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EMERGING DESIGN STANDARDS FOR WEB DATA ACCESS TOOLS

Submitted by the U.S. Bureau of Justice Statistics¹

Many statistical agencies are moving toward the creation of browser-based data access tools and interfaces that allow users to specify the content of the output. Unless developers of such data access tools, which can be very expensive to build, pay close attention to usability, the tools fail to help users find the data they need and may instead increase user frustration.

Several U.S. statistical agencies have been working to develop a set of usability standards for web-based interfaces to statistical databases. While newly developed browser gateways to data still need independent usability testing, designers who follow these standards during design of the tool should be able to achieve a fairly satisfactory degree of usability from the start.

This paper discusses the ten design guidelines or standards that have emerged in response to problems that users encounter when they attempt to use such tools. In addition, the Bureau of Justice Statistics website application, Crime & Justice Data Online, is used to demonstrate implementation of the guidelines.

The movement to electronic dissemination via the Internet

Before the Internet, statistical data was available to expert users in electronic formats for analysis with their own resources while less sophisticated users relied on printed reports. With the advent of the Internet, agencies used the publishing paradigm placing electronic versions of documents on the Internet. However, the data was locked in formats that limited the user's ability to manipulate the data and lost the computational properties of the numbers. As technology to interface databases via the Internet became available, many statistical agencies moved to create electronic data access tools to allow users to extract the data they needed directly from agency databases.

Problems with early data access tools

Suddenly there was a proliferation of information previously challenging to get to and tools to support self-serve access to it. However, the tools were often weak and had a narrow focus. Citizens using the tools were often frustrated. A review of the tools found that they were difficult to use, depended on an expert knowledge of the data, offered too many options to do some things and no options to do others, and frequently mimicked statistical (analytic) software more than being effective access tools.

As more tools were deployed, developers recognized the need for usability testing. The U.S. Bureau of Labor Statistics staff became involved in conducting usability testing and heuristic evaluations of a number of tools from several U.S. government statistical agencies including:

¹ Prepared by Marianne Zawitz

FERRETT - U.S. Census Bureau access tool -(has evolved to DataFerrett)
<http://dataferrett.census.gov/TheDataWeb/index.html>

LABSTAT (LABorSTATistics) - Bureau of Labor Statistics
<http://stats.bls.gov/home.htm>

FedStats "gateway" to statistics at over 100 agencies
<http://www.fedstats.gov>

CDC Wonder - Centers for Disease Control and Prevention access tool (studied for research purposes only)
<http://wonder.cdc.gov/#aboutWonder>

As reported by Bosley and Straub², citizens who used these tools:

1. Did not know how to search large data repositories efficiently.
2. Did not understand technical data definitions and data types/tokens that differ only slightly.
3. Lacked familiarity with multi-variate structure of data repository, and were overwhelmed by quantity and variety of accessible data.
4. Wanted to focus on small scope, personal questions rather than surveying the big picture.
5. Were unable to cope with gaps and other irregularities in data or adopted erroneous expectations and beliefs.
6. Were unable to accurately interpret the data or observe and extract meaning from patterns in the data - the data did not speak to them.

Design guidelines

Based on testing and reviewing of many U.S. statistical sites, BLS staff, in conjunction with Human Factors International, identified 10 points that, if followed, should greatly improve the usability of interactive statistical interfaces. Usability testing is still recommended even if you follow all of the guidelines because users are the final arbiters of what works. However, following the guidelines should result in having less to fix.

Design Guidelines for Web Data Access Tools

Orient the user to the available body of data

1. Give an overview of the available data

Provide general orienting information about the data that can be accessed using the interface. Highlight indicators of data scope, restrictions, deliberate omissions and other important characteristics.

2. Support situational awareness within the available data

Use text or graphics to propagate the data structure across levels. Tell users when they enter a disjoint partition of the data. Make it easy for users to return to the initial state (screens which link to major divergent paths?)

3. Display and clearly define metadata

Embed sufficient metadata with tools to get users started. Provide easy, "just-in-time" access to definitions of technical or unfamiliar descriptive terms encountered as querying proceeds. Avoid using short, cryptic labels for data sets or variables.

² Bosley, John J. and Kathleen A. Straub, "Data exploration interfaces: Meaningful web database mining by non-statisticians", *Proceedings of the IBM Make IT Easy Conference*. 2002

Design the interface for interacting with the data

4. Put adequate and clear instructions on the interface

Tell users explicitly how to work with the interactive elements on the interface. Make the association between an interactive element and user guidance clear and available. Set defaults in all data specification “widgets;” defaulting to the broadest specification is recommended.

5. Link users to frequently requested analyses

Provide links to frequently requested numbers or datasets. Store common queries for novice users to modify to suit their needs. Build shortcuts for advanced users' quick data access.

6. Use simple interaction schemes to accomplish complex query-building

Use logical task sequences or natural language instructions to support advanced Boolean query syntax. Enable users to add or exclude data selections, and express optional inclusion ("or") by making a series of clear, discrete choices.

7. Summarize outcome of complex data specification for review and confirmation

When users apply multiple filters, especially across multiple screens, display the final specification for review and confirmation before a user submits a data request.

Help users anticipate, interpret and evaluate results

8. Offer choices of easy-to-interpret output formats

Offer users choices among well-known, understandable outputs like tables or simple graphs. Use graphics, or actual examples of output formats, as well as text to describe output options.

9. Design output formats to facilitate quick and reliable query validation

Make output labels consistent with variable selection options in query. Make labels clear and highly visible on statistical tables. Support keeping row and column labels visible as user explores table contents (large tables).

10. Help users avoid searching for non-existent or non-available data

Warn against, or actively prevent, requests for missing or unavailable data. Notify user when query will return a null result.

Source: Bosley, John J. and Kathleen A. Straub, “Data exploration interfaces: Meaningful web database mining by non-statisticians”, *Proceedings of the IBM Make IT Easy Conference*. 2002

Bureau of Justice Statistics Crime & Justice Data Online Example

Bureau of Justice Statistics (BJS) Crime & Justice Data Online is an access tool for National, State and local data on –

- Crime trends
- Homicide trends and characteristics of victims and incidents
- Law enforcement agency characteristics

These data were selected for inclusion in the initial development of the tool because of user interest, the opportunity to link data among all of them, and the fact that they included both longitudinal and cross-sectional data. Usability testing was conducted on the tool during development.

Guidelines - Orient the user to the available body of data

1. Give an overview of the available data

BJS Crime & Justice Data Online opens with a list of data sources available and information about geography, population coverage, and time series covered. The scope of what is available is clearly presented.

U.S. Department of Justice
BJS Bureau of Justice Statistics

[BJS Home Page](#) ♦ [Data for Analysis](#) ♦ [Data Online](#)

Crime & Justice Data Online

To start, select one of the following subjects:

- ▶ **Crime trends from the FBI's Uniform Crime Reports**
 - by State including U.S. totals (since 1960)
 - by reporting local agency (since 1985)
- ▶ **Homicide trends and characteristics**
(victim age, gender, and race and weapon used)
 - by State (since 1976)
 - by local agencies with a population coverage of more than 250,000 (since 1985)
- ▶ **Law Enforcement Management and Administrative Statistics**
 - State agencies
 - Large local agencies (100 or more sworn officers)

2. Support situational awareness within the available data

The crumbs at the top of each page give the user a clear picture of how deep they are in the site.

U.S. Department of Justice
BJS Bureau of Justice Statistics

[BJS Home Page](#) ♦ [Data for Analysis](#) ♦ [Data Online](#) ♦ [LEMAS](#)

Law enforcement management and administrative statistics (LEMAS)

Source: BJS, Law Enforcement Management and Administrative Statistics Survey (LEMAS)

Years available: 1997, 1999

Additional information: *Law Enforcement Management and Administrative Statistics, 1999*

Coverage:
Primary State law enforcement agencies (49 State police or Highway Patrols) and
Local police and Sheriff's agencies with 100 or more sworn officers and 50 or more uniformed officers assigned to respond to calls for service. (About 600 agencies)

Results options:

Agency Profiles		Selected Tables		
Select:	Single agency overview including:	Select:	Additional detail for one or more agencies on:	
<input checked="" type="radio"/> State	Employment	<input checked="" type="radio"/> State	Calls for service	Patrols
or	Demographic composition	or	Community Policing	Personnel by function
<input checked="" type="radio"/> Local	Functions	<input checked="" type="radio"/> Local	Computers	Salary
	Agency operations		Courts/detention	Special Operations
	Salaries		Demographics	Training
	Employment requirements and training		Full-time employees	

(See Contents below for variable list)

Contents of Selected Tables

3. Display and clearly define metadata

Definitions of terms used for measuring crime are provided throughout.

U.S. Department of Justice
BJS Bureau of Justice Statistics

BJS Home Page ▶ Data for Analysis ▶ Data Online ▶ Crime Trends ▶ State Level ▶ State-by-State

Crime - State Level
State-by-State and National Trends

Choose years to include: From: 1960 To: 1999

Choose one or more variable groups*:
Number of index crimes
Number of violent crimes
Number of property crimes
Index crime rate
Violent crime rates

Choose one or more States:
United States-Total
Alabama
Alaska
Arizona
Arkansas

Hold down the control key to select more than one option.

Tables with many variables may be very wide.

Get Table Reset Form

*See [definitions](#) for the crimes included in each category.

4. Put adequate and clear instructions on the interface

The tool has few instructions. When used, they are written in clear, easy-to-understand language. User testing was required to make sure that users saw the instructions.

U.S. Department of Justice
BJS Bureau of Justice Statistics

BJS Home Page ▶ Data for Analysis ▶ Data Online ▶ Crime Trends ▶ State Level ▶ State-by-State

Crime - State Level
State-by-State and National Trends

Choose years to include: From: 1960 To: 1999

Choose one or more variable groups*:
Number of index crimes
Number of violent crimes
Number of property crimes
Index crime rate
Violent crime rates

Choose one or more States:
United States-Total
Alabama
Alaska
Arizona
Arkansas

Hold down the control key to select more than one option.

Tables with many variables may be very wide.

Get Table Reset Form

*See [definitions](#) for the crimes included in each category.

Guidelines - Design the interface for interacting with the data

5. Link users to frequently requested analyses

BJS Crime & Justice Data Online provides the option to get an agency profile that has a summary of the most frequently requested statistics.

U.S. Department of Justice
Bureau of Justice Statistics
BJS Home Page ♦ Data for Analysis ♦ Data Online ♦ LEMAS

Law enforcement management and administrative statistics (LEMAS)

Source: BJS, Law Enforcement Management and Administrative Statistics Survey (LEMAS)
Years available: 1997, 1999
Additional information: *Law Enforcement Management and Administrative Statistics, 1999*

Coverage:
Primary State law enforcement agencies (49 State police or Highway Patrols) and
Local police and Sheriff's agencies with 100 or more sworn officers and 50 or more uniformed officers assigned to respond to calls for service. (About 650 agencies)

Results options:

Agency Profiles		Selected Tables		
Select:	Single agency overview including	Select:	Additional detail for one or more agencies on:	
<input checked="" type="radio"/> State	Employment	<input checked="" type="radio"/> State	Calls for service	Patrols
or	Demographic composition	or	Community Policing	Personnel by function
<input checked="" type="radio"/> Local	Functions	<input checked="" type="radio"/> Local	Computers	Salary
	Agency operations		Courts/detention	Special Operations
	Salaries		Demographics	Training
	Employment requirements and training		Full-time employees	

(See Contents below for variable list)

Contents of Selected Tables

6. Use simple interaction schemes to accomplish complex query-building

Step 1

U.S. Department of Justice
Bureau of Justice Statistics
BJS Home Page ♦ Data for Analysis ♦ Data Online ♦ Crime Trends ♦ Local Level ♦ Single Agency

Crime - Local Level Single Agency Trends (Step 1 of 2)

To find an agency, select a State and a population group.

Choose a State:

Choose one or more population groups:

- All
- Cities 1,000,000 or over
- Cities from 500,000 through 999,999

Hold down the control key to select more than one option.

MSA - Metropolitan Statistical Area
city or urbanized area of at least 50,000

Next Reset Form

Step 2

U.S. Department of Justice
Bureau of Justice Statistics
BJS Home Page ♦ Data for Analysis ♦ Data Online ♦ Crime Trends ♦ Local Level ♦ Single Agency

Crime - Local Level Single Agency Trends (Step 2 of 2)

Choose years to include: From: To:

Choose one or more variable groups:

- Number of index crimes
- Number of violent crimes
- Number of property crimes
- Index crime rate

Choose an agency:

- Albaster Police Dept
- Albertville Police Dept
- Alexander City Police Dept
- Anniston Police Dept

Hold down the control key to select more than one option.

Tables with many variables may be very wide.

Get Table Previous Reset Form

*See definitions for the crimes included in each category.

7. Summarize the outcome of complex data specification for review and confirmation

BJS Crime & Justice Data Online presents three-dimensional data, which is hard for users to understand. Originally, the option descriptions were complete sentences. Through user testing, we saw users having a hard time choosing an output format. We determined that most users could not envision an output format from the descriptions. We highlighted the differences between the formats, used two word dimension descriptions in a list, and moved and simplified the examples to be with the descriptions. Testing of the revised design presented here resulted in greatly improved user performance.

U.S. Department of Justice
BJS Bureau of Justice Statistics

BJS Home Page ♦ Data for Analysis ♦ Data Online ♦ Crime Trends ♦ Local Level

Local level crime trends

Source: **FBI's Uniform Crime Reports (UCR)** Variables: **UCR Index offenses** (counts and rates)
 Coverage: Local reporting agencies with population coverage of more than 10,000 (About 3,900 agencies) Violent Crimes: murder and nonnegligent manslaughter, forcible rape, robbery, aggravated assault
 Property Crimes: burglary, larceny/theft, motor vehicle theft (See **definitions**)
 Years available: Since 1965

Select a table type:

Go Single agency trends

> One jurisdiction
 - Multiple variables
 - Multiple years

Example:

Crime reported by Dothan Police Dept, Alabama

Year	Population	Index offenses total	Index offense rate
1997	57,113	4,084	7,159.7
1998	57,004	2,031	4,011.4

OR

Go Trends in one variable

- Multiple jurisdictions
 > One variable
 - Multiple years

Example:

Robbery

Agency	State	1996	1997
Dacatur Police Dept	AL	16	38
Dothan Police Dept	AL	68	61

OR

Go One year of data

- Multiple jurisdictions
 - Multiple variables
 > One year

Example:

Crime in 1999

Agency	State	Number of Offenses	
		Robbery	Burglary
Dacatur Police Dept	AL	103	719
Dothan Police Dept	AL	126	727

Guidelines - Help users anticipate, interpret and evaluate results

8. Offer choices of easy-to-interpret output formats

BJS Data Online makes extensive use of examples of the output to assist the user in deciding what to select. Originally, the examples were further down the page and filled the horizontal space with data. We found that the large table examples intimidated most users. Using smaller extracts of the tables that could result from a query combined with the dimension descriptions aided users in getting what they wanted.

The screenshot shows the BJS Data Online interface for 'Local level crime trends'. It includes source information (FBI's Uniform Crime Reports), coverage (local reporting agencies), variables (UCR Index offenses), and years available (since 1965). Below this, three table types are presented as options, each with a 'Go' button and a red circle highlighting an example table.

Source: FBI's Uniform Crime Reports (UCR)
Coverage: Local reporting agencies with population coverage of more than 10,000 (About 3,900 agencies)
Variables: UCR Index offenses (counts and rates)
Violent Crimes: murder and nonnegligent manslaughter, forcible rape, robbery, aggravated assault
Property Crimes: burglary, larceny/theft, motor vehicle theft
(See [definitions](#))
Years available: Since 1965

Select a table type:

- Go Single agency trends**
- > One jurisdiction
- Multiple variables
- Multiple years
Example:
Crime reported by **Dothan Police Dept, Alabama**

Year	Population	Index offenses total	Index offense rate
1997	57,113	4,064	7,150.7
1995	57,054	2,031	4,011.4
- Go Trends in one variable**
- Multiple jurisdictions
- > One variable
- Multiple years
Example:
Robbery

Agency	State	1995	1997
Decatur Police Dept	AL	18	36
Dothan Police Dept	AL	68	61
- Go One year of data**
- Multiple jurisdictions
- Multiple variables
- > One year
Example:
Crime in **1999**

Agency	State	Number of Offenses	
		Robbery	Burglary
Decatur Police Dept	AL	103	719
Dothan Police Dept	AL	126	727

9. Design output formats to facilitate quick and reliable query validation

In user testing, we saw users scan the results to see if they got what they selected. Our original design did not clearly differentiate the selections like state or years from the other material on the page. We revised the results to emphasize those elements that were part of the selection and are not in the tables.

U.S. Department of Justice
BJS Bureau of Justice Statistics

BJS Home Page ▶ Data for Analysis ▶ Data Online ▶ Crime Trends ▶ State Level ▶ State-by-State

Results from State-level crime trends database Query date: May 28, 2002

[Spreadsheet of this table \(.csv file\)](#) | [Spreadsheet help](#) | [Revise this query](#) | [Get a different type of table](#)

Definitions. Also see notes at the end of the page.

Reported crime in Alabama

		Number of reported			
		Property crime			
Year	Population	Property crime total	Burglary	Larceny-theft	Motor vehicle theft
1985	4,021,000	140,115	41,612	88,108	10,395

Notes: When data are unavailable, the cells are blank or the year is not presented. State offense totals are based on data from all reporting agencies and estimates for unreported areas.

Sources: FBI, Uniform Crime Reports as prepared by the National Archive of Criminal Justice Data

[BJS home page](#) | [Top of this page](#)

10. Help users avoid searching for non-existent or non-available data

BJS Data Online explicitly states when data are not available. By positioning the notes about data that are not available right below the appropriate drop down menu, users saw the information in context.

U.S. Department of Justice
BJS Bureau of Justice Statistics

BJS Home Page ▶ Data for Analysis ▶ Data Online ▶ LEMAS ▶ Local Agency Profile

Law Enforcement Management and Administrative Statistics
Local Agency Profile (Step 1 of 2)

Choose the State where the agency is located:

Alabama

Note: There were no local agencies with 100 or more sworn officers in North Dakota, Vermont, or Wyoming

Next Reset Form

Even though the design guidelines were not yet drafted when BJS Crime & Justice Data Online was developed, it followed many of the guidelines. Specifically, it included:

- Simple two or three step interface.
- Descriptions of the data at beginning, links to definitions throughout, and additional metadata on results pages.
- Drill down to get user to smaller set of relevant data.
- "You are here" clues through "crumbs".
- Simple instructions where relevant.
- Proper use of "widgets" (Drop down menus, radio buttons, etc.).

In user testing, the application scored very well, but we found a few problems as outlined above. We redesigned and retested several problematic features, which are now incorporated in the live site. Bosley and Straub applied the guidelines to the current site and found that it met most of the guidelines as demonstrated above. Clearly, by following the guidelines, we had much less to change as a result of user testing and could get real performance improvements quickly and easily because we needed to focus on only a few issues.

The site was launched in November 2001 and has had over 80,000 visitors between November 2001 and the end of June 2002. BJS has received very positive responses about the application. The greatest evidence about the success of the site is that no one has asked a question about how to use the site.