and packaging letters and forwards them to Software Distribution for customer shipment. Because the medium and accompanying letters are customized for each site, the distribution staff receives an itemized list of all materials that are to be included in the each individual shipment. This ensures that the customer receives the appropriate documentation for the software products ordered.

SAS Institute staff performs all media creation, packing, and final quality checks on the integrity of the shipment itself. Distribution clerks personally sign-off on each shipment, giving customers a direct contact for any problems associated with their package.

On most host platforms, shipment of a new release is staged in two phases: a smaller initial shipment followed a short time later by a mass shipment. The initial shipment gives the Institute one last opportunity to iron out any installation problems that may occur as a result of hardware and software configurations the Institute may have been unable to simulate.

Every step of the process from QA's request of the final installation package to placing your box on the truck is carefully monitored to ensure you are delivered a fully tested, installable, and properly customized SAS System.

SAS MIS DEPARTMENT INSTALLATION

AND VALIDATION

The Institute maintains versions of the SAS System (supported by MIS) on the MVS, CMS, Open VMS, and HP-UX operating systems. MIS procedures for providing an updated production version of the software to the internal user community is described here as an example for customer sites.

When MIS receives their trial package, they install it in a staging area and run the installation and product verification jobs included on the installation medium and documented in the installation instructions. Separate validation jobs are included for many of the SAS software products. These jobs can be run without performing any special implementation or customizations. MIS checks the job logs to ensure that no error messages occur and the return codes are clean.

MIS installers then perform product customizations. MIS installs all products at the Institute. The MIS manager in charge of a particular host then generally performs testing to get a good feeling about the integrity of the installation. Examples of such testing include trying a few quick items in SAS/ASSIST[®], creating some SAS/EIS[®] objects, and producing a large map with SAS/GRAPH[®] software.

Then the system is turned over to the MIS staff to verify that the production systems they are responsible for perform correctly. They use some of the same benchmarking techniques described in the QA section to verify that their applications are still delivering the expected results. The new installation remains in this staging area for a couple weeks while the payroll, contracts, marketing, and other important production systems are verified.

Caroline recommends that the SAS software installer read the installation guide to get a good overview of the entire process before starting with the actual installation. Her experience is that she rarely has to change many of the installation parameters. "It isn't hard - don't be overwhelmed. Installation doesn't take a superhuman effort." Caroline reports that she recently performed four complete SAS System installations to setup a special marketing class on SAS/CPE[®]. She did all four installations in less than a day. "The install process improves with each release...there are fewer steps...the process is more streamlined."

The Institute's commitment to providing valid and reliable software is demonstrated by the MIS department's charge to bring all Institute production SAS applications up to the current production SAS System level on or before the shipment of each new release.

VALIDATION STEPS TO CONSIDER AT YOUR SITE

QA analysts at the Institute evaluate system stability, completeness of test coverage, and the severity of all known outstanding defects in determining the risk to the user community. If risk of failure is low, the system can be shipped.

You, or your SAS site representatives face a similar decision. Production SAS applications need to be evaluated for risk to determine how much verification and validation is needed before placing a new SAS release into production.

At a minimum, you should execute and verify the product tests included on the installation tape. These tests are documented in the installation instructions. Benchmarks for these tests are included on some platforms for comparison purposes. Successful completion of these tests ensures that the installation was performed correctly and completely.

You should also verify the proper functioning of hardware and software that may be unique to your site. For example, if you are running terminal emulators of IBM32xx devices or Xterminals, the Institute may have been unable to replicate your setup for testing. While testing organizations at the Institute try to keep informed about the environments users are running and testing as many of these as possible, it is impossible to do exhaustive testing.

The same consideration also goes for printers and other output devices. Even though the Institute tests hundreds of printers, plotters, cameras, and terminals, the make and model of the output device installed at your site may not be one of those tested. Or, even if the Institute tests the same equipment, it may be tested in a different environment. While the Institute anticipates variations in telecommunication software and methods of output delivery, your exact configuration may not have been replicated. A few hands-on tests are probably in order.

For critical SAS applications, consider establishing some log and list benchmarks using your current production version of SAS software. Then, reproduce those benchmarks with the newest release while it is in a staging area. Techniques used by QA at the Institute discussed in this paper can help produce robust benchmarks. Compare the results and resolve any differences.

Interactive applications may warrant development of written test scripts. These formal tests ensure that the procedures are executed in exactly the same way every time. If you have extensive interactive applications that require frequent testing, consider

purchasing one of the capture-playback tools available on the market. These can be used to automate the testing and benchmarking of interactive applications.

If you are a beta site, install those systems quickly and report problems to the Technical Support department. With your help, SAS Institute can deliver better production software when the beta phase is complete.

Finally, report any anomalies to Technical Support immediately so the staff can help resolve these issues. If you are having a problem with your newly installed SAS System, chances are you are not the only one, and Technical Support wants to resolve any such problems as soon as possible. Timely reporting of problems is particularly important if you are part of an initial shipment where you receive the product in advance of most other sites.

CONCLUSION

The Institute is dedicated to providing the most capable and reliable software in the industry. The Quality Assurance department validates the performance and output of the SAS System using thousands of tests, verifying fixes, and carefully monitoring the production process. Technical Support reports problems from current production and beta releases to ensure that the improvement process is responsive to problems reported in the field. The Institute runs on the software it sells. Systems are installed by the MIS department to run internal, corporate-critical systems before being released in the field. All aspects of producing a complete, installable, customized package are monitored and passed by signature. The result, with your partnership, is a carefully validated product.

ACKNOWLEDGMENT

The author thanks Edie Jeffreys, Donna Bravo, Sue McGrath, and Kay Bydalek for technical review and Susan McCoy for editorial review.

SAS, SAS/ASSIST, SAS/CPE, SAS/EIS, and SAS/GRAPH are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. ® indicates USA registration.

Other brand and product names are registered trademarks or trademarks of their respective companies.