

Improving the User Interface

An Interview with Aaron Marcus

The User and Usability

What is a user-interface?

A user interface is a means for human beings to interact with computer-based "tools" and "messages". By tools, we mean home appliances and devices, office productivity tools, and products people use while traveling, e.g., between home and work. By messages, we mean computer-supported communication, i.e., story-telling and conversations, whether in groups or alone, whether mostly passive, or two-way, whether the other participant is a person or a machine. One presumed goal is to make the user's experience productive, efficient, pleasing, and humane.

The primary components of user interfaces are metaphors (fundamental concepts communicated through words, images, sounds, etc.) , mental models (structure of data, functions, tasks, roles, jobs, and people in organizations of work and/or play), navigation (the process of moving through the mental models), interaction (all input-output sequences and means for conveying feedback), and appearance (visual, verbal, acoustic, etc.).

One special aspect of user-interface design is the challenge of displaying well artifacts commonly referred to as tables, charts, maps, and diagrams. These special items we group under the term information-visualization and emphasize as an aspect of user-interface development that requires separate, special attention.

Please note that the term information is intended as a modest level in this hierarchy : data, information, knowledge, wisdom. These terms may be defined in this way:

Wisdom: significant patterns of relevant knowledge with tested experience

Knowledge: significant patterns of relevant information with action plan(s)

Information: significant patterns of data

Data: simple perceptual or conceptual input

We work with our clients to move up the data-to-wisdom chain. AM+A's objective is to improve people's ability to make wise decisions about their own and others lives by developing effective and compelling user interfaces and information visualization for computer-based products.

How do you define user-interface usability? What are the strengths and weaknesses of your definition?

Usability of user interfaces (including information visualization) may be defined as the measure of whether UI+IVs help people to achieve their goals (not objectives). Goals are defined as measurable achievement of stated ends. (Objectives are defined as general directions in which people wish to move conceptually, but are not necessarily measurable.) Usually, usability is thought of in terms of end-users, or customers. But let's not forget that clients, designers (as part of a UI+IV development team), the general public, and governing organizations also have their own "usability" goals. Let's assume we're talking about end-users, or customers.

Here, usability is often defined in terms of how easy or efficient a product is to recognize, learn, remember, use, and ...enjoy. I would like to mention the last aspect because the user's pleasure, satisfaction, and/or sense of accomplishment (separate from objective performance), is also important in rating usability.

The strength of the above definitions is that they are concise, explicit, and measurable across various demographic/cultural variations (gender, profession, age, education, religion, nationality, "cultural group," cognitive/emotional abilities/disabilities, Gardner's 7±2 dimensions of intelligence, etc.).

Two fundamental weaknesses of this definition are these:

First of all, usability cannot in itself predict successful product design. Usability evaluation (focus groups and testing) is very important in identifying trends and issues in the early stages of the development process. Successful design is based not only on analysis of this available information, but also on professional insight and experience that may sometimes fly in the face of "logic" and be based

on intuition. Consider the success of the Sony Walkman, which was the result of the chairman of Sony defying predictions of engineering and marketing. At a later stage in the development process, usability evaluation is very important in measuring the results of design and implementation. To the extent that usability focuses more on traditional human factors, efficiency, and cognitive/physical performance, it may overlook aesthetic/emotional, specifically pleasure aspects that may contribute to a product's success. AM+A attempts to consider both groups of usability dimensions in all stages of UI+IV development, at least in so far as client's budgets allow.

Second, once one has measured usability in several dimensions at any phase of the development process, it is a fundamental challenge to prioritize the impact of each dimension and to evaluate their interactions. This is similar to Christopher Alexander's classic analysis of interactions of requirements in designing buildings. Nevertheless, patterns, trends, and major impacts can be determined. It is for this reason that AM+A does honor and benefit from outside usability consultants. On other projects, we have been hired ourselves to conduct the usability evaluations.

What are the five primary user-interface components? How do we effectively use them?

As stated earlier: The primary components of UIs+IVs are metaphors (fundamental concepts communicated through words, images, sounds, etc.), mental models (structure of data, functions, tasks, roles, jobs, and people in organizations of work and/or play), navigation (the process of moving through the mental models), interaction (all input-output sequences and means for conveying feedback), and appearance (visual, verbal, acoustic, etc.).

These terms are called differently in other disciplines and even among some of our colleagues. Our clients often have fuzzy notions about them, so we often provide some training in our concepts, vocabulary, and processes, if they are interested and find it helpful to our conversations and reporting.

It was not until SABRE Travel Information Network (STIN) came to us in 1994 that a client finally used the M-word in hiring us: we were originally hired as metaphor designers. In

the course of five years with SABRE, we have gone on to all the other aspects of the UI+IV development process involving all of these UI+IV components.

How do we use these terms? They help focus the client's and our thinking on certain carefully defined aspects of the challenges in the development process. The terms are listed in approximate order of logical necessity in the design phase: If fundamental metaphors are not relevant, impactful, already familiar, or quickly learnable, then later parts of UI+IV will be harder to learn and use, and possibly alienating or offensive. The mental model and navigation should be sturdy before effort is invested in details of interaction (e.g., which widget should one use in this dialogue area and what input, behavior and feedback are appropriate for search/location, selection, retrieval, and decision), and appearance. If the circumstances of a project are fortunate for us, we have opportunity to involve ourselves with the design of all components. At other times, we might be asked to focus on a limited set: e.g., making the mental model and navigation more efficient, with faster movement to primary layers of functions and data, or making the icons more appealing and systematic.

At the very least, these UI+IV design components may provide a useful structure to segregate the tasks of a project into more limited, understandable, and logical sequence. After a needs-analysis task, we may propose initial, interim, and final versions of each of these components. At the very least, the five components serve as a useful basis for in-house and client reviews of any deliverables.

Why must we be concerned with 'tools' and 'signs' in interface design? Similarly, why should we pay close attention to the use of symbols in user-interface design?

User-interfaces are a fascinating intersection of computer-based tools and "signs," or messages. All the questions one would ask about designing tools are relevant and useful in thinking about good UI+IV design. Together, they can constitute an "environment." Another way of understanding UIs+IVs, then, is thinking about them as "spaces" or "experiences." The questions posed in architecture for decades are also relevant to UI+IV design: How do we get in/get out? What is private/public? What does the form tell us about history, social structures, and aesthetics? Like all

things people construct, UIs+IVs are cultural artifacts; they are full of meaning. By thinking about the dimensions of meaning (the dimensions of semiotics), we can understand them more easily and more deeply. This understanding is useful for both the developers or "producers" of UIs +IVs, but also the users or "consumers." Still another, related way of understanding UIs+IVs is to think of them as the most complex form of "interactive, immersive cinema" that civilization has created. As computers become ever faster and smaller, and as software becomes ever more sophisticated, user interfaces will become more and more like virtual- or augmented-reality experiences. What will always survive is "ritual" or shared symbolism. Hint: If you want to see where the future of user-interfaces is going, consider the Japanese tea ceremony.

How do you determine the value of good user-interface design? What are the costs of poor design?

If user interfaces (including information visualization) are good, they have several benefits, not all of them for end-users. Some of these benefits include the following:

Developers: Increased efficiency of production through systematic design and re-use of components, which translates into cost savings.

Developers: Possibility of improved globalization and ease of localization of UI+IV.

End users: Increased speed of becoming proficient in a skill and making good decisions.

Unfortunately, it is not always easy to put a dollar value on some of the merits of good user-interfaces. The best ones may seem novel and require learning at first, but in the end are indispensable to learning, thinking, deciding, and communicating.

The costs of poor design are many:

- Delays of development schedule
- Increased costs of production
- Poorer results among users who may be frustrated, make errors, or perform poorly.

- Increased calls to technology or domain-knowledge centers
- Higher maintenance.

Unfortunately, not very many business-case studies of good design vs. bad design exist. For several years I served on the National Endowment for the Arts' Design Arts Advisory Board. One of the frequent laments among designers was the lack of "evidence" to show the business world what the value of good design is. Some efforts have been made in architecture and traditional product design. UI+IV design professionals would benefit if similar case studies were available.

Background

**What is Aaron Marcus and Associates, Inc. (AM+A)?
What is your role?**

Aaron Marcus and Associates, Inc. (AM+A) provides intelligent design of user interfaces and information visualizations that enable people to make smarter decisions faster. We believe (1) good design helps people to access and absorb relevant information and (2) well-designed products and services are easier to learn, easier to use, distinctive, and appealing. AM+A is one of the oldest (1982), and one of the leading, full-service firms that specialize in user-interface and information-visualization (UI+IV) design. I am the founder of the company and currently President. My primary role, beyond providing leadership to my firm, is explaining issues and encouraging good professional practice of UI+IV design in industry, government, and education.

**Please tell us more about your background and experiences. For example what are your unique skills?
How did you become an expert in interface design?**

My background is a bit unusual. I have degrees in both physics (BA, Princeton University, 1965) and graphic design (BFA, MFA, Yale Art School, 1968). As a graduate student, I learned programming on my own and became a research intern at AT&T Bell Telephone Labs in 1967. A few years later in 1969-71, I programmed a desktop publishing system for the Picturephone (tm) at Bell Labs, approximately five to ten years before commercial systems. That particular project was my first opportunity in user-interface and information-

visualization design. I had to consider what useful page views a typical Yellow Pages graphic designer might need to see on the screen and what functions would need to be selected during the design process.

For approximately ten years, I taught visual communication and computer graphics at Princeton University, the Hebrew University in Jerusalem, and the University of California at Berkeley. During this time, I studied and applied the theory of semiotics (the science of signs) to my teaching, research, and professional work as a graphic designer. I was fortunate to win several awards from the New York Art Directors Club, The New York Type Directors Club, the Society for Publication Design, and others, and had several exhibits of my work in museums and at the American Institute of Graphic Arts.

For a time I was Princeton University's first graphic designer, after almost 200 years of that institution. In 1978, I was appointed leader of a multi-disciplinary, multi-cultural team at the East-West Center, Honolulu, creating a pictographic/ideographic explanation of global energy interdependence. This project convinced me to devote my professional career to information design and visual communication through computer-based systems. In 1980-82, I worked as a staff scientist at Lawrence Berkeley Laboratory's (LBL's) Computer Science and Mathematics Department as was the resident user-interface and information-visualization designer, helping to improve a device-independent, very large database information-management system being developed for the US Departments of Energy and Labor. I wrote my first user-interface design guideline at that time. Of course, screens were simple text-only displays, but the tables, charts, maps, and diagrams being generated were fairly sophisticated in terms of typography, color, and layout.

In 1982, I took a deep breath and launched AM+A. Our first project was to design a graphical user interface for Intran's Metaform forms-design software on an advanced Perq high-resolution (100 dpi) workstation. The product rolled out one month before the Apple Lisa was introduced. We also started a three-year DARPA-funded advanced research project with Prof. Ron Baecker, University of Toronto, to improve the legibility and readability of the C programming language. Our visual design specifications were tested and

proved that novice programmers could improve their comprehension of code by 20 percent just by the way laser-printer dust was deposited on the page!

Since 1982, we have been involved with many significant R+D projects: program visualization, advanced multimedia workstations, personal super computers, consumer car-navigation products, and Internet-savvy message management. We've completed approximately 400 design projects since starting the firm.

Bottom line: our unique expertise lies in the depth and breadth with which we assist our clients throughout the complete product development process: planning, research, analysis, design, implementation, evaluation documentation, and training. We have a fairly unique track record of learning our clients' end-user or customer domain knowledge, needs, and desires, and then providing superior solutions, for mission-critical projects, to the design of metaphors, mental models, navigation, interaction, and appearance, i.e., the basic components of all user interfaces and information visualizations.

How is AM+A different than other design and development firms?

AM+A differs from other "design" and "development" firms in these ways:

- We have a proven track-record in most vertical markets (e.g., e-commerce, travel, medicine/health, finance/banking, education/training , publishing, etc.) for almost all kinds of users (consumers, operators, office-workers, children, etc.). We've been around long enough to have seen and solved just about every kind of challenge through most of the technology changes over the last two decades. We keep re-inventing ourselves every few years to stay both current, but also thinking several years ahead of the industry, to help our clients plan for the future, not only the present.
- Our philosophy, development process, and techniques are exceptionally thorough and are based both on research as well as professional practice. This translates into fewer strategical and tactical mis-steps. We can prevent problems from arising; if they do, we know how to get projects back on track. In fact, sometimes, clients ask us to manage the

projects because they don't have sufficient time, staff, or expertise.

- Because we have a strong capability for analysis as well as design, and can take projects, as required, through implementation, we are ready, willing, and able to take on learning quickly complex subject domains that some other firms shy away from. Everyone of our analysis/design staff must be able to listen, see, think, draw, write, and speak well.
- We are very flexible about how we work with client and sub-contractor teams. This flexibility applies to almost every aspect of a job, from payment terms, scheduling, and scope, to the human resources provided. For example, some clients want a one-stop, turnkey solution. Others have large staffs of programmers and even UI+IV designers. We enjoy working with our client's team members and can take the appropriate responsibilities depending on those the client wishes to provide. In discussing possible projects with prospective clients, whenever budget constraints seem to loom, we can usually work with clients to provide our core visual design expertise in an appropriate way. Sometimes we've even loaned staff to our clients to help them complete jobs on site. In other situations, to help our clients' "creative" accounting needs, we've even been known to accept complete payment in advance!
- We can provide both visionary, revolutionary solutions to challenges that our own discovery process has uncovered (e.g., for customer- or investor-oriented marketing demos) as well as more evolutionary, detail-oriented solutions (e.g., production specification documents) that we implement carefully and thoroughly. Some firms tend to specialize in one or the other. This is another way that we are flexible: we can be either prophet or plumber, as required.

Nuts and Bolts

How do you discover and understand user-interface problems?

We usually think of "UI problems" as UI+IV challenges. They can come up in any of the five components. Some of the challenges arrive with the client's business, marketing, and engineering requirements. Others are encountered during the needs analysis phase of development. Others will crop up later. They cover a wide range:

Can we complete the project in the required time and cost?
Do we have the right people on the team, including the client, domain expert, and user representatives? Do we have the right process steps? Will the technology support the UI+IV design properly?

Detailed challenges pepper us at every stage:

Will the Web product color palette work in all likely browsers?

Will the navigation be sufficiently clear?

How can we fit all of this information within the available real estate?

What is most striking is that we can help people uncover and discover issues they never even realized they had. This occurs quite naturally out of the process of designing and implementing prototypes rapidly. Many client, domain, and user representatives often can not describe clearly their wants/needs/ requirements, but can recognize them immediately when confronted with a prototype, which frees them up to think more deeply.

After the problems with a user-interface are found, what do you do? What steps do you take?

Bugs in UIs+IVs can be found by us, by clients, by domain experts, and by user representatives. We usually try to get client feedback in a univocal documents with bugs identified, grouped, and prioritized (required, recommended, optional). We then try to resolve the highest priority ones first.

Remember that UI+IV bugs can occur in any of the components. For example, there may be bugs in the metaphors as well as the mental model/navigation, the interactions, or appearance characteristics. Usually through three cycles of revision and evaluation, we can get to an acceptable level of improvement within the constraints of budget and schedule.

What five things improve user-interface design the most?

The five actions that generate most of the improvement in UIs+IVs are these:

1. Include budget and expertise for user evaluations in the beginning, middle, and end of UI+IV development.
2. Include budget and expertise for skilled designers.

3. Do simple paper or screen prototypes as soon as possible to begin the cycle of design and revision.
4. Limit the variations of concepts, terms, types of images, fonts, colors, and layouts.
5. Look for systematization wherever possible to reduce costs and increase efficiency of design.

Do these things apply to Web sites also? Why or why not?

Many Web-sites have suffered from the absence of exactly the five actions mentioned above. They definitely would have benefited. In the recent past, most Web-sites were "brochure-ware" or publications. Now Web-sites are becoming applications or locations for transactions. The five points mentioned above will become increasingly relevant and important. In fact, most of our work has shifted to Web-based application development that builds upon our experience over the past 18 years, now appearing in a different context.

Our UI+IV development work for SABRE in helping to perfect an air booking application for travel agents shows exactly the process that we promote. User-representatives were involved early on in the development steps, and the client conducted extensive usability evaluations until previously determined levels of performance were achieved.

Recently for the Bank of America and now for the US Federal Reserve Bank, we again put our development process into action oriented to the steps just mentioned.

What books, Web sites, and software tools do you employ most often? Why are they so useful?

In our firm, the books, Web-sites, and software tools that the staff employ most often are:

Books/magazines:

Baecker, Ronald M., Jonathan Grudin, William A.S. Buxton, and Saul Greenberg, eds., [Readings in Human Computer Interaction: Toward the Year 2000](#), second edition, thorough

collection of papers on all major topics. Cooper, Alan, [About Face](#) by Alan Cooper, a good reference for software etiquette. DelGaldo and Nielsen, International User Interface Design, an introduction to globalization issues.

Fleming, Jennifer, [Web Navigation: Designing the User Experience](#).

Helander, Martin G., Thomas K. Landauer, and Prasad V. Prabh, Eds., Handbook of Human Computer-Interaction, second edition, thorough introduction to all topics.

Marcus, Aaron, [Graphic Design for Electronic Documents and User Interfaces](#), a wide selection of useful guidelines on typography, color, and symbolism.

Mullet, Kevin, and Darrell Sano, [Designing Visual Interfaces: Communication Oriented Techniques](#), a good general reference for the appearance of UIs (grids, button layout, etc.)

Microsoft, The Windows Interface Guidelines for Software Design.

Nielsen, Jakob, [Usability Engineering](#).

Preece, Jenny, Human-Computer Interaction.

Sano, Darrell, Designing Large-Scale Web Sites: A Visual Design Methodology.

Tufte, Edward, [The Visual Display of Quantitative Information and Visual Explanations: Images and Quantities: Evidence and Narrative](#).

Card, Stuart K., Jock D. Mackinlay, and Ben Shneiderman, authors and editors, [Readings in Information Visualization: Using Vision to Think](#)

Rosenfeld, Louis D., and Peter R. Morville, [Information Architecture for the World Wide Web](#)

Spool, Jarred, [Web Site Usability: A Designer's Guide](#)

Wainer, Howard, [Visual Revelations: Graphical Tales of Fate and Deception from Napoleon Bonaparte to Ross Perot](#).

Waters, Crystal, [Universal Web Design: A Comprehensive Guide to Creating Accessible Web Sites](#), a collection of useful implementation techniques to ensuring compatibility.

Wired, a source of trends in technology and society to consider.

Web sites

www.acm.org/CHI99 e-mail list for consultants (not really a web site, but a useful discussion group on web UI issues)

<http://world.std.com/~uieweb> a good resource for Web usability data and guidelines

www.c|net.com for news and updates

www.Macromedia.com for the latest tools news and updates

Portals Yahoo, NetCenter, MSN, etc., for general connection, searching, and news

www.useit.com, Jakob Nielsen's web site, especially the Alertbox

www.Wired.com for Wire's view of the world

www.zdnet.com for relevant industry news and events

Software Tools

Macromedia Director: useful to simulate quickly UIs+IVs for prototypes

Adobe Photoshop: useful to complete and correct imagery

Adobe Illustrator: useful to initiate imagery

Eudora Pro: for e-mail, in which we live constantly

Microsoft Internet Explorer: good for browser-specific reference material

Microsoft Word: useful for text editing

Netscape Navigator: good for browser-specific reference material

Traditional Tools

Pen and paper: very useful for individual initial sketches

Whiteboard: very useful throughout the process for in-house group meetings

Wrap Up

What is the future of usability and user-interface design?

As the cost of UI+IV design increases, and as UIs+IVs become critical for product and service success, product success, clients will rely increasingly on usability evaluation. Look at the history of the production of movies and medicines. In the early days, "anything goes" rules. In an era of mass distribution, careful analysis before, during, and after deployment was typical. In the future, with UIs+IVs able to be fine-tuned for more diverse and smaller audiences (mass distribution to micro-audiences), usability analysis will rely on statistical sampling across varied groups (mass collection of user data) to examine the efficacy of tools and messages. Fortunately, the same two-way communication technology that enables distribution of products and services also allows for gathering feedback.

What must every person remember about this interview?

According to Miller's magic number (from human factors research), we can easily remember 7 ± 2 items in short-term memory. Here's a list to consider:

1. User-interface and information-visualization (UI+IV) design is mission-critical for successful products and services that enable people to make smarter decisions faster.

2. UI+IV design is complex, but manageable: metaphors, mental models, navigation, interaction, and appearance must/can be designed intelligently to work well together.
3. UIs+IV design means forming tools and messages to impart not just data and information, but also knowledge and wisdom.
4. The UI+IV development process, i.e., planning, research, analysis, design, implementation, evaluation, and training, is similar to, but distinct from software development itself.
5. Contact AM+A if you would like to know more about or need assistance with intelligent UI+IV design.

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