A solution to interface evolution issues : the multi-layer interface

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Abstract

Updating an operational system is often complex and awkward. In this article, we will explain how the concept of multi-layer interface could facilitate the evolution of operational interactive systems. We will explain how the division in several layers could increase the application acceptance and smooth out learning phases. Furthermore, we will present how we implement this concept in the ASTER project.

Keywords

Multi-layer interface, direct manipulation, working method evolution.

ACM Classification Keywords

D.2.2 [Design Tools and Techniques] : User interfaces; H.5.2 [User Interfaces] : Interaction styles;

Introduction

Whatever the operational system, updating it is often complex and awkward. If the system is not critical and does not involve human lives, upgrading its may in the worst case scenario, causes delays and financial losses. If the system involves a critical activity, function degradation or risk is not acceptable. Furthermore, If we actually focus on an *interactive* system, a second element comes into play after the introduction of the

system itself: training and adaptation period, which are likely to cause a temporary loss of user efficiency and production delays. This loss of efficiency cannot be permitted in the context of a critical activity involving human lives.

This paper presents and extends the concept of multi-layer interface introduced by Ben Schneiderman [11], and focuses on two additional issues:

- How to reduce the training period and how to increase the application acceptance,
- How to avoid brutal changes in the evolution of the application.

We will show that, respecting several guidelines in the layer design, the extended multi-layer principle is a suitable solution to facilitate the system transition. They will help the user with the system evolutions issues to:

- limit the loss of efficiency caused by the takeover of the new system,
- Smooth out the evolution of working method,
- Adapt the rhythm of changes to the user receptiveness.

We have applied this concept throughout the interface evolution of the ASTER project (project in the context of air traffic control), and we have started to assess the benefits of such principles.

MULTI LAYER INTERFACE

The multi-layer interfaces were initially designed to promote universal use of application and allow users (novice, amateur, expert) to use the interface efficiently with both heterogeneous objectives and training levels. These interfaces enable different types of uses [7] (from the most superficial to the most complex use), by activating [11] or refining the use of functions [3] and adapting visual density to the user's skills [4].

A group of functions and the available visual entities define a layer. Transitions between active layers are controlled either by the user or by the system; when the layer selection (or composition) is automatic, the selection is based on user activity analysis [3]; this behavior is closed to the suggestive interfaces one [6].

The multi-layer interface mains to lead the user gradually improve his efficiency with the software while retaining continuous control of it. To reach this goal we have to define guidelines for the creation of each layer.

The layers creation guidelines

The first layer
The evolution of a system entails that some functions of the old system are outdated or unused. This evolution also adds improvements in terms of functions, as well as improving the quality of software services (for instance in terms of GUI: information visualization and interaction improvements). This is reason why the old and new systems share a set of common features.

We propose to define the old system or at least a similar modality of services and interactions, as layer '1' of the new interface (figure 1).

Our goal is to build the interface in a continuously evolving process and to avoid gaps between the old and the new software functions. New tools cannot suddenly challenge the working methods of the user. The interface must guide him, new tools must seduce him and progressively change his way of working.

The direct consequence of this "conservatism" in the layer 1 is that the user immediately finds a familiar environment, ideally completely similar. The training period becomes radically shortened because the user is already "layer 1" efficient. Using other layers will be done progressively and immediate mastery is not mandatory to use the new software.

Next layers
We propose to improve the interface in the next layers and to keep a interaction redundancy with other layers. A new layer will be materialized with new functions and with new visual entities. This new layer will lead the user to consider new working methods. With these layers, the user may grasp new way to organize his workspace and new interaction paradigm that improve his task.

Active layer selection
When software involves a critical activity, the user must always keep control over the system. He must be able to visualize at any time the active layer and be free to interact with it. This point is very important, and will make the user comfortable to explore new functions. At any time, the use is free to restore a familiar layer

bringing and completely mastered interface. This provides him to be in a good condition to face crisis situations until he feel the same level of confidence with new richer layers.

Thus, the transition between two layers can be done by the user whenever he wants and in real-time while using the interface. This transition must be reversible and triggered easily. The animation must be quick in case of stressful or under heavy workload context. This user ability dismisses an automatic system which may choose the active layer. This strongly prohibits unexpected transition in heavy workload situations.
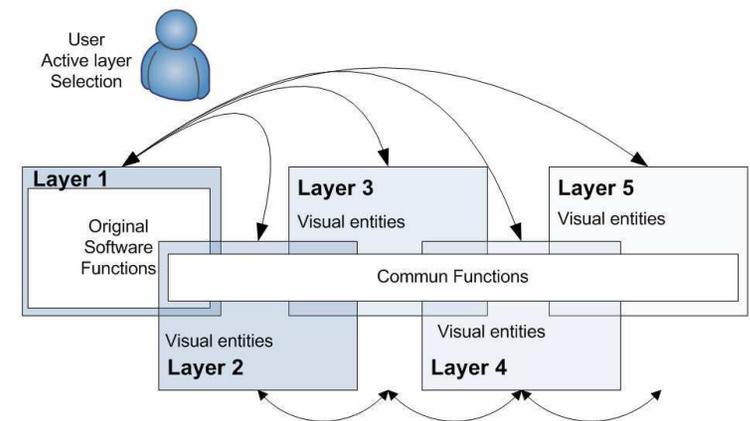

Figure 1 : layer's guidelines

User evolution
Suggested pattern of user progression is depicted in figure 2. Initially the user exploits lower layers (with mastered functions), and afterwards his range of used layers will slide to upper layers. The progression period

of the user may vary with his assurance and his activity workload. In addition, the user's progress can accelerate according to his curiosity and motivation.
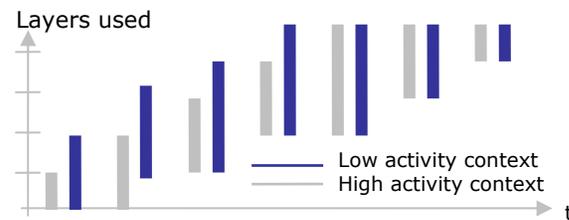

Layers used

Low activity context
High activity context

t

Figure 2 : user's improvements

ASTER

The ASTER project [12] consists in the design of an advanced electronic strip system. A strip is a standardized piece of paper used by air traffic controllers to managed information about aircrafts. This abstraction of a flight is a support for coordination and communication between controllers. The strips are manipulated to plan the work and materialize the controller strategy. ASTER inherits of paradigms and tools initially developed by an older project DigiStrips [9]: Tkzinc & MTools (graphical and interaction toolkits), touch screen interaction (Wacom screens), direct manipulation and basic gesture recognition.

The ASTER project started in 2001. His goal was to transpose the paper strip in an electronic environment and to combine the electronic strip system with a vertical projection of the radar screen [1]. This software provides an efficient support to the air traffic controller in the terminal area (the transition area between the upper sectors and airport approaches). Terminal sectors spread the big international airports,
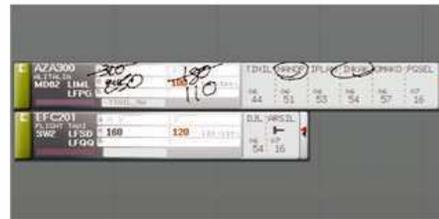
and most of the fights are climbing or descending, few are stable. The goal of vertical view is to complement the main radar screen and to intuitively display evolving aircrafts.

In 2003 [2] and in 2005 [5] two experimentations took place. During this period, air traffic controllers used new tools on a realistic simulator. Despite the relatively positive conclusions regarding to the effectiveness of this tool [2], many controllers expressed skepticism about the possible use of these tools with real flights. The controller didn't feel confident enough with tools that radically changed their working methods. These results, however, correlate the findings of the study conducted by Wendy Mackay on the need for a progressive adaptation of working methods from the use of paper strip to the electronic strip [8].
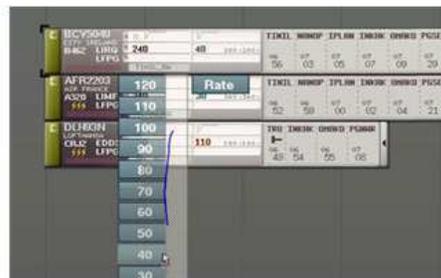
It is true that ASTER offers a significant evolution in the working methods, but above all, it added a new traffic representation and a reorganization of the workspace around this vertical projection. The multi-layer has been a solution to overcome the issues of these drastic changes. The new version of ASTER was built in 2007. This version is based on a multi-layer design that accompanies the controller from his current working methods to the methods promoted in ASTER. The instance of the multi-layer interface implementation of Aster is summarized in the figure 3 and in the video. It depicts the different layers, their tools, their interaction and their visual entities.

Conclusion

While the original goal of the multi-layer interface is to encourage an heterogeneous population to use a new software and to encourage the same population to

The application has four main layers. Each layer modifies the working method. The active layer is controlled by a bimanual interaction: a slider interaction and a background selection.

Layer 1: The first layer allows the air traffic controller to stick to current working method. The electronic strip has the physical properties of paper: motion, inertia, writable.

Layer 4: The fourth layer connects the projected aircraft position to the electronic strip. This layer enables new working method around the vertical projection.

Layer 2: The second layer adds formatted inputs. They are used to send information to the conflict detector algorithm. Most of the time, this paradigm speeds up the hand writing function.

Layer 3: The third layer introduces the vertical projection of the aircraft.

Figure 3 : multi-layer implementation of ASTER

improve their skills, our goal is to guide an homogeneous population to adopt a new working environment. Thus, the working methods of this population will gradually evolve and improve.

The originality of our method is that it inserts the user in a continuous design process of the interface. This ideally suits the invisible integration of new tools.

The benefit of the multi-layer hasn't been quantified yet. Although these results must be confirmed by ongoing experiments, we can already note that this new working methods have been much better accepted by the air traffic controllers than in the previous experiments.

We are strongly convinced that the key element is the following: exploring new functions was difficult to the user because this "challenged" their needs for a continuous control of complex situations. Trying a new tool was perceived as risky and potentially dangerous. The multi-layer concept brings the better of two worlds: being able to revert at any moment in a very short time to a well known environment is a good way to reassure users and build their trust and confidence; from there, exploring new fields becomes less risky and more acceptable. It is likely that, under such conditions, users will be happy to try new layers, the curiosity being satisfied without the cost of the risk.

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