The World Wide Web and hypertext documents provide an ideal way to distribute Decision Support System (DSS) metadata. You can be certain that all your DSS users are reading the most up-to-date information, and varying the organization of the metadata allows novice users as well as experienced users to find the information they need.

This presentation discusses Purdue's Management Information's creation of a Web application to distribute DSS metadata. The metadata is stored in Oracle database tables, which lets you organize it in optimum form. Creating an update system in Microsoft Access is easy, and facilitates quick and simple changes. The Oracle Web Server formats hypertext pages on-the-fly from the database tables as they are requested. This combination gives hundreds of DSS users access to DSS metadata through their web browsers, with instant access to changes as they are entered.
Advances in DSS Metadata Delivery via the WWWeb

The project to develop Purdue’s management decision support system (DSS) was in response to the University’s #1 Client Request:

Provide more management data and make it easy to use

Even in the initial design stages of the project it was clear that “make it easy to use” was going to be more difficult than simply providing data. Selecting the right tool to present the data to the clients was part of the solution. The other part was a combination of communication and education.

A long-standing problem with communication within the University is terminology – different clients use the same term for different concepts, or use different terms for what turns out to be the same thing. This is less of a problem when people communicate mostly with people in their own office or peer group. This becomes a huge problem when we try to use one set of terms for one set of concepts University-wide. And this is what we are doing as we create a management DSS that will be used across the University.

So in order to “provide more management data and make it easy to use”, it isn’t enough to hold information-gathering meetings to define the perfect set of management data, and provide the perfect tool set to present the data. We also have to make sure that every client:

- knows what data that is available,
- understands what it can be used for and how to use it,
- has the same understanding of the data as every other client.

In order to accomplish these requirements, we need to provide each client with encyclopedic documentation of the data that is available to him or her. Each table of data must be defined, and its uses described including any cautions about using the data for particular uses. Each field must be defined, describing its uses and noting where its use is different by table.

Last, and maybe most important of all, the information provided must be phrased in terms that communicate in client terms the full flavor of how each field or table can be used. It does no good to provide definitions that are technically correct, if it leaves clients wondering how it applies to the real-world problems they are trying to solve. This encyclopedic information, expressed in client terms, is our metadata.

Why use the World Wide Web?

The DSS design team held a series of information-gathering sessions where clients were encouraged to identify their information needs and to describe how they would use management information. One result was the discovery that to clients “easy to use” didn’t necessarily mean particular software features – “easy to use” meant not having to learn another application – not having to remember another password – not having to deal with another icon…or window…or manual.

The World Wide Web and hypertext documents provide the “easy to use” way to distribute the metadata:

- we don’t have to give each client a paper manual that is out of date before they get it,
- the clients already have or are quickly getting web browsers on their PC desktop, and
- you can be certain that every client is reading the most up-to-date information.

Hypertext documents give you advanced capability to create an interactive, fully cross-referenced “encyclopedia” of information about the data stored in the decision support system. The ability to link documents together lets you present information at various levels of detail, with access to more detail just a click away.

A key to effective use of the Web is to allow access to the information in more than one way. There will always be a mix of experienced users and novices who need the metadata. You must provide the experienced user a quick way to find the detail he or she is looking for, while allowing for browsing and searching that helps the novice user find what they need. Multiple indexes, arranged for different purposes, need to be provided and each index needs to be interlinked to the detailed information.
This last requirement drives the need to automatically create web pages from a single set of source information. The single source of data makes it easy to change and add data to the metadata, while the automation of page creation makes it possible to present the same information in more than one way and know that each page has the most current information.

**Where we’ve been**

A database query tool selection process was conducted concurrent with the DSS project. Part of that process examined the capability of each tool to store and display metadata. None of the tools reviewed provided as broad a definition of metadata as it was evident was needed, and all of them restricted access to the metadata to their tool. Other storage and display options were examined, and the Web and hypertext document solution was selected. Brio was selected as our query tool.

Purdue is on its third generation of providing metadata on the web. All three embody the same design concepts, but as newer tools became available we were better able to realize the design vision. The key consideration in moving from one generation to the next was to make it simpler to maintain and present the metadata.

In the first generation, multiple hypertext documents were created by doing a one-way conversion of existing word-processing documents that described the data. These provided access and redundant display, but were never updated due to the difficulty of finding and updating all iterations of repeated data.

The second generation stored the source metadata in Microsoft Word documents, in table form.

![Second generation document flow](image)

Microsoft’s Internet Assistant allowed us to create web documents directly in Word. Macros were written to create the various interconnected hypertext documents. Six macros were written to create the five different type documents.

The macros were run whenever the data in the Table or Field documents had changed, recreating the hypertext pages.

This solution worked quite well until the list of fields reached nearly 1000, and we started hitting some Word memory limitations.

The third generation stores the source metadata in Oracle tables, and uses Oracle’s Web Server tools to gather and present the data as the client clicks on a link.

Each of the pages is created by a stored Oracle procedure that combines a query with Hypertext Markup Language (HTML) formatting. Although the query can include any data from any Oracle table, today these are limited to the tables of metadata information. Formatting can include boilerplate paragraphs in combination with metadata from the Oracle tables. The metadata formatting creates the links to interconnect the pages.
Organization of the Metadata into Oracle Tables

The metadata is separated into tables by classic data modeling techniques. The tables are:

- **Table** - data about each table
- **Field** - about fields in the tables
- **Steward** - people who control the definition of the data
- **Security** - levels of data security within DSS
- **Table External Reference** - links to table-related URLs
- **Field External Reference** - links to field-related URLs
- **Fact / Dimension** - which tables relate to each other

Oracle tables through an Open Database Connectivity (ODBC) connection, and uses Access forms to simplify the presentation of the metadata in an updateable format.

...
database and Access.

Metadata Update Application - Initial Form

The table data form displays metadata for a table. Most of the fields are text fields, and the text boxes have been sized to suggest the expected entry size. For instance, the box for “Definition” is larger than the box for “Description” because we expect the definition to be more detailed than the description.

Some drop-down selection boxes have hard-coded selection lists (Table type and Status), while some are Oracle table-driven (Steward and Security).

Metadata Update Application - Table Form

Buttons can be clicked to show the field form, external references form, or related tables form. When accessed from the table form, these forms are limited to values for the table being displayed.

The Print Report button triggers an Access report to the default printer, showing all metadata for this table and the fields in the table.
The field data form displays metadata for a field of a table. Again, most are text fields, and are sized to suggest the expected entry size. Some selection boxes have hard-coded lists (Status and Index), while some are Oracle table-driven (Steward and Security). Two field format fields are not directly typed: "Print" (a readable form) and "DBMS" (the Oracle description). These fields are calculated when the fields just above them change (Field Type, Length, and #Decimals). These three fields are not in the Oracle database; they are calculated from the DBMS format as the form is displayed.

The Show References button shows links to field-related URLs. The Print Report button triggers the same Access report as on the Table data form, but the report only includes the metadata for the table and this one field.

There are additional data forms to display and provide update for Steward data, Security levels, Table and Field reference links to URLs, and Table relationships. The data forms have default values and audits to maintain the referential integrity of the metadata. Towards that end, some of the forms were defined as read-only, and opened for update only if they were accessed from Table or Field data form buttons. This required the only specific coding in the whole system, about 15-20 lines per form. The remainder of the system was built with standard Microsoft Access Wizards and Form builders to point, click, drag, and answer questions.

A button was added to the tool bar to run a macro that makes it simple to insert ad hoc links to any URL. The macro inserts "<A HREF="http://COMPLETE URL">TEXT OF LINK</A>" at the current cursor position. The "http://COMPLETE URL" and "TEXT OF LINK" show the client what needs to be entered and where.
Determining the Metadata Display Structure

In part the metadata display structure is defined by the database it describes. Purdue’s Decision Support System is a multi-dimensional database of fact and dimension tables which are presented to the clients in logical data models.

Fact tables are tables of recurring business events, such as Accounting Transactions or Payroll Charges. The Data Models listed in Brio are named for the Fact table which is central to that model. Dimension tables are tables of multiple-use definitional information, such as Account Numbers. The same Account Number information is useful whether you are looking at accounting transactions, payroll charges, or account balances. Dimension tables are included on Brio Data Models wherever they apply.

Clients need to know what tables are available, and what fields are contained in each table. They also need to know which data tables can and should be used together to answer management questions.

To accommodate these needs Purdue's DSS metadata display is organized to fit the way clients think about and use the data. The “doorway” to the metadata is a DSS home page. This home page is the directory of all information about using DSS, from how to request access, training materials and sample queries, to a list of the DSS steering team. This page also has links to the top-level DSS metadata indexes.

The indexes are the Tables Index, the Fields Index by Common Name, and the Fields Index by Oracle Name.

Due to space and printing limitations, the sample web pages may not be fully readable. The web pages are available at “http://www.adpc.purdue.edu/DSS/”.

This index describes the two types of tables used in multi-dimensional modeling, Fact tables and Dimension tables, and lists the tables.

Each entry contains the table name, description, and a status alert if the table is being modified or is still being developed. The table name is a link to more detailed information about the table.

### Tables Index

<table>
<thead>
<tr>
<th>Table Name</th>
<th>Table Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCOUNT_BALANCE</td>
<td>Fact</td>
<td>Provides various balances for accounts (funds/centers)</td>
</tr>
<tr>
<td>ACCOUNT_NUMBER</td>
<td>Dimension</td>
<td>Information describing a fund and center. Fund/center is commonly referred to as an &quot;account&quot;.</td>
</tr>
<tr>
<td>BUDGETHEADER</td>
<td>Dimension</td>
<td>Organization units as defined for budgeting and fiscal management purposes</td>
</tr>
</tbody>
</table>
This index lists the fields in alphabetic sequence by the common name of the field. Each entry contains the common name, the name of the table in which the field is found, a description of the field, and a status alert if the field is being modified or is still being developed.

The field name is a link to more detailed information about the field. There are letter pointers to allow the client to instantly jump to any point in the alphabetic listing.

This index lists fields by the Oracle (database) name of each field. These names are usually abbreviated versions of the common name, and this is the name displayed by the Brio query tool.

The entries in this index are like those in the common name index, with the Oracle name substituted for the common name.

The Oracle name links to detailed information for the field.

heavy reference books. The World Wide Web is ideal for just such a presentation. With a single mouse click clients can jump to a data definition, drill down for greater detail, or jump back to check for alternative data.
Surfing the Data

balances might go to the index of tables, and display the information about the Account Balance table. They would see:

stored for a table, including description, definition, typical summarized or more detailed data, refresh rate, table size, the staff comments, and security information. Links give a list of fields, external and other related tables. Links are also on every page to jump and the home page.

Table Detail

The client might then click on the “Field list for table: ACCOUNT BALANCE” link to see what data fields are

This list shows the fields in the sequence they are displayed by the is alphabetic sequence, but many “most used” fields were moved to the to find. The list shows the field’s common The field name is a link to detailed information about the field.
Creating and running a simple query on the Account Balance table shows that the balances on a few specific accounts do vary in a regular manner. Returning to the metadata and the table detail for Account Balance, the client clicks on the “Supporting Dimensions” link to see what other tables contain related information.

This page lists the other tables in DSS that contain logically related data. The page is tailored by type of table (fact or dimension).

For each related table, the list shows the table name, description, and status alert. The table name is a link to detailed information for that table.

Related Tables

This information is also available graphically by clicking on the “External References” link.

This page provides a list of links to other documents that help describe a table.

The first use for this has been to link to a graphical picture of the data model for this table.
This is a typical diagram. It shows the data model for the Account Balance fact table. The fact table is in the center, and the supporting dimension tables are arrayed around it. The field names shown are Account Balance fields used to join to the dimension tables.

Checking the related tables, the client wonders if the accounts whose balances vary regularly might have common account characteristics. Looking at the fields in the Account Number table, the client notices the “Pay Method” field, and decides to see what information it contains.

This page shows all information stored for a field, including description, definition, oracle name, originating document, whether the field is indexed, format, and source file.

This information is tailored by table, to accommodate differences when the same field means different things in different tables.

Links are provided to go to the list of all fields in this table, the detailed information for the table, and the common links to the indexes and the home page.

Seeing that this field describes the terms in which a sponsor transfers funds to the University, and noting a link to the list of payment methods, the client clicks on the link.
Advances in DSS Metadata Delivery via the WWW

A link can be inserted into virtually any text description field within the metadata, and that link can be to any URL supported by the browser.

In many cases, these are to hypertext documents that describe code values in plain English. Since these documents may be “linked-to” from various places, they contain instructions to use browser capability to return to the earlier page.

Ad Hoc links

The client adds the Pay Method field from the Account Number table to the simple query that was created earlier. Running the query again shows that all of the accounts in question have payment methods that indicate quarterly payments, and quarterly payments are the reason that the balances of these accounts to vary on a regular basis.
Plans for the Future

The system described above is not a final and complete solution to storing, updating and displaying metadata for Decision Support Systems.

This solution is a huge improvement over our earlier solution that used Microsoft Word documents to store the metadata source, and automated the creation of web pages with Word macros. The Word solution worked well until we reached almost 1000 Fields and started hitting some Word memory limitations. It allowed our clients to to quickly and simply keep DSS documentation current without assistance from Management Information. However, it was a multiple-step process to change the Word documents, run the macros, and FTP the updated pages to the Web server.

The new Oracle table and Oracle Web server system provides one-step metadata updating and instant access to changed information. While this is a wonderful technical solution, it sets the stage for more challenging concerns. Since we are striving for a “one University” data warehouse, we are sharing metadata as we share DSS tables across client areas. Having our second DSS project in the its final stages, the shared metadata is being updated by two clients designated by the data stewards over those business areas.

Sharing metadata means that definitions must speak to varied audiences, ranging from department business managers to school academic advisors. Creating definitions that do that successfully, and keeping this consideration in mind as definitions are refined will be a continuing challenge.

Our one set of metadata is also planned to support new DSS projects as well as the ones in production use. The Status Alert column of many of the displays supports this, but definitions will also need to be crafted that continue to describe the data in production use as well as describing the changes in progress.

Last, but not least, our third Decision Support project may require minor changes in the arrangement and relationship between the tables of metadata information.

Purdue has demonstrated that there are low-tech solutions to providing useful DSS metadata via the World Wide Web, and we have moved on to a more advanced solution. The flexibility and usefulness shown by both solutions continue to suggest possibilities at Purdue for using Web tools to replace University documents and manuals, saving time and paper, and improving communication.