The Convertible Podium:

A rich media teaching tool for next-generation classrooms

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Abstract

The Convertible Podium is a central control station for rich media in next-generation classrooms. It integrates flexible control systems for multimedia software and hardware, and is designed for use in classrooms with multiple screens, multiple media sources and multiple distribution channels. The built-in custom electronics and unique convertible podium frame allows intuitive conversion between use modes (either manual or automatic). The at-a-touch sound and light control system gives control over the classroom environment. Presentations can be pre-authored for effective performance, and quickly altered on the fly. The counter-weighted and motorized conversion system allows one person to change modes simply by lifting the top of the Podium to the correct position for each mode.

The Podium is lightweight, mobile, and wireless, and features an onboard 21" LCD display, document cameras and other capture devices, tangible controls for hardware and software, and also possesses embedded RFID sensing for automatic data retrieval and file management. It is designed to ease the tasks involved in authoring and presenting in a rich media classroom, as well as supporting remote telepresence and integration with other mobile devices.

Keywords: Tangible media, knowledge management, rich media, educational technology, multimedia, educational games, RFID, smart furniture.

1 Introduction

Rich media permeates next-generation classrooms. Even today, high-end systems feature a multiplicity of display screens, smart whiteboards, robotic cameras, and smart remote conferencing systems, all intended to support heterogeneous data and document types. Exploiting the capabilities of such a room, however, is a task that balloons in the imagination. Faced with three or more screens, all but a few educators opt for simply replicating the same image on all of them.

The electronic classroom, though it exists in some form in almost every school building, has gained a reputation as unwieldy and expensive, often requiring the presence of specially trained operators. On a smaller scale, electronics in a modern classroom may consist of a PC and a projector or two, with cabling for laptops and the Net. These installations are usually ad hoc, relatively immobile at the front of the room, with an assortment of cables running everywhere. Still, the pedagogical value of a classroom computer with a networked file system and access to the Web outweighs the inconvenience.

At the same time, education research shows clearly that creating engaging, multi-modal learning experiences increases both knowledge retention and knowledge transfer. Incorporating game-like, media-rich engagement strategies in teaching creates a need to provide the educator with appropriate tools for managing these media: essentially, an edutainment control device optimized for teaching.

The Convertible Podium is a central control station for rich media manipulation, including multi-screen multimedia presentation, shared annotation, and digital multimedia support for teleconferencing. Designed for intelligent meeting support and capture, it is an intuitive, easily operated way station for directing digital information. It is a valuable tool that can allow educators to easily create and integrate rich media learning experiences into their classrooms.

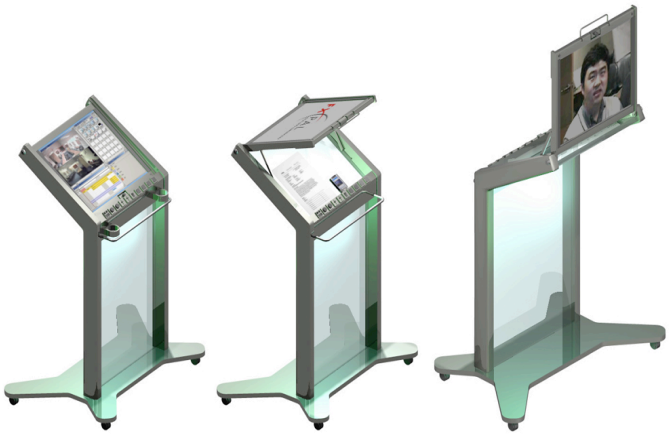

Figure 1. A convertible podium converting from a media-screen podium (a), to a capturing device (b), to an upright mode that can be used for an avatar representation of a remote presenter, an interactive whiteboard, or an information board (c).

1.2 Modal functionality: the flip-top

The Podium provides a focal point for the attention of the class and directs information in as many directions as required (both locally and remotely). It allows one person to manage multiple documents and streams of information directed to or from the classroom. The Podium also controls the room environment: lights, sound, and projector controls. More than just a presentation device, the Convertible Podium facilitates rich media authoring, data and image capture, and interactive communications. One person can easily and rapidly convert the system between its functional modes.

Interacting with the Convertible Podium can be done in three physical modes (Figure 1). In the interactive podium mode, a local presenter can use this podium to make presentations using multiple screens either in an ad hoc fashion – drag-and-drop – or in a linear fashion (just as one presents PowerPoint slides on a single screen). When converted to the capture device mode (half-open), the presenter can use the Podium's document cameras to capture images of documents as well as objects during a presentation. Finally, in the third physical mode (upright), the podium can be converted to a remote avatar, an interactive whiteboard, or an information board for supporting different presentation activities in the room.

As an avatar, a remote lecturer can access the podium from a remote desktop, a laptop, or another convertible podium and use the display and internal speakers to output live video and audio from the remote presenter. During a discussion, a teacher can use the display as an interactive whiteboard to capture annotations and notes contributed by participants in the room. If the Podium is not actively in use, it can also be placed in front of a room and used as an information board to display asynchronous messages, similar to a bulletin board or calendar.

2 Current technologies and prior art

Early versions of the electronic classroom focused on television and telecommunications technologies to support distance learning or to capture an electronic record of the class. Today's educational technologies for the classroom are generally digitally integrated and often serve a variety of pedagogical ends: not just distance learning or online education, but also local classroom support including multimedia presentation, discussion group support, and Web use, as well as traditional lecture-style live lectures. A huge amount of research as well as commercial effort has been undertaken in this area [e.g. Abowd 1999; Fox et al 2000; Mayer 2000]. In the Podium project, we make an effort to fold much of this technology into the Podium itself, streamlining both the communication methods and the control systems for them. Many current podiums are ad hoc repositories for such centralization, with bits of technology added on; we are designing it in deliberately.

Commercial podiums in the market are mostly podium enclosures designed to accommodate a variety of equipment that is used to facilitate different presentation needs in a classroom or lecture hall. A typical podium designed for a multimedia room is equipped with devices ranging from large devices such as a PC, a display, or a document camera to small add-on devices such as light visors, microphones, or an A/V switching device. Each stand-alone device has a specific function and requires a dedicated space for installation. Packaging all these devices into a single podium requires a bulky and heavy enclosure with several tethered (or many untethered) cables, making it difficult to move the podium from one room to another, or even to a different spot in the same room.

Unlike conventional podiums, the Convertible Podium is a compact and lightweight design (Figure 2) that can provide multiple functionalities by converting its form. It converts from an interactive presentation podium to other functions useful in a teaching environment, including a capturing device, an avatar representation for a remote presenter, an interactive whiteboard, and an information board. This is done by integrating all devices into the frame structure of the podium and assigning multiple functionalities to some devices depending on what interaction mode is active. However, only one mode of interaction is possible at each conversion. Similar to multipurpose furniture or "Roomware" [Streitz et al. 1998], the Convertible Podium combines its affordances as a regular podium with the capabilities of other presentation devices while maintaining its primary form and usefulness as a podium.

Figure 2. The Convertible Podium's operational prototype is CNC-machined from aluminum and acrylic panels and incorporates an onboard computer, WiFi, RFID, and custom sensing electronics.

2.2 Ubiquitous computing, tangible media

Our approach to the design of the Convertible Podium has its roots in Mark Weiser's vision of ubiquitous computing [Weiser, 1996] and Hiroshi Ishii's tangible media [Ishii et al, 1997]. Weiser's concept of widely distributed, networked devices permeating our living and working spaces has begun to be realized with the advent of cell phones, PDAs, distributed networks and even smart furniture. At the same time, Ishii's research into the cognitive affordances of tangible controls for complex software systems has driven the work of many research designers. Tangible devices and ubiquitous computing are a natural match; Fishkin [2004] has created a taxonomy detailing research in this area. Several researchers have combined these two ideas in the context of devices for reading, writing, and document management [Back et al, 2001; Schilit et al, 2000]. Moving this work specifically into the realm of education leverages both the work of the interaction community and the work of researchers in the application of games and entertainment technologies in pedagogy. If the electronic classroom is moving toward "edutainment" then the Podium can be thought of as a master game controller for educators.

2.3 Prior art and other interactive podiums

Since this combination of the convertible design and functionalities is unique, there is no other podium available that incorporates these features or is similar in implementation. However, there are a number of related systems that are similar in part.

Teleportec has a product called the Teleportec lectern [0] which is a podium with a reflective screen similar to a teleprompter's set up. It uses a monitor that lies flat at the podium base to display video of a remote presenter and a large 30"x 40" transparent projection surface angled at 45˚ facing the front of the podium to reflect the display on the base. Using reverse chroma key, the background is removed and the presenter appears visible behind the podium. However the Teleportec lectern has no user interactivity and cannot be used by either a local or remote presenter. It is a fixed set up that requires a backdrop wall to hide a videoconferencing camera behind the podium and in some cases a canopy to avoid direct light on the glass surface. The image of the remote presenter on the reflective screen may not be fully visible at extreme corner viewing angles. And finally, because of its fixed setup, it is not portable and cannot be easily moved from one room to another.

SMART Technologies Inc. has a product called Sympodium [Smart Technologies, 2003] which comes in four variations; an interactive lectern, a tabletop lectern, and two integration modules. The Sympodium interactive lectern is equipped with a touch sensitive LCD display that allows users to annotate over documents and control applications from a connected internal PC, laptop, or document camera. The desktop image is displayed through an external projector or large presentation screen allowing audiences to view annotations from the presenter's display. Sympodium has only three video source inputs which can be manually switched by the user. It cannot integrate more input and output devices and cannot control presentation devices or environmental settings.

ETH – Zürich has produced a prototype interactive podium called the "SpeakersCorner"[ETH, 2001] designed to facilitate local and remote teaching. This system is a customized podium enclosure equipped with a touch screen LCD display, a document camera, a dual-processor PC, a fold away keyboard, and an integrated connecter with USB, video, and network connections. It provides a multimedia platform for a presenter to show his/her slide presentation while making real time annotations on the slides. However, each input device implemented here is a stand alone device, designed for a specific application. They are placed in separated parts of the podium and cannot be used for multiple applications.

3 Context: Rethinking media for teaching support

The Convertible Podium project arose from contextual inquiry into the implications of rich media for the kinds of work conducted in meeting rooms and lecture halls. It is designed to integrate with continuing research in education, multimedia, collaborative work and knowledge sharing systems [Foote et el. 2004]. As new technologies (electronic paper, for instance, or cheap mobile projectors) make displays even more ubiquitous, the challenge becomes the management of rich media content across a number of screens. Added into the mix are class participants and the devices they carry with them: laptops, cell phones, and PDAs.

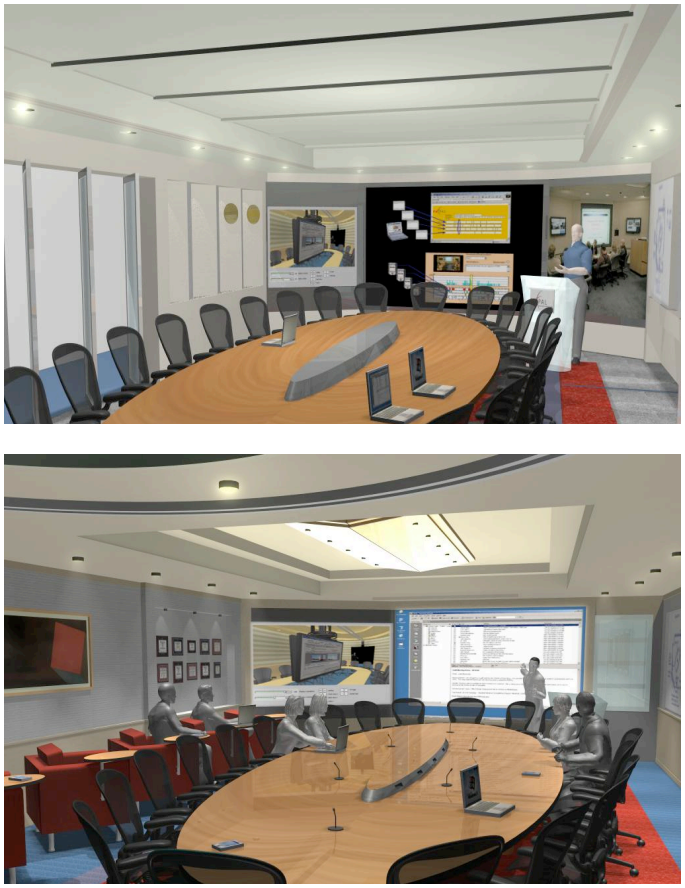

Figure 3: Two design views of a rich media seminar room: integrating multiple screens, encouraging formal and informal

interchange, and creating channels for shared input from students and other participants via portable devices.

Opening up a classroom's media systems to support distributed collaboration raises yet another set of presentation and display issues. We are interested in analyzing and supporting not only the classroom systems, but also the processes of work that happens within the classroom. For example:

- How should the room support teachers, students, and guests during a variety of situations, including formal and casual class meetings, discussions, and presentations?
- What capture technologies and media database functions are appropriate, and how do they support ongoing learning?
- How can both presenters and meeting participants interact with multiple-screen, multimedia, remote presentations?
- What are the implications of new technologies like e-paper as well as current technologies like RFID, cell phones, PDAs, and other multi-function devices?

Though the Convertible Podium can certainly be used as a control center for online education, this paper is primarily concerned with its use in real classrooms, either local or remote, supporting traditional teaching methods as well as introducing new tools for student-teacher and student-student engagement.

4 Active learning with rich media support

Active learning (as opposed to a more traditional lecture-delivery style of pedagogy) is preferred by students and has been proved to increase both knowledge retention and knowledge transfer (the ability to apply what is learned) [Bonwell and Eison, 1991].

Active learning techniques such as discussion, small group work sessions, debate, and problem solving can all be improved by thoughtful use of multimedia components [Bly et al. 1993]. In on-site, remote, or asynchronous teaching situations, the cluster of information applications in the Podium can enable or improve these common teaching tasks and interactions:

- Student interactions with instructor
- Student interactions with each other
- In-class presentations, especially a quick series of them (six or seven students each presenting a five-to-seven minute talk, for example)
- Drawing onscreen (live blackboard, capture to web instantly)
- Easy side-by-side comparison views -- not just two-way
- Guest lecturers via remote viewing – avatar mode plus rich media presentations
- Printing and paperwork including JIT printing for quizzes or questionnaires
- Stereo document camera for demos or quick capture for images from workgroup sessions

4.2 "But where do I put my laptop?"

Though the Podium is deliberately designed as a post-laptop device, it of course allows the use of many kinds of external devices including laptops, PDAs, cell phones, and portable USB/FireWire drives. Or, through the use of a network application using RFID cards [Hilbert and Trevor, 2004] one's personal files can be securely uploaded from any networked computer on the LAN.

Figure 4. The Convertible Podium's operational prototype upright in preparation for avatar mode. A spring-based counterbalance system is installed within the aluminum strut along the left side of the Podium's faceplate, to handle the weight of the LCD monitor and its aluminum framing. In later designs, the monitor will be replaced with thinner lightweight displays such as e-paper or OLEDs.

5 Operation and functions in each mode

The tangible interface offers centralized control over both room and computer systems. One person easily accesses and controls complex functionality through simple physical manipulation. As the counter-weighted hood swings open, the Podium switches modes and applications, from presentation, to capture, to remote conferencing or networked whiteboard.

5.2 Mode 1: Presentation and performance

The Podium uses ePic, a rich media presentation application, as its primary presentation mode for showing slides, Web, video or other media [Liu et el., 2004]. Live annotation is available via touch screen (using finger or pen). Any image can be transferred to any screen with a flick of the finger across the touch screen; alternatively a sequence of slides and media can be pre-programmed to execute across any number of screens, in any order. Audio speakers are also individually addressable for audio output.

Because the monitor screen shows not only control systems but also the content of the screens themselves, a presenter does not need to turn away from the audience, toward the screen, to read the current slide. This, though simple, is one of the single biggest affordances of the Podium: allowing a lecturer to keep facing the audience, rather than turning from them.

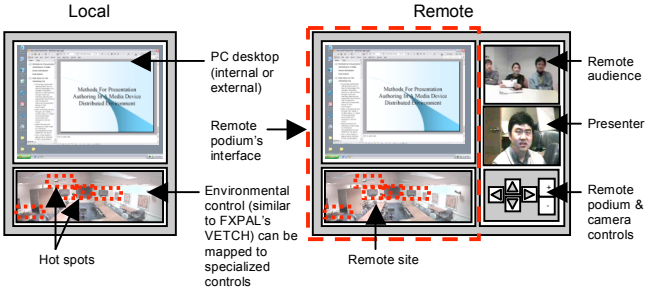

Figure 5. An early example of a user interface: ePic multi-screen remote presentation.

5.3 Mode 2: Capturing images and data

Digital images and real-time video demos are captured via onboard scanner and stereo document cameras (Figure 6). A visor light provides needed light levels. Image capture is controlled via a small secondary computer (originally a PDA, we have decided instead to use a small-form-factor Windows XP computer, made by OQO [OQO 2005]). Images can be directed to room screens, to nearby or remote printers, or filed in a class-meeting media database.

- Scanner for on-the-spot document capture
- Document cameras (stereo) with visor lighting
- Small screen computer for capture systems
- JIT (just in time) printing

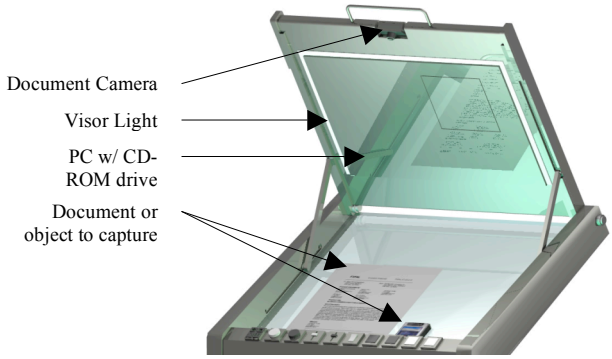

Figure 6. During capture mode, the high-resolution digital camera becomes a document camera for capturing documents or physical objects

5.3 Modes 3, 4: Avatar / interactive whiteboard

Avatar/telepresence mode supports human-scale video avatars for teleconferencing. In an effort to enliven the static talking-head video image most people associate with online learning or videoconferencing, the Podium's avatar/telepresence mode features a life-sized, center-screen image of a remote presenter's face. The image appears on the Podium's LCD screen when it is fully upright, appearing there at approximately human head height. (The avatar image can also appear on one of the room screens if desired.) Remote presenters can control rich media multi-screen presentations from their remote locations, and interact with class participants via high-quality video and audio streaming.

Networked interactive whiteboard and interactive annotation systems with the Podium in upright mode enable local or long-distance group work such as planning, brainstorming and discussion. The drawing mode can also be accessed with the Podium's "hood" closed, so that a live presenter can draw on the touchscreen.

6 Physical design and technology

Lightweight, mobile, and transparent, the Podium's deliberately sleek aluminum form references tools or equipment rather than furniture. As such, it encourages hands-on participation and control.

6.2 Mobile and flexible

The Convertible Podium is human-scale, lightweight, mobile, a clean, simple, powerful control center. Intended to avoid tangles of cabling, its mobile design allows the front of the classroom to be a flexible space. It is easily wheeled from side to side to allow different configurations according to class needs.

- **Aluminum and acrylic** are the basic building materials, plus built-in custom electronics: tangible control strip, LCD monitor/touchscreen, LEDS for mode indication and a visor light for the document cameras.

- **Acrylic panels** (a 24'x 38.6" vertical support bent to a 24"x 20" lectern surface that is 31.6° from horizontal) are outlined and supported by **one-piece aluminum/alodine-finish side supports**. The panels are sidelit with LEDs (colored according to mode).

- The **wheeled base** (also aluminum/alodine) is a modified x-shape with an **underslung tray** that holds the **electronics** (laptop computer, AC power, A/D control card, USB hub and various USB remotes, network connections.

- **Modal functionality** is cued from position of the **swing-open hood**: Presentation, Capture, Telepresence/Avatar, WhiteBoard

Figure 6. The control strip features large, tangibly pleasing buttons and knobs that map clearly to software and environment controls. The control modules are modular and can be custom-designed for use with specific installations. In this case, software controls appear on the right; room controls are on the left.

6.3 Tangible controls

The Podium consolidates environmental and multimedia controls at one easy-access point. A custom analog/digital hardware module, combined with the touch screen, offers control of many common meeting room tasks: screen/projector settings, room lighting, audio volume, presentation and annotation software, and remote teleconferencing.

- Control strip hinges open for easy access to electronics

- Modular plug-n-play design: controls are configurable in software.
- Custom modules can be CNC-tailored to meeting changing specifications.

6.4 Under the hood: custom electronics and software

Custom software and A/D hardware control systems drive the Convertible Podium's services. The Podium's onboard laptop "brain" networks with a number of exterior systems. For sound and light control in the classroom, it communicates via an http/python middleware protocol with an AMX standard environmental control system.

For teleconferencing and remote presentation, meeting capture, media control, and document sharing, we use the same protocol to communicate with a suite of applications developed in our lab [Foote et al. 2004]. One application, ePic, was developed for authoring and presenting on multiple screens and speakers, both locally and remotely. [Liu et al. 2004] Another, PIP (Personal Interaction Points), allows a person to simply swipe an RFID card across a reader to automatically open a directory listing all her Powerpoint files on her own machine (as long as it's on the same Local Area Network). [Hilbert and Trevor 2004] When RFID chips begin to be installed in cell phones (as the FeliCa RFID chip already is in Japan), that means that a student or teacher could use a simple swipe of her cell phone as an identifier to open the Podium's systems and upload a presentation automatically. [Sony, 2005]

7 Future work

Though much of the rich media authoring and control software that supports it has been under development for years, we have just completed the first working physical prototype of the Convertible Podium. Before moving on to the next stage of design, we will do several usage studies, on each mode's software and on the physical aspects of the device. Results from these studies will certainly impact the next stages of the design.

We also intend to create a suite of lightweight podium variants, including specialized applications for mobile devices, for meeting rooms, classrooms, seminar rooms, and tabletops. Each can be fine-tuned for a particular context or environment.

We intend more work on the integration of *n*- mobile devices into an electronic conversation or discussion, particularly cell phones. In addition we intend to make the physical frame of the Podium even more flexible, adding motorized height and angle adjustability. Companion objects such as e-paper media screens or tabletops, smart whiteboards, and other smart-room components may be integrated into the next iteration of the Convertible Podium system.

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