Paper 179-2012

AUTOMATION OF PAPER-BASED SURVEYS USING THE SAS® BI PLATFORM – CUSTOM WEB FORMS FOR REAL-TIME ANALYSIS

Ian Healy, BrightHeight Solutions, Portland, ME, USA
Rocket Wong, Maine Medical Center, Portland, ME, USA

ABSTRACT

Maine Medical Center has traditionally relied on paper-based surveying and inspections in order to determine the level of patient satisfaction and safety on a regular basis. The ability to generate substantial business intelligence using paper surveys was both labor-intensive and proved difficult to convey the results to the hospital community. The Center for Performance Improvement – BI Competency Center worked to bridge this gap by developing custom web forms using the SAS BI Platform. These forms have eliminated most paper surveying and resulted in ease of data entry, instantaneous feedback as well as real-time reporting and dashboards to assist in efforts for continuous improvement at Maine Medical Center.

INTRODUCTION

The medication storage SAS portal allows us to track and trend our compliance with Medication Storage Inspections in an easy to use format. With close to 160 inspections completed every month an electronic solution was a must. The SAS portal is user friendly, generates reports for each area and provides essential data that can be easily complied saving hours of manual calculations.

Jennifer Civiello, Manager of Pharmacy, Maine Medical Center

The Department of Pharmacy at Maine Medical Center was faced with a significant task: to once again compile over 6,000 pages of paper based medication storage inspection reports and notes for year-end reporting. Results were counted manually and recorded into a Microsoft Excel spreadsheet to produce overall and unit-based compliance statistics for medication storage. The Department of Pharmacy contacted Maine Medical Center's Center of Performance Improvement – BI Competency Center to examine requirements for an automated solution to traditional paper-based surveys.

The SAS Business Intelligence Platform is capable of working with customer defined web-based forms within SAS BI Portal. These forms can be customized to work with SAS Stored Processes that allow for:

- Generating automatic e-mails with PDF attachments to Department leaders when an inspection is performed for their unit
- Rich output in HTML and PDF for real-time and summarized year-end reporting
- Integration with SAS BI Dashboard to produce real-time dynamic dashboards, showing compliance and non-compliance with medication storage guidelines

This paper delves into the BICC model that was used to manage the effort and provide details on how to build this capability into your own SAS BI environment.

DISSECTING THE REQUIREMENTS – EMPLOYING THE BICC MODEL

Maine Medical Center has built a Business Intelligence Competency Model to manage all phases of a SAS BI project. This model serves to build a virtual team of subject matter experts and organize the work in such a way that progress can be shown on a regular basis, with instantaneous feedback on research and development efforts.

Below is a diagram that shows the BICC project model at Maine Medical Center for the Medication Storage Inspection project.

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued
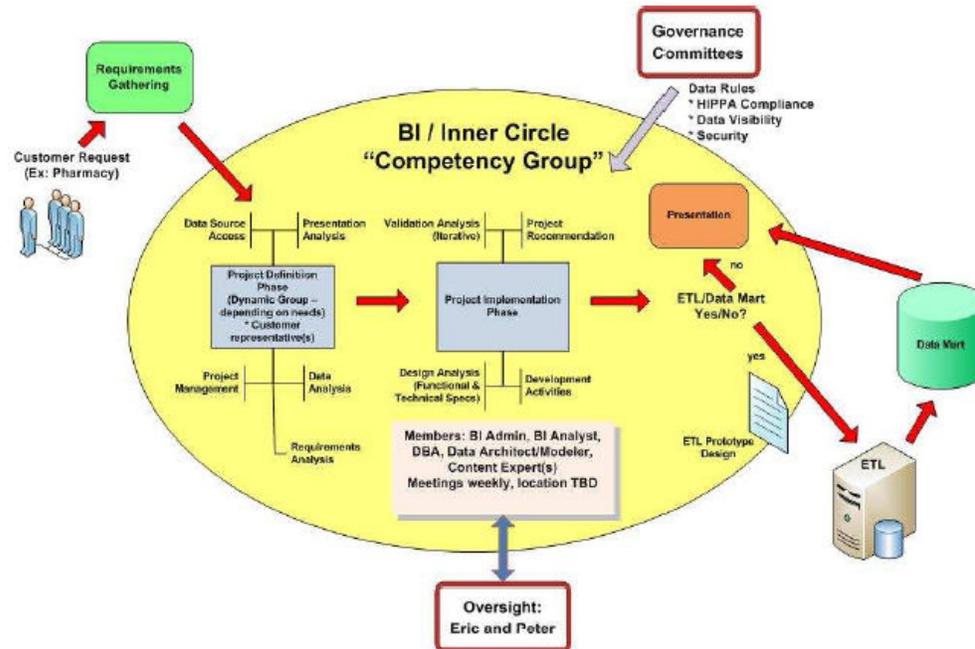

Figure 1 - Maine Medical BICC Model

The initial requirements for the Medication Storage Inspection project were brought up for discussion to the Business Intelligence Clearinghouse. This group is charged with the prioritization of projects and determining the applicability of the SAS BI Platform to address the business problem.

Once the project gained approval from the "Clearinghouse", the Business Intelligence Competency Center team met with the Pharmacy department to draw up the business and technical requirements, as well as to design the project model (shown above). A virtual roster was developed, selecting appropriate subject matter experts throughout the organization to work on various phases of the project.

The project model provided the framework as the team met to refine the requirements and to begin researching a SAS based solution.

The Department of Pharmacy required the following in an automated solution:

- The web based entry form should be set up on the SAS Enterprise BI Portal and the page would be available only to authorized Pharmacy staff
- The entry form should allow for the capability of adding comments for each inspection criteria, a task that once required many attached pages for the paper-based inspection
- Page functionality should include:
    - Ability to search for inspections by location, both current and historical
    - Real-time access to submitted data
    - Automated e-mail functionality to department heads once an inspection is submitted for their unit
    - PDF book output showing compliance YTD information for units
    - PDF book output showing compliance YTD information for each inspection criteria
    - Real-time performance dashboards, updated as results are entered

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

CUSTOM WEB DEVELOPMENT USING SAS BI PORTAL

Once the requirements had been fully developed and vetted with the customer, the CPI BI Competency Center team began to research a SAS-based solution to paper-based surveys. Web searches brought only a limited amount of published information back on custom web development in SAS, namely integrating HTML with SAS Stored Processes. The project team relied on in-house expertise as well as periodic advising from the SAS midtier support group to build a lasting, effective solution.

DEVELOPING THE WEB FORM

The Department of Pharmacy provided their current paper form for medication storage inspection and copies of detailed notes taken by each inspector. The paper form did not provide for comments on each individual inspection question, so additional attached notes were needed for each inspection.

169 Units X 3 pages (average) per inspection X 12 months = <u>6,084 pages per year</u>

Additionally, hard copies of each inspection were provided to each Department head, in addition to managers responsible for the inspected units. The paper approach resulted in little feedback from the units. The Department of Pharmacy spent the majority of time collecting data and results were difficult to analyze at year-end.

The original paper-based form included:

- 33 medication storage inspection questions
- Name of the location inspected
- Date and Time of the inspection
- Overall comments on the inspection
- Signatures

Not included on this form are the detailed notes taken by each pharmacy tech that performed the inspection. This detailed information was often not conveyed to units for their improvement efforts.

A copy of the original paper form is shown below:

Figure 2 - Original Med Storage Inspection Form

An automated solution in SAS would go a long way to improve the efficiency of inspection and to address compliance issues in real-time. The development efforts focused on making the form:

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

- Easy to use and visually effective within SAS BI Portal
- Dynamic in nature with drop down list and calendar functionality for location and date/time entry
- More effective for inspectors as comments would be provided for every question
- More responsive, providing the inspector with instant feedback after form submission

DEVELOPING A WORKING FORM

Developing a web form in SAS was an iterative process, with the Department of Pharmacy actively involved in the design phase. A page was set up specifically for the form and associated dashboards within the SAS BI Portal. The page was made "Persistent" of "Sticky" only to the Pharmacy domain group and is not visible to any other Maine Medical Center users. In this section, we will describe our approach to develop a stored process that worked with a custom web form published to SAS BI Portal.
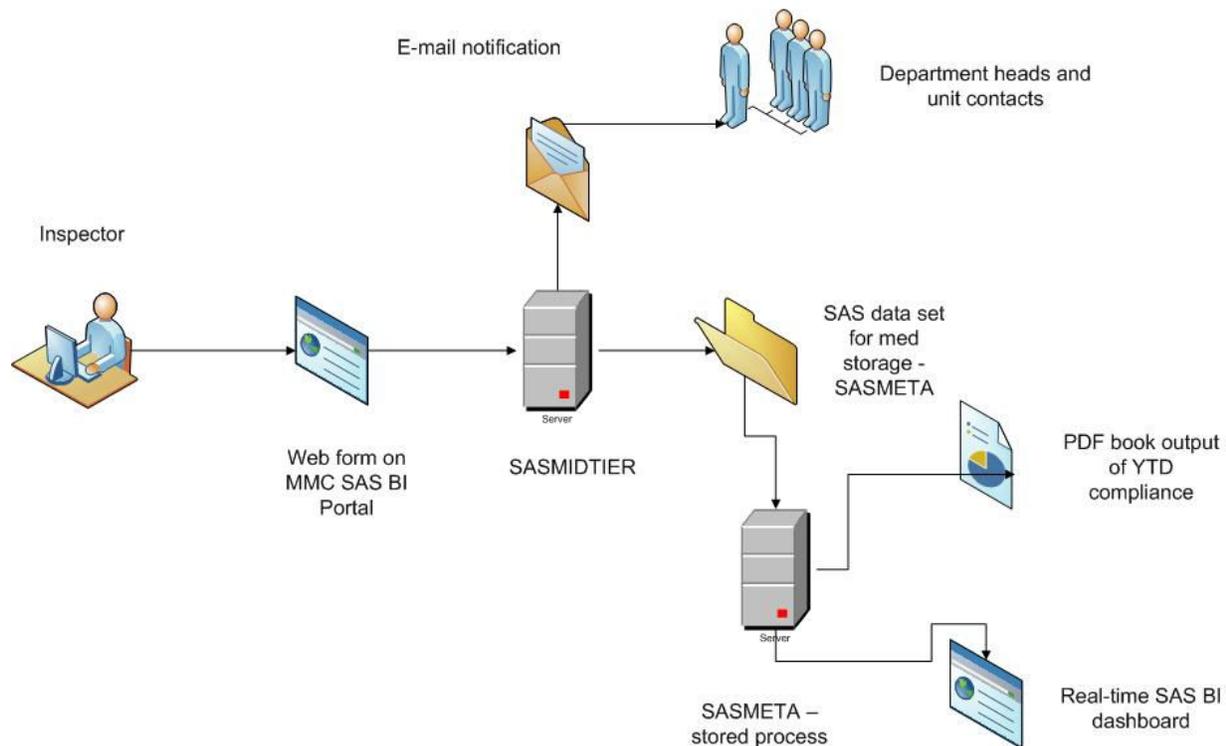
Figure 3 - Requirements Diagram for Web-based form

The SAS BI development team at MMC worked with the Department of Pharmacy to create a basic workflow of activity once the inspector has submitted the form via laptop or tablet.

The medication storage form consists of several HTML and JavaScript elements. This can be developed with any web editing software, or you can customize an existing web form you have in HTML and include the elements that tie in to SAS. The html/jsp page must be saved under the web server directory on the MIDTIER server. A URL Display Portlet in SAS Portal was used for the medication storage form to render the form immediately upon page access by the pharmacy inspector or manager.

Once the inspector selects the location, date and answers the inspection questions, the form is submitted and the inspector immediately receives an HTML summary of what they entered into the SAS Portal. Based on the location of the inspection, the stored process will initiate code that will compare the location entered to a "Contacts Crosswalk" stored on the SASMETA server. This will match the location to the appropriate contacts for that location for the e-mail notification.

After submission, the data is appended to an existing Medication Storage SAS data set, with a SAS date and unique identifier created for each record. From this data set, an additional stored process will generate an YTD PDF document as well as update the real-time dashboards that are created in SAS BI Dashboard.

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

A small section of the completed web form is shown below.

Figure 4 - Med Storage Data Entry Screen - SAS Portal

SETTING UP YOUR HTML

The first critical element you will need to add to your completed HTML/JSP code is the <FORM> action and method values. The action parameter should be set to the URL for your organization's SAS BI Portal URL followed by /SASStoredProcess/do (shown below). This is required as we will be working with a SAS stored process.

```
<FORM action=https://sasportal.mmc.org/SASStoredProcess/do? Method=post
onsubmit="return checkForm(this)">
```

Output 1. FORM action

List the name of the SAS stored process in the INPUT tag string below. Update_medstor is our program name. Also you can set up debugging to detect errors by specifying _debug in the second INPUT tag.

```
<INPUT type=hidden value="/DataEntry/update_medstor" name=_program>
<INPUT type=hidden value="0" name=_debug>
```

Output 2. Calling Stored Process

The completed form should be saved on SASMIDTIER in a specific directory under the web server folder. In MMC's case, we utilize Oracle Weblogic 10.3. The file can be saved in HTML and JSP format.

SAS STORED PROCESS FOR MEDICATION STORAGE

The stored process that is initiated after the inspector submits the data performs the following:

- Defines the SAS data set to be created
- Transposes the submitted data and adds the question text
- Appends the data to the existing medication storage data set
- Establishes the e-mail contact list based on location
- Builds the dashboard SAS data set
- Builds the required PDF output for tracking results

The first step in the stored process is to define the data elements coming in from the HTML/JSP form as well as the variables for the e-mail automation.

```
%global location datetime q1 q1c ID MedStorageLocationNames Contact1 email1
contact2 email2 contact3 email3;
```

Output 3. Define data elements from JSP form

The library location of the medication storage SAS data set is then specified as well as the SAS macro that will generate a unique identifier for each record:

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

```
LIBNAME oppe BASE "E:\Projects\OPPEDataMart";
%GetNextID(OPPE.med_stor_surveydata,ID);
```

Output 4. Define LIBNAME, Location and generate Unique ID

The lengths of each variable are then defined before further processing:

```
data temp;
  length location        $40
  datetime               $20
  q1                     $3
  q1c                    $255
  ID                     8. ;

  LOCATION = "&Location";
  DATETIME = "&datetime";
  Q1 = "&q1";
  Q1C = "&q1c";
  ID=INPUT("&NextAssignedID",8.);
run;
```

Output 5. Establish lengths and data types for form variables

The medication storage data set is created through the use of PROC append and then by specifying the data set name and location:

```
proc append base=oppe.med_stor_surveydata data=temp force;
run;
```

Output 6. Append form input using PROC Append

The data that is passed from the HTML form does not contain the text of each question. In the following step, the medication storage data is transposed using a SQL UNION and the text of each question is added. This is useful to produce a clean output for the inspection record that is sent to each unit after the evaluation is submitted:

```
PROC SQL;
  CREATE TABLE WORK.MED_STOR_SURVEY_Report AS SELECT temp datetime,
    temp.location,
      ("01) Medication storage & preparation areas are clean, neat, well organized
and secure."
) AS Question,
        temp.q1 as Answer,
        temp.q1c as Comment
        FROM WORK.TEMP AS temp
        UNION
  <add additional questions below>
```

Output 7. Generate question text and merge with responses

The next requirement that needed to be addressed was the creation of a contact list and aligning the appropriate contact names to the location inspection submitted. The following SQL step will generate the appropriate contacts for the e-mail automation step:

```
PROC SQL;
  CREATE TABLE WORK.MSLocationCrosswalk AS
        SELECT *
        FROM work.temp as temp, WORK.MSLocationCrosswalk as MSLocationCrosswalk
        WHERE MSLocationCrosswalk.MedStorageLocationNames = temp.location;
  QUIT;
```

**Output 8. Generate contact list crosswalk table**

You can then specify the name and location of the PDF inspection report shown below. Then a PROC REPORT can be used with the desired variables included.

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

```
%let wkloc = %sysfunc(pathname(WORK));
ods pdf file="&wkloc.\MED_STOR_SURVEY_Report_PDF.pdf";
```

Output 9. Define location of PDF attachment report

The final section of the stored process to detail is the automation of e-mails and attachments from the SAS stored process based on the location entered for the inspection submission:
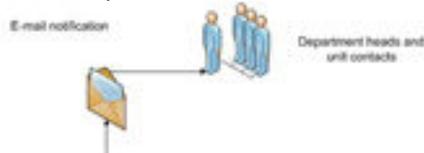

```
filename mailit email to="&email1" cc="&email2" bcc=sasuser@mmc.org
from=SASUSER@mmc.org subject="This month's unit inspection report is attached for
&location ";
data _null;
  file mailit
    attach="&wkloc.\MED_STOR_SURVEY_Report_PDF.pdf"
    subject="A new medical storage record has been submitted for:
&MEDSTORAGELOCATIONNAMES;
run;
filename mailit clear;
```

Output 20. Automation of e-mails based on the location selected in the form

Once the inspection location is matched to the appropriate record in the contacts crosswalk, we are able to include contact email addresses to send the email with the inspection report attached.

REPORTING REQUIREMENTS

The primary benefit of developing a SAS BI solution for automating the Medication Storage inspection process was the ability to quickly generate reports that allowed the Pharmacy management team to:

- Determine units/locations that are not in compliance with medication storage inspection targets
- Track improvement of non-compliant units/locations over the year
- Analyze trends
- Identify the most problematic criteria at Maine Medical Center and provide education and assistance to new and existing medical offices
- See units in a SAS dashboard format and quickly identify problems

The SAS BI project team worked with Pharmacy to produce an automated PDF report that included bookmarks for such reports as:

- Compliance by unit/location with medication storage standards (overal YTD)
- Trend charts showing overal Maine Medical Center performance for the year (by month)
- Compliance by inspection question – ranking the most problematic inspection criteria questions for units/locations
- Trend charts showing overal improvement in inspection areas

The non-compliant question report (shown below) has been extremely successful in identifying problem inspection criteria at Maine Medical Center. At the outset of this project, this report focused management staff on key performance deficiencies and assisted in bringing non-compliance down quite significantly during the six months the SAS functionality has been used for medication storage inspections .

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

Medical Storage and Preparation Areas - Non Compliant Questions Calendar YTD

Number of Inspections	Reported Non-Compliance %	Total NO Responses	Total Reported
09) There are no expired, recalled, deteriorated, broken, contaminated, or mislabeled drugs present.	■%	■	775
21) IV Solutions are not outdated, and are stored in a clean and well-organized manner.	■%	■	775
11) Refrigerator temperatures are monitored and recorded every day. Refrigerator temps are between 2 and 8 C (36 and 46 F).	■%	■	775
10) Medication supplies in treatment rooms and in treatment trays are secured.	■%	■	775
07) Multi-dose vials are dated, when opened, and stored according to policy.	■%	■	775
05) Unit floorstock medications are secured and stored in separate containers, segregated by dossage form; and separated by bins, shelves, dividers or pegs.	■%	■	775

Figure 5 - Non Compliant Questions Report

Through the automated e-mail functionality, department leaders and managers are notified immediately when an inspection has been performed. Inspector comments on non-compliant areas are available in the attached PDF report as well as a list of compliant and non-compliant findings. The Department of Pharmacy receives near-immediate responses by e-mail to discuss findings and look at ways to improve.

SAS BI Dashboard was utilized to produce an effective visualization of unit/location compliance information. The dashboard data is generated as part of the SAS stored process and is updated on a real-time basis as inspectors submit new inspections. Drill down information is also available for each of the indicators to display compliance trends and show improvement over time.
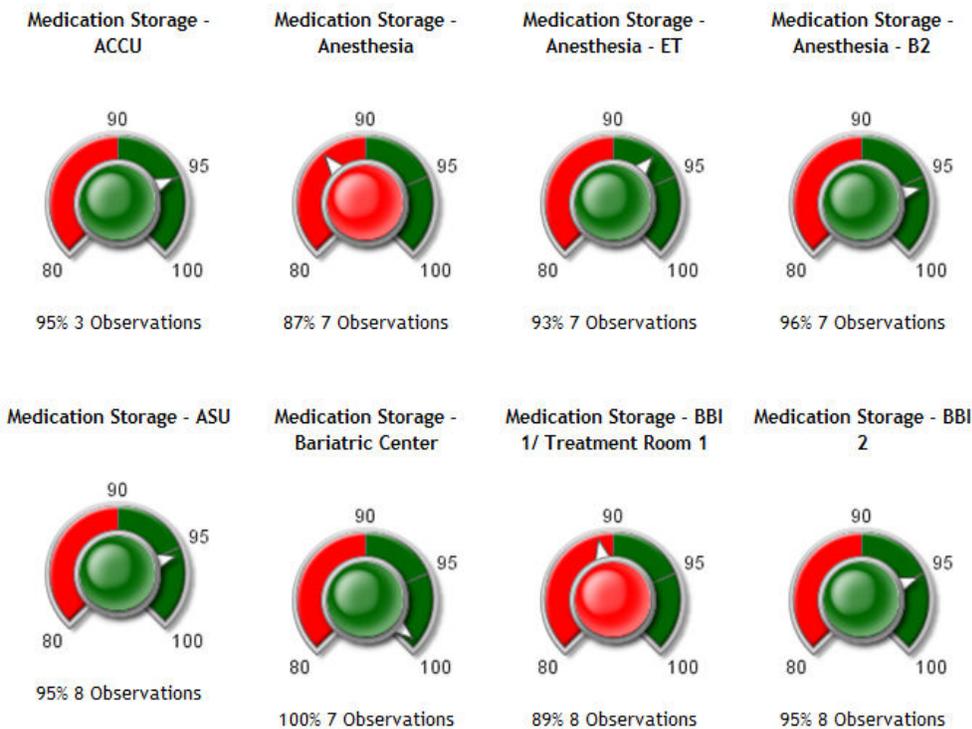

Figure 6 - Med Storage Real-time Dashboard

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

BENEFITS OF AUTOMATING THE MEDICATION STORAGE INSPECTION PROCESS

There were many performance improvement benefits to pursuing an automated solution in SAS BI Portal for the medication storage inspection project.

Inspectors were once asked to compile many pages of notes for each unit inspection in order to generate analysis reports on how units were complying with medication storage regulations. For 169 inspection locations per month, this added up to over 6,000 typed and hand-written pages to keep on hand each year. The counts from each inspection survey were calculated and entered on an Excel spreadsheet for monthly and end-of-year reporting. These reports were distributed but did not have the immediate visibility that they now enjoy on the SAS BI Portal.

The SAS BI Portal web form solution eliminates much, if not all of the paper-based process. Inspectors now bring their laptops onsite during their inspections and can use a wireless connection to enter data into the form and see the results of the inspection in real-time.

- Inspectors can see immediate results in reports and on the SAS BI dashboard of the inspections entered
- Department leaders and managers receive the inspection report immediately and can engage Department of Pharmacy leadership in finding solutions to compliance issues
- Compliance reporting can be done as needed or on a monthly, quarterly or yearly basis

PERFORMANCE IMPROVEMENT AND CONCLUSION

A significant number of inspection and survey data gathering activity have historically been performed through paper based survey techniques. Processing the collected data was a labor intensive task, with results being generated in a time frame that is of little use to diagnosing and solving real performance issues within the institution. Often, third party vendors were contracted to assist in data collection and compilation.

The medication storage inspection project initiated a "re-thinking" of how surveys and data collection were being performed at Maine Medical Center. SAS BI intelligence can collect the data, compile and store results in a secure manner, as well as provide a framework for visually appealing analytics on survey results.

The success of this project has provided a framework for a number of additional initiatives for web based form entry through SAS BI including:

- Diagnostic Error reporting
  - o The diagnostic error reporting application allows for anonymous access to the SAS Portal for medical staff to confidentially enter data on medical errors within the medical center
  - o Results in PDF format are stored in a secure location on the SAS server with access granted to compliance personnel
- Patient Access
  - o Data entry and real-time analysis of patient bed type changes
  - o Reporting by department and admission date range

YOUR OWN REAL TIME DATA COLLECTION WITH SAS

For additional information on setting up real-time data collection in SAS BI, the following resources are quite helpful:

SAS Stored Process Web Application: http://support.sas.com/rnd/itech/doc9/dev_guide/stprocess/stpwebapp.html

SAS Stored Process Development in SAS 9.2

http://support.sas.com/documentation/cdl/en/stpug/61271/HTML/default/viewer.htm#a003152812.htm

Automation of Paper-Based Surveys using the SAS BI Platform – Custom Web Forms for Real-Time Analysis, continued

CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the authors at:

Name: Ian Healy
Enterprise: BrightHeight Solutions
Address: 291 Spring Street, Suite 5
City & Zip: Portland, Maine 04102
Work Phone: (207) 939-4949
Web: http://www.brightheight.com
E-Mail: ian@brightheight.com

Name: Rocket Wong
Enterprise: Maine Medical Center – Center for Performance Improvement
Address: 131 Chadwick Street
City, State ZIP: Portland, Maine 04102
Work Phone: (207) 662-6218
E-mail: wongr@mmc.org
Web: http://www.mmc.org