

TEACHING WITH DIGITAL SKETCHES

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Abstract

Sketches can contain the seeds of ideas, but the process of germination is usually obscured in the final document. A new digital pen with stroke-by-stroke replay allows us to examine and teach drawing in new ways. When used for writing or drawing, the Logitech Io digital pen scans Anoto's specially patterned paper to record each stroke that is made. (1) After the drawing is complete, the user places the pen in a dock that downloads the recorded strokes to a computer where its software allows review of the stroke sequence. The digital document files contain the order in which the strokes were made so that they can be replayed through an interactive timeline.

This paper describes efforts in using this digital pen to research drawing and teach drawing skills to design students. We have found that the ability to record and replay graphic marks with a timeline is a great asset to understanding and teaching drawing. The time-based format changes what can be shown about drawing and the digital nature of the drawing opens up new kinds of classroom interaction.

I. Background

The project comes from a larger effort to look at how mobile tools can help environmental designers learn about places.(2) In starting a project, a designer visits a location and brings away qualitative impressions and observations as well as quantitative measurements. With field tools, a designer can gather visual, audio, quantitative and dynamic information that leads to useful analyses of assets and deficiencies. In studying these tools, we found that complex tools, such as personal digital assistants, become most useful with private ownership and frequent practice. Simple, reliable, easily-connected gadgets worked best for sharing, especially when they are logical substitutes for familiar tools, such laser-measuring tools for tape measures and digital pens for analog ones. The Logitech Io's accessible pen and paper interface made us curious how we could use it in the classroom.

Our goal is to use technology in service to design education: to discover what the simple stroke-recording pen can reveal about drawing and how it can be best deployed in the classroom. We'd like to build on the aesthetic values and practical training of art instruction manuals and eventually bring out a more rigorous understanding of design drawing processes through analytical examination. We believe tools that combine high-tech with high-touch can help bridge the gap between traditional and digital media methods.



Fig. 1. Drawing with the Logitech Io pen (left) and docking the Io pen to download the information (right).

II. Comparisons

We can understand the potential of the Io pen by comparing it with other possibilities for field sketching and digitizing drawings. We developed our project around the Logitech Io after trying the Compaq iPaq 3850 Pocket PC with and without the Seiko Inklink, and the Toshiba Portege 3500 Tablet PC. We naturally considered drawing with these mobile devices in comparison with using a digitizing tablet or scanning traditional sketches.

We chose the Io pen to explore its novel pen and paper interface that combines portability, usability and reliability. We found the hardware sturdily constructed with ergonomic design and the software immediately usable. We appreciated how the pen simultaneously creates both a paper and digital copy of the drawing, a fail-safe mode of operation.

Compared to the sketching on a palmtop computer, the Logitech Io allows a much larger drawing surface, only limited by the specially printed paper. (The currently available maximum size is 8 ½ x 11 or A4.) While there are many fun programs for sketching on palmtop computers such as the Pocket PC, palmtop screen sizes severely constrain the amount of information displayed. Manipulating condensed controls can present visual and ergonomic challenges. Integrated cameras greatly extend the usefulness of palmtop sketching by providing a rich background for annotations.

The Seiko Inklink, a descendant of the Seiko Smartpad, also allows drawing on real paper. It records the movement of a special pen through an IrDA Transceiver that clips to the top of a pad of paper. The data is transmitted via wire and another clip on the PocketPC. One draws on the paper and uses the menus on the PocketPC for setup and pen type, line color and weight. We found carrying both the PocketPC and the paper pad burdensome when standing and rigged up a folder that simulated the original Smartpad design. The device's small pieces often became misaligned and we encountered some software errors.

We also tested PocketCad by ArcSecond on the iPaq PocketPC for recording field measurements taken with the Leica Disto Pro laser-measuring device. After customizing a cable connection between the two devices, we were able to create simple dimensioned polylines from the Leica Disto. The program makes it possible to create elaborate CAD drawings, but the small screen makes it cumbersome to view or manipulate functions. PocketCad appears to be more useful for marking up or annotating CAD drawings than for generating them.

Compared to a Tablet PC computer, the Logitech Io is less multi-functional, but much cheaper, portable and natural to use. The Tablet PC platform provides convenient stylus-based drawing directly on a screen, an asset in working with graphic programs. Some versions incorporate Wacom's pressure-sensitive technology. At least in the Toshiba version, there can be discernable latency (delays in seeing the mark move with the cursor), and problems in screen calibration and defects. The convertible types, in which a traditional laptop screen swivels around and hinges to be a tablet, provides more flexibility than many slate versions with detached keyboards. Initially, the cost premium has curtailed its accessibility, especially for students.

Since a Logitech pen has to be docked to use its digital documents, it is useful to compare it with the common digitizing tools, the tablet and the scanner. The lightweight, compact Logitech pen offers greater portability than either a Wacom digitizing tablet or most scanners (3), but lacks some of their features that enhance artistic expression. The Io does not register pressure differences that can be translated to line widths or saturation the way the Wacom tablet does. It uses a more familiar ballpoint tip on paper rather than the Wacom tablet's plastic-on-plastic. Scanning can capture a wide range of media very faithfully, but can only capture drawings in process by interrupting the process. In contrast, though the Logitech Io pen has limited graphic capabilities, it captures the step-by-step drawing process in an inconspicuous way.

Compared to other ways to record dynamic process of drawing, video-taping and artist or using a digital animation screen-capture software, the pen is less robust but much more natural. Videotape's ability to capture an artist's words and movements along with drawing marks provides a much fuller description but clearly makes people self-conscious. The videotapes show the drawings as intrinsically tied to an individual, making it more difficult to examine only the graphics. Real-time computer recording (i.e. Painter Script recording) requires more concentrated effort and editing than using the pen.

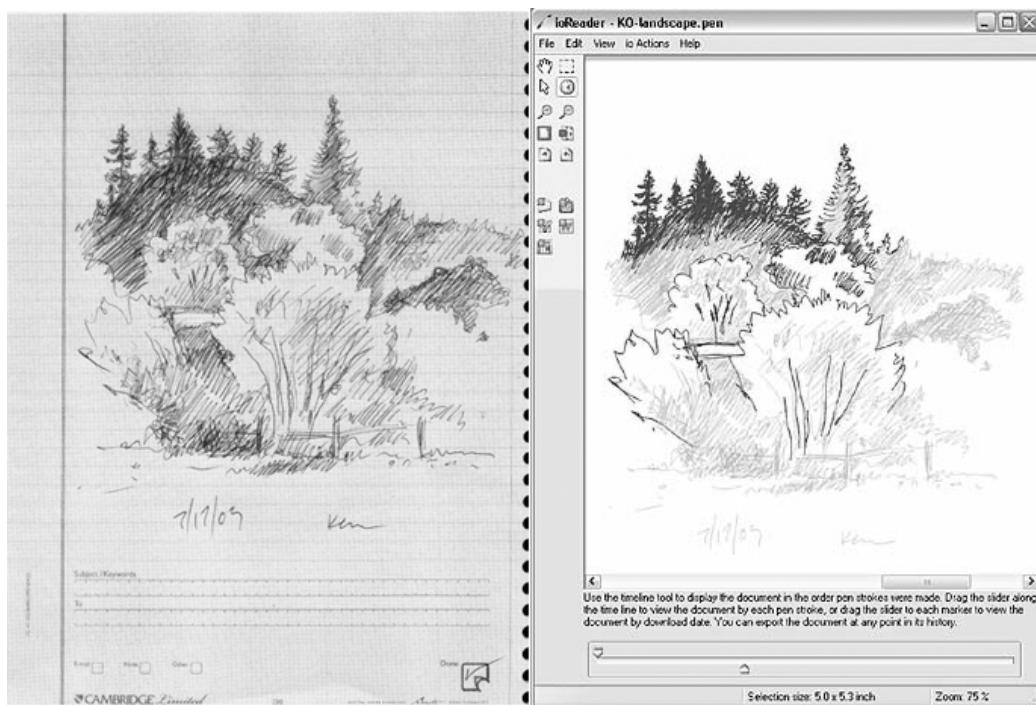


Fig. 2. Logitech paper version and IoReader 1.0 software version of a landscape sketch by Kenneth O'Connell. Advancing the timeline darkens the light grey lines stroke-by-stroke.

III. Procedures

There are two parts to this study: we are collecting specific drawings from expert designers and artists and we are looking at how to use the pens in for drawing instruction.

Gathering Drawings from Experts

Expert subjects have been recruited from the architecture, landscape and art faculty and students, and from the local architects' organization. They are asked to perform drawing tasks such as drawing from a photo, drawing a room interior from life, diagramming a building and designing a simple structure, all within suggested time guidelines. We then have reviewed the results with the authors and discussed their drawing methods.

In these discussions, the artists have talked about how they habitually prioritize graphic marks, what their intentions are in drawing and how they acquired systematic approaches. They have enjoyed seeing the other people's drawings, contributing insight into comparisons. As drawing enthusiasts, they generally have been pleased to learn about the pens and show their drawing skills by participating in the project.

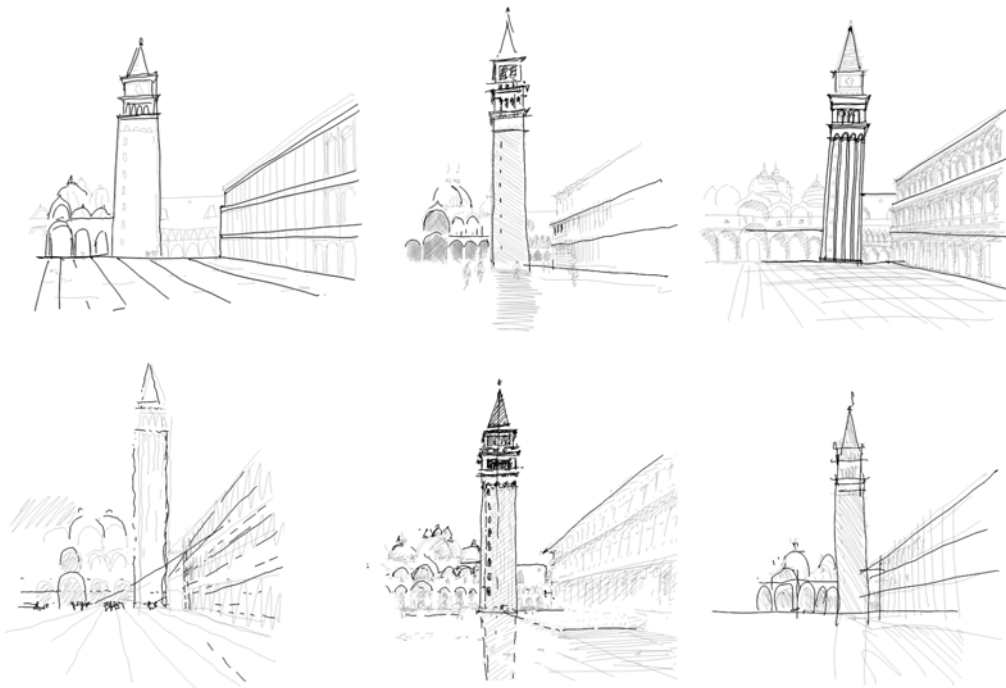


Fig. 3. We can use the pen to compare how different artists approach the same subject, such as a photo of Piazza San Marco. These images reveal personal approaches towards using construction lines and fleshing in detail.

Showing Drawings to Students

We summarized the experts' drawing techniques into lessons, culling specific drawings to illustrate specific techniques. Some of the results have been used in classrooms and published on a website. For the initial lessons, we created Powerpoint presentations explaining the pen technology and these drawing approaches, supplementing the dynamic Io drawings with scanned images from books. We also created a website explaining the project and showing examples of digital drawings at <http://darkwing.uoregon.edu/~arch/digsketch/>. We are displaying the drawings both as

annotated step-by-step lessons as well as animated .GIF files created from screen shots. The website highlights drawing techniques and shows different approaches to the same subject in a thumbnail gallery.

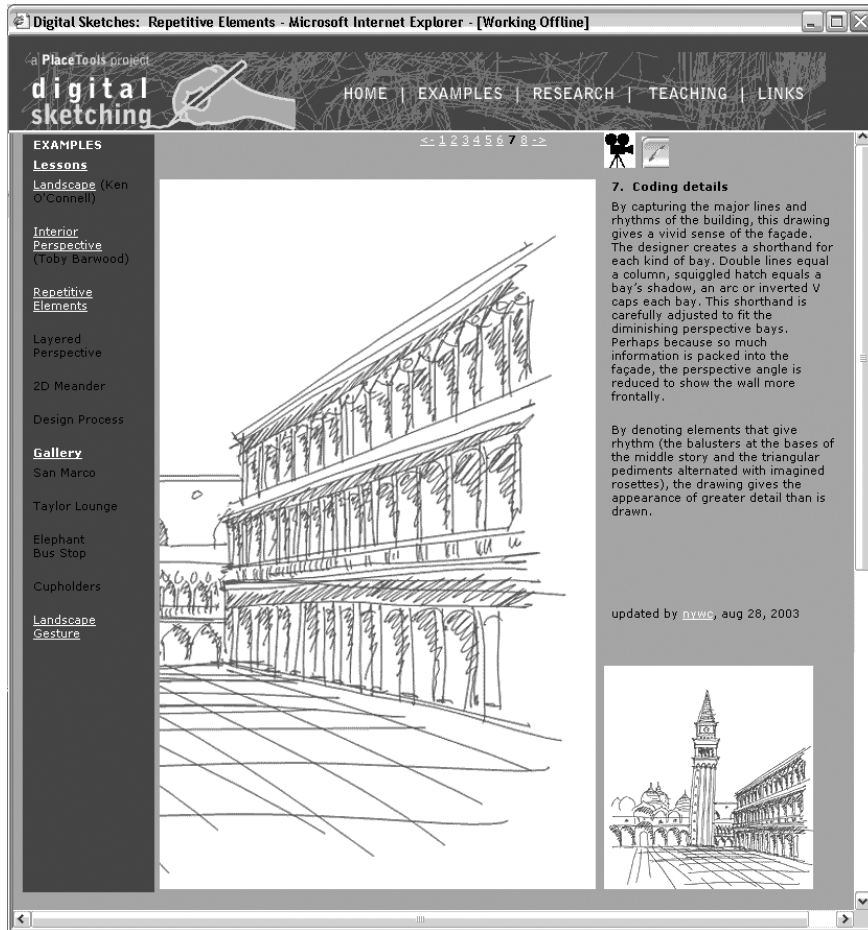


Fig 4. The website lessons describes aspects of the drawing process, presenting it both as annotated steps and a .GIF animation.

We can use the Io software with a laptop and projector to show students both expert drawings and their own work. We have begun with one three-hour beginners' workshop and two intermediate workshops during the summer of 2003, as a pilot for a fall 2003 class. Initial content focused on interior perspectives and for the intermediate students, annotated visual notes based on Paul Laseau's book. (4) After seeing the presentation that reviewed examples and then defined simple procedures, the students used the digital pens to make their own drawings. The drawings were collected and reviewed as a group using the digital projector.

We have begun experimenting with how to best use the pen's stroke sequence property. In one class, to stimulate interaction, students were shown stroke-by-stroke expert examples of several ways to start a drawing (construction lines, contour, tones, landmarks) during the lecture. After students created drawings using the techniques illustrated in the expert examples, we projected the completed drawings and asked the students to guess how each drawing was started. This mystery tactic engaged the otherwise very quiet group. After the students debated the technique, we walked through the drawing timeline to the beginning so that the class to see the answer. Because of the timeline

feature, we could discover how the drawings were begun without requiring the artists to identify themselves.

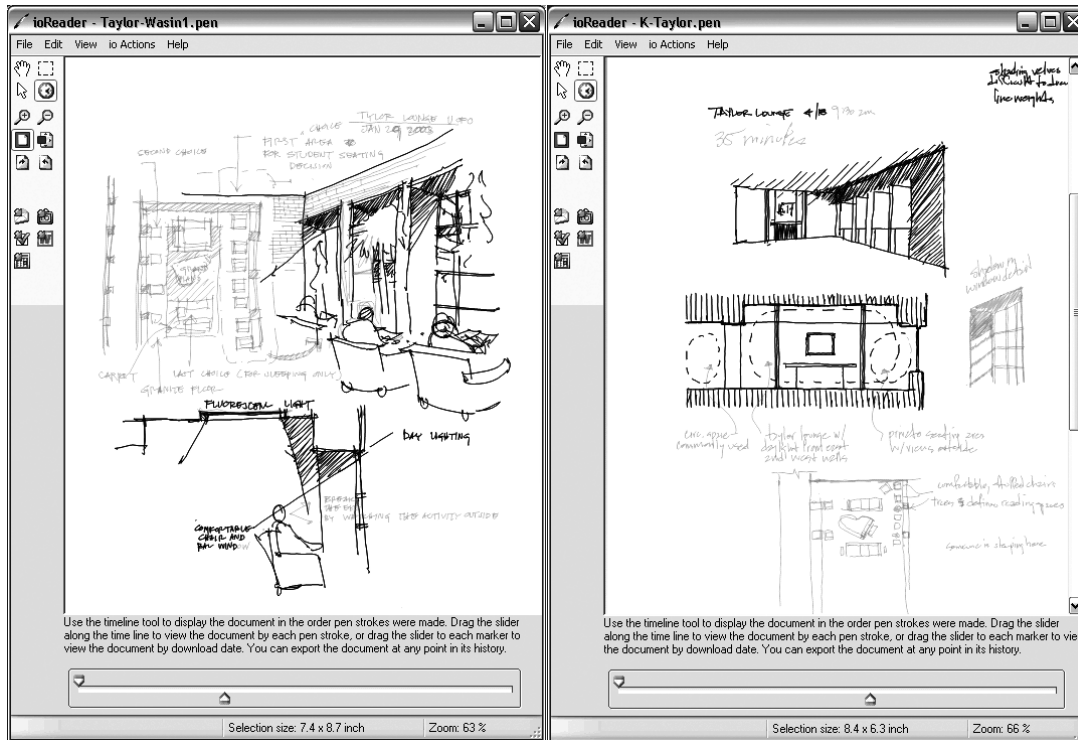


Fig. 5. The Io software shows that visual notes about lighting by different students both started with a perspective, followed by a section and then a plan.

Responses of Faculty and Students

While some faculty see the pen as a cute toy, other members of our Art, Landscape Architecture and Architecture departments have voluntarily contributed drawings to the project. The faculty colleagues involved in the summer pilot sessions were very supportive of the digital pen experiments. They see the pen's potential in drawing instruction and champion a balanced transition to digital media.

Student reaction has also generally been positive. While this could be partly due to the novelty of the pen, students talked specifically about how reviewing the digital drawings helped them see the difference between approaching a drawing first with line or tone. Seeing the stroke order of drawings made them more aware of how to use measuring guidelines, landmark intersections or painterly approaches.

In the classroom, rather than discussing stages in a completed drawing, students and teacher can "watch" the drawing as it was made. The interactive timeline allows accelerated, efficient reviews with selective pauses for discussion of key points of the drawing. The Io software allows side-by-side comparison of two or more drawings at any stage. Because the software has just a few basic functions, it can be quickly mastered. In a class in fall 2003, we found that students can steer through the timelines of drawings with minimal instruction. This means that in a large group, lecture/demonstrations can be complemented by small-group pen downloads and drawing discussions run by students.

IV. Observations

Summarized below are conclusions about when the Io pen can be revealing about drawing and how it can be used in the classroom.

Value with Different Drawing Types

Initial trials show that pen stroke replay varies in usefulness for teaching different kinds of drawings. Drawing replay is suited to teaching descriptive drawing because descriptive drawing is relatively straightforward. Different techniques for drawing the same subject can be easily compared. While descriptive drawing techniques are well-documented in books, interactively viewing every stroke in the development of a drawing is more engaging than looking at a few printed frozen steps. Immediate review of a student's drawing procedure by peers or instructors allows identification of crucial decisions and mistakes.

The pen is less useful in diagramming than descriptive drawing because it involves less mark-making and more internal thinking. The usefulness of recording and replaying stroke sequences depends on the quantity of marks made.

In contrast to terse diagrams, the complexity of design drawings makes the sequence of sketch vignettes more important than the sequence of strokes. Since graphic approaches to design solutions vary widely, digital versions allow individual vignettes to be identified more easily than complete procedures. We can identify steps according to actions or intentions (review of constraints, use of metaphor, creation of alternatives, evaluation of alternatives, correction, etc...) as well graphic methods (i.e. orthographic view, detailed enlargement, etc.).

Idiosyncrasies of the Recording Process

Currently, a line made continuously pressing down on the pen tip is stored as single graphic entity. When replayed, the mark appears all at once, not revealing the start and end of the line's construction.

Time-stamping the start and end point of a stroke as well as pauses would more faithfully represent the drawing process. The software currently remembers the strokes like a voice-activated tape recorder that captures the words without pauses. While this is an efficiency advantage in play-back, it masks the artist's pauses for thinking. With the current software, digital drawings made from short discontinuous strokes reveal more about their construction than ones made with long continuous lines.

Factors in Classroom Use

Initial classroom trials show that social factors must be considered in using this new tool. Group dynamics made a big difference between using the pen in small trials and teaching a large class. Compared to other ways of tracking drawing, such as video or computer tablets, the pen allows the user to work anywhere in apparent privacy, unencumbered by heavy equipment. When we reviewed drawings one-on-one or in small groups, individuals who gave us sample drawings felt comfortable interacting around a large monitor. Because these individuals were generally experienced and confident at drawing, they were proud and interested to see their drawings replayed on the computer monitor.

Students in a large class were much more self-conscious about giving samples and having their work publicly critiqued, even though they were accustomed to showing their work in pin-ups. In our first classes, students viewed the drawings projected onto a large screen, rather than clustering around a monitor as we did with the experts. When pens were passed around for brief timed drawings, students could opt to remain anonymous when the drawings were reviewed, and the crowd masked any shortcomings. But with

more elaborate assignments, student identity was much more apparent and reluctance to record the work with the pens increased. For example, when students sketched designs for bicycle cupholders, we could bring depth to the discussion only if the students who made the drawings talked to the class about their own design thinking. The class's need to relate the representations to their thinking meant they could not remain anonymous. A subsequent trial with more than one laptop for downloading showed that it is viable to have students first discuss their work in small groups and then present highlights to the large class.



Fig. 6. Class using projection to compare stages of two drawings

Reactions to the Equipment

Many people were charmed by the novelty of seeing their drawings in a new way with the Io. Those people who prefer the variable line of a pencil disliked the Io's ballpoint tip with its single-thickness line. Because the pen only registers bold lines, there was a strong contrast between the paper drawing and the homogenized digital equivalent. Others found the large pickle-like size of the pen ungainly, despite its ergonomic profile and rubber grip. Many expressed interest in a Macintosh software and in a greater range of paper choices. Most felt that the set was reasonably priced for the functionality.

V. Summary

Initial results show that the ability to record and replay graphic marks with a timeline is a great asset to understanding and teaching drawing. The pen is very effective for the immediate, interactive review of the drawing process. Supplemented with a computer projector, the software helps a large group examine small sketches made in an intimate setting. With the digital pen and software, students can efficiently review and compare their own drawing processes as well as experts' and other novices' work. The software's easy export as image or vector drawing naturally leads from traditional media into computer graphics.

Next Steps

While we have found the digital pen very useful for teaching descriptive drawing, we are refining how to use the pen to teach the more challenging skills of analysis and design. Initial samples of diagrams and design drawings were too diverse to compare, so we are planning trials in with simpler tasks and fewer visual references. We are also plan to use

the pen so that its vector output flows naturally into a digital workflow using other graphic applications. Currently, the pen is an anomaly in artistic and professional practice and seems unconventional. However curious, it shows that binding a drawing to the sequence of its construction can be extremely revealing.

Design media professors, artists and digital design specialists have helped us understand the pen's limitations and possibilities, and have opened up insights into teaching drawing. Additional contributors are welcome to enrich this project.

For more information see <http://darkwing.uoregon.edu/~arch/digsketch/>.

Acknowledgments

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Notes

1. See <http://www.logitech.com/> and <http://www.anotofunctionality.com/> for product information.
2. Nancy Cheng and Stina Lane-Cummings, "Using Mobile Tools for Learning about Places", *CAADRIA '03*, Proceedings of The Eighth Conference on Computer Aided Architectural Design Research in Asia, (Oct. 18-20, 2003).
3. Portability is relative: small digitizing tablets, handheld and portable scanners are available for use with laptop computers, but increase the number of parts and connections to manage.
4. Paul Laseau, *Visual Notes for Architects and Designers* (New York: Wiley, 1986).