XUIMS
The X-Window User Interface Management System at CERN

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ABSTRACT

The CERN X-Window User Interface Management System (XUIMS) is a modular and highly configurable software development environment allowing the interactive design, prototyping, and production of OSF/Motif Human Computer Interfaces (HCI). Fully compliant with the X11R5 and OSF/Motif industry standards, XUIMS covers complex software areas like the development of schematics, the visualization and on-line interactions with 2D and 3D scientific data, the display of relational database data and the direct access to CERN SPS and LEP accelerator equipment.
The guarantee of consistency across the applications and the encapsulation of complex functionality in re-usable and user-friendly components has also been implemented through the development of home made graphical objects (widgets) and templates.
The XUIMS environment is built with commercial software products integrated in the CERN SPS and LEP controls infrastructure with a very limited in-house effort.
Productivity and quality have been improved through less coding and better HCI prototyping.

INTRODUCTION

The X-Window and OSF/Motif industry standards have been used since 1992 to produce the Human Computer Interfaces (HCI) required for the control of the two CERN largest particle accelerators : SPS and LEP. The decision to base the HCI software activity on industry standards was made to avoid, as much as possible, vendor-specific developments and to guarantee thereby the software investment for a long time [1].
The desire to optimize the production of HCIs led to several market investigations and product evaluations. In 1994, a commercial User Interface Management System was selected to become the kernel of the CERN X-Windows User Interface Management System (XUIMS) [2].

X-WINDOWS AND OSF/MOTIF

The X-Windows and OSF/Motif software market has rapidly evolved during last two years and today offers a large choice of HCI software development environments. One could still consider the development of HCIs using only the standard X-Window and OSF/Motif libraires, but if a higher degree of abstraction and reusability is required, or if special features (i.e. 2D and 3D scientific data visualization) are needed, then using a powerful software development environment becomes mandatory. The next four sections summarise the different strategies that can be considered for the developement of OSF/Motif interfaces.

X-WINDOWS AND OSF/MOTIF LIBRARIES

The X-Windows and OSF/Motif libraries (Xlib, XtIntrinsics, and Xm) are intended to be called from a C application and contain low level functions for the creation and manipulation of HCI components (i.e. buttons, labels and lists of elements). Any modification in the HCI requires a change in the C program (i.e. editing, compilation, and debugging development cycle). The final HCI C code is not understandable by any Interface Development Tool (IDT) or User Interface Management System (UIMS) and has therefore to be maintained manually.

OSF/MOTIF USER INTERFACE LANGUAGE

The OSF/Motif UIL language is a specification language for describing the initial state of a user interface for a Motif application. The specification describes the objects (i.e. menus, form boxes and buttons) used in the interface and specifies the functions to be called when the interface changes state as a result of user interaction. The main advantage of UIL is that it is understood by most IDTs and UIMSs. Nevertheless, UIL does not address the dynamic aspects of the interface (i.e. printing an information message when the user presses a button) and still requires the recompilation of the UIL file after each modification.

INTERFACE DEVELOPMENT TOOLS

Standard Interface Development Tools (IDT) help the developer to design the layout of the interface through a *What You See Is What You Get* (WYSIWYG) interface and to generate the corresponding C code. The application code has then to be inserted into stubs. The main disadvantage of the IDT is that the HCI behavior (i.e putting an alarm message on the screen) must still be handled by the application code, leading to non-reusable software (see chapter about HCI development principles).

USER INTERFACE MANAGEMENT SYSTEMS

User Interface Management Systems (UIMS) add to the IDT functionality the possibility to design and prototype the dynamic behavior of the HCI. These tools can usually import UIL files and export UIL, C, or C++ HCI code. Their ability to address both the static and dynamic aspects of the HCI offers for the first time the possibility to put in place a real HCI software development lifecycle policy.

These considerations led us to buy a commercial UIMS and to enrich it with :

- new HCI components such as 2D and 3D graphics widgets,
- additional high level C functions (i.e. routines for direct SPS and LEP equipment access),
- templates for a common style and behaviour within the SPS and LEP operational environment.

THE XUIMS ARCHITECTURE

As shown in Fig 1, XUIMS is a highly modular and configurable environment composed of the following building blocks :

- *The XFaceMaker™ UIMS.* XFaceMaker[3] has a WYSIWYG editor for the interactive creation of HCI layouts.

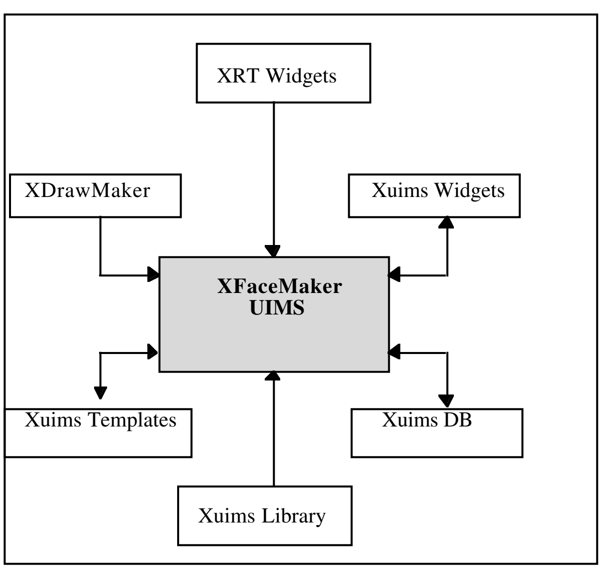

Fig 1 : The XUIMS Architecture

The HCI behavior is specified in the form of procedural scripts in a high-level, C-like programing language called FACE. The behavior can be tested within the tool using the built-in interpreter and debugger for the FACE scripting language. C, C++, and UIL code are generated by the tool. Additional C libraries can be linked into the UIMS kernel (i.e. libraries for SPS and LEP accelerator equipment access) in order to extend the basic functionalities of XFaceMaker. Working HCIs produced with XFaceMaker can run on any workstation without run-time fees (this is also the case for the other commercial products used in XUIMS). XFaceMaker also allows the programmer to define templates (composite objects) and to add new widgets to the standard OSF/Motif widgets set.

- *The XDrawMaker™ drawing package.* XDrawMaker [4] is a drawing editor enhanced by the ability to animate objects. When used with XFaceMaker, every object becomes a widget that can be included and manipulated in the HCI. Attributes of objects in complex schematics (see Fig 2) can be handled as any standard OSF/Motif widget. Almost any imaginable task can be handled with XDrawMaker.

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Creator: xgrabsc
CreationDate: Tue Oct 10 11:11:53 1995

Title: xuims2d
Creator: xgrabsc
CreationDate: Mon Oct 9 16:33:54 1995

functionality of the application and interface layers should be carefully analysed as well as the data flowing through these two layers. Experience has shown that this phase is very often omitted by developers. This situation leads in most cases to the development of monolithic, windowing-dependent, non-reusable code.

III. *Prototyping the interface.* This exercice is aimed at building a first prototype of the HCI layout with a UIMS. The benefits of this phase are the improvement in the definition of the user requirements and the detection of inconsistent or contradictory requirements.
At this stage, no connection between the interface and the application is implemented.

IV. *Designing the application.* This phase consists in the implementation of the application routines (i.e. database access, algorithms, interlocks, ...) as defined in phase I.

V. *Generating the working application.* This phase consists in linking together the interface code generated by the UIMS and the application code in order to produce the working application.

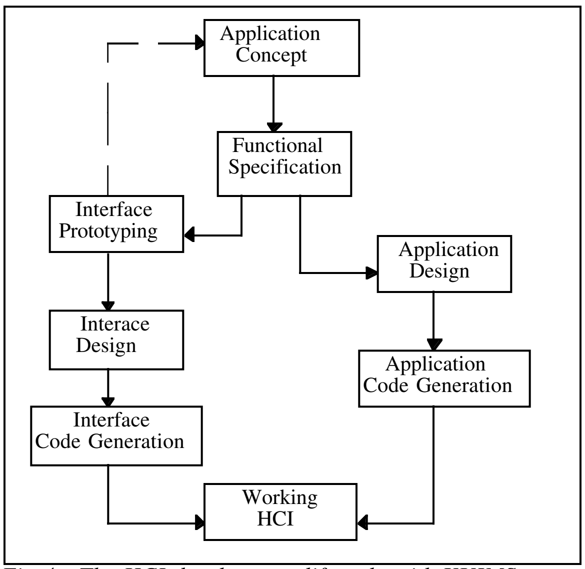

Fig 4 : The HCI development lifecycle with XUIMS

Very often the HCI lifecycle has to be iterative and prototyping should never be ignored. This XUIMS HCI development lifecycle allows the developer to draw the visual metaphor through which the user views and manipulates the system before starting any other coding effort.

CONCLUSIONS

XUIMS is operational since September 1994 and is used by an ever-growing community of software engineers. Major rejuvenation projects such as the SPS transfer line project and several graphical interfaces for the control of SPS beam instrumentation and beam transfer have been developed with XUIMS. Off-line software projects like the interface to the SPS and LEP Oracle logging system have also been developed using the XUIMS graphics capabilities. The robustness of the end-user applications as well as the openness of the environment encourages us to reduce as much as possible home-made developments and to collaborate with industry. CERN engineers now spend more time on the analysis and less time on coding. Unfortunately, providing good HCIs remains a difficult task involving detailed technical knowledge (i.e. layering of the X-Window system) and concepts of ergonomics. Building a functional specification from user requirements is a crucial phase very often omitted by software developers. By using XUIMS, turning a functional specification into a working application is now a quicker process.

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