Transportable Applications Environment (TAE) Tenth Users’ Conference

Edited by
Chris Rouff
NASA Goddard Space Flight Center
Greenbelt, Maryland

and

Elfrieda Harris
Arleen Yeager
RMS Technologies, Inc.
Lanham, Maryland

Presentations from a conference sponsored by the NASA Goddard Space Flight Center and held at the Goddard Space Flight Center Greenbelt, Maryland June 14–17, 1993
PREFACE

Goddard Space Flight Center sponsored the Tenth TAE Users' Conference on June 14-17, 1993 held at Goddard.

This document represents the proceedings of the Tenth TAE Users' Conference. The presentations included in these proceedings were published as received from the authors with little modification and editing.
Message From the TAE Project Manager

This was the first TAE conference that followed an informal workshop format with panel discussions, demonstrations, tutorials and working sessions. It provided a chance for all attendees to participate - and they did! The informal format worked extremely well and helped to create a very interactive environment. Attendees actively participated, and there was a good exchange of information and experiences between TAE users and developers. This feedback from many of you will help us plan future directions for TAE Plus.

The Tenth TAE Conference is the last TAE Users' Conference that Goddard Space Flight Center will coordinate. With the software being transferred into the private sector, all future user conferences will be managed by Century Computing, Inc., the commercial developers/distributors of TAE Plus. On this note, the conference offered a great opportunity for the TAE Project Office, the TAE Support Office and Century Computing to respond to TAE users' questions, concerns and comments about the commercialization of TAE. Several of the presentations discussed more details about the transfer and described what will be available in TAE Version 5.3, the first commercial release. I think we all came away with a better understanding of what the technology transfer "means to me".

Many thanks to each and everyone who participated in the conference.

Chris Rouff
TAE Project Manager
NASA/Goddard

Acknowledgements

The TAE Project would like to express its appreciation to everyone who demonstrated their application at the conference and to all those who participated in the panel sessions. In addition, we would like to thank the following individuals for their significant roles in planning and organizing the conference:

Elfrieda Harris, TAE Support Office, RMS Technologies, Inc.
Arleen Yeager, TAE Support Office, RMS Technologies, Inc.

TAE is a NASA software project within the Data Systems Technology Division at Goddard Space Flight Center with contract support by Century Computing, Inc. The work is sponsored by NASA's Office of Space Communications.
Presentations from the
Tenth TAE Users' Conference
June 14-17, 1993

Sponsored by
Goddard Space Flight Center

Held at
Goddard Space Flight Center
Greenbelt, Maryland

Table of Contents

<table>
<thead>
<tr>
<th>Topic</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Experiences with C++</td>
<td>David Fout, Century Computing Inc.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Elizabeth Wei, Siemens Corp. Research</td>
<td>3</td>
</tr>
<tr>
<td>User Experiences with Ada</td>
<td>Christina L. Langford, Coastal Systems Station</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Roger Sheldon, Loral AeroSys</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>Keynote Address</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Managing the Design of the User Interface</td>
<td>Deborah Mayhew, Deborah Mayhew and Associates</td>
<td>47</td>
</tr>
<tr>
<td>Technology Transfer</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>TAE Yesterday, Today &amp; Tomorrow</td>
<td>Marti Szczur, Goddard Space Flight Center</td>
<td>77</td>
</tr>
<tr>
<td>TAE V5.3 Summary</td>
<td></td>
<td>85</td>
</tr>
<tr>
<td>The Commercialization of TAE Plus</td>
<td>Don Link, Century Computing Inc.</td>
<td>87</td>
</tr>
<tr>
<td>Usability and Application Testing</td>
<td></td>
<td>105</td>
</tr>
<tr>
<td>Computer-Human Interaction Models (CHIMES)</td>
<td>Jianping Jiang, CTA Inc.</td>
<td>107</td>
</tr>
<tr>
<td>User Interaction Testing of the User Interface</td>
<td>Jim Hicinbothom, CHI Systems Inc.</td>
<td>115</td>
</tr>
<tr>
<td>User Interface Design Guidelines</td>
<td>Susan Adams, Pacific Northwest Lab</td>
<td>123</td>
</tr>
<tr>
<td>TAE Plus V5.3 Testing Tools</td>
<td>Phil Miller, Century Computing Inc.</td>
<td>131</td>
</tr>
<tr>
<td>Data Driven Objects</td>
<td></td>
<td>137</td>
</tr>
<tr>
<td>TAE Plus V5.3 Extensions to DDOs</td>
<td>Karl Wolf, Century Computing Inc.</td>
<td>139</td>
</tr>
<tr>
<td>Data Driven Objects Potential Enhancements</td>
<td>Terry Bleser, Century Computing Inc.</td>
<td>153</td>
</tr>
<tr>
<td>User Experiences with Data-Driven Objects</td>
<td>Patricia M. Jones, University of Illinois</td>
<td>163</td>
</tr>
</tbody>
</table>
Object Dependencies ............................................................................................................. 167

Item-to-Item Connections

Craig Warsaw, Century Computing Inc. ........................................................................... 169

Using the Spreadsheet Model of Computation for Defining Object Dependencies

Margi Klemp, University of Colorado .............................................................................. 177

Integration with Other Software ...................................................................................... 187

The Development of a Graphical User Interface to the fault Isolation System Database Manager

Christopher Barclay, Joseph Molnar, Naval Research Lab ........................................... 189

UIL Support and Mrm Code Generation

Kenneth Sall, Century Computing Inc. ........................................................................... 197

CenterLine's Object Center C++ Compiler

Greg Shirah, Goddard Space Flight Center .................................................................... 215

List of Conference Attendees ......................................................................................... 223
User Experiences with C++

David Fout
Century Computing Inc.

Elizabeth Wei
Siemens Corp. Research
Tenth TAE Users' Conference '93

TAE Plus v5.2 User's Experiences with C++

David Fout
Century Computing, Inc.
1014 West Street
Laurel, MD 20707
(301) 953-3330

Internet: dfout@cen.com

June 14, 1993
Outline

- Using the GNU g++ compiler
- Using the ObjectCenter Environment
- Data Manipulation in a TaePanel constructor
- TaePanelFile
- Examples of TAE and C++
Using the GNU g++ Compiler

- On Sun platforms, TAE Plus v5.2 is delivered with libraries built with the Sun C++ 2.0 C++ compiler.

- However, it also tested with g++ 1.40.3 on a Sun. If you want to use g++, you must recompile the entire tree. See *Building TAE Plus from Source*. (g++ can't link with Sun C++ compiled object code.)
Using the ObjectCenter Environment

- Due to a bug in ObjectCenter 1.2, many items will not appear in the panels when running a debug session. (You can get a tedious workaround from the TAE Support Office if necessary.)
- This bug was fixed in ObjectCenter 2.0.
Data Manipulation in a TaePanel Constructor

- When dynamically changing information about a panel or its items in the panel's constructor, you must use the TaeVar or TaeVarTable classes.

- The TaePanel and TaeItem class can't be used because the Wpt panels have not been created yet. They are created by the TaePanel::Show method.

```cpp
panel1C::panel1C (TaeCollection *collect) : TaePanel ("panel1", collect)
{
    // create an instance of each item in the panel.
    new TaeItem (this, "button1", &button1_React);
    TaeVarTable* viewTable = this->ViewTable();
    TaeVar* panelVar = viewTable->GetTaeVar("_panel");
    TaeVar* itemVar = viewTable->GetTaeVar("button1");
    itemVar->Set("fg", "black");
    panelVar->Set("bg", "white");
}
```
TaePanelFile objects allow the user to register and field event sources such as file and socket descriptors.

- C++ binding to Wpt_AddEvent.
- Subclass to give virtual methods your own functionality.

```cpp
class PanelFileC : public TaePanelFile {
    public:
    PanelFileC (int);
    virtual int HandleEvent (const TaeEvent&);
    protected:
};
```
int PanelFileC::HandleEvent(const TaeEventHandler&)
{
    #define BUFFER_SIZE 132
    #define MIN_BYTE 1
    char buffer[BUFFER_SIZE];
    int n;

    // NOTE: There are a few extra file events that can and are being ignored
    int fd = this->Descriptor();
    n = read(fd, buffer, BUFFER_SIZE-1);
    while (n>=MIN_BYTE)
    {
        printf("data byte = %s \t returned block size = %d byte \n", buffer, n);
        n = read(fd, buffer, BUFFER_SIZE);
    }
    return 0;
}
TaePanelFile (cont)

- Create an instance

  ```
  PanelFileC* PanelFile = new PanelFileC(fd);
  ```

- Now you must register the instance with the TaeEventHandler. One option is to register the instance in the subclass' constructor.

  ```
  PanelFileC::PanelFileC (int d) : TaePanelFile (d)
  {
      eventHandler->Register(this, (int) WPT_UPDATE_READMASK);
  }
  ```

- De-register the object with TaeEventHandler. This is often done in the subclass' destructor.

  ```
  eventHandler->Deregister(PanelFile);
  ```
Examples of TAE and C++

- `$TAEDEMONSRC/ddodemo.cc` and `$TAEDEMONSRC/timerdemo.cc` are two C++ programming examples delivered with TAE v5.2.
- New v5.2 Tips and Tricks document (coming soon)
Object Cloning

Elizabeth T. Wei
Object (Tae Item) Cloning

Instead of creating some maximum number of items on the panel, create only a sample in the workbench. At run time, based on certain information at hand, dynamically create needed new items by making each a clone of the sample item.

Rationale

- Number of items is unknown until run time.
- One event handler for all items.
Sample Objects Created using the Workbench

Class Name:  ???

Sort  List

☐  ☐  name (type)
Objects Created At Run Time Through Cloning

Object Cloning

<table>
<thead>
<tr>
<th>Class Name: IMAGE</th>
<th>CreateDate</th>
<th>Description</th>
<th>Owner</th>
<th>Color</th>
<th>Format</th>
<th>Columns</th>
<th>Rows</th>
<th>IconID</th>
<th>BWIcon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sort</td>
<td>List</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Problems Encountered

Protected clone method(s) (5.2 beta)

Work-around/Solution

My own 'clone' function

Much Better Solution

TAE+ 5.2
Work-around/Solution: my own 'clone' function

1. instantiate a new item:

   new_item = new sample_item_class (panel,new_item_name)

2. furnish the new item:

   - extract from the sample the resource values (both common to all
     presentation types and specific to the type being dealt with)
   - set these resources for the newly instantiated item with extracted
     values except for a new location (i.e., the 'origin')
1. Instantiate a new item:

   new_item = new sample_item_class(panel, new_item_name, &react_func);

2. Furnishing:

   View/TargetTable()->Add(sample_item->getView/TargetVar() -> Clone(new_item_name))
User Experiences with Ada

Christina L. Langford
Coastal Systems Station

Roger Sheldon
Loral AeroSys
OPERATOR-MACHINE INTERFACE DEVELOPMENT

Using TAE+ and Ada

Christina L Langford
Coastal Systems Station
Panama City Beach, FL
email: langford@phoebus.nosc.navy.mil
SYSTEM OVERVIEW

Combat System Training Simulator:

Shipboard simulator to provide training for different combat systems.

Operator-Machine Interface (OMI):

Enables person on-board ship to

- Build scenario files for exercise
- Initiate a simulation exercise
- Monitor trainee performance during exercise
- Perform database management functions
DEVELOPMENT ENVIRONMENT

Silicon Graphics 4D/440VGX
IRIX 4.0.5
NCD 19" X-Terminal
Verdix Ada Compiler

TAE+ v5.1
resupgrade to v5.2

STARS Ada/X Bindings
TAE+ With STARS Ada/X Bindings

- **FACT** TAE+ libraries contain "X_Windows"
- **FACT** TAE code generator generates "X_Windows"
- **FACT** STARS Ada/X Bindings contain "X_Lib"

**ACTION**
- Modification of TAE+ libraries
  * replaced "X_Windows" with "X_Lib"

**ACTION**
- Modification of TAE generated code
  * replaced occurrences of "X_Windows" with "X_Lib"
OMI MAIN

MODIFICATION TO EVENT_LOOP

If SW error,
   Display Error Panel;
   -- Selections are "IN_PROGRESS" or "NOT_IN_PROGRESS"
   Set Selection to "NOT_IN_PROGRESS";
Else if Selection is "NOT_IN_PROGRESS"
   If an event is pending (Wpt_Pending)
      When Event_Type is WPT_PARM_EVENT =>
         Set up User_Context_Ptr;
         Set Event_Code;
         Set Selection to "IN_PROGRESS";
   Endif
Else if Selection is "IN_PROGRESS"
   Dispatch_Panel;
   Set Selection to "NOT_IN_PROGRESS";
Endif
EXERCISE SITUATION DISPLAY UPDATES

Update Dynamic Text Fields

Wpt_SetIntg, Wpt_SetReal, Wpt_SetString

Update Status Message Area

message_vec : TAE.s_vector(1..n);
Vm_SetString_vec(Info.View, "item", n, message_vec, P_UPDATE);
Wpt_ViewUpdate(Info.Panel_Id, "item", Info.View, "item");

Update Label and Color of Pushbutton

Vm_SetString(Info.View, "item", 1, "newlabel", P_UPDATE);
Vm_SetString(Info.View, "item.bg", 1, "color", P_UPDATE);
Wpt_ViewUpdate(Info.Panel_Id, "item", Info.View, "item");
Extracting Multiple Selections from Selection List

ptr_to_selections : variable_ptr
sel_count : taeint
selections : array (1..1) of (1..tae_taeconf.STRINGSIZE)
my_list : array (1..n) of string (1..s)
my_count : integer

Vm_Find(Info.target, "item", ptr_to_selections)
Vm_Extract_Count(ptr_to_selections, sel_count)
my_count := integer(sel_count)
For J in 1..sel_count loop
    Vm_Extract_SVAL(ptr_to_selections, J, selections(J))
    my_list(integer(J)) := selections(J)(1..s)
end loop
Retrieving User Selected Position in X Workspace

-- This code is in X Workspace event handler
X_Event : X_Lib.Events.Event
X_Window_Id : X_Lib.Window
X_Window_X, X_Window_Y : X_Lib.Coordinate

Wpt_ItemWindow(Info.Panel_Id, "xworkspace", X_Window_Id);
Wpt_Extract_parm_xEvent(Global.Event_Ptr, X_Event)
When X_Event.Kind is Button_Press or Button_Release =>
XQueryPointer(...,X_Window_Id,....,X_Window_X, X_Window_Y,..)

-- X_Window_X and X_Window_Y contain the user
-- selected position in the X Workspace.
CONCLUSION

TAE PROVIDES RAPID DEVELOPMENT AND EASY MAINTENANCE OF USER INTERFACE

TAESO AND BULLETIN BOARD ARE ALWAYS HELPFUL

TAE ON-LINE MAN PAGES (V5.2) LACK ADA SPECIFIC LIBRARY ROUTINES

NOT ALL TAE LIBRARY Routines WORK CORRECTLY
Agenda

- Describe application
- Discuss Pros and Cons of using TAE+ and Ada
- Summary
Overview of Application

- Developed a planning and scheduling tool, SORTIM, for the US Air Force.
- Performs resource scheduling for student pilot training. Resources include students, instructor pilots, aircraft, simulators, and classrooms.
- SORTIM is based on ROSE, the Request Oriented Scheduling Engine. ROSE was developed by Loral AeroSys for NASA Goddard Space Flight Center. ROSE has its own GUI developed in Ada using TAE+, Motif, and X Windows.

Loral AeroSys
Overview of Application, cont.

- SORTIM is based on ROSE, but has a completely different user interface, also developed using TAE+, Motif, and X Windows.
Pros of Using TAE+ and Ada

- By using Ada, the programmer is less likely to write buggy code due to Ada's strong type checking.
Cons of Using TAE+ and Ada

- TAE+ was written in C++. The Ada bindings to TAE+ do not match exactly with the programmer's interface available to the C++ programmer.

- The underlying Ada bindings to Motif and X Windows also fail to provide all the features available to the C programmer.

- Some of the Ada bindings are broken.
Summary

- Using TAE+ to develop the SORTIM GUI saved considerable time.
- Given a choice, the best language to use with TAE+ is C++.

Loral AeroSys
Keynote Address

Managing the Design of the User Interface

Deborah Mayhew
Deborah Mayhew and Associates
Managing the Design of the User Interface

AGENDA

- What Makes an Interface Usable?
- How Do You Do It?
- Why Should You Care?
- Who Else is Doing It?
- What Has Their Experience Been?
- How Can You Get Started?

WHAT MAKES AN INTERFACE USABLE?

Design Issues

Example One: Screen Design

Example Two: Organization of Functionality

Example Three: Color

Example Four: I/O
Managing the Design of the User Interface

WHAT MAKES AN INTERFACE USABLE?

Example ONE: Screen Design

POOR:

LaserWriter "LaserWriter II NT" OK
Copied Pages: All ○ From: To: Cancel
Cover Page: No ○ First Page ○ Last Page Help
Paper Source: Paper Cassette Manual Feed
Section Range: From To: Print Selection Only
○ Print Hidden Text ○ Print Next File ○ Print Back to Front
Managing the Design of the User Interface

WHAT MAKES AN INTERFACE USABLE?
Example ONE: Screen Design

PRINCIPLES:
- Poor use of white space
- No grouping
- Group titles not distinguished from captions - hard to find
- Horizontal orientation of menus - hard to read
- Poor ordering
- Inconsistent button location

IMPROVED:
Managing the Design of the User Interface

WHAT MAKES AN INTERFACE USABLE?
Example TWO: Organization of Functionality

POOR:

Company ABC
ORDER FORM

1. Gloria Vanderbilt Jeans $125.00
2. Gloria Vanderbilt Jeans $125.00
3. Gloria Vanderbilt Jeans $125.00
4. Mohair Turtleneck Sweater $210.00
5. Mohair Turtleneck Sweater $210.00
6. Mohair Turtleneck Sweater $210.00
7. Reversible Disc Bag $55.00
8. Italian Sling Back Pumps $175.00
9. Italian Sling Back Pumps $175.00

To View Item Summary, Press Item Number and ENTER
To View Next Page, Press NEXT
To Leave Form, Press CANCEL

WHAT MAKES AN INTERFACE USABLE?
Example TWO: Organization of Functionality

POOR:

Company ABC
ORDER FORM

6. Mohair Turtleneck Sweater

Size: M
Color: Jade
Quantity: 1
Price: $210.00

To Change Item, Press ENTER
To View Next Item Summary Press NEXT
To View Previous Item Summary, Press PREV
To Return to Order Form, Press CANCEL

Copyright 1983 Deborah J. Mayhew & Associates
WHAT MAKES AN INTERFACE USABLE?
Example TWO: Organization of Functionality

**PRINCIPLES:**
- Overtaxes human short-term memory
- Tedious navigation
- Organization does not support user task

---

**Company ABC**

<table>
<thead>
<tr>
<th>NO.</th>
<th>ITEM</th>
<th>COLOR</th>
<th>SIZE</th>
<th>PRICE</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. Jeans</td>
<td>Black</td>
<td>8</td>
<td>$125.00</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2. Jeans</td>
<td>Black</td>
<td>10</td>
<td>$125.00</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>3. Jeans</td>
<td>Black</td>
<td>12</td>
<td>$125.00</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>4. Sweater</td>
<td>Red</td>
<td>8</td>
<td>$210.00</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>5. Sweater</td>
<td>Blue</td>
<td>8</td>
<td>$210.00</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>6. Sweater</td>
<td>Orange</td>
<td>8</td>
<td>$210.00</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>7. Disco Bag</td>
<td></td>
<td></td>
<td>$50.00</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>8. Pumps</td>
<td>Black</td>
<td>81/2M</td>
<td>$175.00</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>9. Pumps</td>
<td>Black</td>
<td>9M</td>
<td>$175.00</td>
<td>1</td>
</tr>
</tbody>
</table>

To View Item Summary, Press Item Number and ENTER
To View Next Page, Press NEXT
To Leave Form, Press CANCEL.
Managing the Design of the User Interface

WHAT MAKES AN INTERFACE USABLE?
Example THREE: Color

POOR:

<table>
<thead>
<tr>
<th>4/13/93</th>
<th>XYZ SYSTEM</th>
<th>11:30 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>ACCT No.</td>
<td>DUE DATE</td>
</tr>
<tr>
<td>Alberts, S.</td>
<td>123-45</td>
<td>4/7/93</td>
</tr>
<tr>
<td>Cameron, S.</td>
<td>416-44</td>
<td>4/7/93</td>
</tr>
<tr>
<td>Fisher, G.</td>
<td>334-01</td>
<td>4/15/93</td>
</tr>
<tr>
<td>James, R.</td>
<td>214-91</td>
<td>4/20/93</td>
</tr>
<tr>
<td>Jones, P.</td>
<td>987-23</td>
<td>4/7/93</td>
</tr>
<tr>
<td>March, K.</td>
<td>441-88</td>
<td>4/12/93</td>
</tr>
</tbody>
</table>

To scroll forward, press DOWN. To exit, press CANCEL.
To scroll back, press UP.

Use color sparingly
Use color to support the user's task
Use color consistently
Provide good foreground/background contrast
Color contrasts better with black or white than with other colors
Use lighter (vs. darker) colors to draw attention
Avoid saturated blue for text
Exploit cultural color associations
"Warm" colors appear larger than "cool" colors
Allow users to turn color coding off or ask for different coding criteria.
Managing the Design of the User Interface

WHAT MAKES AN INTERFACE USABLE?
Example THREE: Color

IMPROVED:

4/13/93
XYZ SYSTEM
3:30 pm

Accounts Payable

<table>
<thead>
<tr>
<th>NAME</th>
<th>ACCT #</th>
<th>DATE PAID</th>
<th>DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alberts, S.</td>
<td>123-45</td>
<td>4/1/93</td>
<td>Yes</td>
</tr>
<tr>
<td>Cameron, B.</td>
<td>416-44</td>
<td>4/1/93</td>
<td>No</td>
</tr>
<tr>
<td>Fisher, G.</td>
<td>334-01</td>
<td>4/15/93</td>
<td>No</td>
</tr>
<tr>
<td>James, R.</td>
<td>214-91</td>
<td>4/28/93</td>
<td>No</td>
</tr>
<tr>
<td>Jones, E.</td>
<td>967-23</td>
<td>4/7/93</td>
<td>Yes</td>
</tr>
<tr>
<td>March, K.</td>
<td>441-88</td>
<td>4/12/93</td>
<td>No</td>
</tr>
</tbody>
</table>

To scroll forward, Press DOWN To exit, Press CANCEL
To scroll back, Press UP

WHAT MAKES AN INTERFACE USABLE?
Example FOUR: I/O
SOUND AS OUTPUT

"One can imagine how a single sound could be used to give information about a file arriving in a message system. The file hits the mailbox, causing it to emit a characteristic sound. Because it is a large message, it makes a rather weighty sound. The crackle of paper indicates a text file - if it had been a compiled program, it would have clanged like metal. The sound comes from the left and is muffled: The mailbox must be in the window behind the one that is currently on the left side of the screen. And the echoes sound like a large empty room, so the load on the system must be fairly low. All this information from one sound!"

Managing the Design of the User Interface

HOW DO YOU DO IT?

Principles and Guidelines

Methods

Expertise

User Model

Dialog Style

I/O Devices

Organization of Functionality

Screen Layout and Design

Response Time

Error Handling

User Documentation
Managing the Design of the User Interface

HOW DO YOU DO IT?
Methods

- Scoping
- Functional Specification
- Design
- Development
- Testing/Implementation

Adding Human Factors to the Software Development Process

<table>
<thead>
<tr>
<th>Scoping</th>
<th>Functional Spec</th>
<th>Design</th>
<th>Development</th>
<th>Testing/Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Project Team</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User Interface Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright 1989 Deborah J. Mayhew & Associates
Managing the Design of the User Interface

How do you do it?

Methods

Adding Human Factors to the Software Development Process

<table>
<thead>
<tr>
<th>Functional Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Project Team</td>
</tr>
<tr>
<td>User Interface Group</td>
</tr>
</tbody>
</table>

19

57
Managing the Design of the User Interface

**Methods**

**HOW DO YOU DO IT?**

**ADDING HUMAN FACTORS TO THE SOFTWARE DEVELOPMENT PROCESS**

**DJMA**

Managing the Design of the User Interface

Copyright 1989 Deborah J. Myhre & Associates
Managing the Design of the User Interface

HOW DO YOU DO IT?

Methods

ADDING HUMAN FACTORS TO THE SOFTWARE DEVELOPMENT PROCESS

APPLICATION PROJECT TEAM

Software Testing

Hardware/Installation Testing

Production Testing

USER INTERFACE GROUP

UI Testing

UI Prototype

Senior Human Factors Engineer

Minimum Requirements:
- Ph.D. or Masters degree in Cognitive Psychology or Human Factors
- Minimum 3-5 years experience as a human factors professional
- Minimum 3-5 years experience in a software development environment
- Experience managing human factors/user interface projects
- Experience conducting user profiles
- Experience performing task analysis
- Experience designing user interfaces
- Experience developing style guides
- Experience designing and implementing usability tests
- Strong interpersonal skills
- Strong negotiating skills

On-The-Job Training:
- Send to short courses on advanced topics in user interface design
- Send to annual SIGCHI and Human Factors Society conferences
Managing the Design of the User Interface

HOW DO YOU DO IT?

Expertise

User Interface Designer

Minimum Requirements:
- Minimum 3-5 years experience in a software development environment
- Experience designing user interfaces
- Motivation/Interest in designing user interfaces
- Strong interpersonal skills
- Strong negotiating skills

On-The-Job Training:
- Send to short courses or night courses on basic user interface design and cognitive psychology
- Send to annual SIGCHI and Human Factors Society conferences

WHY SHOULD YOU CARE?

- Low Productivity
- High Training Costs
- Costly User Errors
- High Support Costs
- High Employee Turnover
- Underutilized Systems
Managing the Design of the User Interface

WHY SHOULD YOU CARE?

**Productivity**

20 Users  
230 Days per year  
80 Screens per day  
10 Seconds per screen

1022 Hrs (25.5 Wks) per year

**Training**

20 Users  
2 Systems per year  
1.5 Days per system

60 Days (12 Wks) per year
Managing the Design of the User Interface

**Errors**

- 600 Users
- 12 Errors per year
- 17 Minutes per error
- 2040 Hrs (51 Wks) per year

**User Support**

- 600 Users
- 4 Calls per year
- 15 Minutes per call
- 600 Hrs (15 Wks) per year
Managing the Design of the User Interface

WHY SHOULD YOU CARE?

SAMPLE COST/BENEFIT ANALYSIS
OF ADDING HUMAN FACTORS TASKS
TO A SOFTWARE DEVELOPMENT PROJECT:


GENERAL ASSUMPTIONS:
Medium sized software system (32,000 lines source code)
15 person years to build (including HF time)
System to be used by 200 employees
Developers and HF Engineers fully loaded wages = $35.00/hour
Users fully loaded wages = $25.00/hour
Clerical support staff fully loaded wages = $15.00/hour

ANALYSIS SUMMARY:
TOTAL BENEFITS: $175,104 (per year)
TOTAL COSTS: $132,165 (one time)
FIRST YEAR SAVINGS: $42,939

copyright 1989 Deborah J. Maples & Associates
Managing the Design of the User Interface

**WHY SHOULD YOU CARE?**

**BREAKDOWN OF BENEFITS**

<table>
<thead>
<tr>
<th>TYPE OF SAVING</th>
<th>AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased Training</td>
<td>$62,500</td>
</tr>
<tr>
<td>Decreased Errors</td>
<td>71,846</td>
</tr>
<tr>
<td>Increased Productivity</td>
<td>23,958</td>
</tr>
<tr>
<td>Decreased Late Design Changes</td>
<td>16,800</td>
</tr>
<tr>
<td><strong>TOTAL BENEFITS:</strong></td>
<td><strong>$175,104</strong></td>
</tr>
</tbody>
</table>

**DERIVATION OF COSTS**

1. **HF LAB SET UP**
   - Lab design and equipment selection: 160 hrs @ $25/hr: $4,000
   - Carpenters and electricians: 80 hrs @ $25/hr: 2,000
   - Videocameras, VCRs, one-way mirror: 12,400
   - **TOTAL:** $20,000

2. **USER INTERVIEWS**
   - 10 Interviewees for 1 hour @ $25/hr: $250
   - Interviewer @ $25/hr: 16 hrs designing interview: 1,600
   - 10 hrs conducting interviews: 1,800
   - 28 hrs analyzing results: 700
   - Support staff @ 5 hrs each @ $15/hr: 150
   - Videotapes: 20
   - **TOTAL:** $3,425
**Managing the Design of the User Interface**

**WHY SHOULD YOU CARE?**

**DERIVATION OF COSTS**

### 3. USER SURVEYS/QUESTIONNAIRES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of survey</td>
<td>40</td>
<td>$35</td>
<td>$1,400</td>
</tr>
<tr>
<td>Pilot testing</td>
<td>40</td>
<td>$35</td>
<td>$1,400</td>
</tr>
<tr>
<td>Distribution and collection</td>
<td>20</td>
<td>$15</td>
<td>$300</td>
</tr>
<tr>
<td>Responding: 80 users for 1/2 hr</td>
<td>40</td>
<td>$25</td>
<td>$1,000</td>
</tr>
<tr>
<td>Coding and entering data: 20 hrs @ $15/hr</td>
<td>1</td>
<td></td>
<td>$300</td>
</tr>
<tr>
<td>Analyzing results: 40 hrs @ $35/hr</td>
<td>1</td>
<td></td>
<td>$1,400</td>
</tr>
<tr>
<td>Computer time</td>
<td>100</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Supplies and duplicating costs</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td></td>
<td></td>
<td>$8,000</td>
</tr>
</tbody>
</table>

### 4. USAGE STUDY, SIMULATION TEST OR PROTOTYPE TEST

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Rate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of test: 40 hrs @ $35/hr</td>
<td>1</td>
<td></td>
<td>$1,400</td>
</tr>
<tr>
<td>Pilot testing and revisions: 40 hrs @ $35/hr</td>
<td>1</td>
<td></td>
<td>$1,400</td>
</tr>
<tr>
<td>Running test: 40 hrs @ $35/hr</td>
<td>1</td>
<td></td>
<td>$1,400</td>
</tr>
<tr>
<td>Subjects: 10 @ 2 hrs @ $25/hr</td>
<td>10</td>
<td></td>
<td>$500</td>
</tr>
<tr>
<td>Analyzing results: 40 hrs @ $35/hr</td>
<td>1</td>
<td></td>
<td>$1,400</td>
</tr>
<tr>
<td>Videotapes</td>
<td>120</td>
<td></td>
<td>120</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td></td>
<td></td>
<td>$6,220</td>
</tr>
</tbody>
</table>
### Managing the Design of the User Interface

#### WHY SHOULD YOU CARE?

**DERIVATION OF COSTS**

5. **STYLE GUIDE**

- Author: 200 hrs @ $35/hr  
  **$7,000**
- Committee: 4 x 50 hrs @ $35/hr  
  **$6,000**
- **TOTAL:**  
  **$13,000**

6. **PURCHASE OF UI/MS**

- Reviewing packages: 100 hrs @ $35/hr  
  **$5,000**
- Cost of average package  
  **$10,000**
- **TOTAL:**  
  **$15,000**

---

### Managing the Design of the User Interface

#### WHY SHOULD YOU CARE?

**DERIVATION OF COSTS**

7. **PROTOTYPE CONSTRUCTION** (does not include design)

- Screen layout: 80 hrs @ $35/hr  
  **$2,800**
- Screen transitions: 80 hrs @ $35/hr  
  **$2,800**
- **TOTAL:**  
  **$5,600**

8. **PROTOTYPE CHANGE IN RESPONSE TO TESTING**

- Screen layout: 4 hrs @ $35/hr  
  **$140**
- Screen transitions: 4 hrs @ $35/hr  
  **$140**
- **TOTAL:**  
  **$280**

---

66
Managing the Design of the User Interface

**DERIVATION OF BENEFITS**

1. **DECREASED TRAINING**
   - Typical 1 week training course reduced by 25% to 10 hrs
   - Hourly rate of $25
   - Total cost:
     
     $250 \times 10 \times 25 = 62,500 \text{ in first year}

2. **DECREASED ERRORS**
   - 250 users
   - 1.5 errors eliminated per user per day
   - 230 working days per year
   - 2 minutes in recovery time per error
   - Hourly rate of $25
   - Total cost:
     
     $250 \times 1.5 \times 230 \times 2 \times 25 = 71,848 \text{ per year}

3. **INCREASED PRODUCTIVITY**
   - 250 users
   - 60 screens per day
   - 230 days per year
   - Processing time per screen reduced by 1 second
   - Hourly rate of $25
   - Total cost:
     
     $250 \times 60 \times 230 \times 1 \times 25 = 22,956 \text{ per year}

4. **DECREASED LATE DESIGN CHANGES**
   - Changes made early cost $35 per change
   - Late change cost = 4 X early change cost = $22,400
   - Savings = late change cost - early change cost = $18,800 in first year
   - Total cost:
     
     $18,800

**WHY SHOULD YOU CARE?**
Managing the Design of the User Interface

WHY SHOULD YOU CARE?

- Common questions about CBA of Human Factors function
  - Is there a legitimate benefit for a CBA?
    - Yes
    - Time is money.
    - User time can be expensive.
    - Companies often want to increase volume of sales/service without increasing personnel.
  - Will users actually take advantage of potential productivity gains?
    - Yes.
    - Studies show users realize bigger productivity gains on complex tasks than on simple ones.
    - Organizations provide incentives for productivity.
    - Personal and anecdotal experience suggest people make use of more powerful tools by being more productive.

- Why should development incur the cost when users get the benefits?
  - To meet overall business goals.
  - Development should be driven by business goals.

WHO ELSE IS DOING IT?

<table>
<thead>
<tr>
<th>SOFTWARE VENDORS</th>
<th>COMPUTER VENDORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lotus</td>
<td>IBM</td>
</tr>
<tr>
<td>Apple Computer</td>
<td>DEC</td>
</tr>
<tr>
<td>Ashton-Tate</td>
<td>Wang</td>
</tr>
<tr>
<td>Microsoft</td>
<td>Xerox</td>
</tr>
<tr>
<td></td>
<td>Unley</td>
</tr>
<tr>
<td></td>
<td>Data General</td>
</tr>
<tr>
<td></td>
<td>Hewlett Packard</td>
</tr>
<tr>
<td></td>
<td>Bell Labs</td>
</tr>
<tr>
<td></td>
<td>Symbolics</td>
</tr>
<tr>
<td></td>
<td>Sun Microsystems</td>
</tr>
<tr>
<td></td>
<td>NCR</td>
</tr>
<tr>
<td>Citibank</td>
<td>200</td>
</tr>
<tr>
<td>Actna</td>
<td>40</td>
</tr>
<tr>
<td>IDS Financial Services</td>
<td>15</td>
</tr>
<tr>
<td>The New England</td>
<td>1</td>
</tr>
<tr>
<td>ChemicalBank</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

OTHERS

| US West          | 4                |
| Eastman Kodak    | 10               |
| Nynex            | 1                |
| CLDS Church      | 8                |
|                  | BBN              |
|                  | AIR              |
|                  | DRC              |
|                  | GTE Labs         |
|                  | GTE Data Services|
|                  | Mitre Corp.      |
|                  | Boeing           |

copyright 1988 Deborah J. Meyers & Associates

41

43

68
Managing the Design of the User Interface

WHAT HAS THEIR EXPERIENCE BEEN?

(An Aerospace Contractor): CAD
(A major Computer Vendor): On-Line Help
IBM: Security
DEC: Disk Drive
(A Phone Company): Videotex

A large aerospace contractor evaluated several CAD systems. An identical task was performed by expert operators on each vendor's equipment. Task was to input a complex 3D part, starting with engineering sketches.

RESULTS:
Fastest system: 4 hours to complete task
Slowest system: 8 hours
The contractor purchased the fastest system.
Managing the Design of the User Interface

WHAT HAS THEIR EXPERIENCE BEEN?

(A major computer vendor): On-Line Help

Engineers proposed an on-line help system be added to an existing product
Customer Support objected, concerned it would be more software to support
Help system was implemented

Help calls on product reduced by 30% as a result

GOAL:
95% end users to sign on error free after three tries
Ideal average time for experienced user = 4 seconds

SUBJECTS:
IBM Administrative staff
2 years experience in current jobs
Experienced computer users
Managing the Design of the User Interface

WHAT HAS THEIR EXPERIENCE BEEN?

IBM: Security

RESULTS:
- In Test 3, 100% signed on error free after third try
- Median time on third trial in Test 3 = 7 seconds

COST/BENEFIT ANALYSIS:
- Calculated for first three sign on attempts only
- Total difference between Test 1 and Test 3 summed across three trials per user = 4.67 minutes
- 23,876 users x 4.67 minutes = 1,781 hours
- Benefit = 1,781 hours x hourly rate = $41,700
- Cost of three tests = $ 20,700
- Net Benefit of $ 31,000
Managing the Design of the User Interface

HOW CAN YOU GET STARTED?

- Short Term Action Items
  - Recognize Importance
  - Raise Awareness
  - Provide Education for Project Managers on Methods
  - Provide Education for Designers/Developers on Design Principles and Guidelines
  - Conduct Experimental Projects to Demonstrate Value (e.g. usability tests)
  - Gain Commitment

- Long Term Planning
Managing the Design of the User Interface

HOW CAN YOU GET STARTED?
Long Term Planning

- Design a Human Factors methodology
- Design a Human Factors organization
- Recruit and hire Human Factors Engineers, train internal User Interface Designers
- Develop Appropriate Style Guides
- Develop/Expand a Usability Lab
- Expand the Human Factors function across the company
Technology Transfer

Marti Szczur
Goddard Space Flight Center
TAE
Yesterday, Today & Tomorrow

Marti Szczur
NASA/Goddard Space Flight Center
Software and Automation Systems Branch

Under Discussion

• TAE Classic, the Prewindow Period 1980-1985
• TAE Plus, the New Beginning, 1985-1988
• TAE Plus Matures 1989-1992
• TAE Plus Commercialization 1993
• GSFC's Future Directions
REQUIREMENTS

- multiuser, portable applications control executive
- friendly environment for users
- extensive information management support
- standard set of executive services
- extensibility to allow installation of new programs with ease
- VICAR compatible
1981

- Develop Proof-of-Concept Prototype
- Implementation language Selection Issue
- Support 3 operational systems
- Future versions must be upward compatible
- TAE Support Office created
- 1st TAE External Review

1982 - 84

- Four prototype releases between August '81 and Oct '82
- C selected for implementation language
- By 1982, 13 different projects were using prototype versions
- November 1983, first operational system, V1.0
- New releases delivered in 1983 and 1984
- Operational on VAX/VMS, PDP 11/RSX-11M, Data General Eclipse
- TAE ports into UNIX environment
- TAE Support Office works with the user community
- By 1984, 30 different user sites are recorded
1985

- Introduction to the Macintosh and the arrival of GUIs with mice and windows
- Arrival of first "low-cost" graphic workstations with windows
- 5th TAE Users' Conference
- ... And the fun begins
  - experiments with VT220 and VAXStation 100
  - the TAE Facelift phase

1986-89

- Conceptual Description of a WorkBench in '86
- Rapid Proof-of-Concept Prototype of TAE Plus in '87
  -- Smalltalk and X Windows 10
- 6th Users' Conference ('86) and 7th Users' Conference ('88)
- Object-oriented language selected for implementation language
  -- C++ or Objective C?
  -- Compiler Woes
- Papers given at ACM Symposium '87, OOPSLA '88, NCGA '88, Xhibition '89
- Two Prototypes in '88 followed by two beta releases in '89
• TAE Plus papers given at USENIX '90, MIT X Conference '90

• Over 350 Beta Test Sites

• TAE Plus V4.1 (1st Operational Release) goes to COSMIC in '90

• 8th Users Conference hosted by JSC

TAE 8th Users Conference

Future Directions

• Full Motif functionality support?
  -- WorkBench support for all Motif objects
  -- WorkBench support for Motif conventions/style
  -- UIL support

• Architect/Builder WorkBenchs

• Integrate/add object builder into TAE Plus

• Graph builder support

• Hypermedia support

• WorkBench improvements

• Support object direct manipulation and object dependencies
1990

- TAE Plus papers given at USENIX '90, MIT X Conference '90

- Over 350 Beta Test Sites

- TAE Plus V4.1 (1st Operational Release) goes to COSMIC in '90

- 8th Users Conference hosted by JSC

1991

- Honorable Mentions for "Best in Open Systems Solutions" (FEDUNIX)

- NASA Group Achievement Award to TAE Plus team

- TAE Plus presented/demoed at several aerospace conferences and tutorial at MIT X Conference

- TAE Plus Submitted as a candidate API to IEEE 1201 Committee

- V5.1 (with OSF/Motif™ toolkit) is delivered to COSMIC

- 9th TAE Users Conference in held in November '91
1992

- TAE Plus article published in The X Resource Journal
- TAE Plus presented/demoed at CHI'92 and HCI '92
- Over 500 TAE Plus V5.1 User Sites
- TAE Plus V5.2 is delivered to COSMIC
- Decision to transfer the technology...Why Now?
- Planning the transition

1993

- GSFC's TAE Project Management changes hands
- TAE Plus article published in ACM's TOIS
- V5.2 goes to COSMIC
- Technology Transfer Agreement is finalized
- TAE 10th Users Conference
- Commercialization of TAE Plus
Future Directions

Successful User Interfaces

- Usability Engineering Laboratory
- User Interface Development Tools
- HCI Guidelines Documents

Controlled Experimental Research
Multi-media Interactions, 3-d objects

* diagram derived from Ben Shneiderman's "Three Pillars of Successful UI Design

In Conclusion
TAE V5.3 Summary

Don Link
Century Computing Inc.
THE COMMERCIALIZATION OF TAE PLUS

Don Link
Century Computing, Inc.
1014 West Street, Laurel, MD 20707
(301) 952-2000
Internet: dlink@one.com

Agenda

- Introducing Century Computing
- TAE Plus Business Philosophy & Plans
- TAE Plus Development Directions
  BREAK
- TAE Plus v5.3
Introducing Century Computing

- Our People
- Our Company
- Our Business

Our People

- 47 Employees
- Average of 12 yrs Experience
- Expertise in C, C++, Ada
- Over 50% with Advanced Degrees
Our Company

- Founded in 1979
- Began TAE Development in 1981
- Employee Owned
- Financially Sound
- Committed to Customer Satisfaction

Our Business

Graphical User Interfaces

Image Processing
Our Business

Simulation  Spacecraft
Ground Systems

1992 Business Mix

Government Prime  18%

Government  Commercial
Business Philosophy and Plans

- Focus on Installed Base
- Emphasize Quality
- Promote Customer Participation
- Meet Customer’s Needs
- Provide an Affordable Product

Focus on Installed Base

- Continue Excellent Support and Services
  - Technical Support Office
  - Newsletter
  - Users’ Conference
- Make Upgrade to v5.3 Affordable
Emphasize Quality

- Fix Known Bugs
- Beta Test Sites
- New QC and QA Procedures
- Automated Testing
- Quality Service

Customer Participation

- TAE Plus Advisory Group
- Electronic Suggestion Box
- E-mail Discussion Group
- Users’ Conferences
- User Surveys
- Focus Groups
Meet Customer's Needs

- Customer Satisfaction Key to Success
- Market Forces at Work
- New Features
- Better Documentation
- Competent & Available Technical Support
- Technical Training Seminars
- Consulting Services

An Affordable Product

- Aggressive Pricing
- Creative Licensing
- Unbundle Ada and C++
- Government and Educational Discounts
Development Directions

- Truly Graphical Interfaces
- Direct Manipulation
- Rapid Prototyping and Iterative Refinement
- Non-Programmer Use
- Standards Compliance
- Integration with Other Tools
- Targeted Application Areas

Questions and Answers

Coming up:
TAE Plus v5.3
TAE PLUS v5.3

Don Link
Century Computing, Inc.
1014 West Laurel, Laurel, MD 20707
(301) 953-3330
Internet: dl@linkcrs.com

Development Directions

- Truly Graphical Interfaces
- Direct Manipulation
- Rapid Prototyping
- Non-Programmer Use
- Standards Compliance
- Integration with Other Tools
- Targeted Application Areas
**Graphics + Direct Manipulation**

- New Types of DDOs (e.g., 2-D mover)
- Import of Graphics (e.g., TIFF)
- DDO Input
- Composite DDOs
- Object Creation at Runtime
- Color Pixmaps
- Movable Items at Runtime
- Simple Graphic Decorations

---

**2-D Movers**

![Graph of Altitude vs. Range](image)
Import of TIFF Pictures

• Supports direct manipulation applications
• Increases flexibility of user input & control

DDO Input

- Supports direct manipulation applications
- Increases flexibility of user input & control
DDO Input (Selection)

- Keys are separate dynamics
- Mouse clicks on keys generate events for DDO

Composite DDOs

- Allows collections of DDOs to be treated as one unit
- Allows different types of DDOs on a common background
Runtime Creation of Dynamics

Rapid Prototyping

v5.3

- Automated Code Merge
- GUI Scripting
- Addition of New Widgets
- Tool Maker's Workbench
- Workbench Productivity Aids
**Automated Code Merge**

- Speeds up iterative development
- Reduces maintenance costs
- Reduces errors related to code regeneration
- Promotes iterative development

**How It Works**

```
GUI #1  GUI #2
Manual Modify GUI
Generate Code
Generate Code

gen code #1  gen code #2
Manually Edit Code

appl code #1  appl code #1
Automated Code Merge
```
GUI Scripting

- Automated and Repeatable Application Tests
- Application Demos
- Tutorials
- Record/Playback Facility
- Based on perl Language

Non-Programmer Use

- v5.3
  - Extended Connections
  - Inter-Item Relationships
  - Object Templates with Inheritance
  - Composite Presentation Types
Standards Compliance

- v5.3
- UIL Support
- ANSI C
- Full Motif Widget Set
- Geometry Management

UIL Support

- Code Generation of UIL and Mrm
- TAE Plus Applications without Runtime Libraries (Wpt, Vm, Co)
- New DDO Widget
- Increased Portability of Applications
- Easier Access to Widget Resources & Callbacks
- Easier Use of Non-TAE Widgets
ANSI C Support

- Increased Application Portability
- Improved Code Quality and Maintenance via Function Prototypes

Integration with Other Tools

v5.3
- Software Development Tools
e.g., Energize, ObjectCenter
- U/I Design Tools
e.g., style checkers/advisors
- Usability Testing Tools
Targeted Application Areas

- Image Processing
- Geographic Information Systems
- Command & Control

Summary of TAE Plus v5.3

v5.3 2-D Movers
☑ Interviews 3.1 with Graphics Import
☑ DDO Input
☑ Composite DDOs
☑ Runtime Creation of DDO Dynamics
☑ Automated Code Merge
☑ GUI Scripting
☑ UIL and DDO Widget
☑ ANSI C
Usability and Application Testing

Jianping Jiang
CTA Inc.

Jim Hicinbothom
CHI Systems Inc.

Sue Adams
Battelle

Phil Miller
Century Computing Inc.
PRESENTED AT

TENTH TAE USERS' CONFERENCE

JUNE, 1993

PRESENTED BY

JIANG (JIM) JIANG
GROUP ENGINEER

CTA INCORPORATED

SPONSORED BY

ADVANCED SYSTEMS PROGRAM NASA HEADQUARTERS (CODE 0)
THROUGH THE AUTOMATION TECHNOLOGY SECTION (CODE 522.3)
NASA-GODDARD SPACE FLIGHT CENTER
GREENBELT, MD 20771.
WHAT IS CHIMES?

- User-Interface Designer's Associate

- Knowledge - Based Evaluation of UI Design's "Look and Feel"

- Modifier of UI Designs for Compliance with Human Factors Guidelines and Toolkit Style Guides
• PROBLEM:
  How can we automate a human factors evaluation of user-interface design?

• TECHNICAL APPROACH:
  - Model Demands on Users
  - Check for Compliance with Guidelines
  - Prototype Evaluation Concepts

• PRODUCT:
  Computer-Human Interaction Models (CHIMES) Methodology and Toolset

• BENEFITS:
  Savings in Time and Expense Training in Human Factors for UI Designers
CHIMES: CURRENT STATUS

- Proof-of-Concept Prototype (CHIMES '93)
  - Demonstrates evaluation graphic features for single and multiple UI panels
  - Demonstrates Advice-in-Context, including recommended colors
  - Supports automatic modification and re-evaluation of UI design
  - Supports utilization of sample-design library

- Continuing R&D In Progress
CHIMES: HIGHLIGHTS OF CURRENT AND PLANNED R&D

Current:

• Extension Of Chimes Knowledge Base

• Heuristics For Evaluation Of GUI Behavior

Planned:

• Preparation For Submission To COSMIC¹ For Distribution

• Implementation Of GUI Behavior Evaluation Heuristics

• Heuristics For Evaluation Of GUI Behavior

• Integration Of CHIMES With Other UIMs

¹ COSMIC is a NASA-sponsored center for distribution of NASA software and is managed by the University of Georgia

Copies Of This Document May Be Obtained From

Walt Truszkowski
Code 522.3
NASA/Goddard Space Flight Center
Greenbelt, MD  20771

301-286-8821
User Interaction Testing of the User Interface

by

James H. Hicinbothom
Senior Scientist
CHI Systems, Inc.

Sponsored by
U. S. Army Research Laboratory
Human Research & Engineering Directorate
(Under Contract # DAAA15-92-C-0026)
Motivation

- Bad systems development starting with lines of code and no requirements or clear design
- Bad systems development that assumes the user is a peripheral with an I/O interface
- Slightly better systems development that incorporates evaluation, although put off until near the end of development
- Decreasing productivity after automation in some situations (e.g., when work flow obstructed by inappropriate design)
- Friends, relatives, and neighbors who are abused by bad tools at work, home, and play
Background

- Human-computer interaction dependent on situation
  \[ \text{task domain(s)} \times \text{tool(s)} \times \text{user population(s)} \]
  (task domain knowledge and tool knowledge are critical attributes of human subjects)

- Each situation different enough to constrain generalizability of interaction designs

- The only 'constant' is the human cognitive architecture, and thus, human cognitive limits

Therefore, evaluation must address both the specifics of the situation, and the more general human cognitive limits at work in the situation.

Additionally, this evaluation should be based on analyses of both the static features (e.g., layout, object semantics, vocabulary usage, and pre-defined 'connections') and the dynamic features (e.g., mappings of cognitive task structure to 'threads' of user action sequences, identified attention shifts, and undesirable navigation behaviour) of the human-computer dialogue.
Human Cognitive Limits

1. Predicting Processes
2. Combining Choice Attributes
3. Managing Information
4. Performing Intermediate Analysis/Reasoning Steps
5. Visualizing/Representing Problem and Solution Spaces
6. Making Required Judgments (e.g., Quantitative Judgment Biases, Maintaining Vigilance)
Cognitive Limits Extension Methodology

1. Perceived Need for New or Revised Interactive System
2. Situation Analysis Protocol
3. Cognitive Limits and Other Aiding/Training Constraints
4. Potential Aiding/Training Functions
5. Functional Taxonomies of Aiding/Training Techniques
6. Trade-off Rules and Criteria for Technique Selection
7. System Design Methodologies

Describe Problem

Analyze Situation(s)

Identify Limits

Define Requirements

Identify Techniques

Assess Costs/Benefits

Define Architecture

Problem Description

Situation, Cognitive Task, and Knowledge Blackboard Models

List of Applicable Limits Targeted for Aiding/Training

List of Required Aiding/Training Functions

List of Candidate Aiding/Training Techniques

Situation-Defined Aiding/Training Sub-systems

Data

Problem Data Description

Situation, Cognitive Task, and Knowledge Blackboard Models

List of Applicable Limits Targeted for Aiding/Training

List of Required Aiding/Training Functions

List of Candidate Aiding/Training Techniques

Situation-Defined Aiding/Training Sub-systems

Data

Situation, Cognitive Task, and Knowledge Blackboard Models

List of Applicable Limits Targeted for Aiding/Training

List of Required Aiding/Training Functions

List of Candidate Aiding/Training Techniques

Situation-Defined Aiding/Training Sub-systems

Data

Situation, Cognitive Task, and Knowledge Blackboard Models

List of Applicable Limits Targeted for Aiding/Training

List of Required Aiding/Training Functions

List of Candidate Aiding/Training Techniques

Situation-Defined Aiding/Training Sub-systems

Data
Overview of Mid-Section of Software Life-Cycle

- Design
  - Information requirements
  - Human cognitive limitations and constraints
  - Functional and performance requirements
  - Architectural design
  - Procedural design

- Development
  - Implementation feedback
  - Data design
  - User feedback
  - Executable modules

- Testing and Evaluation
  - User-tested software
Integrating Evaluation into the Full Life-Cycle

1. Start with CLEM (Cognitive Limits Extension Methodology) for initial requirements analysis and aiding techniques selections

2. Follow up with initial architecture and design concepts, realized as Rapid Interface Prototypes using a Graphical User Interface (GUI) Builder

3. Evaluate overall architecture concept(s) and individual design concepts

4. Select or revise architecture concept (re-evaluating revisions as needed)

5. Revise initial individual design concepts (e.g., database navigator component, file selection component, etc.)

6. Define additional individual design concepts required for the chosen architecture

7. Evaluate new and revised design concepts

8. Iteratively revisit steps 5, 6, and 7, as needed

9. Integrate all available components of architecture

10. Evaluate integrated tool

11. Revise and re-integrate

12. Iteratively revisit steps 5 through 11, as needed
Tools to Aid Integrated Evaluation:
The Intelligent Interface Construction (IICON) Evaluator

- Supports evaluation of advanced interactive systems using X Window System
- Aids Human Evaluator in preparing and managing evaluation sessions (e.g., test plan)
- Records sessions, producing both machine- and human-readable dialogue transcripts
- Records User's verbalizations, and annotations by Users and Human Evaluators
- Replays recorded sessions, including annotations, for further analyses
- Aids Human Evaluator in analyzing event sequences in dialogue
- Aids Human Evaluator in mapping semantics of dialogue
- Aids Human Evaluator in analyzing layout and organization of Graphical User Interface
- Provides a central repository for storing data, notes, and results of analyses for evaluation
- Supports distribution and re-integration of evaluation tasks, data, and results across sites
- Aids Human Evaluator in composing recommendations for design concept changes
User Interface Design Guidelines

Susan M. Adams
Pacific Northwest Laboratory
Fort Lewis, WA
Overview

- ATCCS Guidelines -> DoD Style Guide
- Where they fit in design process
- Impact on design
- What's included
- Examples using TAE+
- Software demonstration
AES Methodology for User Interface Rapid Prototyping

- Automated User Event Capture
- ATCCS User Interface Guidelines
- AES Experimentation
- Products for the Developer
- Consistent & Usable ATCCS SMI
- AES-Enhanced Rapid Prototyping Tools

AES
Commercial Style Guides

OSF/MOTIF    SUN/OPENLOOK    MICROSOFT WINDOWS

IBM PRESENTATION MANAGER    APPLE MACINTOSH

[ SELECT ONE STYLE ]

DoD HCI Style Guide

Application Specific Style Guide
Impact on Industry and Government

- Provides positive influence on HCI design
  - Greater standardization
  - Reduced training requirements
  - Easier migration of personnel across applications and systems
  - Reduced Life-Cycle costs

- Conformance should be expected for future system design

- Need to plan for migration towards conformance
Style Guide Contents

- Discussion of differences in Motif and Open Look applications
- Hardware considerations including issues relating to Computer/Electronic Accommodation Program (CAP)
- Application Interface Design Guidelines
- Objective Security Interface Requirements
- References by Paragraph & Bibliography
Style Guide Contents

- HCI Guidelines
  - Screen Design
  - Windows
  - Menu Design
  - Object Manipulation
  - Common Features
  - Text Graphics
  - Decision Aids
  - Query
  - Embedded Training
  - Emerging Technologies
Future Directions

- Revision of StyleGuide
  - Industry and Government comment
  - Style issue review
  - Uniform API (IEEE P1201.1)
  - Conformance checklist
  - “Look and Feel” (IEEE P1201.2)
  - Personal Layer

- Publication of Style Guide Version 3.0
Tenth TAE Users' Conference '93

TAE Plus v5.3 Testing Tools

Phil Miller
Century Computing, Inc.
1014 West Street
Laurel, MD 20707
(301) 953-3330

Internet: pmiller@cen.com

June 16, 1993
Outline

- Motivation
- Overview
- taepel Language
- Scripting Example

Note: demos available
Motivation

- Repeatable tests of TAE Plus applications
- Minimal human involvement
- End-to-end tests with automatic verification
- Stress tests
- Easily maintainable test cases
- Generation of script via "record" mode
Overview

Notes:
- Script is sequential (as opposed to event-driven)
- Script language based on perl
- Application GUI interface remains alive
- Script is "interlocked" with event handlers
- Script may control multiple applications

June 16, 1993
Based on perl; see Larry Wall's "Programming perl", O'Reilly & Associates, 1992

- No perl changes; only new subroutines for application scripting
- Why perl as the base?
  - Public domain
  - Interpreted
  - C-like syntax
  - Many powerful features
  - Becoming very popular in the UNIX community

Note: taeperl may also be used as a GUI application language
Example Script

$$\texttt{appHandle} = \&\texttt{Aut'Connect ("myApplication")};$$
for ($i=1; i <= 1000; i++)
{
    print "processing file number $i . . \n";
    &Aut'UserEvent ($appHandle, "main", "fileName", "fileNumber$i");
    &Aut'UserEvent ($appHandle, "main", "ok");
    sleep(4);
}
&Aut'Close($appHandle);

June 16, 1993
Data Driven Objects

Karl Wolf
Century Computing Inc.

Terry Bleser
Century Computing Inc.

Patricia M. Jones
University of Illinois
Tenth TAE Users' Conference '93

TAE Plus v5.3

Extensions to DDOs

Karl Wolf
Century Computing, Inc.
1014 West Street
Laurel, MD 20707
(301) 953-3330
Internet: kwolf@cen.com

June 16, 1993
Extensions to DDOs (aka TAE Plus v5.3 DDOs)

- Refresher on current DDOs
- Plans for TAE Plus v5.3
- Open Issues

June 16, 1993
Current DDOs

- Map application data values to graphical objects.

- These objects change in response to changes in these data values in one of five ways:

  Mover, Rotator, Stretcher, Discrete, Stripchart

- Color thresholds can be applied to ranges of data values.

- In TAE Plus V5.2 we introduced multi-valued homogenous DDOs.

- Standard naming convention for idraw objects.

- Based on InterViews v2.6

- Entirely implemented within Wpt
Plans for TAE Plus v5.3

- New acronym DDO = Dynamic Data Object (was Data Driven Object)
- Implemented using InterViews v3.1
- Input Capabilities
- Extensions to DDOs
- Runtime Creation of Additional Dynamics
- Heterogeneous DDOs
- Introduction of a DDO widget

June 16, 1993
Advantages of InterViews v3.1

• InterViews v3.1 uses Glyphs. Glyphs are “light weight” objects.

• Improvements to taeidraw:
  Can import X bitmap files as stencils.
  Can import of color TIFF files as raster images.

• On color displays stippled fill patterns are rendered as smooth intermediate colors.

old

new
Input Capabilities

Allow user to click/drag dynamic objects

When a dynamic is changed, event handler is called

- Target value is updated (just like all other presentation types)
- Value array is filled with target Real values

Allow for click/select on dynamic objects

- Target value won’t change (like Push Button)
- Event handler is called

June 16, 1993
Input Capabilities (cont.)

Input Properties apply to each dynamic in a DDO

Input Properties
- Input Enabled
- Report Events
  - At End
  - Continuously
- Feedback to User
  - Rubberband
- Input Delta: [0.3]

Input Delta
- Similar to Update Delta; picture and target update only if moved past input delta

Extend WptEvent structure to hold the additional information to support input (such as select vs. drag.)
Extensions to DDOs

(2-D Movers)

Each Dynamic has 2 target indices in value array
- dynamic1 => value[0], value[1] => horizontal, vertical
- dynamic2 => value[2], value[3]

Start (Range Minimum) and Stop (Maximum) Positions
- Current 1-D Mover has an implicit start (from position in idraw file)
- Current 1-D Mover has a stopn picture (or defaults to edge of DDO)
- Use same for 2-D Mover
- new "rangen" picture

- For Multiple Dynamics wanting to use the same range (or stop)
  - New picture named "defaultrange" (and "defaultstop")

If no associated rangen (or stopn) for a dynamicn, then use defaultrange (or defaultstop)
Runtime Creation of Additional Dynamics

- With addition of 2-D Movers, naturally want to do map-type DDOs
- Allow user to create new dynamic objects from a palette (e.g. place tanks, trucks, etc.)

- Additions to the Wpt_API:
  - Wpt_CreateDynamic
  - Wpt_DeleteDynamic
Heterogeneous DDOs

- Different dynamic object types share the same static background

- In this example, dynamic3 is a discrete
- picA and picB are threshold pictures
- Still use a multi-valued Real target

- Use our v5.2 standard naming conventions to keep the WorkBench side simpler

- Input Properties, Range Min & Max, Thresholds, etc. are per Dynamic (not per DDO)

Future enhancements are planned. Terry Bleser will discuss some.
Introduction of a DDO Widget

• The previous discussion focused on the Wpt side of the DDOs. An effort is underway to “widgetize” them.

• The plan is to support only TAE Plus v5.2 DDO functionality with the addition of multiple thresholds. This implies:
  • Each dynamic may have its own set of thresholds.
  • No input support other than what is available for current DDOs.
  • No 2-D movers.

• UIL code generation will only support v5.2 style DDOs.
Open Issues

What does Input mean to a discrete?

What does it mean to have color thresholds for an dynamic with more than one degree of freedom (e.g. 2D-Mover)?

If a stretcher has shrunk to its minimum size (0 height or width), how do you select it to stretch it out again?

June 16, 1993
Data Driven Objects Potential Enhancements

Terry Bleser
Century Computing, Inc.
1014 West Street
Laurel, MD 20707
(301) 953-3330

Internet: tbleser@cen.com

June 16, 1993
Future Directions for DDOs

- Beyond Location, Size, and Angle
- Multi-dimensional DDOs
- Tailored Input
- Creating DDOs
- Other Media
- Escaping Flatland
DDO Structure

Static

Rotators

Dynamics

Stretchers

Movers

DDO

June 16, 1993
Beyond Location, Size, and Angle

- Constrained location - along a specified path
- Area, volume
- Foreground and background
- Color hue, saturation
- Visibility
- Stacking order
- Line thickness, line pattern, fill pattern
- Text attributes
- Sensitivity of each attribute
Multi-dimensional Dynamics

- Move and rotate - planes, tanks
- Move and stretch (scale)
- Rotate and stretch - angle and amount for direction and speed
- Move, stretch, and rotate
- Move (rotate, stretch) and discrete

- or any combination of other attributes

June 16, 1993
Tailored Input

- Fine vs gross control
- Key/event mapping
- Hot spot definition
Tailored Input (cont'd)

- Surrogates - graphical input object pops up on select
- Gestural input
- Currently selected object
- Alternative selection methods - multi-select, cycling
- Object interactions - drag and drop, collisions

June 16, 1993
Creating DDOs

- Drawing facility
  - exact positioning and sizing
  - precise control over scaling
  - fine adjustment
  - color, font, line width assignment feedback
- Import drawings from other drawing tools
- Copy dynamics from an existing ddo - change the static only
- Arbitrary names
- Hierarchy of dynamics, groups of dynamics
- Group modify - thresholds, ranges
- Semantic attributes
Other Media

Sound output
  data representation - scatter plot, size of mail message
  symbolic "picture"
  interaction of objects

Voice input

June 16, 1993
Escaping Flatland

- 2-d Stretcher
- 3-d Mover, stretcher, rotator
- 3-d Surrogates - shadows

June 16, 1993
User Experiences with Data-Driven Objects

Patricia M. Jones

University of Illinois at Urbana-Champaign

Department of Mechanical and Industrial Engineering
1206 W. Green St.
Urbana IL 61801

TAE Plus User's Conference, June 1993
• Part of "pilot" course on Interactive Systems Design

Application: Manufacturing

Students' favorite Presentation Item: Discrete DDO

Very flexible

Utilized example in documentation on switching picture files dynamically

Easy to use

Fun!
Wish List

Generate code for thresholds set for DDO's

(e.g.,

#define ITEM1_PICTURE1_THRESHOLD 10

better yet:

#define ITEM1_RED 10)

Incorporate dynamic text into Movers (e.g., for AGV)

In general, composite DDOs
New DDO: "Tracker" object for vehicle applications.

User draws arbitrary path ("static"), "dynamic" vehicle follows it.
Object Dependencies

Craig Warsaw
Century Computing Inc.

Margi Klemp
University of Colorado
Object Dependencies

Item-to-Item Connections

Craig Warsaw
Century Computing, Inc.
1014 West Street
Laurel, MD 20707
(301) 953-3330

Internet: cwarsaw@cen.com

June 16, 1993
Overview

Goals
- Static Layout vs. Dynamic Behavior
- Current Connection Capability
- Separate User Interface from Application
- Miscellaneous Connection Enhancements
- Item-to-Item Connections

June 16, 1993
Goals

Enhancements to Connections

Allow non-programmer/UI designer to specify more dynamic behavior

Improve separation of UI and application (potentially)

Interested in input from the user community

These enhancements are only in the idea phase. They are not slated for a particular release

June 16, 1993
Static Layout vs. Dynamic Behavior

Non-programmer uses the WorkBench to define the User Interface

User Interface is composed of *static layout* and *dynamic behavior*

Static Layout

- Visual Attributes, Position, Size, Color, Font, Label

Dynamic Behavior

- DDO Thresholds, Connections

Problem: Most UI dynamic behavior must be specified by the programmer. Programmer should only be concerned about the application, not the UI.

Solution: Extend connections to allow non-programmer to specify more dynamic behavior

June 16, 1993
Current Connection Capability

**Item-to-Panel**

Connections allow non-programmer to specify simple dialog control, e.g.

- When the user presses buttonA on panel1, panel2 appears and panel1 disappears
- Display a different panel for each choice in a menu

No Separation of User Interface from Application

- Connection is implemented via code generated into the event handler
- If connection is changed (in the WorkBench), code must be regenerated and recompiled

June 16, 1993
Separate User Interface and Application

To Generate into Code -- Or Handle in Wpt

Generate connections into code

- Generated code can be modified (by programmer) to integrate dynamic behavior with application knowledge

- E.g. if database is empty, display panel1, else display panel2

Handle connections in Wpt

- Change connection in WorkBench doesn't require application change

- Should be able to change connection at run-time

Which would most fit people's needs

- Applies to current and future connections

- An option would be most desirable, but we need to focus our development efforts

June 16, 1993
Miscellaneous Connection Enhancements

Item-to-Multiple Panels
Create, delete, or change state of many panels from a single event

Handle Multiple Selection - Selection List
Loop through all indices of value array (must be done for all event handlers)

Default Connection
A single connection for all choices of a multiple connection item
E.g. Show panel 2 when any choice is made from a radio button

MACRO facility - developed by University of Colorado
Allows non-programmers to insert code using customizable macros

Request input from user community

June 16, 1993
Item-to-Item Connections

Potential types of item-to-item connections (all driven by user-events)

- Update Properties (e.g. Sensitivity, Visibility)
  Select a mode from a Radio Button — certain control buttons dim

- Update Target values
  Manipulate a Scale — set the target value of a DDO

- Update Constraints or Menubar entries
  Press a button — change the choices of a menu

- Update View attributes
  Check a checkbox — Change the title and foreground color of a label

Request input from user community

- Consider your applications — How often would this be useful?
- Even without application knowledge?
USING THE SPREADSHEET MODEL OF COMPUTATION FOR DEFINING OBJECT DEPENDENCIES

PRESENTED BY

MARGI KLEMP
UNIVERSITY OF COLORADA
Why the Spreadsheet?

- Programming languages are difficult for non-specialists.

- The spreadsheet model has done more to make computing accessible than any development since Fortran (Clayton Lewis - New Approaches to Programming, 1989).

- The spreadsheet model fits well with graphical user interfaces which can be viewed as intercommunicating objects.

- NoPumpG extends the spreadsheet model to control graphical interactions and animation (Lewis, 1987).

- Software development projects at the University of Colorado are building on this model to define interactions of objects used for scientific visualization.
Spreadsheet View of TAE objects:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object Type</td>
<td>Text</td>
<td>Rotator</td>
<td>Stripchart</td>
<td>Graph</td>
<td>Button</td>
<td>Button</td>
<td>Button</td>
<td>Button</td>
<td>Workspace</td>
</tr>
<tr>
<td>Bg Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fg Color</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Font</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xsize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ysize</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xorigin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yorigin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Geometry Management Examples

Assume the user resizes the panel:

- Item B (rotator) changes size in proportion to the new window size
  
  \[
  \begin{align*}
  B.Xsize &= 0.2 \times P.Xsize \\
  B.Ysize &= 0.1 \times P.Ysize
  \end{align*}
  \]

- The position of B remains the same relative to the new panel size
  
  \[
  \begin{align*}
  B.Xorigin &= 0.1 \times P.Xsize \\
  B.Yorigin &= 0.05 \times P.Ysize
  \end{align*}
  \]

- Item E (button) remains the same size regardless of panel size. There are no formulas for the size cells
  
  \[
  \begin{align*}
  E.Xsize &= 50 \\
  E.Ysize &= 20
  \end{align*}
  \]
Geometry Management Examples (continued)

- Items E - H (buttons) are always displayed in the same order but will be placed in separate rows if not fully visible on the panel.

\[ E.X\text{origin} = 0.1 \times P.X\text{size} \]

F - H are positioned relative to the previous button.
We create an ordinary cell for the previous X distance.

previous-diste = E.X\text{origin} + E.X\text{size} + \text{space x}

The formula for the X origin of button F is an if construct:

\[ F.X\text{origin} = \text{if}(F.X\text{size} + \text{previous-diste} > P.X\text{size}, E.X\text{origin}, \text{previous-diste}) \]

- Object visibility could be controlled by a formula. Assume that item D (graph) should be invisible if the panel X size is less than 180.

\[ D.\text{visible} = \text{if}(P.X\text{size} < 180, 0, 1) \]

- If an item on a panel were resized, the origin and size of surrounding items could be defined in terms of the new size of adjacent items.
Other Examples

• Attributes can be propagated via formulas. To maintain the same background color for buttons E - H define an ordinary cell for the color

  Button-color = "red"

  Then use formulas to set the color for each button

  E.Bgcolor = Button-color
  F.Bgcolor = Button-color
  ... 

  Note that the color could be set from a menu item, a text list, etc.

• A checkbox (J) could control the visibility of workspace I

  I.visible = J
A Simpler Interface for the TAE WorkBench

Panel resize options:

• Resize an item (or all items on panel) in proportion to the new panel size

• Leave an item (or all items on panel) the same size clipping where necessary

• Group selected items maintaining sequential positioning within the group (create extra rows or columns as needed)

Specify the options above via standard TAE interaction objects

Automatically generate the spreadsheet including formulas to define the selected option
Summary

- The spreadsheet model of computation appears to handle many of the problems encountered by user interface designers in regard to object dependencies which would traditionally require a programming solution.

- Formulas may become quite complex. A simpler interface could be used to define the behavior for the most commonly used scenarios.
Integration with Other Software

Chris Barclay, Joseph Molnar
Naval Research Lab.

Ken Sall
Century Computing Inc.

Greg Shirah
Goddard Space Flight Center
The Development of a Graphical User Interface to the Fault Isolation System Database Manager

Delivered to the Tenth TAE User's Conference
June 14-17, 1993

Christopher Barclay
Joseph Molnar

Information Technology Division
Naval Research Laboratory
Knowledge Databases

TAE

Empress

Enhanced knowledge database development and management

Goal: Working Expert System

- Reliability
- Ease of Use
- Robust
- Data Management

Method:

- Empress
  - Reliable Database
  - Data Management Functionality
- TAE
  - Ease of Use
  - Rapid Prototyping
  - Intuitive Interface
Choose a selection:
^ Database Conversion
^ Print a Database
^ Expert Knowledge Acquisition
^ Work with a Database
^ Create a Database
^ Delete a Database

[OK] [Help] [Quit]
What type of database is it:
  ^ Rules
  ^ Tests

Current Files:
bugs
close.c
compile*
fisdmpro*
fisdmpro.c
fisdmpro.clog
fisdmpro.h
fisdmpro.mak
fisdmpro.o

What is the database you would like to convert
What is the name of the new file

Convert       Main Menu
Move the mouse and click to enter values.

What is the module name: a26a1a1_delay_line
What is the cause: a26a1a22_a17-out beam_3_wave bad
What is the effect: a26a1a1J4 bit_0_left_input bad
What is the type: D
What is the precondition: t
What is the failure rate: 0.1

Skip:
- Number of Records
- Particular Name
- Top
- Bottom

Enter number of records to skip: 2
Enter the name

OK
Tenth TAE Users' Conference '93

UIL Support and
Mrm Code Generation

Kenneth B. Sall
Century Computing, Inc.
1014 West Street
Laurel, MD 20707
(301) 953-3330

Internet: ksall@cen.com

June 16, 1993
UIL Support and Mrm Code Generation

Overview

- What are UIL and Mrm?
- Advantages of UIL/Mrm Applications
- Advantages of Wpt Applications
- UIL Generation
- Sample Mrm Code (prototype)
- Sample UIL File (prototype)

June 16, 1993
What are UIL and Mrm?

UIL is Motif’s *User Interface Language*

- Permits separation of user interface specification from application code.
- Textual description of the UI which is compiled into binary form called **UID (User Interface Definition)** using the Motif compiler, named *uil*.
- **Static** description (e.g., no item-to-panel connections)

MRM is the *Motif Resource Manager*

- Set of functions in libMrm.a which retrieve the widget hierarchy from the UID file and create the widgets.
- Application code defines callbacks in the normal X Toolkit manner, but doesn’t call XtCreate[Managed]Widget.
Advantages of UIL/Mrm Applications

- A more **standard representation** for interfaces developed with TAE Plus.

- **No proprietary libraries** (DDOs, however, require new DDO widget library, libXtae.a).  

1. Link libs are simply "-[lndo -lxte -lInterViewsX11] -lMrm -lxm -lxt -lx11" instead of "-lwpt -lxtterm -lddo -lwmxw -lInter-
   ViewsX11 -lxm -lx t [-lxmu] -lx11 -ltae -ltae -ltermlib -lm -lc"

- Eliminates the requirements for applications to use the Wpt, Vm, and Co runtime packages, thereby significantly reducing the **size of executables**.  

2. Test case: single panel with 29 items [all presentation types except DDOs, color logger, and dynamic text]; static layout only; comparison of Sun stripped binary size. **UIL application was approximately one-half the size of the Wpt version.** (Size of interface description files was approximately the same.)

- Eases the **porting** of applications to platforms not supporting TAE Plus.

- New interfaces developed in TAE Plus will be more easily migrated to **other UIDs** (user interface development tools).
Advantages of UIL/Mrm App. (cont.)

- Improved application performance using compiled UIL file (app.uid).

- Permits access to all widget resources and callbacks for finer control than is allowed in the WorkBench. ³

- Enables addition of widgets not supported by TAE Plus. Knowledgeable Motif programmers can directly add Motif widgets (e.g., XmArrowButton, XmScrollbar, XmCommandBox) to app.uil.⁴

- All 23 Presentation Types supported including DDOs.⁵

← Note: To use UIL, your Motif vendor must supply the Mrm library (default location: /usr/lib/libMrm.a) and the uil compiler (default: /usr/bin/X11/uil). Most vendors do provide these.

³ At this time, automatic merging of hand-edits to generated UIL when regenerating is still TBD.
⁴ Can also add your own widgets by registering them with UIL, which is what we've done with DDOs. This will be covered in the v5.3 Guidelines for Adding a New Presentation Type.
⁵ Dynamic Text is generated as simply an XmLabel widget in v5.3.

June 16, 1993
Advantages of Wpt Applications

- Wpt library provides greater functionality, usually with less application code than Xt, whereas UIL apps. have to simulate Wpt_PanelMessage, Wpt_HideItem, Wpt_ParmReject, etc.

- Designer and programmer need not be as familiar with Motif, Xt, and Xlib details, especially Motif resources and callbacks.

- Automatic error checking, such as for constraints (e.g., keyin, multi-line edit)

- Customized error messages (keyin, multi-line edit, textlist)

- TAE Plus Help mechanism

- Scripting (a v5.3 feature) - recording and playing back

- Code merging (a v5.3 feature; TBD whether in v5.3 UIL)

- Item-to-panel connections may only be available to Wpt applications. (TBD whether supported for UIL in v5.3.)
UIL Generation

- Generated code is Mrm, Xt, and some Xlib (no Wpt or IV).
- Type "make" to build; type "make app.uid" to compile app.uid (into app.uid) using the uil compiler.

June 16, 1993
Sample Mrm Code (prototype)

/* *** TAE Plus Mrm Code Generator version 5.3 *** */
#include <stdio.h>
#include <Mrm/MrmPublic.h>
#include <Xm/Xm.h>
#include <X11/Intrinsic.h>
#include <X11/StringDefs.h>
#include <Xm/MwmUtil.h> /* for MWM_DECOR_* and MWM_FUNC_* */
#define MAX_ARGLIST 12

int SetTopLevelResources ();

Display *TheDisplay;
XtApplicationContext AppContext;
Widget TopLevelWidget;
MrmHierarchy S_MrmHierarchy;

int main (argc, argv)
int argc;
char **argv;
{
    int n;
    Arg arglist[MAX_ARGLIST];
    MrmType dummy_class;
    Widget main_window_widget = NULL;
    static char *db_filename_vec[] = {"app.uid");
    static int db_filename_num =
        (sizeof db_filename_vec / sizeof db_filename_vec [0]);

June 16, 1993
MrmlInitialize ();
XtInitialize ();
AppContext = XtCreateApplicationContext ();
TheDisplay = XtOpenDisplay (AppContext, NULL, argv[0], "theApplication",
    NULL, 0, &argc, argv);
if (TheDisplay == NULL) {
    fprintf (stderr, "%s: Can't open display\n", argv[0]);
    exit (1);
}

n = SetTopLevelResources (arglist, "Presentation Types Demo",
    617, 871, 511, 39, 5, "presdemo", "$TAE/inc/bitmaps/tae.icon",
    (MWM_DECOR_MENU|MWM_DECOR_TITLE|MWM_DECOR_BORDER|
    MWM_DECOR_TITLE|MWM_DECOR_MINIMIZE),
    (MWM_FUNC_MOVE | MWM_FUNC_MINIMIZE ) );

TopLevelWidget = XtAppCreateShell ("ToppresdemoPanel", NULL,
    applicationShellWidgetClass,
    TheDisplay, arglist, n);

if (MrmOpenHierarchy (db_filename_num, /* Number of files */
    db_filename_vec, /* Array of file names */
    NULL, /* Default OS extension */
    &S_MrmHierarchy) /* Pointer to returned MRM ID */
    !=MrmSUCCESS)
{
    fprintf (stderr, "can't open hierarchy\n");
exit (1);
}
RegisterCallbacks ();

if (MrmFetchWidget(S_MrmHierarchy,
    "presdemoPanel", /* ui name of panel */
    TopLevelWidget, /* TBD */
    &main_window_widget, /* TBD */
    &dummy_class) /* TBD */
    != MrmSUCCESS)
{
    fprintf(stderr, "can't fetch main window\n");
    exit (1);
}

XtManageChild(main_window_widget);
XtRealizeWidget(TopLevelWidget);
XtAppMainLoop(AppContext);
} /* main */

void presdemo_textlist_cb (widget, client_data, call_data)
    Widget widget;
    XtPointer client_data;
    XtPointer call_data;
{
    printf ("event handler: presdemo/textlist\n");
}
void presdemo_checkbox_cb (widget, client_data, call_data)
{
    Widget widget;
    XtPointer client_data;
    XtPointer call_data;
{
    printf ("event handler: presdemo/checkbox\n");
}

/* list of functions to register */

static MrmRegisterArg RegList[] =
{
    ("presdemo_textlist_cb", (XtPointer)presdemo_textlist_cb),
    ("presdemo_checkbox_cb", (XtPointer)presdemo_checkbox_cb),
    ("", 0) /* dummy last entry */
};
#define NRegList (sizeof(RegList)/sizeof(RegList[0]) - 1)

int RegisterCallbacks ()
{
    int code;
    code = MrmRegisterNames (RegList, NRegList);
    if (code != MrmSUCCESS)
    {
        printf ("cannot register callbacks\n");
        return;
    }
} /* RegisterCallbacks */

June 16, 1993
int SetTopLevelResources ( arglist, title, 
                        width, height, x, y, border, 
                        iconName, iconFilename, 
                        decorMask, funcMask )

    Arg arglist[];
    char *title;
    Dimension width, height;
    Position x, y;
    Dimension border;
    char *iconName, *iconFilename;
    unsigned long decorMask, funcMask;

    { int n = 0;
      XtSetArg (arglist[n], XmNtitle, title ); n++;
      XtSetArg (arglist[n], XmNmwmDecorations, decorMask ); n++;
      XtSetArg (arglist[n], XmNmwmFunctions, funcMask ); n++;
      XtSetArg (arglist[n], XmNwidth, width ); n++;
      XtSetArg (arglist[n], XmNheight, height ); n++;
      XtSetArg (arglist[n], XmNx, x ); n++;
      XtSetArg (arglist[n], XmNy, y ); n++;
      XtSetArg (arglist[n], XmNiconName, iconName ); n++;
      XtSetArg (arglist[n], XmNborderWidth, border ); n++;
      return ( n ); /* number of resources set in arglist */
    } /* SetTopLevelResources */
Sample UIL File (prototype)

module main
version = 'v1.1'
names = case_sensitive

    pixmap_icon: xbitmapfile('/net/bat/home/tae/v53/inc/bitmaps/tae.icon');
color_black: color('black');
color_gold: color('gold');
font_alias_courB18: font('courB18');

procedure
    presdemo_textlist_cb();
presdemo_checkbox_cb();

object presdemo_checkbox : XmToggleButton
{
    arguments
{
      ! Item Specification Panel resources
    XmNlabelString = "Checkbox";
    XmNfontList = font_alias_courB18;
    XmNx = 15;
    XmNy = 26;
    XmNwidth = 129;
    XmNheight = 53;
    XmNforeground = color_black;
    XmNbackground = color_gold;
    XmNborderColor = color_black;
    XmNborderWidth = 2;

June 16, 1993
XmNshadowThickness = 2;
XmNtraversalOn = true;
XmNnavigationType = XmTAB_GROUP;
XmNhighlightThickness = 0;
! Presentation Panel resources
XmNspacing = 5;
XmNset = true;
XmNalignment = XmALIGNMENT_BEGINNING;
XmNselectColor = color_black;
);
callbacks
{
    XmNValueChangedCallback = procedure presdemo_checkbox_cb();
};

object presdemo_textlist : XmBulletinBoard
{
    arguments
    {
        ! Item Specification Panel resources
        XmNx = 446;
        XmNy = 94;
        XmNwidth = 117;
        XmNheight = 112;
        XmNforeground = color_blue;
        XmNbackground = color_beige;
        XmNborderColor = color_blue;
    }
XmNborderWidth = 1;
XmNshadowThickness = 2;
XmNtraversalOn = true;
XmNnavigationType = XmTAB_GROUP;
XmNhilightThickness = 2;
! Presentation Panel resources
XmNmarginHeight = 0;
XmNmarginWidth = 0;
);
controls
{
    XmScrolledList
    {
        arguments
        {
            XmNx = 1;
            XmNy = 22;
            XmNwidth = 117;
            XmNheight = 89;
            XmNfontList = font_alias_variable;
            XmNforeground = color_blue;
            XmNbackground = color_beige;
            XmNborderColor = color_blue;
            XmNitemCount = 5;
            XmNitems = string_table("choice 1",
                                "choice 2",
                                "choice 3",
                                "choice 4",
                                "choice 5");

June 16, 1993
XmNvisibleItemCount = 3;
XmNselectedItemCount = 3;
XmNselectedItems = string_table("choice 2",
    "choice 3",
    "choice 4");
XmNselectionPolicy = XmMULTIPLE_SELECT;
XmNlistSizePolicy = XmVARIABLE;
XmNscrollBarDisplayPolicy = XmSTATIC;
XmNhighlightThickness = 0;
XmNlistMarginHeight = 3;
XmNlistMarginWidth = 3;
XmNlistSpacing = 3;
);
callbacks
{
    XmNmultipleSelectionCallback = procedure presdemo_textlist_cb();
};

XmLabel
{
    arguments
    {
        XmNx = 2;
        XmNy = 4;
        XmNheight = 14;
        XmNwidth = 117;
        XmNfontList = font_alias_variable;
        XmNforeground = color_blue;
XmNbackground = color_beige;
XmNborderColor = color_blue;
XmNlabelString = 'Selection List';
XmNalignment = XmALIGNMENT_BEGINNING;
};
);
);
);

object presdemoPanel : XmBulletinBoard
{
arguments
{
XmNx = 511;
XmNy = 39;
XmNwidth = 617;
XmNheight = 871;
XmNforeground = color_black;
XmNbackground = color_beige;
XmNborderColor = color_black;
XmNborderWidth = 5;
XmNresizePolicy = XmRESIZE_GROW;
XmNtraversalOn = false;
XmNnavigationType = XmNONE;

! TBD: Font default for objects without font resources
XmNlabelFontList = font_alias_variable;
XmNbuttonFontList = font_alias_ncen14;
! TBD panel mwm resources and other panel resources; See SetTopLevelResources
};
controls
{
    XmBulletinBoard presdemo_textlist;
    XmToggleButton presdemo_checkbox;
};
end module;
Experience

<table>
<thead>
<tr>
<th>Technology</th>
<th>Division</th>
<th>520</th>
</tr>
</thead>
</table>

- C++                | 2 years  |
- TAE+               | 1 year (no TAE C experience) |
- X/Motif            | 3+ years |
ObjectCenter C++

TAE

TPOCC
(Transportable Payload Operations Control Center)

Other

GenSAA
(Generic Spacecraft Analyst Assistant)
What is GenSAA?

- Generic Spacecraft Analyst Assistant
- Graphical expert system builder for spacecraft monitoring & fault isolation
- Written in Centerline's C++
- Used TAE 5.2 for GenSAA Workbench
- Integrated with TPOCC
- GenSAA Workbench - graphical specification of:
  - Data to be monitored/generated
  - Expert System Rules
  - User Interface
- GenSAA Runtime - execution environment
<table>
<thead>
<tr>
<th>Object Center C++ With TAE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object Center interprets source or loads object code</strong></td>
</tr>
<tr>
<td><strong>Used graphical debugger initially</strong></td>
</tr>
<tr>
<td><strong>Found bug in Object Center related to displaying TAE widgets - Object Center / TAE responded with a fix</strong></td>
</tr>
<tr>
<td><strong>Our system grew to be too large to load into Object Center’s debugger</strong></td>
</tr>
<tr>
<td>Using TPOCC with TAE and ObjectCenter C++</td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
</tbody>
</table>

- TAE & TPOCC redefine several common macros
  - LONG
  - DOUBLE
- TPOCC used a C++ keyword "class"
- TPOCC & TAE work together smoothly, otherwise
Lessons Learned

• Object Center is very good at:
  • Enabling quick access to source files
  • Identifying compile time errors
  • Identifying runtime errors
  • Unit testing

• Object Center is not so good at:
  • Debugging large systems
TAE Tenth Users' Conference
June 14-17, 1993

Participant List
Stowe Davison  
Century Computing Inc.  
1014 West Street  
Laurel, MD 20707

Bob Deen  
JPL  
4800 Oak Grove Drive  
Mail Stop 168-414  
Pasadena, CA 91109

Valerie Denney  
Martin Marietta Civil Space & Communications  
4451 Parlament Place Suite C  
Lanham, MD 20706

Steven L. Dodge  
Naval Surface Warfare Center  
Code K52  
Dahlgren Road  
Dahlgren, VA 22448

Wayne Donavan  
Vitro Corp.  
P.O. Box 381  
Dahlgren, VA 22448

Edward Dorsie  
Booz Allen & Hamilton  
7404 Executive Place  
Suite 500  
Seabrook, MD 20706

Deborah Douglass  
Goddard Space Flight Center  
Code 683.2  
Greenbelt, MD 20771

M. "Shelly" Dumas  
Fairchild Space  
20301 Century Blvd.  
Germantown, MD 20874

Lisa A. Dutra  
Carlow International Inc.  
3141 Fairview Park Drive  
Suite 750  
Falls Church, VA 22042

Debbie Eckel  
Naval Surface Warfare Center  
Code K51  
Dahlgren, VA 22448

Steve Edwards  
Goddard Space Flight Center  
Code 522  
Greenbelt, MD 20771

Kathleen A. Erno  
Computer Sciences Corp.  
4600 Powder Mill Road  
Beltsville, MD 20705

Shin-tsuen Fang  
ATSC  
12015 Citrus Grove Road  
N. Potomac, MD 20878

Mary Farrall  
Computer Sciences Corp.  
4600 Powder Mill Road  
Beltsville, MD 20705
David Fout
Century Computing Inc.
1014 West Street
Laurel, MD 20707

Darren Gemoets
Century Computing Inc.
1014 West Street
Laurel, MD 20707

John Gillen
Century Computing Inc.
4141 Col. Glenn Highway
Dayton, OH 45431

Christine Goertz
DLR/GSOC
SEEFELDER WEG
8031 Gilching
GERMANY

Nancy Goodman
Goddard Space Flight Center
Code 522
Greenbelt, MD 20771

Thomas E. Greenhorn
Goddard Space Flight Center/ATSC
B23 Rm. W153
Greenbelt, MD 20771

Kimberly A. Gudyka
NSWC DD
Code (K51)
Dahlgren, VA 22448

Bernard Harris
Goddard Space Flight Center
Code 532.3
Greenbelt, MD 20771

Elfrieda Harris
Goddard Space Flight Center/RMS
Code 522
Greenbelt, MD 20771

Jonathan Hartley
Goddard Space Flight Center
Code 520
Greenbelt, MD 20771

Jim Hicinbothom
CHI Systems Inc.
Gwynedd Plaza III
Bethlehem Pike at Sheble Lane
Spring House, PA 19477

Jean Hobgood
NSWC DD
Code (K51)
Dahlgren, VA 22448

Jackie Hoglund
Computer Sciences Corp.
4600 Powder Mill Road
Beltsville, MD 20705

David Howell
Goddard Space Flight Center
Code 520
Greenbelt, MD 20771
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution/Department</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>George J. Huffman</td>
<td>Goddard Space Flight Center/USRA</td>
<td>Greenbelt, MD 20771</td>
</tr>
<tr>
<td>Dennis Kingsley</td>
<td>Naval Sea Systems Command</td>
<td>Washington, DC 20362</td>
</tr>
<tr>
<td>Pete Hughes</td>
<td>Goddard Space Flight Center</td>
<td>Greenbelt, MD 20771</td>
</tr>
<tr>
<td>Margi Klemp</td>
<td>University of Colorado</td>
<td>Boulder, CO 80303</td>
</tr>
<tr>
<td>David Jennings</td>
<td>Naval Surface Warfare Center</td>
<td>Dahlgren, VA 22448</td>
</tr>
<tr>
<td>Connie Kroneman</td>
<td>Goddard Space Flight Center</td>
<td>Greenbelt, MD 20771</td>
</tr>
<tr>
<td>Jim Jiang</td>
<td>CTA Inc.</td>
<td>Rockville, MD 20852</td>
</tr>
<tr>
<td>Chris Langford</td>
<td>Coastal Systems Station</td>
<td>Panama City, FL 32407</td>
</tr>
<tr>
<td>Patricia Jones</td>
<td>University of Illinois</td>
<td>Urbana, IL 61801</td>
</tr>
<tr>
<td>Doug Lankenau</td>
<td>Goddard Space Flight Center/ATF</td>
<td>Greenbelt, MD 20771</td>
</tr>
<tr>
<td>Patricia W. Kilduff</td>
<td>U.S. Army Research Lab.</td>
<td>Aberdeen Proving Ground, MD 21005-5425</td>
</tr>
<tr>
<td>Kathleen P. Le</td>
<td>U.S. Army CAA</td>
<td>Bethesda, MD 20814</td>
</tr>
<tr>
<td>Stephen H. Jovanelly</td>
<td>Goddard Space Flight Center/RMS</td>
<td>Greenbelt, MD 20771</td>
</tr>
<tr>
<td>Jae Lee</td>
<td>National Weather Service</td>
<td>Silver Spring, MD 20910</td>
</tr>
</tbody>
</table>
Kuang-Tzung Liang  
Hughes STX  
4400 Forbes Blvd.  
Lanham, MD 20706

Connie Liang  
The Nature Conservancy (TNC)  
1815 N Lynn Street  
Arlington, VA 22209

Gene Liberman  
Sverdrup Corp.  
2001 Aerospace Parkway  
Brookpark, OH 44142

Don Link  
Century Computing Inc.  
1014 West Street  
Laurel, MD 20707

Karen Lolio  
Computer Sciences Corp.  
4600 Powder Mill Road  
Beltsville, MD 20705

Keith Lukshin  
Computer Sciences Corp.  
6100 Western Place  
Suite 105, Mail Stop 5303  
Ft. Worth, TX 76107

Art Manksy  
Vitro Corporation  
1400 Georgia Avenue  
Silver Spring, MD 20906

Mary Martz  
Computer Sciences Corp.  
4600 Powder Mill Road  
Beltsville, MD 20705

Deborah Mayhew  
Deborah Mayhew Associates  
Panhandle Road  
P.O. Box 248  
West Tisbury, MA 02575

John McBeth  
Century Computing Inc.  
1014 West Street  
Laurel, MD 20771

Claudia McIlwain  
Century Computing Inc.  
1014 West Street  
Laurel, MD 20707

Mary Meckley  
HRB Systems  
P.O. Box 60  
Science Park Road  
State College, PA 16804-0060

Johnny E. Medina  
Goddard Space Flight Center  
Code 522  
Greenbelt, MD 20771

Cindy Mellor  
Naval Surface Warfare Center  
Code K51  
Dahlgren, VA 22448
Phil Miller  
Century Computing Inc.  
1014 West Street  
Laurel, MD 20707

Karen Moe  
Goddard Space Flight Center  
Code 522  
Greenbelt, MD 20771

Michael Mohler  
Loral AeroSys  
7375 Executive Place, Suite 101  
Seabrook, MD 20706

Walt Moleski  
Goddard Space Flight Center  
Code 522.2  
Greenbelt, MD 20771

Joseph Molnar  
Naval Research Lab.  
4555 Overlook Avenue  
Code 5524  
Washington, DC 20375-5000

Betty Murphy  
CTA  
6116 Executive Blvd., Suite 800  
Rockville, MD 20852

John J. Nelka  
Advanced Marine Enterprises, Inc.  
2341 Jefferson Davis Highway  
Arlington, VA 22202

Cuong M. Nguyen  
Naval Surface Warfare Center  
10901 New Hampshire Avenue  
Code B40  
Silver Spring, MD 20903-5640

Deanna Niechwiadowicz  
HRB Systems  
P.O. Box 60 Science Park Road  
State College, PA 16804-0060

Michael Nowak  
Naval Surface Warfare Center  
Code L13U  
Dahlgren, VA 22448

Christopher Olson  
Logicon  
1408 Fort Crook Road South  
Bellevue, NE 68005

Paul Paluzzi  
Computer Sciences Corp.  
4600 Powder Mill Road  
Dept. 562  
Beltsville, MD 20705

Steve Panzer  
Century Computing Inc.  
1014 West Street  
Laurel, MD 20707

Steve Pardue  
International Software Systems  
Suite 250, Echelon N  
9430 Research Blvd.  
Austin, TX 78759
Jigish Patel
Computer Science Corp.
4600 Powder Mill Road
Beltsville, MD 20705

Linda Rosenberg
Goddard Space Flight Center
Code 522
Greenbelt, MD 20771

Ajay D. Pattni
Comptek Federal Systems Inc.
2121 Crystal Drive
Suite 700
Arlington, VA 22202

Chris Rouff
Goddard Space Flight Center
Code 522
Greenbelt, MD 20771

Alan Perunovich
Computer Sciences Corp.
1100 West Street
Laurel, MD 20707

Stephen Sacco
CSDL
555 Technology Square
Cambridge, MA 02139

Vy Pham
U. S. Army
CECOM
AMSEL-RD-C3-CC-L
Fort Monmouth, NJ 07703

Ken Sall
Century Computing Inc.
1014 West Street
Laurel, MD 20375-5000

Peter Pickard
National Weather Service
W/OS012 MS 12464
1325 East-West Highway
Silver Spring, MD 20910

Melvin Sanders
National Weather Service
1325 East-West Highway
Rm. 12438
Silver Spring, MD 20910

Debasis Ray
Advanced Marine Enterprises, Inc.
1725 Jefferson Davis Hwy, Suite 1300
Arlington, VA 22202

Philip Shady
Booz Allen & Hamilton
7404 Executive Place
Suite 500
Seabrook, MD 20706

Thomas Roatsch
JPL
Mail Stop 168-414
4800 Oak Grove Drive
Pasadena, CA 91109-8099

Roger Sheldon
Loral AeroSys
7375 Executive Place
Suite 400
Seabrook, MD 20706
<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sylvia Sheppard</td>
<td>Goddard Space Flight Center, Code 522, Greenbelt, MD 20771</td>
<td></td>
</tr>
<tr>
<td>Elvira Shieh</td>
<td>Stanford Telecom Inc., 7501 Forbes Blvd. #105, Seabrook, MD 20706</td>
<td></td>
</tr>
<tr>
<td>Greg Shirah</td>
<td>Goddard Space Flight Center, Code 522, Greenbelt, MD 20771</td>
<td></td>
</tr>
<tr>
<td>Sharad Singh</td>
<td>Infotech Enterprises, Inc., 2361 Jefferson Davis Highway #1004, Arlington, VA 22202</td>
<td></td>
</tr>
<tr>
<td>Arun Jit Singh</td>
<td>Computer Sciences Corp., 4600 Powder Mill Road, Beltsville, Md 20705</td>
<td></td>
</tr>
<tr>
<td>Peggy C. Smith</td>
<td>Naval Surface Warfare Center, K52 P.O. Box 94, Dahlgren, VA 22448</td>
<td></td>
</tr>
<tr>
<td>Gary Smith</td>
<td>Naval Surface Warfare Center, Code 214, Carderock Division, Bethesda, MD 20084</td>
<td></td>
</tr>
<tr>
<td>Bill Stoffel</td>
<td>Goddard Space Flight Center, Code 513.1, Greenbelt, MD 20771</td>
<td></td>
</tr>
<tr>
<td>Wendi Sugarman</td>
<td>Century Computing Inc., 1014 West Street, Laurel, MD 20707</td>
<td></td>
</tr>
<tr>
<td>Marti Szczur</td>
<td>Goddard Space Flight Center, Code 522, Greenbelt, MD 20771</td>
<td></td>
</tr>
<tr>
<td>David Taylor</td>
<td>Century Computing Inc., 1014 West Street, Laurel, MD 20707</td>
<td></td>
</tr>
<tr>
<td>David M. Taylor</td>
<td>971 Lloyd Court, Beavercreek, OH 45434-6437</td>
<td></td>
</tr>
<tr>
<td>My-Hanh Trinh</td>
<td>Naval Surface Warfare Center, 10901 New Hampshire Avenue, Code B40, Silver Spring, MD 20903-5640</td>
<td></td>
</tr>
<tr>
<td>Walt Truszkowski</td>
<td>Goddard Space Flight Center, Code 522, Greenbelt, MD 20771</td>
<td></td>
</tr>
</tbody>
</table>
Robert Tutchings
Comptek Federal Systems
2121 Crystal Drive
Suite 700
Arlington, VA 22202

John Walker
Fairchild Space
20301 Century Blvd.
Germantown, MD 20874

Jeffrey M. Wall
Army Research Lab.
Attn: AMSRL-HR-SA (Jeff Wall)
Aberdeen Proving Ground, MD 21005-5425

John Warren
Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, MD 20814

Craig Warsaw
Century Computing Inc.
1014 West Street
Laurel, Md 20707

Elizabeth Wei
Siemens Corporate Research
755 College Road East
Princeton, NJ 08540

Stuart M. Weinstein
Loral AeroSys
7374 Executive Place, Suite 101
Seabrook, MD 20706

Lisa Weisbeck
Naval Surface Warfare Center
Code K-51
Dahlgren, VA 22448

Brenda Wheatley
Goddard Space Flight Center
Hughes STX
Code 633
Greebelt, MD 20771

Jed Wilson
Battelle/Pacific Northwest Lab
Attn: PNL-AES (Bldg. 8B8, )
Fort Lewis, WA 98433-5000

Dan Winslow
Logicon
1408 Fort Crook Road South
Bellevue, NE 68005

Karl Wolf
Century Computing Inc.
1014 West Street
Laurel, MD 20707

J. Jay Wolf
CHI Systems Inc.
Gwynedd Plaza III
Bethlehem Pike at Sheble Lane
Spring House, PA 19477

Chung Wu
National Weather Service
1325 East-West Highway
Room 16303
Silver Spring, MD 20910
Peter Wu
Goddard Space Flight Center/SSAI
Code 912
Greenbelt, MD 20771

Jine-Hwa Yang
Computer Sciences Corp.
4600 Power Mill Road
Beltsville, MD 20705

Arleen Yeager
Goddard Space Flight Center/RMS
Code 522
Greenbelt, MD 20771

Kim Youngblood
Atlantic Research Corp.
P.O. Box 719
Fort Huachuca, AZ 85613

Ming-Hsuan Yu
Computer Science Corp.
4600 Powder Mill Road
Beltsville, MD 20705

Elissa Zizzi
NSWC DD
Dahlgren Road (K51)
Dahlgren, VA 22448
**REPORT DOCUMENTATION PAGE**

<table>
<thead>
<tr>
<th>1. AGENCY USE ONLY (Leave blank)</th>
<th>2. REPORT DATE</th>
<th>3. REPORT TYPE AND DATES COVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>July 1993</td>
<td>Conference Publication</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. TITLE AND SUBTITLE</th>
<th>5. FUNDING NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportable Applications Environment (TAE)</td>
<td>Code 522</td>
</tr>
<tr>
<td>Tenth Users’ Conference</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. AUTHOR(S)</th>
<th>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edited by Chris Rouff, Elfrieda Harris, and Arleen Yeager</td>
<td>Goddard Space Flight Center</td>
</tr>
<tr>
<td></td>
<td>Greenbelt, Maryland 20771</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</th>
<th>8. PERFORMING ORGANIZATION REPORT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Aeronautics and Space Administration</td>
<td>93B00098</td>
</tr>
<tr>
<td>Washington, D.C. 20546-0001</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10. SPONSORING/MONITORING AGENCY REPORT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA CP–3225</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11. SUPPLEMENTARY NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elfrieda Harris and Arleen Yeager: RMS Technologies, Inc., Lanham, Maryland.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12a. DISTRIBUTION/AVAILABILITY STATEMENT</th>
<th>12b. DISTRIBUTION CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclassified–Unlimited</td>
<td></td>
</tr>
<tr>
<td>Subject Category 61</td>
<td></td>
</tr>
<tr>
<td>Report available from the NASA Center for AeroSpace Information, 800 Elkridge Landing Road, Linthicum Heights, MD 21090; (301) 621–0390.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. ABSTRACT (Maximum 200 words)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goddard Space Flight Center sponsored the Tenth TAE Users’ Conference on June 14–17, 1993. This document represents the proceedings; the papers included are published as received from the authors. This was the first TAE conference that followed an informal workshop format with panel discussions, demonstrations, tutorials and working sessions. With the TAE software being transferred into the private sector, all future user conferences will be managed by Century Computing, Inc., the commercial developers/distributors of TAE Plus.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>14. SUBJECT TERMS</th>
<th>15. NUMBER OF PAGES</th>
<th>16. PRICE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software, User Interface, Transportable Applications Environment</td>
<td>233</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>17. SECURITY CLASSIFICATION OF REPORT</th>
<th>18. SECURITY CLASSIFICATION OF THIS PAGE</th>
<th>19. SECURITY CLASSIFICATION OF ABSTRACT</th>
<th>20. LIMITATION OF ABSTRACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unclassified</td>
<td>Unclassified</td>
<td>Unclassified</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>