ODS for Data Analysis: Output As-You-Like-It in Version 7

Christopher R. Olinger
Randall D. Tobias
SAS Institute Inc., Cary NC

Abstract

This paper discusses advances made in the output generated by all Version 7 SAS® Software procedures. New features provided by the Output Delivery System (ODS) include automatic rendering of procedure output in HTML for the web, rich-text, Postscript or PCL format, output data sets from any printed output, and the ability to edit the look and feel of most output. ODS also supports all legacy line-mode printing and supports a document feature to allow post-procedure replaying of output. This talk introduces ODS features to be delivered in Version 7 and provides some concrete examples of how data analysts and statisticians can take advantage of the feature set provided by ODS.

Motivation

Every SAS user knows and loves the listing file, the vehicle for all printed SAS output for more than two decades. While familiar, the listing file has its limitations. For starters, output is restricted to monospace fonts only. On top of that, there isn't any tab information in the listing to let SAS users parse a table themselves. Industrious users have been forced to use all sorts of tricks to get SAS output into a document editor like Microsoft Word.

The limitations of the SAS listing stemmed from the fact that each procedure rendered its output to the listing file one line at a time. This outputting technique made it virtually impossible to add new output destinations (like HTML and RTF) to the SAS System as each procedure was wed to its own internal print routines. Adding new output destinations would require each procedure to support the output destination explicitly. One of the main goals of ODS was to get the statistical procedures out of the output formatting business — and, indeed, one of the nice things about Version 7 ODS is that it completely removes the burden of adding new output destinations from the procedures.

However, the listing file *is* handy for reading as a flat file. In fact, it is too handy. Have you ever had to read a listing file with a PROC PRINTTO and a _NULL_ DATA step just to rearrange some output or to grab some statistic that wasn't on the output data set? Did you ever think to yourself that there should be a better a way to do these sorts of things?

Enter ODS. The following table, generated by the RSREG procedure, was dropped into this document with no intermediate translation. Other ODS features make it possible to create a data set directly from this piece of output.

Factor	DF	Sum of Squares	Mean Square	F Value	Prob>F
Temperature	4	5258.016826	1314.504006	2.60	0.1613
GasLiquidRatio	4	11045	2761.150641	5.46	0.0454
PackingHeight	4	3813.016026	953.254006	1.89	0.2510

Figure1:RSREGoutputproducedasRTF

The ODS Solution

ODS provides a more flexible mechanism for procedures to produce output. Instead of writing to the listing file directly, the procedure creates an *output object* for each piece of output to be displayed. Every table, plot, and chart is thus a separate entity in the system. Each output object can be further broken down into two component parts:

- a *data* component, the collection of raw numbers and characters comprising the contents of the output
- a *template* component, the description of what the output is supposed to look like when the data is formatted and arranged on a page

Each piece of output exists in a logical hierarchy of output directories that is created as your SAS job executes. For instance, consider the following example.

```
dataa;
doa=1to4;
dob=1to4;
doc=1to4;
n=int(6*ranuni(1));
doi=1ton;
y=a+b+rannor(1);
x=a*b/rannor(3);
output;
end;
end;
end;
end;
end;
run;

procglmdata=a;
classabc;
modelxy=a|b|c/ss1;
run;
```

The output from the GLM procedure is arranged in the following output directory structure. Items in bold are directories and items in *italics* are output object names:

GLM
Data
ClassLevels
NumberofObservations
AnalysisofVariance
DependentVariableX
OverallANOVA
FitStatistics
TypeIModelANOVA
DependentVariableY
OverallANOVA
FitStatistics
TypeIModelANOVA

Every piece of output that a procedure produces has a name, a label, and a directory path describing where the output resides in the directory structure.

Output objects are created by the procedure, and they are rendered based on the *output destinations* that the user has requested. An output destination describes the type of formatting requested for the output (HTML, RTF, and so forth). You can control which output destinations are in effect by using the ODS statement or by selecting output destinations in the SAS Explorer.

Three new features afford users control of ODS output: the ODS statement, the TEMPLATE procedure, and the ODS Output Document.

- Using the ODS statement, you can set output destination attributes, select or exclude individual pieces of output, request that pieces of output be turned into a data set, and control which templates should be used for rendering purposes.

- The TEMPLATE procedure enables you to specify the attributes that describe how a piece of output should be formatted, as well as specify stylistic elements for output destinations. You can specify cell formats and headers, change column ordering, specify colors and fonts, add GIF images to HTML, and specify various other formatting and stylistic characteristics.

- And, finally, there is support for a persistent form of your output. The ODS Output Document enables you to save your output in raw form, modify the appearance of a piece of output, and replay it to any output destination. The Document also enables you to pick and choose individual pieces of output and combine them into more complex reports. You can do all of this without rerunning the procedure that initially created the output.

Details

All procedures have been converted to produce their output as ODS output objects.[1] You can control these objects and interact with ODS in a variety of ways. The primary ways to interact with the system are through the ODS statement, the SAS Explorer, PROC TEMPLATE, and PROC OUTPUT.

The ODS Statement

The ODS statement is a global statement that enables you to control ODS in batch mode. Using the ODS statement, you can specify options for output destinations, control the templates that are in effect for your SAS job, and select and exclude various pieces of output. You can also use the ODS statement to display the names of individual pieces of output as they are generated.

Output Destinations

Each output destination *generates* a particular type of output. HTML, output data sets, and Postscript are all separate output destinations. ODS is designed to allow multiple output destinations to be active at the same time. A single SAS job can, therefore, create both HTML and the SAS listing concurrently.

The initial release of Version 7 will contain support for the following output destinations:

- the standard SAS listing
- HTML for the Web
- output data sets

[1] Some procedures are more ODS compliant than others. The PLOT procedure, for instance, does not separate data and template information. It relies on what is known as "batch mode" - the old SAS listing is captured and passed along as the output object's data.

Soon after the initial release of Version 7, SAS Institute will be releasing support for the following output destinations:

- the ODS Output Document for modifying and replaying output without rerunning the procedure that created it
- RTF for inclusion in Microsoft Word
- PS and PCL for high fidelity printers
- *possibly* SGML and LaTex

You select an output destination by specifying the appropriate ODS statement options before your SAS job is executed. As an example, consider the following statements that compute a response surface regression analysis and render the results as RTF. The table produced by this job is included at the start of this paper (Figure 1).

```
odsrtffile='example.rtf';
odsselectfactorANOVA;

dataa;
inputOdorTemperatureGasLiquidRatioPackingHeight@@;
datalines;
66-1-10391-1043-11049110
58-10-11710-1-5-101-40101
650-1-1701-1430-11-22011
-31000-35000-26000
run;

procrsreg;
modelodor=TemperatureGasLiquidRatioPackingHeight;
run;

odsrtfclose;
```

See the "Examples" section for some examples of other output destinations.

Tracing and Selecting Output

You may have noticed in the previous example that you can select and exclude individual pieces of output with the ODS statement. Each piece of output has associated with it a name, a label, a directory path, and a template path. You can display this information by using the ODS TRACE option. Once you know the name or label of a piece of output, you can select it, exclude it, or turn it into a SAS data set. See the "Examples" section for a demonstration.

The SAS Explorer

The SAS Explorer is a new feature in the Version 7 SAS Display Manager that enables you to explore the various pieces and parts of the SAS System. Part of the SAS Explorer is the RESULTS node. The RESULTS node retains a running record of the output directory hierarchy that is produced when a SAS job is executed. Figure 2 shows the Explorer with the results for an analysis of variance. By clicking on the output labels in the Explorer you can link directly to the output in the output window or in an HTML browser. The items on the left-hand side of the RESULTS node are output directories. The items on the right-hand side of the RESULTS node are pieces of output (tables in this case).

The Explorer also enables you to set ODS options and edit templates. All of the options available in the ODS statement can be set from the Explorer. The template editor is a dialogue-based editor that allows you to set values for all of the template options.

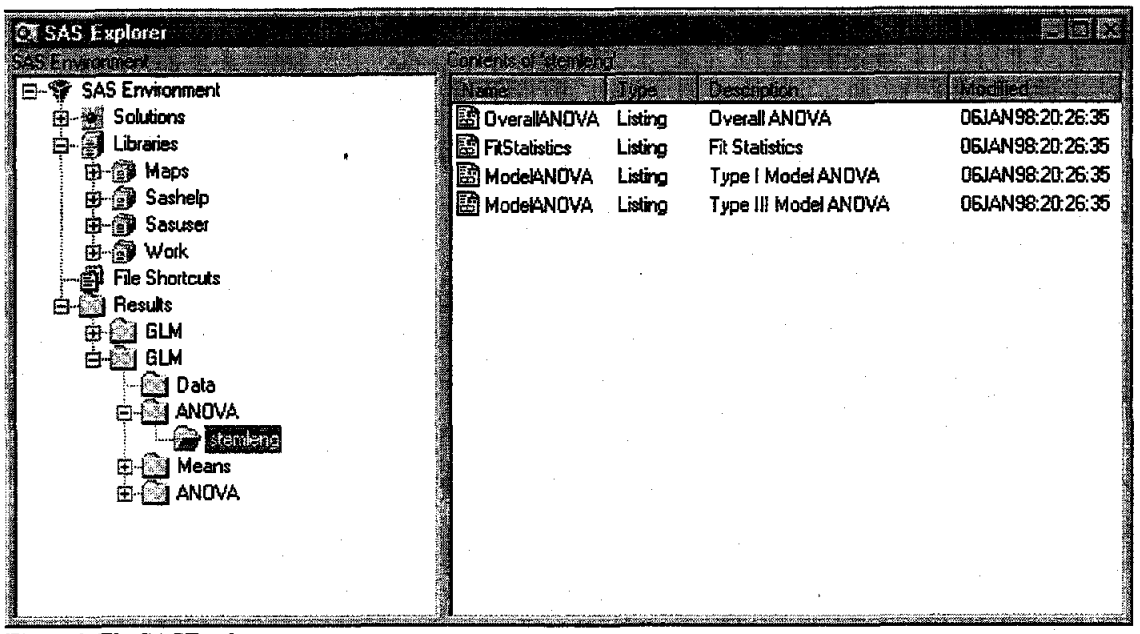

Figure2:TheSASExplorer

The Template Procedure

A *template* is an abstract description of what a piece of output is supposed to look like when it is formatted. A template contains attributes describing column ordering, style information, justification, cell formats, and other formatting characteristics. Most output objects have a template associated with them. You can find the template associated with a particular piece of output by looking at the ODS TRACE record. For an example, please see Figure 8.

The TEMPLATE procedure enables you to create and edit templates in batch mode. Templates are fully editable, so you can change the appearance of most output in the system. You can edit a template in Display Manager mode by using the new SAS Explorer.

SAS System templates are stored in the SASHELP library. When you run PROC TEMPLATE to modify or edit a template, the template is stored in the SASUSER library. You can modify the concatenation path that ODS uses to look up templates with the ODS PATH statement. In this manner you can set up a default set of templates for your organization to use that modifies the look and feel of SAS output. Once you have edited a template for a piece of output, the output continues to use that template until the template is deleted.

For an example of editing and using templates, please see the "Examples" section.

Styles

A style template is mostly concerned with stylistic issues such as colors, fonts, and presentation attributes. A style can be specified only for output destinations that support them. At present, the only destinations that support styles are HTML, RTF, and PS/PCL. The SAS output window does not participate in the style scheme, so if you want to use styles you need to use an output destination that fully supports them.

It is important to note the difference between a style template and a normal table template. A style applies to an entire SAS job, and a table template applies only to the tables that reference the template. Use of styles ensures a consistent look and feel across all output from the SAS System. You can, however, reference style information in templates for individual headers and data cells.

You can specify a style to use for an output destination using the ODS statement. As an example of what you can do with styles, see the PROC TABULATE output in Figure 3.

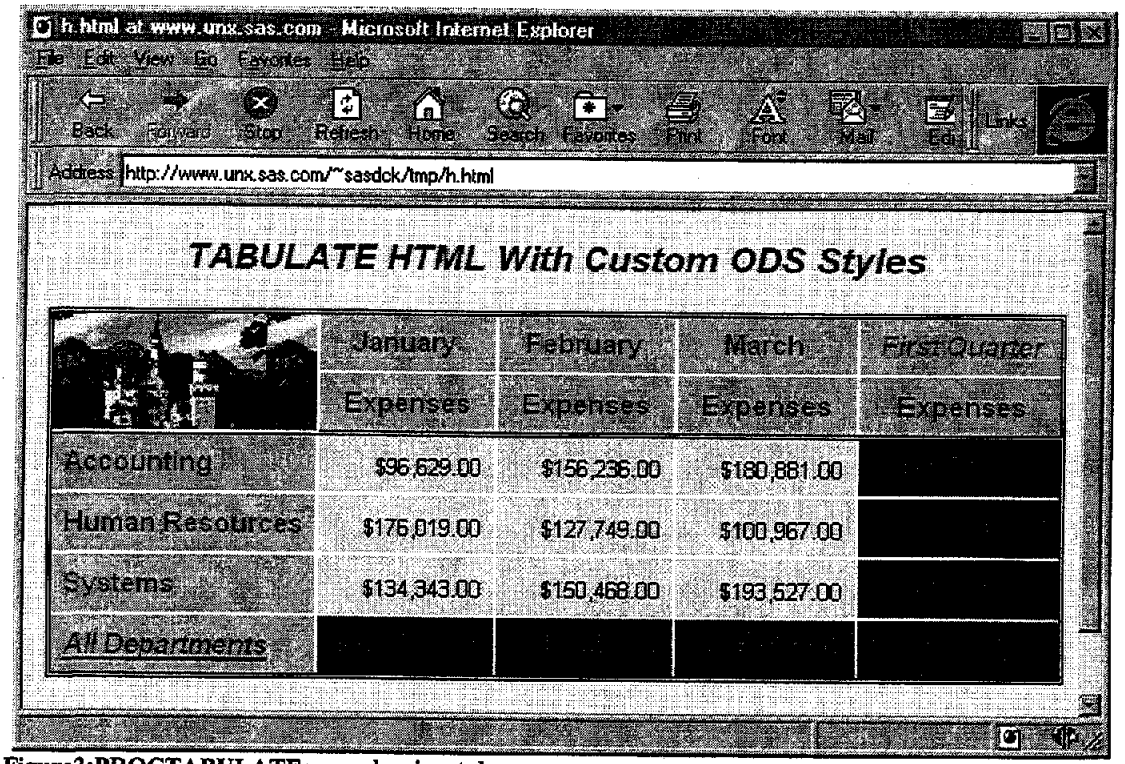

Figure3:PROCTABULATEexampleusingstyles

The ODS Output Document

Have you ever wanted to reformat output from a procedure without actually having to rerun the procedure? If so then the Document is for you. The Document is a persistent representation of the output that is produced by your SAS job. Output is stored completely in raw form. This enables you to change formatting characteristics (formats, column headers, and so on) without rerunning the procedure that created the output. The Document also enables you to browse and modify SAS output from previous runs, combine output into custom reports, and access your output from client-server applications.

The OUTPUT Procedure

The OUTPUT procedure enables you to manipulate ODS Output Documents in batch mode. There are commands to reorder output in the output directory hierarchy, to move and copy output to new directories, and to replay output to the various ODS output destinations. For Display Manager users, there is support for managing Output Documents in the SAS Explorer. All of the functionality in PROC OUTPUT will be available in the Explorer.

Examples

The examples were omitted due to the length of this paper. The full paper, including examples, can be found at http://www.sas.com/rnd/base/topics/odsfordata/readme.html.

The Usual Caveats

Compatibility Issues with Version 6 ODS Prototype

- In Version 6, a few procedures such as the MIXED procedure and the GENMOD procedure use a prototype ODS and use the MAKE statement to create data sets from output objects. This statement remains supported in these procedures, but all other procedures achieve this objective with the global ODS OUTPUT statement.
- The Version 6 prototype of the ODS output hierarchy is stored in a SAS catalog. Version 7 SAS Software has a more flexible *item-store* file type used to store templates and ODS Output Documents. There are currently no plans for a conversion procedure.
- The Version 6 prototype ODS uses two macro variables (_DISK_ and _PRINT_) to regulate the saving of an output hierarchy. Version 7 uses the global ODS statement to indicate this.
- The Version 6 and Version 7 PROC TEMPLATE and PROC OUTPUT syntax are not compatible.

Your Turn

The SAS Institute staff that brings you ODS is very excited about the potential of these new capabilities of the SAS System. You can send electronic mail with your comments or to request a copy of example HTML files to ods@unx.sas.com.

We will be adding more information about ODS capabilities to the Research and Development section of SAS Institute's Web Page. See http://www.sas.com/rnd

You can find more information about various aspects of ODS by referring to Heffner (1998) and Patel (1998).

Acknowledgements

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References

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