

Get Smart! Eliminate Kaos and Stay in Control – Creating a Complex Directory Structure with the DLCREATEDIR Statement, SAS® Macro Language, and Control Tables

Louise S. Hadden, Abt Associates Inc.

ABSTRACT

An organized directory structure is an essential cornerstone of data analytic development. Those programmers who are involved in repetitive processing of any sort control their software and data quality with directory structures that can be easily replicated for different time periods, different drug trials, etc. Practitioners (including the author) often use folder and subfolder templates or shells to create identical complex folder structures for new date spans of data or projects, or use manual processing or external code submitted from within a SAS® process to run a series of MKDIR and CHDIR commands from a command prompt to create logical folders. Desired changes have to be made manually, offering opportunities for human error. Since the advent of the DLCREATEDIR system option in SAS version 9.3, practitioners can create single folders if they do not exist from within a SAS process. Troy Hughes¹ describes a process using SAS macro language, the DLCREATEDIR option, and control tables to facilitate and document the logical folder creation process. This paper describes a technique wrapping another layer of macro processing which isolates and expands the recursive logical folder assignment process to create a complex, hierarchical folder structure used by the author for a project requiring monthly data intake, processing, quality control and delivery of thousands of files. Analysis of the prior month's folder structure to inform development of control tables and build executable code is discussed.

INTRODUCTION

Since 1998, the U.S. Centers for Medicare and Medicaid Services (CMS) has maintained a website, Nursing Home Compare, which provides detailed quality information about every certified nursing home in the country. In December 2008, CMS greatly enhanced the usability of the website by adding an easy-to-understand 5-star rating. Each nursing home receives one to five stars based on performance in each of three key quality domains (health inspections, reported staffing levels, and quality measures derived from mandated assessments of resident health and well-being) plus an overall quality rating. Calculation of ratings requires integration of information from both facility and resident-level data sources. SAS® was used extensively in analysis to support the development of the rating system, and it is currently used to process data to refresh the ratings each month, based on newly collected data in each domain.

Data from two organizations is received monthly, data from two additional organizations is received quarterly, and data from an additional organization is received biannually. Processing is classified into four separate categories: reading in original data, calculating ratings, "other" processing (reading in data not used in ratings, redacting text fields, preparing for various types of output), and production of various types of output. A standard set of programs run in a standard, complex folder structure each month, with additional programs for quarterly and biannual processing.

This project is representative of the adage attributed to Heraclitus "The only constant is change". The incoming data changes every month. Sometimes the underlying structure of the data changes, and there needs to be flexibility in our system. Accordingly, we employ control tables in a number of instances, including date macro include files, hard code include files, self-writing batch files to run sequential programs, etc. This has worked to an extent - our processes have worked well for a long time, over 9 years, perhaps with and/or because of extraordinary effort by the programmers and technicians. As we look at our system with an eye toward software quality, though, it is clear we have a long way to go.

One time-consuming aspect of this project is recreating the complex directory structure every month for the next month's processing. We had been using an empty "skeleton" file structure, copying it over each month, then copying the most recent programs used in the prior month's processing by hand. The files in the "skeleton" and even the structure itself had a habit of changing on a regular basis, and we started to have a clutter of file skeletons, something inevitably would not get copied over, and chaos reigned. The DLCREATEDIR option as described by Troy Hughes¹ offered an alternative to this clumsy and error prone manual process.

COLLECTING INTELLIGENCE

In order to construct the desired directory structure for each prospective month, it is necessary to inventory the previous month's directory structure, and the contents thereof, as it is possible that the directory structure has

changed in the prior month. There are a number of ways to accomplish this, and several excellent papers describing those ways, some referenced in this paper. I chose to repurpose a data management tool that I originally designed for data storage management. It is also advisable to fully familiarize oneself with the task at hand – in my case, monthly processing, in terms of knowing the data being processed, the environment in which your data is housed and processed, and the software used to process it. SAS provides a number of tools to assist in this process including many ways to utilize SAS metadata and a wide variety of data step functions and macro functions.

As noted above, our monthly processing routine utilizes control tables containing date macros, including macros describing dates for the previous month's processing. Utilizing these control tables, we run a program "readdirlist.sas" on the previous month's processing folder. This program redirects piped input into a temporary SAS data set, which is massaged to parse out file type variables, etc., including directories and subdirectories. Note that running the program "in situ" allows us to define file paths as they exist in the current system, which increases portability of the techniques shown in this paper. The program outputs an MS Excel® workbook and a SAS data set named with a date stamp. We use the data set, filtered for specific purposes such as creating directories and copying files, as input.

Note: date macros are part of a separate include file. You can also use %WINDOW and %DISPLAY to collect this information. This technique works either interactively or in batch (in either case you need to fill in the information in order for the program to run.)

```
/* set the dates for the current round of processing */
/* prompts the user for the date and year each time batch mode is ran */

/** %WINDOW defines the prompt **/
%window info
    #4 @5 'Please enter the year files are received(YYYY):'
    #4 @53 fileyear 4 attr=underline display=yes auto=no color = blue

    #8 @5 'Please enter the date files are recieved(MMDD):'
    #8 @53 filedate 4 attr=underline display=yes auto=no color = red;

/** %DISPLAY invokes the prompt **/
%display info;
```

OR

```
/* Either in a control file referenced by the program or located in the program as
shown below */
```

```
%let prevyear=2017;
%let prevdate=0701;

%let archout=mp&prevyear.&prevdate.;

libname dd '.';
filename yy '.\reviseddirlist.txt';
filename dirlist pipe "dir ""S:\Projects\NH-Compare\Data_from_CMS\Monthly
Processing\Files&prevyear.&prevdate."" /s";
run;

data temp1000 ;
    infile dirlist lrecl=1000 missover pad;
    input fool $char1000.;
    if fool='' then delete;
    fool=left(fool);
    if index(fool,'bytes')>0 then delete;

    seqnum=put(_n_,z8.);
    retain sumflag 0;
    dirflag=(substr(fool,1,9)='Directory');
    if substr(fool,25,5)='<DIR>' then rectype='sdirname';
    if substr(fool,40,1)='.' then delete;
    if substr(fool,38,1) ne ' ' then rectype='filename';
```

```

        if substr(fool,1,9)='Directory' and substr(fool,25,5) ne '<DIR>' then
rectype='mdirname';
        sumflag=sumflag+dirflag;
run;
...
proc export data=temp5 dbms = excel
        outfile = ".\&archout._listing.xlsx" replace;
        sheet="&archout.";
run;

data dd.mp&prevyear.&prevdate.;
        set temp5;
run;

```

Bonus tip: Use %WINDOW to create a prompt to collect information to be used as a macro variable.

	A	B	C	D	E	F	G	H	I	J	K
			name	date	time	ampm	filetype	size	bytesize	sizefmt	rectype
1	original\directory										
2	2 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		1OriginalData	6/16/2017	12:28	PM	Directory				sdname
3	3 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		2ReferenceFiles	6/22/2017	03:12	PM	Directory				sdname
4	4 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		3denatlog	7/8/2017	05:57	PM	Directory				sdname
5	5 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		4OtherProcessing	7/12/2017	05:45	PM	Directory				sdname
6	6 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		5Output	6/16/2017	12:28	PM	Directory				sdname
7	7 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		6Metadata	7/10/2017	01:51	PM	Directory				sdname
8	8 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		HardcodeTracking_Deficiency.xlsx	7/8/2017	05:53	PM	Excel	120629 KB+	119KB		filename
9	9 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		HardcodeTracking_Provider.xlsx	7/8/2017	05:13	PM	Excel	133314 KB+	130KB		filename
10	10 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		HardcodeTracking_SurveyData.xlsx	5/28/2017	05:33	PM	Excel	38458 KB+	38KB		filename
11	11 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		INTERNALReadme_Files20170501.docx	6/13/2017	02:22	PM	Word Doc	26305 KB+	26KB		filename
12	12 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		INTERNALReadme_Files20170601_draft.docx	6/13/2017	09:49	PM	Word Doc	29294 KB+	29KB		filename
13	13 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		INTERNALReadme_Files20170701.docx	7/17/2017	09:41	AM	Word Doc	29115 KB+	28KB		filename
14	14 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		METADATA_VERSION_MACROS.txt	6/13/2017	11:26	AM	Text file	1850 KB+	2KB		filename
15	15 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		MonthlyProcessingLog_2017-0701.docx	7/6/2017	12:08	PM	Word Doc	75879 KB+	74KB		filename
16	16 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		OTHER_DATE_MACROS.txt	6/26/2017	09:29	AM	Text file	1725 KB+	2KB		filename
17	17 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		PROVIDER_PREVIEW_MACROS.txt	6/26/2017	09:32	AM	Text file	4404 KB+	4KB		filename
18	18 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		QM_DATE_MACROS.txt	6/26/2017	09:33	AM	Text file	1752 KB+	2KB		filename
19	19 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		readme20170701.txt	6/26/2017	09:37	AM	Text file	1978 KB+	2KB		filename
20	20 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		RUG_DATE_MACROS.txt	6/26/2017	09:37	AM	Text file	1777 KB+	2KB		filename
21	21 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701		STANDARD_DATE_MACROS.txt	6/26/2017	09:38	AM	Text file	1907 KB+	2KB		filename
22	22 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData		DataFromAbt	6/22/2017	03:13	PM	Directory				sdname
23	23 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData		DataFromCMS	7/10/2017	12:18	PM	Directory				sdname
24	24 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData		DataFromRTI	6/22/2017	03:14	PM	Directory				sdname
25	25 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData		DataFromTelligen	7/7/2017	08:33	AM	Directory				sdname
26	26 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData		Processing	7/9/2017	03:40	PM	Directory				sdname
27	27 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData		TestingEnfCmp	7/3/2017	03:50	PM	Directory				sdname
28	28 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData\DataFromAbt		claimsms_2015q3_2016q2.sas7bdat	4/28/2017	12:50	PM	SAS DS	2359296 MB+	2MB		filename
29	29 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData\DataFromAbt		clms_ra_15q3_16q1_041917.sas7bdat	4/20/2017	04:13	PM	SAS DS	2359296 MB+	2MB		filename
30	30 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData\DataFromAbt		clms_ra_15q3_16q2_041917.sas7bdat	4/20/2017	04:13	PM	SAS DS	2359296 MB+	2MB		filename
31	31 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData\DataFromAbt		Prep_cdm_msr03.sas	4/28/2017	12:50	PM	SAS progrs	3631 KB+	4KB		filename
32	32 S:\Projects\NH-Compare\Data_from_CMS\Monthly Processing\Files20170701\1OriginalData\DataFromAbt		Readme_filenames.txt	4/21/2017	03:19	PM	Text file	437 B+	0KB		filename

Careful review of the Excel workbook output is absolutely essential. Automation of any sort inherently requires constant vigilance in order to achieve quality outcomes – and this time-saving technique is no exception. “Ad Hoc” changes may have occurred in a prior month’s processing that were not intended to go into production. There’s no such thing as being too careful! Luckily SAS provides many opportunities to collect metrics in this effort. Comparison of READDIRLIST output from one month to another allows review of changes to the directory structure, programs, etc. and can be done programmatically using PROC COMPARE.

Bonus tip: Use the SAS supplied SIZEKMG format to convert a numeric size variable into kilobytes, megabytes, and gigabytes. For example

```
sizefmt=put(size,sizekmg.);
```

results in a character string such as 118KB.

TAKING CONTROL

Creating a directory with the DLCREATEDIR option is as easy as entering an OPTIONS DLCREATEDIR statement at the top of your program, and then specifying the desired library name in a libname statement. However, our directory structure is both complex and voluminous, and since the DLCREATEDIR system option only creates one subdirectory at a time, requiring changes in the “base” directory, the program would have been inordinately long, and would have required a lot of upkeep. In our programs the date macros are contained in an external control file, shown

here for explanatory purposes. Note that to avoid any potential catastrophic overwriting of a production library the new “base” folder has a suffix of “T”.

```
OPTIONS dlcreatedir;

%let fileyear=2017;
%let filedate=0801;
%let prevyear=2017;
%let prevdate=0701;

%let basedir=S:\Projects\NH-COMPARE\Data_From_CMS\Monthly Processing\;

/* create a top level libname */

libname monthly "&basedir.Files&fileyear.&filedate.T";

/* now create the new month's directory */

libname base "&basedir.Files&fileyear.&filedate.T";
```

We modified two macros, pioneered by Troy Hughes¹ in “SAS® Spontaneous Combustion: Securing Software Portability through Self – Extracting Code”. One of these macros “crawls” through a list of folders (seen below in control table dirconfig.txt), and the primary macro which reads in the control table, and calls the crawler macro. The primary macro uses two parameters specifying the directory name and the level (seen at the far left below). Data from the directory listing above is used to self-generate the macro call.

11	<LIBRARY>
11	Folder: 1OriginalData
11	Folder: 2ReferenceFiles
11	Folder: 3GenRatings
11	Folder: 4OtherProcessing
11	Folder: 5Output
11	Folder: 6Metadata
11s1	<LIBRARY>
11s1	Folder: Processing
11s1	Folder: DataFromCMS
11s1	Folder: DataFromIntelligen
11s1	Folder: DataFromAbt
11s1	Folder: DataFromRTI
11s1	Folder: TestingEnfComp
11s2	<LIBRARY>
11s2	Folder: QtrlyData
13s1	<LIBRARY>
13s1	Folder: 1HlthInspec
13s1	Folder: 2Staffing
13s1	Folder: 3MDS_QMs
13s1	Folder: 4Composite
13s2	<LIBRARY>
13s2	Folder: QtrlyData
14s1	<LIBRARY>
14s1	Folder: 2567s
14s1	Folder: PrepMCD_DMG
14s1	Folder: Outfiles
14s1	Folder: PBJ_ForPPs
14s2	<LIBRARY>
14s2	Folder: Outfiles
14s2	Folder: Redact
14s3	<LIBRARY>
14s3	Folder: Outfiles
15s1	<LIBRARY>
15s1	Folder: 2567s
15s1	Folder: Analysis
15s1	Folder: DataMedicareGov
15s1	Folder: Deliverables
15s1	Folder: Helpline
15s1	Folder: ProvPreviews
15s1	Folder: QMPlatformFiles
15s1	Folder: SASOutput
15s1	Folder: StateSpreadsheets
15s1	Folder: XMLOutput
15s2	<LIBRARY>
15s2	Folder: Outfiles
15s3	<LIBRARY>
15s3	Folder: Outfiles
15s3	Folder: Templates
15s4	<LIBRARY>
15s4	Folder: Outfiles
15s4	Folder: SASDs
15s5	<LIBRARY>
15s5	Folder: Intermediate
15s6	<LIBRARY>
15s6	Folder: Outfiles

```
%createlev(modirsuff=Files&fileyear.&filedate.T,level=11);
%createlev(modirsuff=Files&fileyear.&filedate.T/1OriginalData,level=11s1);
%createlev(modirsuff=Files&fileyear.&filedate.T/1OriginalData/Processing,level=11s2);
```

As you can see from the control table above, a level may have more than 1 subfolder, but the DLCREATEDIR system option requires that directories be built one at a time. The crawler macro allows the creation of multiple subdirectories with a single macro invocation. The control table is also easily editable if the directory structure changes (which it has and does.)

```

%let modir=&basedir.&modirsuff.;

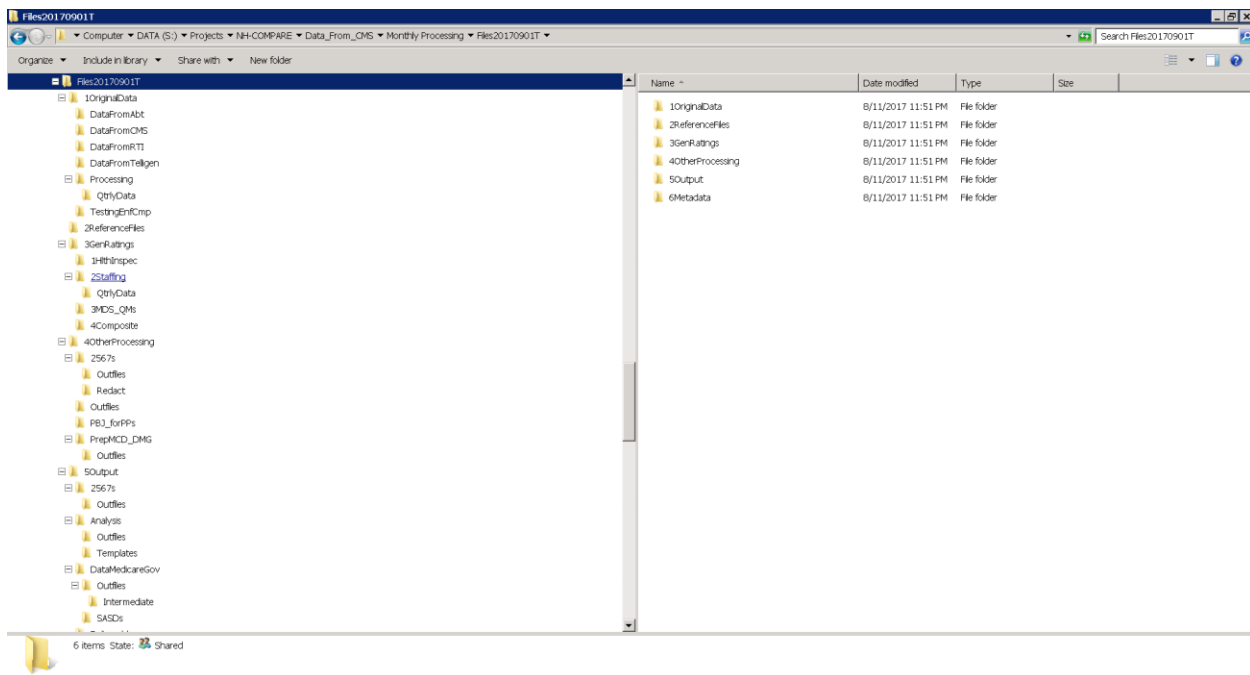
data temp&level;
  length category $ 8;
  set control;

  if upcase(tab)("<LIBRARY>") then category="lib";
  else do;
    if category="lib" then do;
      call execute('%crawler(dir='||strip(lib)||',loc='||strip(loc)||');');
    end;
  end;

  retain category;

run;

```



This portion of the combined directory creation and file copying routine runs quickly and efficiently, yielding a perfectly formed, empty directory structure for succeeding months.

ELIMINATING KAOS

Along with a complex directory structure for our project, there are a multitude of other files required for processing the data: programs, include files, control files, metadata files, XML maps, format and macro catalogs, etc. As with the directory structure itself, other files change over time, and the same information we collected about the previous month's directory can help us populate our new monthly folder. Copying over all of the processing from a prior month would be counter-productive and confusing. We can use our metadata from the prior month (and some substantive knowledge about the processing) to choose the files we need, by subdirectory.

As with creating directories and subdirectories, there are many ways to copy files within SAS. An in-depth discussion is not within the scope of this paper. Suffice it to say that the choice of which method to use will depend on a number of factors, including your operating system, environment, security concerns, etc. We wanted to be able to use macro processing, and control file types that were copied by subdirectory. We created several specific macros for different purposes – one for copying just SAS programs, one for copying SAS programs and files with .txt extensions (include and control files), one for copying SAS data sets and MS Excel workbooks, and so on.

Each macro performs 3 primary tasks: identifies matching directories for the prior and upcoming month, creates a list of curated files to be copied, and executes copying the files. Two macros, %gocopy and (variants of) %copyfiles,

drive the processes. The macro used for copying files in the top level of the monthly processing folder serves as a template for the other more specific file copying macros.

```
/* copies previous mo files to current mo directories based on order number */

%macro copyfiles(num);

proc sql noprint;
select filename into: name
from filenames
where ord=&num;
quit;

options noxwait;

%local rc fileref ;

%let rc = %sysfunc(filename(fileref,%qcmpres(&currpath))) ;

%if %sysfunc(fexist(&fileref)) %then %do;
%sysexec copy "%qcmpres(&prevpath\&name)"
"%qcmpres(%qcmpres(&currpath)\&name)" ;
%end;
%let rc=%sysfunc(filename(fileref)) ;
%mend;

%macro gocopy;
%do i=1 %to &maxord;
%copyfiles(&i);
%end;
%mend;

/* macro to copy top level files */

%macro copytop;

%let prevpath=&basedir.Files&prevyear.&prevdate./;
%let currpath=&basedir.Files&fileyear.&filedate.T/;

/* make a list of everything in a directory */

%let indir=&prevpath;
%let nfiles=0;
filename indir "&indir";

data _filenames1(where=(
index(upcase(filename),'.') gt 0
));
format filename $45. ;
did=dopen('indir');
do i=1 to dnum(did);
filename=dread(did,i);
output;
end;
rc=dclose(did);
keep filename ;
run;

data filenames;
set _filenames1;
ord=_n_;
run;
```

```
proc sql noprint;
select max(ord) into: maxord
from filenames;
quit;
```

```
%gocopy;
```

```
%mend copytop;
```

```
%copytop;
```

Selective copies are done on files in subdirectories, using a macro parameter to run through subdirectories, and using the index function to select certain file types by extension. The macro below selects SAS PROGRAMS but excludes SAS data sets, and selects files with the .txt extension. Other macros select only SAS programs and files, and all files. As always, you should consult your metadata (directory listing) to assess whether or not all needed files are being copied, and that ONLY needed files are being copied. In our case, processing yields some massive, and numerous, files that should not be copied. Specific macros are assigned to subdirectories based on a careful review and knowledge of our project metadata.

```
%macro copysasp(subdir=1OriginalData/Processing);
```

```
...
```

```
data _filenames1(where=(
index(upcase(filename),'.SAS') gt 0
and index(upcase(filename),'BDAT') eq 0) OR
index(upcase(filename),'TXT') gt 0
)); ...
```

Name	Date modified	Type	Size
1OriginalData	8/11/2017 11:51 PM	File folder	
2References	8/12/2017 12:43 AM	File folder	
3GenRatings	8/12/2017 12:43 AM	File folder	
4OtherProcessing	8/12/2017 12:43 AM	File folder	
5Output	8/11/2017 11:51 PM	File folder	
6Metadata	8/12/2017 12:43 AM	File folder	
HardcodeTracking_Deficiency.xlsx	8/2/2017 3:39 PM	Microsoft Excel Wo...	123 KB
HardcodeTracking_Provider.xlsx	8/4/2017 1:34 PM	Microsoft Excel Wo...	137 KB
HardcodeTracking_SurveyData.xlsx	8/1/2017 11:24 AM	Microsoft Excel Wo...	41 KB
INTERNAL_Readme_Files20170501.docx	6/1/2017 2:22 PM	Microsoft Word Do...	26 KB
INTERNAL_Readme_Files20170601_draft.docx	6/13/2017 9:49 PM	Microsoft Word Do...	29 KB
INTERNAL_Readme_Files20170701.docx		Word Do...	29 KB
INTERNAL_Readme_Files20170801.docx		Word Do...	29 KB
METADATA_VERSION_MACROS.txt	6/13/2017 9:49 PM	Text Document	2 KB
MonthlyProcessingLog_2017-0701.docx	7/6/2017 12:08 PM	Microsoft Word Do...	75 KB
MonthlyProcessingLog_2017-0801.docx	8/2/2017 2:57 PM	Microsoft Word Do...	75 KB
OTHER_DATE_MACROS.txt	6/26/2017 9:29 AM	Text Document	2 KB
PROVIDER_PREVIEW_MACROS.txt	8/1/2017 11:27 AM	Text Document	5 KB
QML_DATE_MACROS.txt	6/26/2017 9:33 AM	Text Document	2 KB
readme20170701.txt	6/26/2017 9:37 AM	Text Document	2 KB
readme20170801.txt	8/1/2017 11:29 AM	Text Document	2 KB
RUG_DATE_MACROS.txt	6/26/2017 9:37 AM	Text Document	2 KB
STANDARD_DATE_MACROS.txt	8/1/2017 11:30 AM	Text Document	2 KB

WOULD YOU BELIEVE? AND NEXT STEPS

The DLCREATEDIR macro process and copy files suite of macros are contained in the same program, and take just seconds to execute.

NOTE: SAS Institute Inc., SAS Campus Drive, Cary, NC USA 27513-2414

NOTE: The SAS System used:

```
real time      29.23 seconds
cpu time       8.06 seconds
```

The concept of control tables and metadata as program drivers, in conjunction with SAS macros, makes a difficult and onerous monthly chore a pleasure.

In order to more fully automate the process, we could use the metadata worksheet created above, and filter a list of the base directory and subdirectories from the prior month into specialized control tables the series of macros can read. However, it is difficult to ascertain what folders should be copied from which directories mechanically. As long as change is a constant, control tables will need to be rigorously created and reviewed.

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Usage Note 56710: The DLCREATEDIR system option creates a single directory

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RECOMMENDED READING

- Base SAS® Procedures Guide



CONTACT INFORMATION

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

Louise Hadden: Louise_Hadden@abtassoc.com

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