

Research Statement

Richard C. Davis

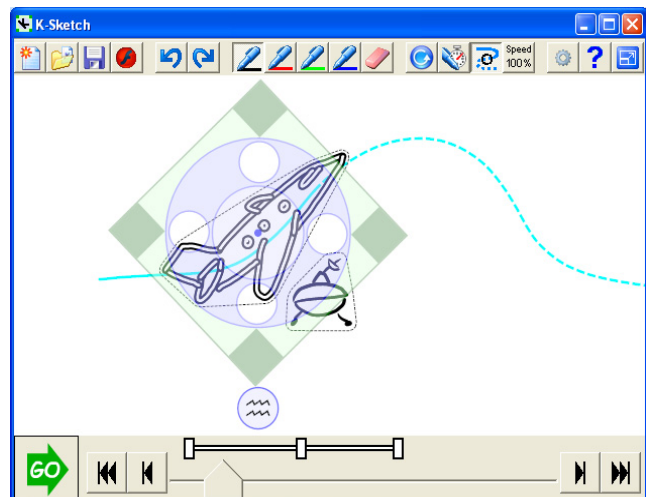
My research seeks to remove unnecessary complexity from modern creativity support tools by allowing people to manipulate ideas in rough form. Systems that work in rough form help people clarify and communicate ideas in their early stages, when they are most fragile. Good ideas can easily fall prey to excessive focus on details like graphic design before they have matured. Ideas can also die if people can't find a proper medium for expressing them.

My approach to research is user-centered, systems-oriented, and collaborative. I start every project by asking what problem I am trying to solve and collecting data from real users. Because the unexpected results of adopting a new technology are often the most interesting, I believe no project is fully complete until a real system has been built and deployed. Building working systems often requires the expertise of many researchers and the integration of diverse technologies. I have been fortunate to engage in many fruitful collaborations both in academia and during five years in industry, and I plan to expand such collaboration in the future.

K-Sketch: Rough Animation for Novices

My dissertation research, K-Sketch, gives everyday computer users a powerful new way to express and manipulate rough ideas through animation [2,3]. Many people envision moving images but can't communicate them, because animation tools are either too complex or too limiting. Many teachers, for example, want animations to illustrate concepts, and they need to work *quickly* to create animations before or possibly even during class. Many professionals need to communicate moving visuals to colleagues, and they need a single tool that is *powerful* enough to handle a wide variety of tasks. Also, there are numerous amateur artists who want to play with animation, but they lack an *easy* way to get started. K-Sketch provides a fast, simple, and powerful animation interface that is streamlined for these rough animation tasks and allows users to focus more effectively on their high-level creative task.

During my field studies, I collected a library of 72 examples that show how rough animation is useful in education, business, and entertainment. I also identified 18 "animation operations" that could be used to express the events in each animation. Next, I developed a novel interface optimization technique for designing an interface that is simultaneously fast enough to create animations in seconds, simple enough to learn in minutes, and powerful enough to handle most tasks [3]. This technique includes a detailed analysis of all 72 example animations and an optimization program that finds the fastest, simplest approaches to creating each animation. This method helped me identify 10 animation operations that fit into a simple and elegant design while still supporting over 80% of the animations in my library.



K-Sketch provides a simple and powerful animation interface for novices.

K-Sketch uses pen input and relies heavily on users' intuitive sense of space and time. To record an animation, users demonstrate object behavior. This behavior is recorded in real time, allowing users to

specify a long chain of events in one fluid gesture. The interface also provides an iconic view of edit operations just above the time slider bar, visible motion paths for manipulating motions, and tools for easier coordination of object motions.

To evaluate K-Sketch, I observed 16 animation novices performing two tasks with K-Sketch and Microsoft PowerPoint [3]. K-Sketch allowed participants to work three times faster and required half the practice time. It also felt significantly faster and easier and imposed much less cognitive load. In many cases, this improvement was due to the fact that K-Sketch encouraged users not to fret over details. In spite of this, participants were no less comfortable showing their K-Sketch animations to others. This demonstrates that K-Sketch's simplified design can help users avoid unnecessary details. Participants were also significantly more comfortable creating animations in front of others with K-Sketch, indicating that the system enables spontaneous collaboration with animation.

K-Sketch will be released soon, and it has already generated media attention [1]. We have also received over 40 download requests from teachers, students, designers, and other professionals excited by the fact that K-Sketch gives them an easy way to express their rough ideas in this medium. Video demonstrations and downloads can be found at www.k-sketch.org.

NotePals and Jotmail: Rough Note Taking for Information Retrieval

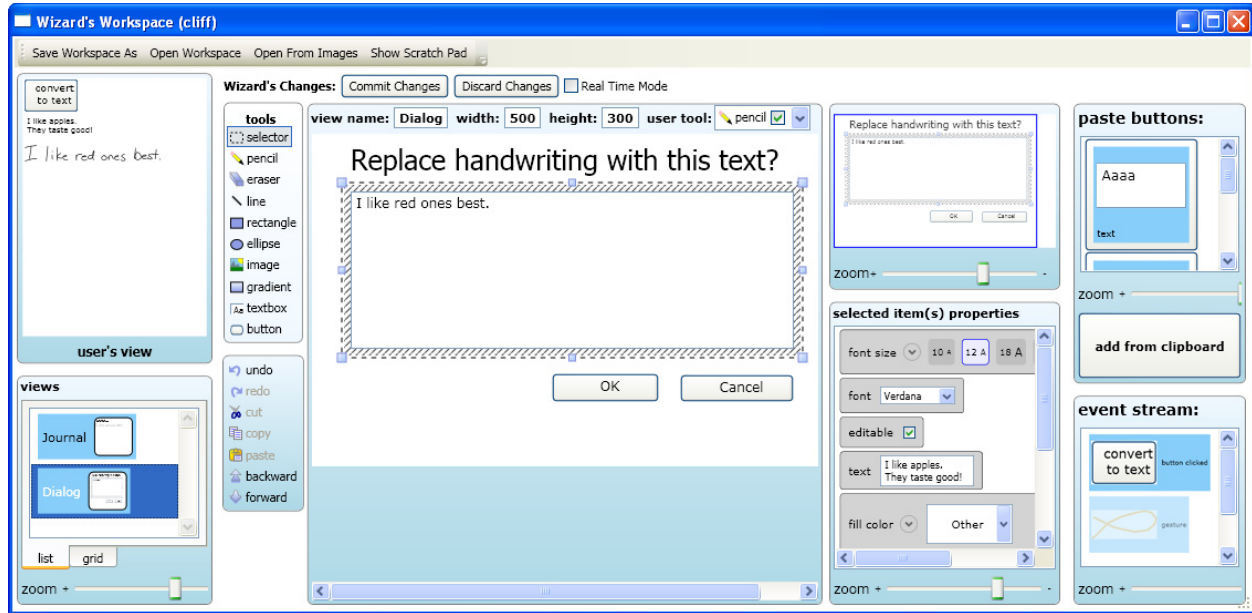
My earlier research helps people think creatively with the rough notes they take as they encounter new information. Many people take such notes reflexively, and if these notes can be captured along with their context, we can automatically link these notes to other relevant information to facilitate creative thinking.

NotePals helps teams of people find creative solutions to problems by sharing the rough notes they create during informal meetings [4,6]. Users take handwritten notes on devices such as Palm PDAs or the paper-based CrossPad that capture contextual information, such as author and creation time. These notes are then uploaded to a shared web repository and placed next to colleagues' notes taken at the same time. NotePals users took nearly 3200 pages of notes in the first 18 months of the system's deployment and found new value in their notes by combining them with colleagues'. One group held particularly thorough conference review sessions by browsing their notes together, and another group reported that shared class notes helped them prepare for exams in a course where all content was delivered in lectures. These experiences led to new browsing interfaces that put notes alongside other relevant information such as conference papers and lecture slides, making it even easier to think creatively with rough notes.

Jotmail is a web-based interface to voicemail in which each message has a text note field where users place fragments of information as they listen [8]. Placing their notes next to each message gives users a new ability to "see" their voicemail inbox. This system was deployed in an eight-week field trial with nine users, totaling 935 hours of use over 184 sessions. Jotmail improved ease of scanning, information extraction, and status tracking. This is another example of how we can facilitate creative thinking by simply capturing rough ideas as users create them and linking them to relevant information.

SketchWizard: Designing Interfaces for Rough Ideas

Systems that manipulate rough ideas are challenging to design, and this has led me to an interest in design tools for such systems. Pens allow free-form input that makes it easy to express rough ideas quickly, but pen-based applications are particularly difficult to design. Hard design problem can usually be tackled with low-fidelity prototyping methods that allow rapid iterations on a design before implementation begins, but such methods do not easily handle pen input. Yet early iteration is particularly important for pen-based interfaces, because they are hard to develop and often rely on complex recognition technologies. SketchWizard allows designers with no programming experience to create Wizard of Oz prototypes of pen-based user interfaces early in the design process [5]. In SketchWizard, designers share a



The SketchWizard “Wizard’s Workspace” allows a designer to construct pen-based interfaces with graphical tools and show them to users in real time. In the center, a designer is preparing a dialog box that will be shown to a user during a test. The user’s current view is in the upper left.

drawing canvas with an end user and simulate interface behavior in real time, allowing designers to get feedback on a design before implementation begins. Special editing features help designers respond quickly to end-user input.

I have run two evaluations of SketchWizard. The first was a feasibility study in which I used SketchWizard to design a pen-based sketch beautification interface. The second evaluation of SketchWizard was a laboratory study in which seven real designers prototyped interactions of pen-based UIs with end users in another room. Designers were able to simulate the interactions in these interfaces, and end users gave valuable feedback without ever suspecting that a human being was controlling their interface.

Through SketchWizard, I am enabling others to design creativity support tools that manipulate rough ideas. SketchWizard has been downloaded 41 times since it was made available two months ago. Downloads and videos showing the system in action can be found at dub.washington.edu/sketchwizard.

Future Directions

In the future, I plan to continue building creativity support tools that manipulate rough ideas. I also plan to build systems that help people transform their rough ideas into a more polished form. Following are some specific research directions that I would like to pursue as a faculty member.

Enabling the Next Generation of Pen-based Applications: There are very few compelling pen-based applications in spite of 40 years of pen interface research and development. Earlier research has produced powerful pen computing hardware and interaction techniques but few compelling reasons to use any of it. We need to stop thinking of pens simply as a way to enter data and start tuning pen-based interfaces to support the creative process. Developing new interaction techniques will be a part of this, and I will develop and compare new pen-based interaction techniques whenever necessary, as I did with Bimanual Marking Menus [7]. A more important step, however, will be developing methods like K-Sketch’s interface optimization technique for choosing the capabilities of pen-based interfaces. The key ideas in

this technique are collecting real-world tasks, analyzing those tasks in a principled way, and using that analysis to design a highly-tuned interface that focuses users' attention on the right details at the right time. I will extend this technique to new application domains and develop tools that help others apply it.

Managing Ideas Throughout Their Life Cycle: An artificial wall currently exists between users' rough sketches and the finished artifacts produced from them. This boundary is difficult to cross, and it causes ideas to become fragmented and unmanageable. For example, animators often make character sketches in a notebook, but if they wish to show their clients an animated storyboard, they will scan their drawings and animate them in a complex tool like Adobe AfterEffects. The character may be modified in AfterEffects, but it is hard to bring this sketch back into the notebook where it can be browsed alongside other character sketches. K-Sketch blurs the boundary between rough sketches and the animations produced from them, making it possible to move seamlessly from brainstorming character ideas to working out character motions and back again. I plan to extend this idea and build an electronic notebook that helps users managing rough notes or sketches and move them gradually to and from more finished forms such as animations, presentations, and web sites.

From Sketching to End-User Programming: The increasing complexity of modern life requires all people to find ever more creative solutions to ever deeper problems. K-Sketch is an example of how the use of informal sketching can transform a complex problem like animation into something tractable. In the future, I will apply sketching to end-user programming in more domains. For example, I authored a grant proposal to investigate the use of sketched animation as the first step toward creating small, interactive graphical applications. Such applications can illustrate subtle concepts to students, but few teachers have the programming skills to build them. By folding ideas from current research in end-user programming and cognitive science into K-Sketch, it will be possible to create an informal programming tool that is more accessible to novices than existing tools. This proposal was awarded a \$142,281 NSF Small Grant for Exploratory Research (IIS-0742877) under PI James Landay to begin exploration of this new area.

Applications of Informal Animation Sketching: K-Sketch makes the production of animation so simple that it enables new forms of artistic expression, new educational uses, and new ways to investigate how people reason with dynamic images. By collaborating with researchers and practitioners in art, education, and psychology I plan to deepen my exploration of this topic.

Through my work on systems that manipulate rough ideas, I am helping people do creative work. As more systems use the techniques I am developing, the burdens imposed by the excessive complexity of modern information technology will become lighter. I look forward to a day when this technology fades into the background and allows us to focus more of our attention on creativity, collaboration, and all the best things in life.

References

1. Celeste Biever. Easy animation to get novices jumping for joy. *New Scientist*, issue 2524, November 5, 2005, p 26.
2. Richard C. Davis and James A. Landay. Informal Animation Sketching: Requirements and Design. *Proceedings of AAAI 2004 Fall Symposium on Making Pen-Based Interaction Intelligent and Natural*. Arlington, VA, October 21-24, 2004, p. 42-48.
3. Richard C. Davis and James A. Landay. K-Sketch: A "Kinetic" Sketch Pad for Novice Animators. To appear in *the 2008 ACM Conference on Human Factors in Computer Systems (CHI'08)*.
4. Richard C. Davis, James A. Landay, Victor Chen, Jonathan Huang, Rebecca B. Lee, Francis Li, James Lin, Charles B. Morrey III, Ben Schleimer, Morgan N. Price, and Bill N. Schilit, NotePals:

Lightweight Note Sharing by the Group, for the Group. *Proceedings of the 1999 ACM Conference on Human Factors in Computer Systems (CHI'99)*, Pittsburgh, PA, May 15-20, 1999, p. 338-345.

5. Richard C. Davis, T. Scott Saponas, Michael Shilman, and James A. Landay. SketchWizard: Wizard of Oz Prototyping of Pen-based User Interfaces. *Proceedings of the 2007 ACM Symposium on User Interface Software and Technology (UIST'07)*, Newport, RI, October 7-10 2007, p. 119-128.
6. James A. Landay and Richard C. Davis. Making sharing pervasive: Ubiquitous computing for shared note taking. *IBM Systems Journal*, vol. 38, no. 4, 1999, p. 531-550.
7. Daniel L. Odell, Richard C. Davis, Andrew Smith, and Paul K. Wright. Toolglasses, Marking Menus, and Hotkeys: A Comparison of One and Two-Handed Command Selection Techniques. *Proceedings of Graphics Interface 2004*, London, Ontario, Canada, May 17-19, 2004, p. 17-24.
8. Steve Whittaker, Richard Davis, Julia Hirschberg, and Urs Muller. Jotmail: A Voicemail Interface that Enables You to See What Was Said. *Proceedings of the 2000 ACM Conference on Human Factors in Computer Systems (CHI'00)*, The Hague, Netherlands, April 1-6, 2000, p. 89-96.