

Object Investigator

an interface for thinking
about the objects that inspire us

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Background and Motivation:

Over 25 years ago Seymour Papert wrote *Mindstorms*, a seminal book about the power of computers in education. In the book, Papert derives his ideas about complex systems from his early experiences as a child playing with gears. The differential gear became a focal point for Papert, something he terms a "transitional object," allowing him to bridge the sensory and the abstract, all the while thinking deeply about mathematical concepts. Papert writes in the preface that, while gears were magical to him, "[t]he computer is the Proteus of machines. [...] Because it can take on a thousand forms and can serve a thousand functions, it can appeal to a thousand tastes."

Mindstorms was a huge success and generated excitement about how to envision computers in the classroom. In particular, the LOGO programming environment was one tangible product of the *Mindstorms* movement; through this application, complex mathematical concepts take on the form of a turtle. Instead of moving the turtle to X and Y coordinates on a grid, programmers drive the turtle first-hand with commands that allow actions such as moving forward 10 steps or turning right 30 degrees. The original LOGO turtle was a physical dome-shaped robot with a specialized box of buttons to control it. However, new considerations such as the need for scalability and mathematical precision led to a purely digital on-screen turtle that embodied the same command ideas and perspective-shift as the original drawing robot.

Photo removed due to copyright restrictions.

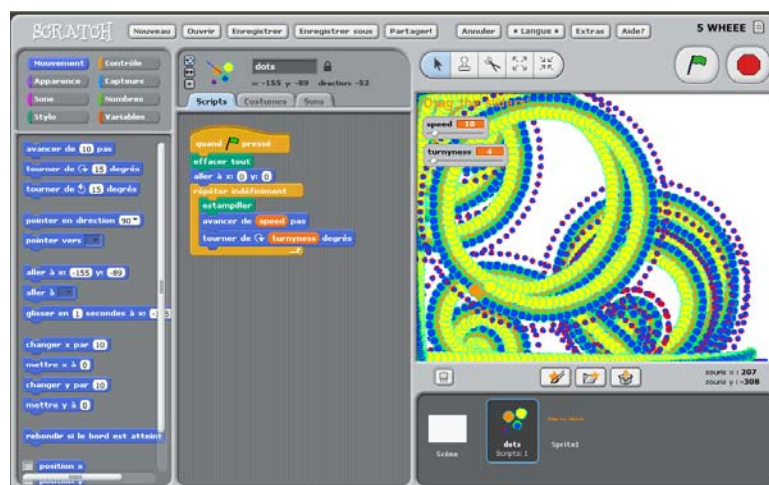
Diagram removed due to copyright restrictions.
See Fig. 12.2 at http://investigations.terc.edu/library/bookpapers/effective_use.cfm.

Two children program the LOGO turtle to make a drawing. Image from the cover of *Mindstorms*.

A student using a LOGO-based programming environment. Image from *The Effective Use of Computers with Young Children* by Douglas H. Clements.

While these ideas are compelling, there is a significant disconnect between the magic that young Seymour Papert saw in a gear and the experience of manipulating a programming environment such as LOGO--Papert's gear was likely special to him in part because he was the one who chose it. Just because the computer "can appeal to a thousand tastes" doesn't mean that all children will fall in love with it. My personal experiences indicate quite the opposite. People often latch on to unique, ephemeral, and sentimental things--of which the computer may be only one. The OLPC project (see: <http://www.olpc.com>) may be an exception, since the organization's goal is for each student to have their own personal computer, but even then, the laptop is only one of several objects a given child may find inspiring.

Scratch is a recent application developed to expose children to concepts of programming by graphically stacking computational blocks and controlling characters. Instead of a predefined turtle, users are able to use any image they like as their interactive, computational, drawing agent. Children themselves can identify what is important to them and include pictures and stories that reflect their interests. While there have been many similar programming-for-kids initiatives, Scratch was designed to encourage each component of Resnick's learning spiral: imagine, create, play, share, and reflect.



Scratch running a program that paints patterns based on user-controlled sliders.

Scratch fulfills its role as a learning tool, but there are still some shortcomings that need to be addressed. With the exception of the ScratchBoard (an input board allowing sounds, a push-button, a slider, and analog signals), there is nothing that strongly ties the Scratch programming environment together with the physical world. Comparing the structure of two Scratch project is also not explicitly supported--projects can be easily

extended, but finding differences and similarities is cumbersome. And finally, reflection is left as an exercise for the user that either happens by chance (for example, when another user asks a question) or by a group facilitator.

Image removed due to copyright restrictions

Diagram from *Interaction Design Sketchbook* by Bill Verplank, describing Bruner's three representations.

LOGO and Scratch provide graphical characters as physical handles, but they are fundamentally limited by their graphical representation and generic grounding. Building upon Papert's gear, I suggest the juxtaposition of Jerome Bruner's idea of representations with transitions. Bruner describes three forms of representation (enactive, iconic, and symbolic), each of which informs the others and allows for moving smoothly between them. By combining these ideas, it follows that a system could somehow leverage the relationships with physical objects that children (and adults) already have and provide a bridge to higher-level symbolic and reflective thinking.

Approach:

By allowing students to bring in objects that they already find interesting, a smooth transition can be made between the physical world and the powerful abstract thinking that computers allow.

The key components of the designed systems should:

- Integrate meaningful physical objects with the computer
- Catalyze thinking with thought-provoking questions
- Provide reference, analysis, and comparison tools
- Foster internal motivation for deep thinking

Additionally, the floor of the system should be low enough that students as young as third graders can make use of the platform. The look and feel should be somewhat formal, yet playful, to facilitate both a sense of deep thoughtfulness and inspired creativity.

Design:

The Object Investigator system is built on top of the Trackmate platform: a device connected to the computer which is capable of scanning circular barcodes attached to various objects.

Students can attach a unique barcode to each object they wish to track.



An object selected to be used with the Object Investigator.



Tag placed on the bottom of the object to be read by the scanning surface.

Once a circular barcode is placed onto an object, it can be detected on the Trackmate scanning surface at any location. Information about each object on the table is then passed to the Object Investigator application where it can be processed.

When a new object is placed, the Object Investigator notifies the user and requests their name and information about their object. Any information input into the application will be paired with the object's unique tag identifier and automatically saved for future sessions.

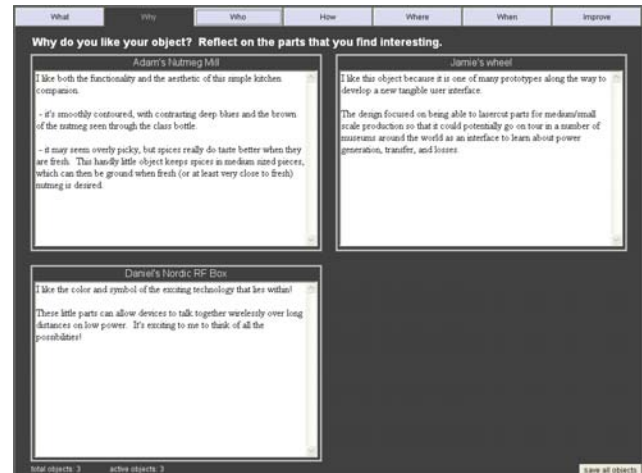
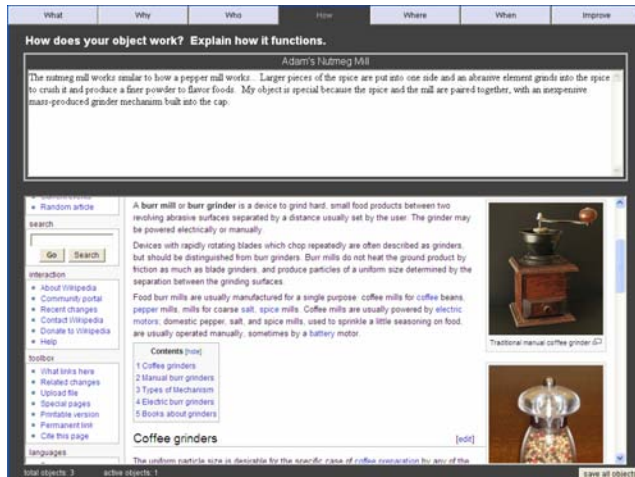


Three objects placed on the scanning surface of the Object Investigator system.

The Object Investigator application is designed to facilitate seven different areas of thinking (via provoking questions) and accompany clubhouse workshops or classroom lessons that discuss creative problem solving and invention.

Each question is contained within a tab at the top of the application. If only one object is present on the scanning surface, the user is given a large space for text entry, and in some cases, limited-domain web browsing capabilities (such as online encyclopedias and patent search engines).

However, when multiple objects are present on the surface at the same time, the application enters a comparison mode in which objects are spatially arranged on the screen similarly to their physical arrangement on the scanning surface. The grid of objects being compared scales dynamically between two and eight windows depending on the number of objects simultaneously present.



A screenshot from the Object Investigator. The "How" tab includes a box for text entry as well as a limited-domain web browser, shown here with access to <http://en.wikipedia.org>.

When multiple objects are placed onto the scanning surface, the information associated with each object is arranged to match their relative locations.

Each tab represents an area of thinking and is provoked by a question.

- **What:** Asks for a description of the object. This serves as a bridge to think of the object symbolically as words and to key off of the object's iconic characteristics.
- **Why:** Asks why he or she chose his or her particular object. This encourages reflection about a previous decision and deeper thoughts regarding the object in question.
- **Who:** Asks for a story about someone using the object. This is intended to be open-ended, but will likely include elements of social simulation, empathetic thinking, narration, or reflection.
- **How:** Asks how the object works. This promotes both logical thinking about systems and reasoning about design choices made during the object's creation, by the child or someone else.
- **Where:** Asks where the object came from. This contextualizes the object either in terms of the environment in which the object is typically used or its historical background.
- **When:** Asks when the object works well, and when it breaks. This provokes analysis by applying both an optimistic and a critical lens to the object, as well as simulation of the object under extreme circumstances.

- **Improve:** Asks how the object could be improved. This facilitates creative problem-solving by considering all of the previous questions (and their answers) and synthesizing ideas to make the object better.

The combination of these questions, a creative space to express thoughts, and a direct link between a student's meaningful physical object and the computer will hopefully increase reasoning skills, personal reflection, creative thinking, and an overall sense of empowerment.

Usage Scenario:

Maura is a teacher in a third grade class of 24 students. In conjunction with a weekly series of lessons on invention, Maura asks each student to bring in a small object that he or she finds interesting and wants to improve upon. The students each place a small tag on their object so that it can be recognized by the Object Investigator system.

When each student places his or her object on the scanning surface for the first time, a question box appears on the screen asking them what their name is and what object they have placed on the surface. Billy, one of the third grade students, places a toy racecar and answers the first two questions. From now on, anytime Billy places his object on the surface it will be recognized as "Billy's Racecar."

Each week Maura introduces a new way to think about objects. She starts off with the "What" tab--most of the class finds describing the object pretty easy--and builds towards deeper questions of "Why" and "How." The students are encouraged to look at other sections and reflect on their previous thoughts to help them think about the question at-hand. Over the course of a few weeks Billy has described his racecar, reflected on why he chose it, written a story, reasoned about how racecars work, thought about the racecar's history, and analyzed when the racecar works best, as well as when it breaks.

Finally, each student progresses to the "Improve" tab where they creatively synthesize ideas for how to make their object better. With Maura's weekly lessons on invention, most of the students are excited and internally motivated to invent a solution to their problems. Accompanying the "Improve" section is a limited-domain web browser that allows each student to perform patent searches and describe their ideas in detail. Many students feel empowered to solve bigger problems and apply their creative thinking beyond the schoolday.

The students who do not share the same level of excitement about invention are instead encouraged to build narratives related to their objects; they can thus continue creative reflection and projection about their objects in a way that feels comfortable to them.

Evaluation:

The evaluation of the Object Investigator has only reached pilot study observations. A small number of users (approximately 5) around the Media Lab were shown the system, given a few minutes to try it, and then asked questions about the experience. Responses regarding usability were folded back into the system as much as possible.

Users reported the "coolness" of being able to link physical objects to information, but also noted that the interface felt a bit impersonal and lacked motivation for entering text. Images and drawing capabilities were suggested by many of the users as a way to add warmth and engagement. After these two features were prototyped, they were eventually removed because they distracted users' focus from abstract reflection about their objects. Admittedly, removing the drawing and imaging features may have been a mistake since they also served as a potential entry point to deeper symbolic thought.

Users also commented that the supplemental internet content from external sources, such as Wikipedia and the U.S. Patent and Trademark Office, helped them to begin researching background information. Still, the non-uniformity of pages--some tabs don't map to internet content, as no appropriate website was found--made some parts seem less interesting than others.

Future Work:

One of the users in the evaluation noted that when working with a single object on the table, it would be helpful to see multiple tabs at once. In other words, focusing on the layout consistency for comparison between multiple objects, which originally led to the tab layout, became a design flaw when working with only one object. A proposed solution for future object investigation tools is to allow the user to view multiple questions simultaneously; the ability to freely choose would likely give the user a better sense of control.

Another proposed change is to build a physical metaphor into the graphical interface. For example, each object could be associated with a set of digital cards. Because the size of a stack of cards can be easily changed, the child could add more cards as they begin to explore deeper questions or consider the possibility of multiple perspectives over time.

The Object Investigator is not classroom-ready yet, but with additional prototyping and testing an object-based investigation system may be on the horizon. If any object could carry with it stories, ideas, and references, how might young minds use their own transitional objects to unlock new ways of thinking about the world?

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