François Guimbretière

Research Statement

I am interested in developing new *fluid interaction* interfaces for computers. By making the cognitive load of using a computer virtually disappear, fluid interaction interfaces will give access to computational resources during the creative process. These interfaces will be the foundation of successful casual human computer interactions for ubiquitous computing appliances.

Interests

When product designers, architects or mathematicians are exploring a new problem, they rely on pen and paper, not computer tools, to explore possible solutions. An architect draws a sketch of a building on tracing paper to observe how it relates to the site. A mathematician sketches a diagram on the board to check the validity of a hypothesis. A designer plays with a low-resolution interface mock-up to understand its limitations. In all these examples, the interactions are rapid, fluid, and almost transparent to the user, who explores the solution space by a rapid cycle of sketching followed by visual queries. It is only when a solution has emerged that they will use powerful computer tools to run simulations or verify formal derivations. I believe that this separation is artificial and limits the creative process.

My research intent is to bridge the gap between the fluid interaction style used during the creative process and the more rigid interfaces used to control computational resources. My goal is to establish the foundation for a new class of *fluid interaction* interfaces, which reduce the cognitive load of using a computer to a point where it will no longer interfere with other cognitive activities. These interfaces will be well adapted to accessing computational resources in a way compatible with the fluid, casual interaction style often used during the creative process. They will also simplify the use of computers for users engaged in attention demanding activities such as teaching, conducting a meeting, or managing the vagaries of everyday life. As such, they will be the interface of choice for ubiquitous computing appliances.

Research philosophy

The cognitive load required by an interface may depend on numerous factors such as the quality of the display, the responsiveness and accuracy of input devices, the cognitive load required by the command mechanisms, and how well an application meets the requirements of the task at hand. For this reason, my approach in exploring this new path is holistic in nature, blending software and hardware development and focusing on breakdown points in current practice as a reality check. In the course of my research, I designed new hardware to demonstrate the feasibility of a new interaction paradigm, proposed new interaction techniques limiting the cognitive load, conducted ethnographic studies to understand requirements of a given task better, and ran controlled experiments to evaluate users' performance.

This approach proved to be very successful during my first large effort to explore how to design a fluid interaction interface. Given that whiteboards are used extensively during the creative process, and high-resolution "digital wallpaper" is expected to become a commodity within ten years or so, I focused on fluid interaction for large high-resolution whiteboard-like displays. To explore the possible uses of such a device, I built the Stanford Interactive Mural[1] a 9 Mpixel, 64 dpi display. The resolution of the display makes the Stanford Interactive Mural a unique tool among other wall-size displays to study arm-distance interaction.

Because the Mural was designed as a device with a digital pen as sole input, users cannot rely on a keyboard to enter parameters or to issue commands using shortcuts. My first challenge was to provide an efficient command issue mechanism for the Mural. The solution was a menu system called FlowMenu, a new type of radial pop-up menu, which fluidly combines command selection, parameter entry and direct manipulation. FlowMenu is well adapted for large display surfaces since it provides command selection and parameter entry at the locus of attention and eliminates the need for surface-wide temporal modes. FlowMenu is also well adapted to fluid interactions: its structure limits the cognitive load of using the menu by helping people transition from the declarative knowledge of a menu structure to the motor program of a gesture. FlowMenu is a general selection mechanism for interactive surfaces, and I am in the process of running a controlled experiment to compare FlowMenu to other command selection techniques such as Marking Menus and See-Through tools.

[1] My web site http://graphics.stanford.edu/~francois contains additional information about each system described in this statement.

To understand further the use of fluid interfaces for high-resolution vertical interactive surfaces, I explored two key applications. With the Geometer's Workbench, I illustrated how to bring fluid interaction to a simulation and symbolic computation tool such as Mathematica. With PostBrainstorm, I illustrated how to bring fluid interaction to the brainstorming process.

The Geometer's Workbench: a Mathematica front-end for the Interactive Mural

While Mathematica is a very powerful engine, its syntax and interaction structure is in sharp contrast with the casual interaction style of a mathematician working at a whiteboard. The Geometer's Workbench is a new front end to Mathematica, which attempts to close the gap between casual whiteboard interaction and the power provided by a symbolic computation engine. Developed in collaboration with a colleague from the mathematics department, the Geometer's Workbench focuses on the study of differential manifolds such as minimal surfaces.

One of the important contributions of the Geometer's Workbench is MultiPoint, a new dynamic parameter selection mechanism. It is often the case that users push their simulation tools to the point where response times become incompatible with direct manipulation. In that common situation, using sliders to adjust simulation parameters becomes very difficult because of the latency. Instead of relying on sliders, MultiPoint lets users select parameters by pointing directly on a representation of the parameter space. At each sample, MultiPoint draws the corresponding simulation result, allowing its users to compare different options at one glance. MultiPoint relies on a large, high-resolution display to let users explore a complex parameter space even in the presence of latency. It provides us with a glimpse of how fluid interaction interfaces can make computational steering more fruitful.

PostBrainstorm: a fully digital brainstorming tool for the Interactive Mural

With PostBrainstorm, I explored how the Stanford Interactive Mural can be used during brainstorming sessions for industrial design. Brainstorming presents many advantages as an application domain for my research. It is a challenging instance of the creative process: this fluid process requires a focused team, which can generate and organize more than one hundred sketches per session. The current practices have a clearly identified breakdown point: while the information is gathered using pen and large Post-It notes during the meeting, the leader has to produce a digital report of the findings of the meeting. This forces her to manually transfer information from paper to digital format, an awkward process dreaded by most leaders. The fluid interaction techniques developed for PostBrainstorm let users gather a wider variety of material including not only sketches, but web pages, digital pictures and 3D models. Using the tangible interface of FlowScan, the overhead scanner I developed for that purpose, users can also rapidly scan non-digital items such as printed documents or medium size objects. Using ZoomScape, a new Focus+Context technique, users can manipulate a large number of items because the resolution of the display allows them to read handwriting scaled down one fourth. At any time, PostBrainstorm can create a Microsoft Office document that gathers all the pieces of information present on the display, making the creation of the brainstorming session report a simple process.

PostBrainstorm was developed in close collaboration with expert brainstormers from IDEO, one of the leading product design studios in the world. It was tested on real-world examples by IDEO designers. As further validation of my design it was used in the preliminary design stage of the Chrysler Design Award 2001. PostBrainstorm is a confirmation that fluid interaction interfaces can bring powerful computer tools to the creative process.

Future directions

Large vertical surfaces are a small part of the design space of interactive surfaces and only constitute one piece of my vision of a fully digital design environment. Others surfaces, such as tables, sketchpads and drawing boards, are used heavily in a design studio and during meetings. They all are opportunities to explore new aspects of fluid interaction interfaces.

A high-resolution interactive table is probably the most natural evolution for my work. Using design elements similar to those used for the Stanford Interactive Mural, an interactive table will allow me to explore the very different social conventions that take place when people interact at a meeting table. However, my interest is not limited to large surfaces. I also intend to explore how emerging technology—such as very high-resolution LCD displays, powerful new tablet computers and the upcoming digital pens—can be used to develop new fluid interaction appliances.

My experience with PostBrainstorm was a successful first step toward my goal of bringing powerful computational resources to the creative process. I intend to extend the scope of fluid interaction interfaces to more challenging tasks. Potential candidates, such as architecture, combinational chemistry and biomedicine, will require access to complex tools, such as large databases, simulation tools, and authoring tools during the creative process.