Adding Control to Your Data Using SAS System and Dataset Options
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ABSTRACT

Controlling access to your data and keeping track of any changes to it is becoming an increasingly important task. A lot is at risk when data becomes compromised, and depending on the event, regulators may become involved. This paper looks at a way that SAS provides of controlling who has access to the datasets for modification, and also looks at two alternatives for tracking changes, first through an audit trail and second using SAS dataset "versioning".

INTRODUCTION

Since SAS version 8 was first released the ability to do an audit trail on a SAS dataset has been available to the SAS user. With this new feature and the existing SAS options to control viewing and modification of data, SAS provides the user to have control over their most valuable asset, their data. While there are other applications out there that will track changes of SAS datasets, the features provided by SAS are robust enough for users to at least consider SAS as a possible answer to keeping track of changes to their data.

It must be noted from the onset that the idea of adding an audit trail to a SAS dataset is to track changes and modifications - rebuilding the dataset deletes any existing audit trail.

SAS OPTIONS

There are four SAS Options that are very good for controlling access to a SAS dataset:

- ALTER= password to alter structure
- READ= password to read
- WRITE= password to modify the data
- ENCRYPT= password to encrypt the data

These passwords can be set when the dataset is first created. While there are the four options, in practice on a controlled network only two of these options are used, ALTER and WRITE, as to put READ and ENCRYPT passwords on a SAS dataset will require all users who want to view the data to have these passwords. Enabling only the ALTER and WRITE password will restrict altering the structure of the dataset, e.g. adding or deleting columns, and also restrict who can modify, add or delete data. The following example demonstrates adding ALTER and WRITE passwords to a SAS dataset that has information on medical monitors:

```
data trial.crew (alter=Navy write=Lark label='HMS Troutbridge');
    infile cards;
    input name $ 1-16 rank $ 18-36 sn $ 38-42;
cards;
Leslie Philips    Sub Lieutenant       61885
Jon Pertwee       Chief Petty Officer 50796
Ronnie Barker     Able Seaman          96822
Dennis Price      Number One           52925
Stephen Murray    Lieutenant           57467
Richard Caldicot Commander             07973
;
run;
```

Running a CONTENTS procedure will produce the following output indicating that the dataset has been protected with an ALTER and WRITE password:

```
                        The CONTENTS Procedure

     Data Set Name          TRIAL.CREW                         Observations          6
     Member Type            DATA                               Variables             3
     Engine                 V9                                 Indexes               0
     Created                Sunday, February 24, 2008 10:12:06 AM   Observation Length    40
     Last Modified          Sunday, February 24, 2008 10:12:06 AM   Deleted Observations  0
     Protection             WRITE/ALTER                        Compressed            NO
     Data Set Type                                             Sorted                NO
     Label                  HMS Troutbridge
     Data Representation    WINDOWS_32
     Encoding               wlatin1  Western (Windows)


                   Alphabetic List of Variables and Attributes

                        #    Variable    Type    Len
                        1    name        Char     16
                        2    rank        Char     19
                        3    sn          Char      5
```

With the ALTER and WRITE passwords in place only those who are privy to these would be able to alter the structure of the dataset or add, delete or modify the records.

GETTING THE AUDIT TRAIL STARTED IN A SAS DATASET

An audit trail is useful if the dataset is in a state where few if any changes are needed, or it is a dataset that is like a list that is constantly changing. It is not good for the case where the dataset will be rebuilt many times over the life of the dataset – in this case the user should consider versioning which is discussed later in this paper.

You start an audit trail using the AUDIT statement in the DATASETS procedure. The following initiates the audit trail to the dataset CREW:

```
   proc datasets lib=trial;
     audit crew (alter=Navy);
       initiate;
       user_var reason $100;
     quit;
   run;
```

Note that a password had to be entered to alter the dataset. A variable REASON has also been created using the USER_VAR statement so that it is possible to put a note to a record that has been changed. The output from a CONTENTS procedure call will produce a similar output as before but with four extra lines added at the bottom of the header indicating that the dataset does have an audit trail, but it does not contain any of the variables used to store the audit information:

```
                        The CONTENTS Procedure

     Data Set Name          TRIAL.CREW                         Observations          6
     Member Type            DATA                               Variables             3
     Engine                 V9                                 Indexes               0
     Created                Sunday, February 24, 2008 10:12:06 AM   Observation Length    40
     Last Modified          Sunday, February 24, 2008 10:17:31 AM   Deleted Observations  0
     Protection             WRITE/ALTER                        Compressed            NO
     Data Set Type                                             Sorted                NO
     Label                  HMS Troutbridge
     Audit                  Active
     Audit Before Image     YES
     Audit Admin Image      YES
     Audit Error Image      YES
     Audit Data Image       YES
     Data Representation    WINDOWS_32
     Encoding               wlatin1  Western (Windows)


                   Alphabetic List of Variables and Attributes

                        #    Variable    Type    Len
                        1    name        Char     16
                        2    rank        Char     19
                        3    sn          Char      5
```

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To get the audit trail variables for the dataset the TYPE=AUDIT option needs to be used in the CONTENTS procedure call, as shown below:

```
proc contents data=trial.crew (type=audit);
run;
```

with the following output:

```
                         The CONTENTS Procedure

Data Set Name        TRIAL.CREW.AUDIT                    Observations         0
Member Type          AUDIT                               Variables            10
Engine               V9                                  Indexes              0
Created              Sunday, February 24, 2008 10:17:31 AM  Observation Length  206
Last Modified        Sunday, February 24, 2008 10:17:31 AM  Deleted Observations 0
Protection           WRITE/ALTER                         Compressed           NO
Data Set Type        AUDIT                               Sorted               NO
Label                HMS Troutbridge
Data Representation  WINDOWS_32
Encoding             wlatin1  Western (Windows)

              Alphabetic List of Variables and Attributes

          #    Variable         Type    Len    Format

          5    _ATDATETIME_     Num      8     DATETIME19.
         10    _ATMESSAGE_      Char     8
          6    _ATOBSNO_        Num      8
          9    _ATOPCODE_       Char     2
          7    _ATRETURNCODE_   Num      8
          8    _ATUSERID_       Char    32
          1    name             Char    16
          2    rank             Char    19
          4    reason           Char   100
          3    sn               Char     5
```

Descriptions of the variables created for the audit trail are listed below:

Variable	Description
ATDATETIME	Date/time of modification
ATUSERID	User ID of person making modification
ATOBSNO	Observation number of record being modified (NOTE: if the option REUSE=YES is on then value will always be '0')
ATRETURNCODE	Success/Failure return code (blank if successful, error code from SAS Log if unsuccessful)
ATMESSAGE	Stores the SAS log message from SAS when the modification occurred
ATOPCODE	Modification code. Valid return codes are: DA=Record added DD=Record deleted DR=Copy of record before update DW=Copy of record after update EA=Record added failure ED=Record deleted failure EW=Record update failure.
REASON	User created variable for purpose of noting a reason.

It is possible to suspend, resume and terminate the audit trail for a dataset using the following code examples:

```
proc datasets lib=trial;
  *Suspend an audit trail;
    audit crew (alter=Navy); suspend;
  *Resume an audit trail;
    audit crew (alter=Navy); resume;
  *Terminate an audit trail;
    audit crew (alter=Navy); terminate;
  quit;
run;
```

While it is possible to do these actions on an audit trail within a SAS dataset these are not encouraged since it will invalidate the integrity of the dataset.

TIME TO MODIFY SOME DATA WHEN AN AUDIT TRAIL IS ACTIVE

In the Introduction it was indicated that if a SAS Dataset was rebuilt then audit trail information pertaining to that dataset will be lost so some particular strategies have to be adopted when editing data in the SAS dataset.

The three tasks that are generally done in a SAS dataset are:

- modify an existing observation
- add a new observation
- delete an existing observation

Whenever a DATA step SET statement is used the dataset is rebuilt so using this statement in the code to modify the dataset should be highly discouraged. However the SQL procedure with UPDATE, INSERT and DELETE statements is one way of modifying the data while keeping the audit trail. The following examples show how to update the dataset while keeping the audit trail:

```
proc sql;

  *Correct record;
  update trial.crew (write='Lark')
    set name='Leslie Phillips',
        reason='Corrected name, ref. memo 2008-02-24'
        where sn='61885';

  *Delete record - update first to add reason;
  update trial.crew (write='Lark')
    set reason='On loan to US Navy, ref. memo 2008-02-24'
    where sn='52925';
  delete
    from trial.crew (write='Lark')
    where sn='52925';

  *Add new record;
  insert into trial.crew (write='Lark')
    set name='Heather Chasen',
        rank='WRN, First Class',
        sn='98072',
        reason='New crew member, ref. memo 2008-01-24';
  quit;
run;
```

After the amendments the dataset has the following data:

```
Obs        name            rank                sn
 1     Leslie Phillips     Sub Lieutenant      61885
 2     Jon Pertwee         Chief Petty Officer 50796
 3     Ronnie Barker       Able Seaman         96822
 5     Stephen Murray      Lieutenant          57467
 6     Richard Caldicot    Commander           07973
 7     Heather Chasen      WRN, First Class     98072
```

To list the audit data the option TYPE=AUDIT must be used, as shown in the following SAS code and output:

```
proc print data=trial.crew (type=audit);
   title1 'Audit Trail After Modifying CREW Dataset';
run;
```

```
                      Audit Trail After Modifying CREW Dataset

Obs      name               rank            sn                    reason

 1   Leslie Philips     Sub Lieutenant    61885
 2   Leslie Phillips    Sub Lieutenant    61885     Corrected name, ref. memo 2008-02-24
 3   Dennis Price       Number One        52925
 4   Dennis Price       Number One        52925     On loan to US Navy, ref. memo 2008-02-24
 5   Dennis Price       Number One        52925
 6   Heather Chasen     WRN, First Class  98072     New crew member, ref. memo 2008-01-24


Obs        _ATDATETIME_   _ATOBSNO_  _ATRETURNCODE_    _ATUSERID_    _ATOPCODE_   _ATMESSAGE_

 1   24FEB2008:10:30:24       1           .             dfrankli         DR
 2   24FEB2008:10:30:24       1           .             dfrankli         DW
 3   24FEB2008:10:30:24       4           .             dfrankli         DR
 4   24FEB2008:10:30:24       4           .             dfrankli         DW
 5   24FEB2008:10:30:24       4           .             dfrankli         DD
 6   24FEB2008:10:30:24       7           .             dfrankli         DA
```

Note that in the listing from the audit trail it recorded that the record for SN 61885 was changed, the record for SN 52925 was deleted (it was actually modified first to get a reason for deletion in the audit trail) and a new record for SN 98072 was added. Also added was the UserID of the person who added it and the date/time it occurred.

ANOTHER WAY TO TRACK CHANGES, DATASET VERSIONING

As mentioned earlier the audit information is lost when a SAS dataset is rebuilt using a statement like SET in the DATA step. However it is sometimes necessary to keep versions of a SAS dataset. This can be achieved using the SAS DATASETS procedure with the COPY statement and placing that copy into another directory or placing it on another media.

SAS has another feature that is available if "versions" of a dataset have to be made instead of using the audit trail facilities. To set a SAS dataset up for "versions" the GENMAX= option is invoked, as shown in the example below:

```
data trial.crew (alter=Navy write=Lark label='HMS Troutbridge' genmax=2);
    infile cards;
    input name $ 1-16 rank $ 18-36 sn $ 38-42;
cards;
Leslie Philips    Sub Lieutenant      61885
Jon Pertwee       Chief Petty Officer 50796
Ronnie Barker     Able Seaman         96822
Dennis Price      Number One          52925
Stephen Murray    Lieutenant          57467
Richard Caldicot  Commander           07973
;
run;
```

The GENMAX=2 statement allows for three versions of the dataset to exist at any one time with number 0 as the current version, 2 as the most recent version, and 1 as the oldest version. A maximum of 999 versions, excluding the latest version, can be set for a dataset with the oldest version "dropping off" if the new version is created and the number of versions exceed that allowable.

To access a particular version of a dataset the option GENNUM= is used and can be used both in a direct and relative reference, as the following examples show:

```
*Print current version of dataset;
proc print data=trial.crew;
run;

*Print previous version of dataset;
proc print data=trial.crew (gennum=-1);
run;
```

Using this same technique it is possible to use the COMPARE procedure and compare versions of a dataset using the following code:

```
proc compare base=trial.crew data=trial.crew (gennum=-1);
run;
```

Versions of a SAS dataset can be deleted using the DELETE statement in the DATASETS procedure, as the following example shows:

```
proc datasets library=trial;
  *Deletes all versions except current version;
    delete crew (gennum=hist);
  *Deletes current version and moves previous version to current;
    delete crew;
  *Deletes all versions of dataset;
    delete crew (gennum=all);
  quit;
run;
```

The main disadvantage of using this method is that no note is available as to why a version was needed or any record as to why an individual observation was changed. However changes can be quickly seen using tools like the COMPARE procedure.

CONCLUSION
With careful planning it is possible to use SAS for tracking and securing SAS datasets. The methods looked at here are good and can track changes using their own features but it is important to know that with each method there are limitations.

CONTACT INFORMATION
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