
Universal Model of a User Interface

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Abstract

This article describes a model of a user interface that can be applied to any interactive medium or product. The model begins with on the established model of structure-behavior-presentation but adds additional levels of granularity and specificity.

The article also describes the importance and utility of such a model, both in regards to cross discipline communication and the allocation and prioritization of tasks and resources.

The article illustrates the model in practice by applying it to a single detailed example as well as to four well-known interfaces drawn from different mediums. By demonstrating how the model can be used to evaluate the relative complexity and sophistication of an interface and its constituent parts, the examples serve to illustrate the model's utility as both a communication device and a diagnostic tool.

Keywords

Interface Design, Design Models, Interaction Design, Information Architecture, Conceptual Model, Design Planning, Process Improvement

Industry/category

All industries and all interactive mediums.

Project statement

The goal of this project was to create a universal model and consistent language for identifying,

describing, and prioritizing the various elements of a user interface. Originally developed as an educational and organizational tool for the book, "Making the Web Work: Designing Effective Web Applications", the model's utility lies in its ability to help designers and non-designers deconstruct a complex user interface into a collection of smaller issues that can be understood and discussed in relative isolation from one another. The model also provides a consistent methodology for prioritizing design issues according to their impact on usability and engineering efforts. Although the model was initially created to describe Web applications, it is equally applicable to other interactive mediums including desktop software applications, automated teller machines, and DVD menu systems. The adoption and standardization of this model aids communication and improves efficiency by providing a consistent method for engineers, marketers, and designers to discuss, prioritize, and evaluate design issues.

Project participants

The editorial staff for "Making the Web Work: Designing Effective Web Applications", played a key role in the development and refinement of this model. That staff included Lisa Lord as Development Editor and Tim Kostolansky and Scott Berkun as Technical Editors. The visual design of the diagram was initially created by Jerome Doran.

Project dates and duration

The creation and refinement of the model evolved alongside the early writing of the book, a period of approximately 6 months beginning in September of 2001 and ending in March of 2002.

Process

Like virtually all designers involved in the creation of interactive media, I had developed my own mental model of the various aspects of an interface as a way of approaching my work. Unfortunately, I had never been forced to formalize that model so it could be readily understood and utilized by others. Although I was often frustrated in my attempts to explain the importance of process and design prioritization, I lacked a concrete tool for communicating and categorizing design issues for engineering, marketing, and management. Without a formal model to understand the relative importance and effect of aspects of the interface, I experienced non-designers and inexperienced designers grasping at patchwork solutions or pursuing knee-jerk reactions to both user studies and peer feedback.

The process of writing a book intended for non- and inexperienced designers however, required me to formalize my own thinking into a concrete, explicit, and articulate model that could serve as both a teaching and an organizational device. That model is the subject of this paper.

Although the traditional delineation between structure, behavior, and presentation served as an obvious starting point, those three elements alone did not provide sufficient granularity to describe the full set of issues and considerations involved in more complex forms of interactive media such as Web applications.

Although I also consulted the five-plane model described by Jesse James Garrett in, "The Elements of User Experience", I found Garrett's emphasis on the bifurcation of content and functionality a difficult concept to apply to applications in general and Web applications in particular. In addition, because Garrett's model was developed to describe Web sites, it did not

delineate some of the concepts and mechanisms critical to functionality-centric applications.

Ultimately I devised my own model by adding additional layers of granularity and meaning to the traditional three-tier approach. During the course of writing, I discovered various weaknesses or inconsistencies in the model that required both minor and major changes to the ordering and definition of the individual layers of the model. Except for a minor change to one layer of the model, it has remained stable since the book was published.

Since I devised and adopted this model, it has become fundamental to how I approach and evaluate different design problems and solutions. Although I have had limited opportunity to use it on new projects, it continues to prove its worth as a teaching, communications, and diagnostic tool.

In addition, since the publication of "Making the Web Work", I have heard from other designers, engineers, usability researchers, and educators who have found the model a useful tool for structuring the design process, interpreting usability findings, and discussing design issues.

Finally, forums such as this one have provided me the opportunity to further explore the applicability of the model to mediums beyond the Web.

Practice details

Like other sophisticated, multi-dimensional forms of communication, interactive media requires the designer to harmonize and balance a variety of differing and often opposing concerns. Even though a user encounters an interactive product as a single, unified experience, the designer has to construct and understand the experience one element at a time. Put another way, although spectators may experience the

juggler and the juggled as a single phenomenon, the juggler himself has to simultaneously consider each ball as a single object and as part of a whole.

Therefore, the ability to consistently create superior solutions requires the designer to adopt a method for deconstructing the overall experience into a series of smaller, interrelated problems that can be solved in a conscious, consistent, and repeatable manner. This allows the designer to proceed with an understanding of discrete interface elements as well an appreciation of their influence on the whole. This type of method also supports the consistent prioritization of design and engineering efforts by placing individual design considerations on the continuum of foundational to supporting.

To understand the value of such a model, it's instructive to look at another form of multi-dimensional communication: movies.

Dissecting Cinema: Models at the Movies

Although an audience experiences a movie as a single, coherent, unified expression, the process of creating a movie requires the filmmaker to understand and manipulate a number of different elements and aspects individually. In addition, these elements tend to build on and reinforce one another, necessitating a particular sequence of activity and creative decisions.

Applying the traditional structure-behavior-presentation model of interactive design, a movie can similarly be dissected along the lines of story-production-presentation. Those three tiers can subsequently be divided into nine layers as shown in figure 1.

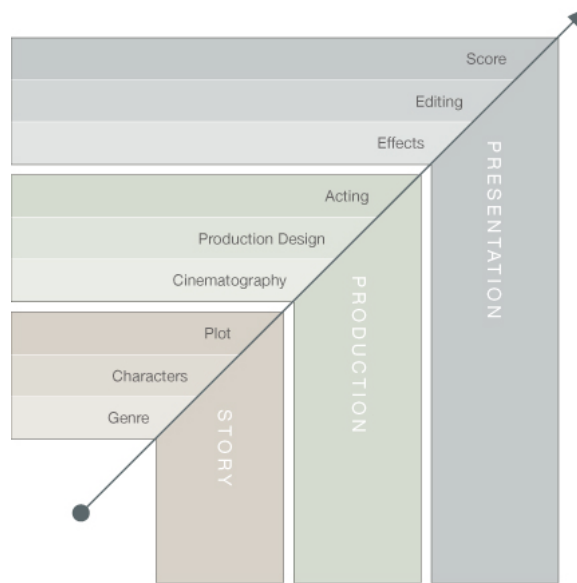


Figure 1: By deconstructing the components of a movie into individual layers, it is possible to better understand how the various aspects of a film work together to create a cohesive experience.

Although most people would never describe a movie in this way, they would surely notice if a particular film was inconsistent across these layers. For example, once a film has been identified as comedy, action, or horror, only certain types of characters, action, or music are acceptable. Similarly, the purpose of the outer layers, Effects, Editing, or Score for example, is to support and augment the inner layers.

Approached this way, the filmmaker is able to recast the overwhelming challenge of creating a finished film into a series of prioritized, interrelated

problems that can be solved in a systematic, controlled manner. A similar deconstruction of a user interface provides comparable benefits to the process of creating interactive products.

Dissecting the Interface: From Concepts to Pixels

Figure 2, illustrates a universal model of the user interface. Beginning with the three tiers of structure-behavior-presentation, the model is divided into nine discreet layers arranged from foundational to supporting. Because interactive design lacks the shared vocabulary of cinema however, further definition is required.

TIER 1: STRUCTURE

The *Structure* tier comprises the three lowest levels of the user interface: the conceptual model, the task flow, and the organizational model. Because the abstract nature of these layers makes it impossible for users to readily “touch” them, few users are ever consciously aware of them. However, because they form the conceptual and organizational basis of the experience they are ultimately the most important aspects of the design.

Layer 1: The Conceptual Model

The *conceptual model* is the most fundamental aspect of the interface, describing the relationship between the interface and the outside world. The purpose of the conceptual model is to draw on the user’s past experiences so they can readily understand basic operations and accurately predict functionality.

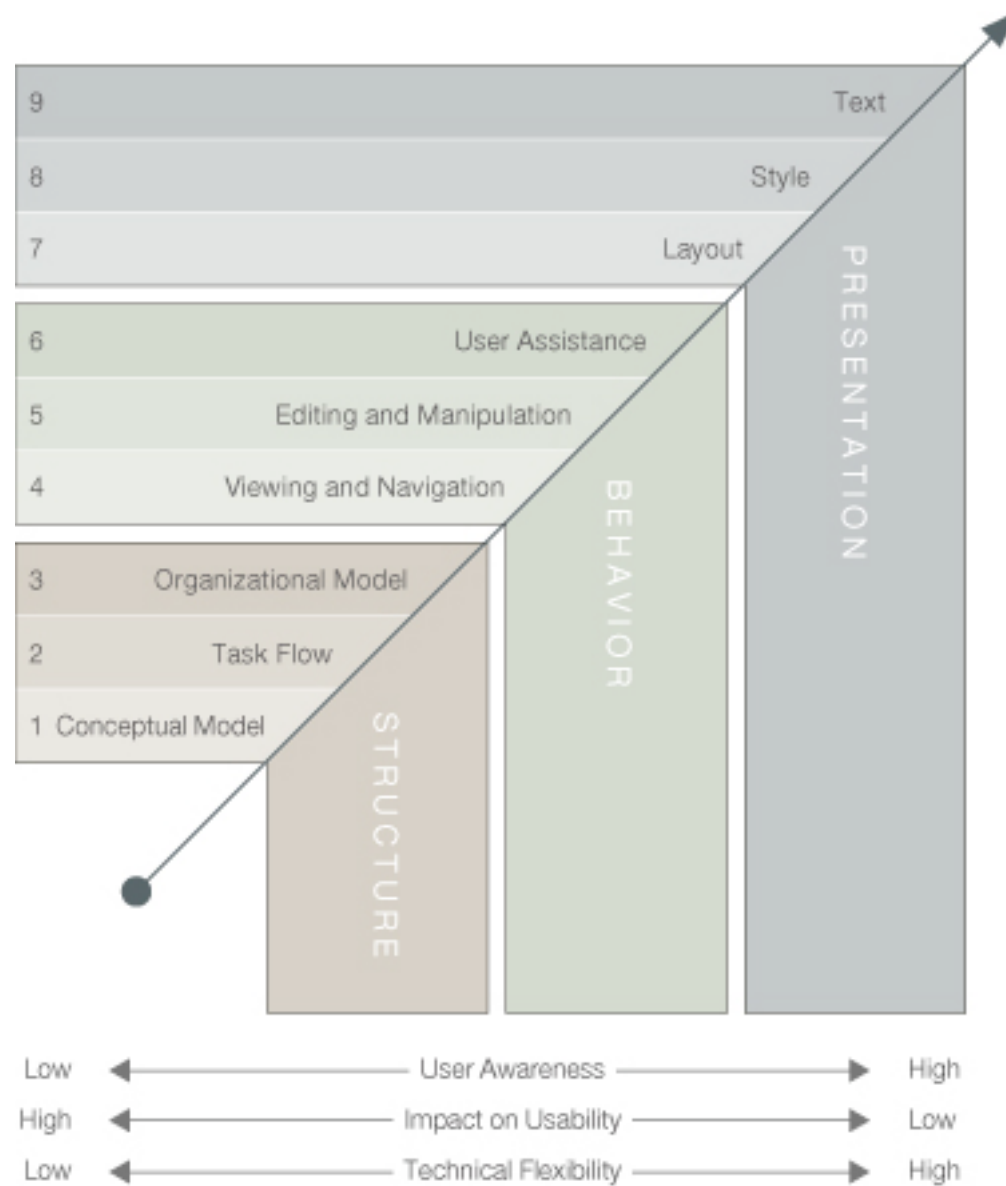


Figure 2: A universal model of a user interface spanning the conceptual to the specific.

Layer 2: Task Flow

The *task flow* is concerned with the manner in which users complete specific operations with the system. In contrast to the conceptual model, the task flow is largely dependent on the product's technical environment. For example, the steps required to select and delete a mail message in a Web environment are different than those required to accomplish the same task in a desktop environment.

Layer 3: Organizational Model

The *organizational model* describes how the system's content and functionality are ordered and categorized. Also known as the *information architecture*, the organizational model encompasses both the classification scheme as well as the model of association, hierarchy versus index for example.

TIER 2: BEHAVIOR

The middle layers of the model comprise the *Behavior* tier and describe interactive qualities as opposed to a conceptual framework or visual presentation. The design problems encountered in the Behavior tier call on the designer to anticipate and accommodate the user's actions as well as the system's reaction as they unfold over time.

Layer 4: Viewing and Navigation

The *Viewing and Navigation* layer encompasses the wide variety of behaviors and operations that allow users to navigate the interface and effect its presentation. Resizing windows, customizing a palette, sorting data, or navigating between pages are all examples of viewing and navigation behaviors.

Layer 5: Editing and Manipulation

The *Editing and Manipulation* layer contains the behaviors that result in permanent changes to user's stored information. In a word processor for example, the addition and deletion of text as well as changes to text formatting are part of the Editing and Manipulation layer. Behaviors in this layer can often be recognized by the following traits: they result in permanent, stored changes; they require an implicit or explicit save operation; and they typically require validation of the input data.

Layer 6: User Assistance

Interface elements that inform users of the application's activity and status, as well as elements dedicated to user education, are all contained in the *User Assistance* layer. This includes online help, error alerts, and status alerts.

TIER 3: PRESENTATION

The *Presentation* tier describes the specific visual and textual expression of the interface. Unlike the Structure tier, which is primarily concerned with the interface as a whole, or the Behavior tier, which is generally focused on individual operations, the Presentation tier has to simultaneously accommodate pixel-level detail and system-wide standards.

Layer 7: Layout

The various design decisions governing the placement and ordering of onscreen elements are expressed in the *Layout* layer. In addition to providing an ordered visual flow, the Layout layer also supports the Behavior tier by arranging elements in a manner that helps communicate behavior, importance, and usage.

Layer 8: Style

Like many forms of visual design, the *Style layer* is concerned with emotion, tone, and visual vocabulary. Because it is the most visible and concrete aspect of an interface, it typically accounts for people's first impression of a product. Paradoxically however, the ultimate effect of style on overall usability or user satisfaction is minimal.

Layer 9: Text

Contained within the *Text* layer are all the written, language-based elements of the interface. This includes the labels used to represent the organizational model, the names of the input and navigational controls contained in the Viewing and Navigation layer, and the alert messages and help text used by the User Assistance layer.

Critical Implication from the Model

More than facilitating a common vocabulary, the critical value of this model is what it implies about the appropriate prioritization of design tasks, the allocation of design resources, and the reaction to user input. This is captured in the specific ordering of the layers according to their impact on technical flexibility, user awareness, and usability. This is illustrated in the three axes that appear at the bottom of the diagram.

TECHNICAL FLEXIBILITY: Because the three layers contained in the Structure tier describe the foundations of the interface, they are invariably represented in the architecture of the application's code. For example, the underlying code of an application like Microsoft Word assumes the product is a tool for editing words, a sort of electronic typewriter. Although it has obviously been possible to expand the code to handle images, the

architectural assumptions made at the beginning of the product's lifecycle make it impossible to reorient the product into a tool dedicated to the editing and manipulating of numbers. Because of the engineering effort required to modify structural elements of the interface, it is crucial for designers to create a successful solution before code is written.

USER AWARENESS: Because the elements of the presentation layers; color, typography, style, layout, and text, are the most concrete and visible aspects of an interface, they dominate user awareness and usability feedback. As a result, wire frame diagrams and other methods that eliminate or minimize the presentation layers are often used to increase understanding of the more foundational layers.

IMPACT ON USABILITY: The elements that users are least aware of; the conceptual model, task flow, and organizational model for example, are also the elements that have the most severe impact on usability. And vice versa, the elements, which are the most visible, the layers of the Presentation tier, paradoxically have the smallest impact on usability.

Note however that research by Fogg et. al. at Stanford's Web Credibility Project indicates that the quality of the visual design is the most important factor in a consumer's evaluation of a Web site's credibility. Although it is unclear whether such research is applicable to applications either on or off the Web, the importance of visual design to the creation of a positive first impression and a satisfying user experience cannot be overstated.

It is equally important to note however, that while visual design is clearly an important component of a comprehensive design, it can not repair deficiencies in

the foundational layers any more than special effects can make up for a bad story.

The critical message of these three axes is evident: Although the foundational components of the Structure tier generate the smallest amount of direct user feedback, they are also the elements that have the greatest impact on usability and engineering effort.

In addition, although products should always meet some minimal level of visual and behavioral sophistication, incomplete or rushed solutions in the Presentation tier and even the Behavior can more easily be fixed in a subsequent release. Therefore, for new products or projects with limited time or resources, the design effort should initially focus on the lower layers of the interface.

The model also holds an important implication for interpreting usability studies. Because users are most aware of the Presentation tier, a majority of their comments are likely to be focused on this area. However, because of technical flexibility and relatively lower impact on overall usability and satisfaction, such comments or criticisms should not be weighted as heavy as comments or confusion over more foundational components of the interface. For example, if a designer or researcher concludes that a problem exists with the conceptual model, it is critical to address the issue as soon as possible since any weakness in a foundational layer will echo through the remainder of the interface.

Putting the Model to Work

To better understand the utility and application of the model it is instructive to use it to deconstruct a complex interface such as that shown in figure 3.

Although many elements of the example are readily recognizable by an experienced user of the Web, there are in fact a multitude of different concepts, behaviors, controls, and visual presentations, each of which represents a conscious decision or unconscious decision on the part of the designer. By using the model described here, it is possible to analyze and understand those decisions and to evaluate their impact on the overall experience.

Layer 1: Conceptual Model

The most instantly recognizable conceptual model of this interface is a tabular grid of information displayed in rows and columns. Once a user grasps this fundamental motif, they can easily understand the main purpose and function of the page. In addition, if they are experienced with other software implementations of row/column grids, they should also be able to infer other common functionality such as sorting and editing.

In addition to the tabular grid model, the page also requires the user to understand and grasp the conceptual model of a page as represented on the World Wide Web. Without this conceptual framework it would be very difficult for them to operate the various interface controls such as the links, buttons, and tabs.

Fundamental to any interaction with this interface is an understanding and knowledge of these two conceptual models, the tabular grid and the Web page. Similarly, these two models underlie the technical

implementation of this application and are embedded in that implementation.

Layer 2: Task Flow

Although it is not represented in this single page, the task flow of the example relies on a hub structure. The hub structure follows a launching pad metaphor where a single page serves as a leaping off point to single page forms, which in turn, bring the user back to the center of the hub. In this specific example, clicking the Edit Account button takes the user to a form where they can edit properties of the selected account before being brought back to the page shown here.

In addition to hubs, Web applications also make use of two other types of task flows, wizards and guides.

Layer 3: Organizational Model

The most conspicuous aspect of the organizational model shown in this example can be seen in the primary navigation area represented by the blue tab bar near the top of the screen. In this case, the designer has organized the overall site by financial practice, further subdividing the investments practice as shown in the gray bar. In addition, they have organized this specific application by accounts and views as shown in the selector area on the left side and the menu labeled View.

Finally, they have made specific choices regarding what types of data to display with each of the views contained in the View menu. In the case of this particular view, they have chosen to display seven different fields as well as three summary values.

Layer 4: Viewing and Navigation

Elements of the Viewing and Navigation layer are evident in the myriad of links and buttons displayed in

the navigation areas and the main table. By definition behaviors in this layer do not permanently affect stored data and in fact, the behavior of every navigation and control element in this page is part of this layer. One of the critical decisions contained in this layer is the relationship between the view and account selectors and whether or not they should be represented as links, menus, or some combination of the two.

Layer 5: Editing and Manipulation

Although this page contains a variety of form elements, it does not contain any functionality that results in permanent changes to stored data. As a result, it does not have any effect on the Editing and Manipulation layer of the interface.

Layer 6: User Assistance

Although this page contains a link to the Help page, it does not contain any specific elements of the User Assistance layer. This is consistent with it making use of a well understood conceptual model and not having any behaviors related to the Editing and Manipulation layer. Were the page to rely on a less common form of data presentation, it might be necessary to include instructional text or some other types of user aid.

Layer 7: Layout

The example uses a simple two-column layout with a banner spanning both columns at the top of the page. The primary column and data grid dominates the layout with a subordinate column located on the left-hand side. This is consistent with the behavioral relationship between the columns where the left-hand column functions as selector, determining what data is presented in the primary column.

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HELP
LOG OFF

SUMMARY INVESTMENTS EXPENSES TAXES PHILANTHROPY

Portfolio Tracker Investment Reports Research

Name Symbol GO

Portfolio Tracker

Preview Edition

Accounts Add

- All Accounts Consolidated
- Intl at Merrill Lynch
- Intl at Morgan Stanley
- IRA at Fidelity
- IRA at Schwab
- Merrill Account** # ▶
- Phil Hale at Merrill
- Trading at eTrade #

View: Market Value

Cash Balance \$xx,xxx,xxx Securities Value \$xx,xxx,xxx Total Value \$xx,xxx,xxx

Account: Merrill Account # Refresh Holdings Edit Account

Symbol	Quantity	Last	Change (\$)	Change (%)	Securities Value	% of total
AAPL	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
CSCO	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
INTC	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
AMAT	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
SCH	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
EMC	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
AOL	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
BBH	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
NOK	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
ORCL	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%
EPNY	xxx,xxx	\$ xx.xx	\$ x.xx	x.xx%	\$ xxx,xxx	x.xx%

Prices as of 09:11 EST, 10.10.00
Positions as of 03:17 EST, 10.09.00

Refresh Holdings Edit Account

Figure 3: A page from a typical stock tracking application. Note the number of interface elements including links, buttons, menus, and style elements

Decisions made in the Layout layer are also evident in the placement of the main navigation areas and the location of the buttons.

Layer 8: Style

The elements of the Style layer are visible in the logo, the imagery in the upper-right corner, the color scheme, and font choices. One of the more conspicuous choices is the decision to use standard HTML/system buttons for the Refresh Holdings and Edit Account buttons. Although the visual presentation of the button leads the user to believe that they effect data, the buttons actually function as nothing but navigation devices. Clicking one of the buttons takes the user to the appropriate page to edit the indicated information. Fortunately, this choice is readily modified and a change could be quickly made based on user feedback.

Layer 9: Text

Design decisions contained in the Text layer of this page are clearly present in button names, link names, and column titles. Fortunately, the choices for most of the issues in this layer are relatively obvious thanks to the strong conceptual underpinnings of the rest of the interface.

As demonstrated by this example, the model provides a structured method for analyzing a complex interface and increasing the understanding of how individual design decisions effect the overall user experience. The example also shows how an interface can be consistently described in terms of foundation to supporting, with an eye towards maximizing the efficiency of the design and implementation process.

Applying the Model to Different Mediums

Further evidence of the model's utility can be seen by using it to illustrate the relative complexity of an interface, regardless of the interactive medium. By altering the width of each layer in the diagram, the unique problem areas of various interfaces can be made visible, making it possible to more accurately allocate skills, resources, and time.

Figure 4, 5, 6, and 7 illustrate the model applied to various products operating in different interactive mediums.

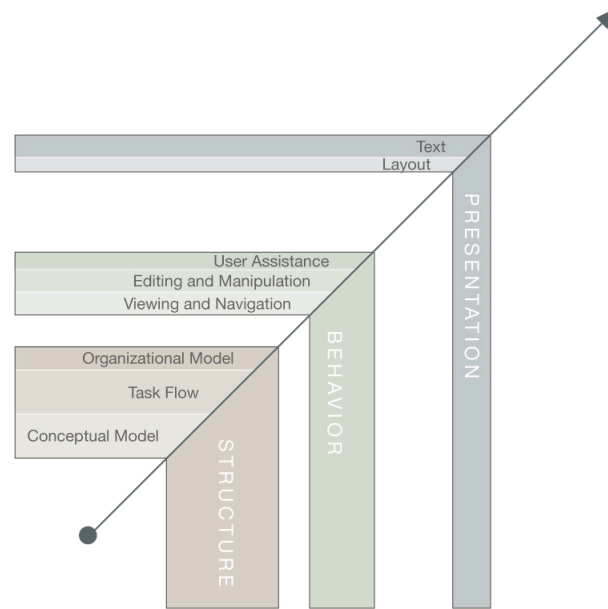


Figure 4: Interface for an Automated Teller Machine.

As illustrated here, the focus of an ATM interface is on task flow, navigation, and editing. The Task Flow layer has some complexity since the kiosk environment of the medium requires step-by-step operations. Similarly, there are various interface elements to support navigation as well as a minimal amount of input validation as reflected in the User Assistance layer. Finally, the primitive visual nature of the medium leaves little room for the Presentation tier.

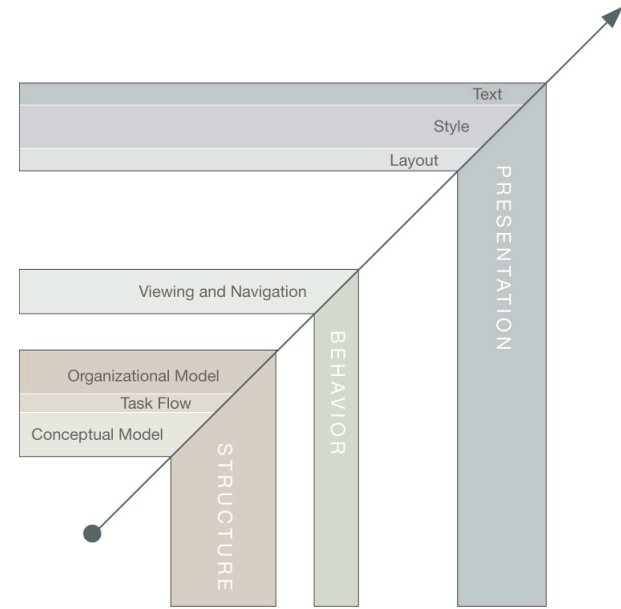


Figure 5: Interface for a DVD Menu System.

The menu system of modern DVDs allows the user to set a variety of options and navigate to different program segments. This requires an interface that is relatively complex in terms of the organizational model and navigation operations but completely lacking in editing operations or user assistance. These types of interfaces are also highly dependent on a sophisticated visual presentation as shown by the weight of the Style layer.

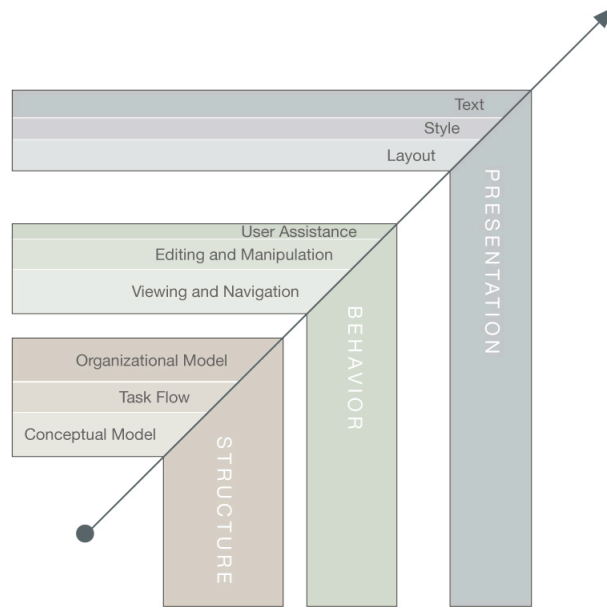


Figure 6: Interface of Amazon.com

The rich collection of content and functionality found at Amazon.com requires an interface focused on the organizational model and navigation. Although the checkout process and ability to store addresses and other personal information results in some complexity in the Editing and Manipulation layer, the User Assistance layer remains relatively thin. Finally, although Amazon.com has a clearly distinguished style, the visual sophistication of their interface is relatively low.

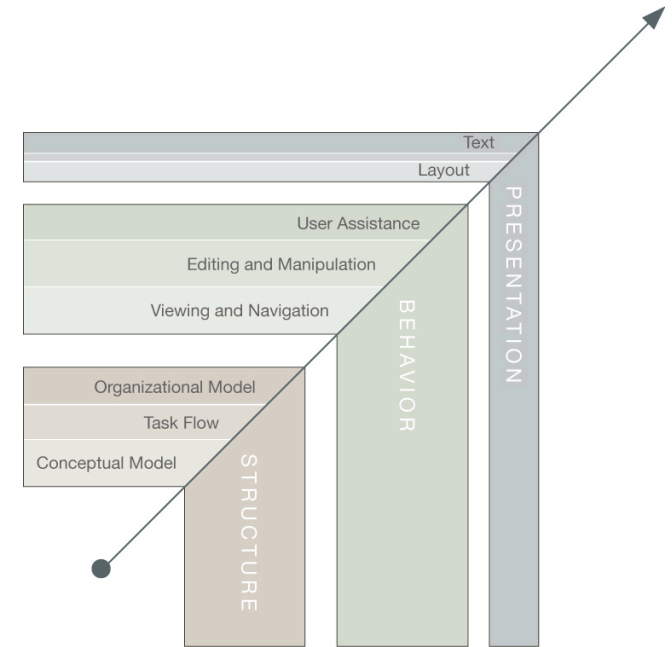


Figure 7: Interface of Microsoft Word

The mature feature set of Microsoft Word is supported by an interface emphasizing the Behavior tier. However, the ability of the desktop environment to provide direct manipulation techniques reduces the complexity of the task flow by placing most operations in palettes or dialog boxes. In addition, the interface requires a rich set of viewing and navigation behaviors to support the enormous number of modifications to the interface itself such as the manipulation of toolbars, document zooming, and support for multiple windows onto the same document. Finally, because the visual presentation of desktop applications is largely dictated by the operating system, the Presentation tier is relatively thin, particularly in the Style layer.

Next Steps

This model was introduced in the book, "Making the Web Work: Designing Effective Web Applications". Since the publication of that book in October of 2002 I have received generally positive feedback on the model from the readers who have contacted me. Along with various online articles and publications, this paper represents another forum in which I am presenting the model and soliciting feedback from the larger design community. My hope is that the model will gain general acceptance and provide other interactive designers with additional clarity and precision in their communication and process.

Acknowledgements

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