The Analytical Laboratory Sample Tracking and Reporting System

W.J. Colvin

Information Services, Reactor Program Services Division, Argonne National Laboratory-West, Idaho Falls, Idaho 83403

Abstract: Regulatory and project requirements stipulate that samples submitted for chemical/physical analysis be tracked throughout the analytical process. The Analytical Laboratory (AL) began tracking sample request information electronically using a simple dBASE IV database in 1992. In mid 1993, AL chemists formed a committee to determine the software requirements for a formal sample tracking system. The requirements were outlined for a multi-user PdDow application which tracked sample logs, login templates, worksheets, and sample results and also provided standardized reporting capabilities. The Analytical Laboratory Sample Tracking and Reporting System became available to AL chemists and management in February 1994. Chemists now have quick, easy access to organized and readable sample data. Up to date, on-line access to sample status information also benefitted AL management. The ability to closely monitor samples decreased sample process time. AL customers also benefited by receiving standardized Final reports for their samples. Eventually, system performance began to deteriorate as the database grew and network traffic increased. To improve performance, ANL-W Information Services recommended upgrading the system. Upgrading to a fully relational, client/server Oracle database accessed from a front-end application developed using Visual Basic, one of the many Graphical User Interface (GUI) design tools available today, would improve performance times by greater than 50%. The move to Oracle would improve throughput times of transactions and employ a more efficient use of resources. Oracle would also provide additional data security and integrity mechanisms not available in some other databases. Visual Basic front-end application development began in May 1995. In October 1995, the first prototype of the Visual Basic application was made available for testing. AL users were pleased with the added ease-of-use the GUI interface provided. The production version is scheduled for release mid May, 1996. The tracking of AL sample data has, in a relatively short amount of time, evolved from bulky hardcopy to a state-of-the-art, highly sophisticated electronic database system.

INTRODUCTION

The Analytical Laboratory (AL) receives a variety of analytical samples from diverse sources within the Argonne-West site and from various outside contractors. Chemical, radiochemical, and physical measurements are performed in hot cells, glove boxes, and general laboratories in support of the ANL-West nuclear, environmental, and other diverse research programs. Measurement results provide data for R & D, nuclear accountability, radiation control, process control, and environmental monitoring.

Regulatory and project requirements dictate that the AL document the analyses...
and experiments performed for each sample request received. AL chemists
determined a further need to track samples, analyses, experiments, and results. In
mid 1993 AL chemists formed a committee to outline the requirements for an
electronic sample tracking system. The application they wanted would simplify
record keeping, provide quick record searching capabilities, and standardize the
reporting information customers received. Requirements included that the system
1) automatically generate a unique log number for each sample request received,
2) that it track analyses and experiment results, and 3) that it produce final reports
for customers. The committee not only outlined several system requirements but
also detailed many of the desired application features including screen contents and
menu formats.

System Attributes

The status of samples can be followed throughout the analytical process from
login to final report generation. Sample requests are logged-in to the system as
they are received. The system generates a unique incremented log number at login
that is used to identify the sample request. Login information input by the analyst
comes directly from the sample request form provided by the customer. Sample
request data includes: the requester, requester's phone, facility, the sample
description, the chain of custody identifier, a cost code, the customer's sample
identifier, and comments. Additional login data entered by the analyst includes: a
login name, the sample classification, a priority level, where the sample(s) will be
taken, the lab storage location, the type(s) of analyses or experiments to be
performed, and additional comments.

The analyst has the choice to login a sample request using a login template. A
collection of login templates exists for recurrent sample requests. For example,
AL rinse water is tested frequently. The facility is always the AL, the type of
analysis performed is usually Radio Chem, and the analyst, gross alpha. The AL
Rinse Water template is used for login of a sample request for an AL rinse water
sample. The facility, requester, requester's phone, sample login name, description,
type, where the sample is taken, the lab storage location, and the analyses
information: group name, worksheet, and species, are all contained in a login
template. Sample request login from a template fills the login fields with the
template data minimizing the amount of typing that the analyst must do at login.

Analytical result data are entered by the analyst as analyses are completed.
Result data includes: the analysis result, units of measure, percentage of error, the
analyst's initials, and a log book identifier/page number. The system automatically
changes record status when it detects that all results for a sample request have
been entered. The sample record status is displayed on the sample record screen
and is included on the sample request record's listing as a quick reference for
sample status. The Final report cannot be generated until all results have been entered for a sample request. The system prompts the user that the Final report needs to be generated upon exiting results entry if all results have been entered. When the Final report is generated, the Final report date and time fields are automatically entered and displayed. The Final report date and time indicate that the sample request has completed the analytical process.

In addition to sample, analyses, results data, and the login templates, a collection of worksheets is also maintained by the analysts. A worksheet can be relationally associated with each analysis group. Worksheets can be used for taking notes during analyses and experiments. These worksheets can be kept in the analysts' notebook and referenced when logging results into the system.

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![Image](image.png)

Figure 1. The first page of a Final report for an AL Rinse Water sampling shows the results data for the first of three samples analyzed.

The system wouldn't be complete without extensive reporting capabilities. Final reports, Interim reports, record listings, and single record reports are built into the system. The Final report (Fig. 1), a controlled document, is generated once all results have been entered into the system for a particular sample request. The signed original report is filed in the Analytical Laboratory record files and a copy is sent to the customer. The Interim report is similar to the Final report, but can be printed at any time and requires no signature. This report is useful for customers who want to know results on a partially completed sample request. Record listings are useful for examining large amounts of data. Record listings can be printed for the three top level data tables the system tracks: sample request
logins, login templates, and worksheets. AL managers find the sample request logins listing useful for monitoring sample throughput. A single record report, also available for sample requests, templates, and worksheets, contains all levels of relational data beneath a record in the top-most table in the relation. These reports may be printed for any number of reasons. An analyst may use a single record report of a sample request login for a detailed reference document in the laboratory.

System Development

The system software took six months to develop with requirements being refined weekly. The production version of The Analytical Laboratory Sample Tracking and Reporting System (ALSTAR), a FoxPro\textsuperscript{1} 2.5 for MS-DOS\textsuperscript{2} multi-user distributed application, became available to the Analytical Laboratory in February 1994. Fine-tuning of the production version continued for another year. The system software and databases resided on the AL file server AJAX connected to the ANL-W LAN\textsuperscript{3}. In addition to satisfying the initial requirements, the final product included login templates for simplifying the login process, worksheets generation for analyses and experiment note taking, reporting capabilities for providing sample information for management, analysts and customers, and many other functions which enhanced the capabilities of the system.

Performance testing performed in January and February 1995 produced results which indicated that the amount of time it took to login a sample request had increased by approximately 75\% since ALSTAR had gone into production use. System performance had deteriorated as the amount of stored information increased.

To improve performance and upgrade the system to Windows\textsuperscript{4} system compatibility, ANL-W Information Services recommended converting the system to Microsoft Visual Basic\textsuperscript{5}. Visual Basic (VB) provides the appropriate tools for graphical user interface (GUI) development. VB development began in June 1995. New system requirements were outlined as the analysts became aware of the added interface options available using VB Tools. FoxPro databases were converted to Microsoft Access\textsuperscript{6} tables and data relationships were refined. The main functions

\textsuperscript{1} FoxPro is a registered trademark of Microsoft Corporation. FoxPro is relational database management software.

\textsuperscript{2} MS-DOS is a registered trademark of Microsoft Corporation.

\textsuperscript{3} The ANL-W LAN is a standard IEEE 802.3 Ethernet local area network with wide-area connections to ANL-E and Lockheed Martin Idaho Technologies.

\textsuperscript{4} Windows is a registered trademark of Microsoft Corporation.

\textsuperscript{5} Microsoft Visual Basic and Visual Basic are registered trademarks of Microsoft Corporation.

\textsuperscript{6} Microsoft Access and Access are registered trademarks of Microsoft Corporation.
of the system have been maintained. System testing began in October 1995 with the release of the first VB prototype. Performance testing on the second VB prototype demonstrated performance improvements for all of the principal functions the system provides (Fig. 2). The amount of time for login of a sample request showed a performance improvement of nearly 50% with both systems accessing the same type and amount of data. In addition to the marked performance improvement that the VB system exhibited, the analysts testing the system conceded that the learning curve for the new system was much shorter. Upon acceptance of the VB application interface, the VB system will fully replace the FoxPro system.

To achieve optimal performance, the final phase will be conversion from Access data tables to ORACLE7 tables. ANL-W Information Services group is in the process of configuring an ORACLE Server. The Server will act as an information repository for the various Laboratory departments. Once the ORACLE server is in place, the ALSTAR Access data tables will be converted to ORACLE and the application interface will be modified to accommodate the switch. The move to ORACLE will further improve performance by increasing transaction throughput and employing a more practical use of resources.

The AL is gradually moving towards a paperless method for internally tracking sample data. Regulatory requirements continue to mandate retention and distribution of paper documentation but as these procedures are updated to reflect current technological capabilities, these requirements will more than likely, be phased out.

FIGURE 2. Function performance comparisons between FoxPro and Visual Basic sample tracking systems. Comparison testing was completed by system users and averaged. Times were evaluated from application startup to completion of task.

7) ORACLE is a registered trademark of Oracle Corporation.
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