

# TECHNICAL RESEARCH REPORT

## A Family of User Interface Consistency Checking Tools

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## **A Family of User Interface Consistency Checking Tools**

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### **ABSTRACT**

Incorporating evaluation metrics with GUI development tools will help designers create consistent interfaces in the future. Complexity in design of interfaces makes efficient evaluation impossible by a single consistency checking evaluation tool. Our focus is on developing a family of evaluation tools in order to make the evaluation process less cumbersome. We have developed a dialog box typeface and color table to facilitate detection of anomalies in color, font, font size, and font style. Concordance tools have been developed to spot variant capitalization and abbreviations globally in the interface and specifically in the button widgets. As buttons are frequently used widgets, a button layout table has been created to spot any inconsistencies in height, width and relative position between a given group of buttons if present. Finally, a terminology basket tool has been created to identify unwanted synonyms of computer related terms used in the interface which may be misleading to the end user.

**KEYWORDS:** Automated metrics, consistency checking tools, concordance tools, spatial and textual evaluation tools, user interface



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## **1. INTRODUCTION AND PREVIOUS RELATED RESEARCH**

Creating user interfaces is a composite procedure involving iterative design, usability testing and evaluation processes (Shneiderman, 1992). Iterative refinement methods like Formative Evaluations can be used to design/redesign the interface from early development stages through completion stage ( Hix & Hartson, 1993). Interactive tools like IDEAL (Interface Design Environment Analysis Lattice) support procedures like Formative Evaluations (Ashlund & Hix, 1992). Recent advances in powerful user interface development tools have expedited the interface development process helping both novice and experienced developers. However these expeditiously created designs may be clogged with spatial and textual inconsistencies that may have a subtle and negative impact on interface usability.

Inconsistencies in spatial and textual style of an interface designed by several designers' may result in a chaotic layout. Each designer may have different interpretation of terminology and uses his/her own style of abbreviations and computer terms. Furthermore designers personal preferences on fonts and colors add to the problem in group designs. Such anomalies in terminology and format lead to poor design, ultimately misleading and confusing the user (Chimera & Shneiderman, 1993). Although many organizations are adopting more stringent usability testing standards to monitor quality and layout of the design, better automated evaluation tools are needed which would scan for inconsistencies in the interface layout at early design and development stages thereby decreasing the complexity of usability testing.

Usability testing is a highly beneficial but costly process when compared with automated evaluation. Prerequisites for these tests may include availability of developed working prototypes, test users and expert evaluators (Sears, 1994). These requirements are hindrances in this very powerful evaluation method. Alternative techniques like Heuristic Evaluations (Nielsen & Molich, 1990) can decrease but not eliminate these requirements. Furthermore usability testing works best for smaller applications. It is practically impossible to analyze every dialog box in an application with thousands of dialog boxes. Finding anomalies or differences while reviewing thousands of dialog boxes is even hard for expert reviewers who may leave undetected flaws and inconsistencies. In contrast automated evaluation tools can be used in early prototypes (or later iterations) and can detect anomalies across thousands of dialog boxes.

Automated evaluation tools can be made independent of platform and development tool, as textual and spatial properties are independent of these constraints. Research in automated design and evaluation tools in recent years has resulted in development of first generation test models and systems based on metrics. Spatial metrics to check consistencies in alignment, screen symmetry, screen balance, average distance between groups of items, percentage of screen used to display information, average size of groups of items were introduced by Strevler and Wasserman (1987) and were later implemented by Tullis(1988). Furthermore Kim and Foley (1993) used metrics as a constraint for design space and layout style. They developed a tool which generated potential designs for an interface when provided with design specifications and guidelines for metrics. Effectiveness of their metrics has not yet been evaluated.

Evolution of modern user interfaces like multimedia interfaces has sparked research in automated evaluation based on visual techniques. Vanderdonckt and Gillo (1994) proposed five visual techniques: physical, composition, association, ordering and photographic which identified more spatial properties than traditional balance, symmetry and alignment. These visual properties also include proportion, neutrality, singularity, repartion, grouping, sparing, simplicity etc. Dynamic strategies for automated evaluation using these visual techniques have been introduced. (Bodart, Hennebert, Leheureux and Vanderdonckt,1994). Visual metrics introduced above for traditional layout grids and multimedia layout frames have not yet been tested.

Sears (1993, 1994) has developed a first generation tool using automated metrics for both design and evaluation using Layout Appropriateness metrics. The tool AIDE (semi-Automated Interface Design and Evaluator) allows designers to create, evaluate and modify an interface using a single tool. Layout Appropriateness compares layout based on user's task sequences and frequencies. AIDE has demonstrated its effectiveness in analyzing simple interfaces.

## **2. METRICS EVALUATION USING CANONICAL FORMAT**

Our research evolved from the concept of converting interface form files generated by Visual Basic into canonical format files and feeding them as input to the evaluation program. The canonical format is an organized set of GUI object descriptions. These object descriptions are enclosed in curly braces and embrace information in a sequence of attribute-value pairs. The canonical format is advantageous because of its lucidity and

extendibility characteristics. It can be easily modified to include any new attribute encompassing interface description information in the form files.

A metrics evaluation program takes the canonical format file and first does preprocessing for two basic reasons, to extract relevant information and possibly to expand objects' descriptions (e.g., absolute coordinates, sibling information, etc.). Any class hierarchy or other related specifications are not part of the canonical format. Such things exist as separate documents.

The canonical format file uses unique keys for all objects that are constructed via parent-self ID pairs. (If a parent-self ID pair is not unique, then all non-unique occurrences get enlarged to be parent-parent-self ID triples, and so on until uniqueness is achieved.) The attribute called "unique-id" is provided in the event that the originating system has the capability to supply unique numbers for objects. If not supplied, this value can be filled in by expansion programs. Each object is completely self contained and has no information about child objects, except for menus. Menu objects describe their child objects within the menu's own description in a hierarchical fashion. A generic object can list any of the following attribute-value pairs. Those marked with an asterisk (\*) are required.

(*type	Object-value
*parent	ID
*resource-id	String
name	String
variable-reference	String
unique-id	Number
*top	Coordinate (relative to parent)
*left	Coordinate (relative to parent)
*width	Coordinate
*height	Coordinate
*unit-of-measure-width	Unit-value
*unit-of-measure-height	Unit-value
*border-is-visible	Boolean
*background-color	Color
*foreground-color	Color
font-family	String
font-size	Number
font-is-bold	Boolean
font-is-italic	Boolean
font-is-underline	Boolean
font-is-serif	Boolean
label-type	Label-value
label	String
label-background-color	Color
label-foreground-color	Color
label-justification	Justification-value
label-placement	Placement-value
label-font-family	String
label-font-size	Number
label-font-is-bold	Boolean
label-font-is-italic	Boolean
label-font-is-underline	Boolean

```

label-font-is-serif      Boolean
margin-top               Coordinate (relative to attribute "top")
margin-left              Coordinate (relative to attribute "left")
margin-bottom            Coordinate (relative to calculated "bottom")
margin-right             Coordinate (relative to calculated "right")
navigation-order         Number
navigation-type          Navigation-value
help-text                String
is-default                Boolean (uses window origin)
is-cancel                Boolean (uses window origin)
is-help                  Boolean (uses window origin)
mnemonic                 Character
menu-accelerator         Key-value (type Menu-item only)
menu-is-pinnable         Boolean (type Menu only)
menu-content             Menu-value (big hierarchical description)
task                     String
comments                 String
)

```

We feel that attribute names are self-explanatory, but many of the value types appearing in the canonical format are abstractions. The following table specifies value types that are not completely obvious.

```

Number ::= nonnegative integer
ID ::= String | Number
Coordinate ::= real number (uses top-left origin)
Unit-value ::= Unit-pixel | Unit-point | Unit-MSWindows dialog-unit | ...
Color ::= String | Color-specification
Color-specification ::= RGB-triple | HSB-triple
Label-value ::= String | Icon | String-and-icon
Justification-value ::= Justify-left | Justify-center | Justify-right
Placement-value ::= Place-left | Place-right | Place-top | Place-bottom
Navigation-value ::= Nav-parent | Nav-window (whether navigation is
                    relative to parent or entire window)
Character ::= a single alphanumeric character value
Modifier ::= Shift-key | Control-key | Alt-key
Key-value ::= Character + Modifier | Function-key + Modifier
Object-value ::= Window | PopupWindow | ModalPopupWindow |
                PushButton | CheckButton | RadioButton |
                Container | StaticLabel |
                ScrollingListOneSelection | ScrollingListMultipleSelection
                ScrollingListContiguousSelection |
                MenuHighestLevel | Menu | MenuItem | MenuSeparator |
                TextPane | TextPaneReadOnly |
                TextPaneOneLine | TextPaneOneLineReadOnly | ....
                (basically responsibility of metric conversion
                program to know about these values)
Menu-value ::= hierarchical object description of only
                Object-types Menu | MenuItem | MenuSeparator

```

Our evaluation tools convert the Visual Basic form files into canonical format through a translator which distills relevant information from the form files. These canonical formats are platform independent and may be created for other interface tools like Power Builder, Galaxy and XVT by writing a translator program for these tools. So our evaluation programs are not specific to Visual Basic and can be used for evaluating interfaces developed by other tools.

## 2.1 Our Previous Method

This research is an extension of previous work (Shneiderman, Chimera, Jog, Stimart and White, 1995) in which we developed spatial and textual evaluation tools. The spatial tool was a dialog box summary table which gave an overview of spatial and visual properties. Each dialog box corresponded to a distinct row and each column a metric. The metrics Aspect Ratio, Widget Totals, Non-Widget Area, Widget Density, Margins, Griddedness, Top-Bottom Balance, Left-Right Balance and Distinct Typefaces formed our metrics column set. This list of metrics was developed by consultation between analysts at University of Maryland and General Electric Information Services to evaluate categories such as spatial layout, alignment, clustering, cluttering, fonts, etc. The textual tool was a concordance built to extract all the words that appear in labels, menus, buttons, etc. in every dialog box. These words were sorted in one file with reference to the dialog boxes containing them. The concordance was to help designers in appropriate word use such as spelling, abbreviation, tense consistency, case consistency, passive/active voice etc.

The objective of developing the dialog box summary table and the concordance was to provide interface designers rapid feedback on possible flaws and inconsistencies from early prototyping to advanced development stages. The gist of the tools is to help designers spot inconsistencies by providing a compact overview. Thus, assisting them in determining which screens needed redesign/modifications. Our programs allowed the designers to check the dialog boxes for inconsistencies and the output of the dialog box summary table revealed interesting anomalies. For example the margins were irregular and aspect ratio (ratio of the height of a dialog box to its width) was surprisingly variant. The non-widget area (ratio of the non-widget area to the total area of the dialog box, expressed as a percentage) and widget density ( number of top level widgets divided by the total area of the dialog box and multiplied by 100,000 to normalize it) varied from single digits to lower hundreds. Numbers closer to 100 and higher for Non-Widget Area indicated high screen utilization and for Widget Density indicated crowding of widgets. The concordance table revealed terms used in the interface which had variant forms including capitalization and abbreviations. The results were useful but required too much interpretation. The concordance report being twenty pages long made it hard for designers to spot anomalies quickly and efficiently. The dialog box summary table was also too cumbersome to interpret inconsistencies at a glance.



## 2.2 Modification of Previous Method

Our new approach is to modify the large dialog box summary table and the concordance tools by dividing them into smaller tools, plus adding new tools. The family of consistency checking tools was constructed by modifying our previous tools. These new tools perform exception reporting by outputting the possible anomalies and irregularities in textual layout. The reports generated by these mini tools require little interpretation, thereby expediting the quick evaluation process and providing feedback to the designer. The designer then must decide whether the spotted inconsistencies are relevant to the particular prototype. We have developed six consistency checking tools:

- dialog box typeface and color table to spot any anomalies in color, font, font size and font style.
- interface concordance to spot variant capitalization and abbreviation in the interface.
- button concordance to spot variant capitalization and abbreviation in button widgets.
- button layout table to spot any inconsistencies in height, width and relative position among a given group of buttons.
- interface speller to detect terms used in the interface that are nonexistent in the dictionary.
- terminology basket to provide the interface designer with the feedback on misleading synonym computer terms.

### 2.2.1 Dialog Box Typeface and Color Table

The dialog box typeface and color table was developed to provide designers feedback on inconsistencies in fonts and colors, two of the most striking appearance features of the interface. Each row represents a single dialog box and the columns represent dialog name, distinct typefaces and distinct background colors.

**Dialog Name:** Name of the file in which dialog is contained.

#### **Distinct Typefaces:**

Typeface consists of a font, font size, bold and italics information. Each distinct typeface in all the dialog boxes is randomly assigned an integer and is described in detail at the end of the table. For each dialog box all the integers representing the distinct typefaces are listed so that the typeface inconsistencies can be easily spotted locally within each dialog box and globally among all the dialog boxes. The idea is that a small number of typefaces should be

used for all the dialog boxes. Occurrence of multiple typefaces within a dialog box is not desired.

### Distinct Background Colors:

All the distinct background colors in a dialog box are displayed. Each distinct color is randomly assigned to an integer for display and comparison convenience and is described in detail at the end of the table. The purpose of this metric is to check if all the dialog boxes have the same background colors. Multiple background colors in a dialog box may indicate inconsistency.

This tool was tested with two interfaces containing 30 (small interface) and 140 (large interface) dialog boxes respectively. Inconsistencies in fonts and colors were revealed in both the test interfaces. The results with the smaller interface were surprising. The designers used 17 distinct typefaces and 6 distinct colors in the small interface with only 30 dialog boxes. These inconsistencies were brought to the attention of the designers who were amazed by the results. A portion of the table is shown below:

No.	Dialog Name	Distinct Typefaces						Distinct Background Colors				
		1	2	3	4	5	6					
1	cover.cft											1
2	coveraf.cft											1
3	coveruf.cft											1
4	feed.cft											2 3
5	frmcompaz.cft											1
6	frmcompu.cft											1
7	frmhand.cft											1
8	frmlogin.cft											1
9	frmlogo.cft											1 4 5
10	frmmatch.cft											1

#### DISTINCT TYPEFACES:

1 = MS Sans Serif 13.5	2 = Symbol 13.5 Bold
3 = MS Sans Serif 12 Bold	4 = MS Sans Serif 24 Bold Italic
5 = MS Sans Serif 13.5 Bold	6 = MS Sans Serif 18
7 = MS Sans Serif 9.75 Bold	8 = Symbol 9.75 Bold
9 = MS Sans Serif 8.25 Bold	10 = Arial 18 Bold
11 = Symbol 8.25 Bold	12 = MS Sans Serif 16.5
13 = Times New Roman 24 Bold Italic	14 = Times New Roman 30 Bold Italic
15 = System 9.75 Bold	16 = MS Sans Serif 9.75 Bold Italic
17 = MS Sans Serif 8.25	

#### DISTINCT BACKGROUND COLORS:

1 = ffffffff80000005    2 = c0c0c0    3 = e0ffff    4 = ffffff    5 = c000006

### 2.2.2 Interface Concordance

The interface concordance tool checks for variant capitalization for all the words that appear in buttons, labels, menus, etc. in every dialog box of the interface. This tool outputs

strings which have variant capitalization, listing all the variant formats of the string and its dialog box sources. These variant forms are spelling differences and may be acceptable, but they may be something that should be reconsidered. For example the words "Item" , "items" and "Items:" are Variant Capitalization forms of the same word. A portion of the concordance output is shown below:

```

Items
    reonly.cft    reonly.cft    reonly.cft    reonly.cft
    sendrec.cft  sendrec.cft  sendrec.cft  sendrec.cft
Items:
    moreinfo.cft
items
    wastedef.cft
Ship
    create.cft    create.cft    dp.cft        dp.cft
    invoice.cft  po.cft        po.cft        po.cft
SHIP
    invoice.cft
Execute
    exnow.cft     sched.cft     sched.cft     sched.cft
    sched.cft     sview.cft
Execute:
    scriptor.cft

```

### 2.2.3 Button Concordance

This tool is a further filtration of the interface concordance. As buttons are one of the most frequently used widgets performing vital functions like "Save", "Open", "Delete", "Exit" checking variant capitalization in them becomes more important. The button concordance tool checks for variant capitalization for all the words that appear in buttons in every dialog box of the interface. This tool outputs button labels which have variant capitalization, listing all the variant formats and their dialog box sources. Considerable variant capitalization in button labels was detected in both our test interfaces. The most frequently used button labels such as "OK", "Cancel", "Exit" were not consistently used in the same case. A portion of the button concordance output is shown below:

```

Cancel
    frmcompaz.cft  frmcompu.cft  frmquesaz.cft  frmquesu.cft
CANCEL
    frmmatch.cft  l_login.cft   passwd.cft     r_login.cft
DONE
    feed.cft      graph.cft     ibm_az.cft     ibm_um.cft
    infoas.cft    infoums.cft  mulq.cft      omp.cft
Done
    info2ums.cft
Exit
    cover.cft     coveraf.cft   coveruf.cft    frmhand.cft
    frmlogin.cft
EXIT
    syllabus.cft

```

## 2.2.4 Button Layout Table

Given a set of buttons that frequently occur together (e.g. OK Cancel Help), if the first button in the set is detected in the dialog box then the program prints the height, width and position relative to the first button of every button detected in the list. The relative position of every button detected in the set is outputted as ( $x \pm$  offset,  $y \pm$  offset) to the first button, where offset is in pixels. Buttons stacked in rows would yield ( $x \pm$  offset,  $y$ ) relative position and those stacked in columns would yield ( $x$ ,  $y \pm$  offset). These button columns enable us to spot highly inconsistent sizes and relative positions of buttons within a set. Dividing the button analysis into a family of button sets expedites inconsistency checking process. Designers can determine inconsistencies while browsing each button set output in a single glance.

Our program reads an ASCII file containing different sets of buttons. These button sets were constructed after analyzing many previously developed interfaces. Variations in terminology were considered while constructing these button sets. Button set (Start Stop Exit) is incomplete as designers may use "Close" , "Done" or "Cancel" instead of "Exit". The set ( Start Stop End Pause Halt Exit Done Cancel Close) forms a much better button detector set. The button sets may be easily updated as more interfaces are analyzed in the future. Some of the sample button detector sets are:

• OK	Cancel	Help						
• Start	Stop	End	Pause	Halt	Exit	Done	Cancel	
• Close								
• Cut	Copy	Paste						
• Add	Remove	Delete	Copy	Clear	Cancel	Close	Exit	
• Help	Close	Cancel	Exit					

Output of the button detector set (Add Remove Delete Copy Clear Cancel Close Exit) tested with the larger prototype is shown below. Inconsistency in height and relative button positions within a button set can be checked by moving across the rows of the table. Inconsistency in height and relative position for a given button can be spotted by moving down in columns. For example, the height of all the "Add" buttons are constant (25 pixels) but the width varies from 65 pixels to 97 pixels. Also, the relative position between "Add" and "Remove" buttons varies in all the three files in which they occur together. In the files "archive.cft" and "autoff.cft" the "Remove" button is 15 pixels and 39 pixels down respectively from the "Add" button, but in the file "dp.cft" the buttons occur next to each other in the same row. Also, both the buttons "Remove" and "Delete" have been used with the button "Add" which is a terminology inconsistency.

	Add		Remove		Delete		Cancel		Close	
	(H,W)	(H,W)	Rel.	Pos.	(H,W)	Rel.	Pos.	(H,W)	Rel.	Pos.
archive.cft	25,65	25,65	x,	y+15				25,73	x-9,	y+151
autoff.cft	25,73	25,73	x,	y+39				25,73	x,	y+71
dp.cft	25,97	25,89	x+1,	y				25,81	x+351,	y
famdef.cft	25,89				25,89	x+1,	y	25,97	x+87,	y
standard.cft	25,89				25,89	x+1,	y	25,89	x+175,	y

## 2.2.5 Interface Speller

Interface Speller is a tool which reads all the terms used in widgets including menus, buttons, list boxes, combo boxes etc. throughout the interface and outputs words that are not found in the dictionary. The spell checking operation is performed within the code and all the possible misspelled words are stored in a file. This file can be reviewed by the designer to detect possible misspelled and abbreviated words which may create confusion for the end users. The file may also contain proper names, esoteric words or computer words which are valid computer science terms, but are not found in the dictionary.

Interface speller was tested on the two prototypes outputting words not found in the dictionary and their corresponding dialog boxes. The tool detected many misspelled, incomplete and abbreviated words such as "App", "Trans", "Quik", "Provence", "Interchg" which are spelling errors or potentially confusing abbreviations. A small portion of the output is shown below:

addfamdf.cft									
addr.cft	Doc		Msg						
admpwd.cft	App		EDI		HDLR		UNDA		WDGT
contacts.cft	ADMIN		EDI						
docsearc.cft	Provence		Quik						
dp.cft	ILOG		Interchg						
profile.cft	NAD		Trans						
	Ctrl		FAX				Provence		

## 2.2.6 Terminology Baskets

A terminology basket is a collection of computer task terms including their different tense formats which may be used as synonyms by the interface designers. Our goal is to construct different sets of terminology baskets by constructing our own computer thesaurus and then search for these baskets in every dialog box of the interface. The purpose of terminology baskets is to provide interface designers with feedback on misleading synonym computer terms, e.g. Search, Retrieve, Query and Select.

Our program reads an ASCII file containing the basket list. The baskets are sorted alphabetically and for each basket all the dialog boxes containing any of the basket terms are outputted. Occurrence of labels in different cases are not preserved as unique occurrences of terms so the labels like "VIEW", "View" and "view " are considered the same. Any punctuation characters are stripped before comparing the labels and the basket terms. The list of baskets may be easily updated as more interfaces are analyzed in the future. Some of the idiosyncratic baskets are:

- Remove Removes Removed Removing Delete Deletes Deleted Deleting Clear Clears Cleared Clearing Purge Purges Purged Purging Cancel Cancels Canceled Canceling Refresh Refreshed Refreshing
- Execute Executes Executed Executing Run Runs Running Start Starts Started Starting Enable Enables Enabled Enabling Begin Begins
- Item Items Entry Entries Record Records Segment Segments Segmented Segmenting Field Fields
- Add Adds Added Adding Insert Inserts Inserted Inserting Create Creates Creating
- Message Messages Note Notes Letter Letters Comment Comments

Our basket browser revealed some interesting terminology anomalies after analyzing the large interface that led to reconsideration of designs. As shown below terms like "record", "segment", "field" and "item" were used in similar context in different dialog boxes. Other interesting anomalies included use of "start", "execute" and "run" for identical tasks in different dialogue boxes.

Entries	Entry	Field	Fields	Item	Itemized	Itemizing
Items	Record	Records	Segment	Segmented	Segmenting	Segments
Field	search.cft					
Items	reonly.cft	reonly.cft		reonly.cft		
	reonly.cft	sendrec.cft		sendrec.cft		
	sendrec.cft	sendrec.cft		wastedef.cft		
Record	ffadm.cft	profile.cft				
Segment	addr.cft	search.cft				

Enable	Enabled	Enables	Enabling	Execute	Executed	Executes	Executing
Run	Running	Runs	Start	Started	Starting	Start	
Enable	admpwd.cft logger.cft		admpwd.cft preferen.cft		eepwd.cft preferen.cft		
Execute	exnow.cft sched.cft sview.cft		sched.cft sched.cft		sched.cft scriptor.cft		
Run	sched.cft						
Start	addr.cft		docsearc.cft				

### 3. Testing Our Evaluation Tools

Effectiveness of these consistency checking tools has been determined by evaluating two commercial prototype applications developed in Microsoft Visual Basic. Our testing method incorporates a sequence of steps beginning with applying the tools to the prototype application followed by analysis and review of the interface screen shots and outputs generated by our tools. Furthermore test results and interpretations were shown to developers to elicit feedback and reactions. One prototype application was a 140 dialog box Electronic Data Interchange Interface developed at GE Information Services and the other was a small 30 dialog box interface developed at the University of Maryland for teaching courses remotely via networked PC's. Our evaluation tools were not created with reference to any particular test prototype and can evaluate any interface that is converted to the canonical format.

The interface textual and spatial descriptions of the prototypes were inputted to the evaluation tools in canonical format after running the translator program on the Visual Basic form files. To facilitate analysis of the prototypes, screen shots of the interface dialog boxes were printed. The results generated by these family of consistency checkers show possible anomalies or irregularities in textual and spatial layout of the interface. These evaluation tools act as consistency patrollers reporting exceptions and anomalies, making interpretation easier for the developers. Developers at the University of Maryland, College of Business & Management were surprised to know that their 30 dialog box interface had 17 distinct typefaces plus terminology inconsistencies in button labels. It was discovered that these inconsistencies occurred as the interface was created by two developers. Developers at GE Information Services are adapting the reports to fit their development environment and to ensure that their internal guidelines are being adhered to. They plan to apply these automated evaluation tools to all their projects. Our consistency checking team

is in the process of testing more complex commercial prototypes created by GE Information Services.

#### **4. Limitations**

Our evaluation tools are designed to aid the interface evaluation process by providing a compact overview of possible inconsistencies and anomalies on certain textual and spatial characteristics of the interface. The designer must decide what to do, if anything with these possible inconsistencies. Certain issues like efficiency in screen layout including proper placement of widgets on the dialog box, violation of any design constraints, use of inappropriate widgets types are not evaluated by our tools. Other evaluation methods, such as usability testing and heuristic evaluation, are needed to locate typical user interface design problems such as inappropriate metaphors, missing functionality, confusing terminology, chaotic screen layouts, unexpected sequencing of screens, misleading menus, excessive demands on short-term memory, poor error messages, or inadequate help screens. Currently, the evaluation is limited to Visual Basic applications, but any experienced programmer can write a translator to convert interface form files created by other development tools to a canonical format read by our evaluation tools.

#### **5. Future Directions**

Currently, the printouts provided by our tools showing the possible anomalies and inconsistency patterns need to be compared manually with the interface dialog boxes. Checking back and forth between the printouts and dialog boxes to make corrections can be time consuming for large interfaces. It would be good to have these mini evaluation tools in the form of interactive evaluation and modification tools. This would help developers to interactively make changes to the prototype while creating it rather than amassing printouts. In the future, we plan to incorporate the canonical format file translator and the evaluation tools into a single tool in Visual Basic. We also plan to diversify the metrics set of our evaluation tools to perform more detailed interface evaluation.

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