DRAFT

Building the Personalized Audio Information System (PAIS) Final Report*

Ellyn Sheffield, PhD
Towson University

and

Rich Rarey
Mike Starling
NPR

May 1, 2011

* This work was fully funded by grant CFDA #84.133G-2 from the DOE-NIDRR

Table of Contents

Table of Appendices

Executive Summary

Over three years, NPR Labs and Towson University designed and developed a system that could assemble a selection of customized audio content from audio information service broadcasts. With flexibility afforded by the transition to digital radio, the Personalized Audio Information System (PAIS) was created to be an on-demand media tool, bringing Radio Reading Services to blind consumers. The following are high-level findings and resulting design decisions:

- In all of our consumer tests and surveys, people were very enthusiastic about on-demand services. Blind consumers, like sighted ones, lead busy, productive lives. They are most likely to use reading services on their own terms, and providing flexibility for radio reading services will help to revitalize this very important service. Buffering, ability to store programs, creating lists of favorite programs for later playback all were critical to the design of PAIS.
- Blind consumers have special requirements in terms of user interface, including the incorporation of spoken or tactile feedback. With sleeker product design of digital products, tactile feedback has become obsolete, leaving designers with spoken feedback as the preferred method. We have incorporated spoken feedback into the PAIS design to assist consumers in navigating the menu structure.
- Good user interface design accommodates both accessible features and established mental models. Investigation into well-designed products currently in the marketplace and surveys conducted to garner consumer preferences led the PAIS design to incorporate a "telephone" keypad with familiar programmed behaviors and a tiered menu structure.

Specific Consumer Comments considered in the design of PAIS and for future design requirements:

- Although human voices were preferred by many people, the majority of consumers we talked with formally and informally felt synthetic speech was acceptable. They were keen on being able to manipulate the speed of the voice prompts, as more seasoned users find listening to real-time rate of speech slow and tedious.
- Consumers wanted to be able to delete audio manually, but also wanted to have the system automatically clean out old audio. Manually tagged audio would remain until the user deleted it, as is the practice for buffering playback devices found on television and other media. They also wanted to know how much storage capacity they had left, again mirroring other playback devices.
- Consumers wanted the ability to record a live broadcast in real-time. They also felt it would be convenient to be able to set "markers" in the recorded audio to facilitate jumping to specific locations as needed.

Introduction

In 2007, National Public Radio (NPR) proposed a new system that could automatically assemble a selection of locally relevant, customized audio content from audio information service broadcasts for blind consumers -- the Personalized Audio Information Service (PAIS). This new system would combine established audio information services with new programming flexibility afforded by HD Radio, creating an on-demand media tool that would improve Radio Reading Services for blind and low-vision consumers. This report details and highlights the development of the PAIS, and suggests a direction for future research.

Background

The incentive for designing the PAIS grew from two concepts: (a) blind, low-vision and print-impaired consumers have a right to thoughtfully designed media products that deliver local and emergency programming and (b) new digital radio technology affords the opportunity to develop delivery mechanisms that are flexible, powerful and in step with other communication products in today's marketplace.

To date, radio continues to be an important media that serves the blind community. In 1969, the Minnesota Radio Talking Book was launched as the first audio information service designed to specifically address the media needs of the visually-impaired population.[1] Typically utilizing hundreds of volunteer readers, each local radio reading service broadcasts daily readings of news stories and other locally relevant information (grocery ads, train schedules, obituaries, etc.) to print disabled listeners

[1] This U.S.-led innovation has been replicated globally with services now operating in Canada, New Zealand, the United Kingdom, and other countries.

across the nation.[2] The reading service model has proven so popular it is now replicated in partnerships and collaborative agreements between hundreds of audio information services and radio stations nationwide. Additionally, these audio information services serve a primary role in information deployment and public safety.

However, Radio Reading Services as currently configured run the risk of becoming obsolete. They are limited by substandard audio quality, lack of portability, an inflexible operation format, a cottage industry base of specialized receiver manufacturers, and the significant resource drain of restricting physical access to service delivery (for copyright maintenance[7]). And finally, perhaps most important to the consumer, audio information services are governed by a broadcast schedule requiring "appointment listening" versus "on-demand listening".

In late 2006, a survey was distributed to 17 organizations and colleges soliciting opinions from consumers with vision loss about the current radio reading services they use and what may need to be improved or added. One-hundred-thirty blind and low-vision individuals completed the survey. Two-thirds were male, 73% reported being blind from birth, 72% reported being completely blind, and 71% reported working outside the home.

Results from this survey showed that 73% were pleased with the variety of content, 58% reported enjoying access to local content, but only a small fraction (19%) were pleased with how easy the service was to use. Thirty-eight percent felt reading services were not portable enough, while others reported a need for audio quality improvement, and complained about limited availability of specialized receivers. In an

[2] The model ITR-100A HD Radio Receiver was a commercial product, readily available, and had accessible features.

open ended question, we asked what features and technologies respondents would want to see in future technology. Suggestions fell into six main categories:

1. Making the listening experience more individualized, portable and accessible (e.g., picking select articles from newspapers and magazines to read);
2. Having the ability to record/download broadcasts for playback at a later time;
3. Creating more universal, simpler interfaces to access the services;
4. Converting to digital service, in hopes of better audio quality;
5. Providing more books, magazines, and more choice of programming material in a timely manner, and;
6. Integrating emergency and weather-related announcements from both the local and national perspectives.

Additionally, we described the PAIS concept, and asked for their reactions. An overwhelming majority (93%) thought it was a good concept.

HD Radio promise as future medium for Reading Services

Since the FCC embraced HD Radio as the system for U.S. operations in 2003, NPR and the IAAIS have worked to evaluate, demonstrate, and document the utility of HD Radio multicast channels as a suitable upgrade for analog-FM-subcarrier based radio reading services. SunSounds at KJZZ-FM/HD in Phoenix has been simulcasting their analog SCA service on KJZZ's HD-3 channel for several years and audio performance has been excellent compared to the original SCA service. A lurking legal issue concerning copyright exemption for distributing RRS content (readings of newspapers and magazines, etc.) has led to assumptions that conditional access technology would need to be commercially available at nominal costs for reading services to migrate en mass to HD

multicast channels. The conditional access technology limits reception of the channel to only “authorized” low vision, blind and other print impaired consumers.

NPR and the IAAIS cooperated in testing a formal pilot deployment of the conditional access technology in 2009-2010 in a project funded by the Public Telecommunications Facilities Program. Final results revealed a working fundamental system, but the first run DICE ITR-100A receivers suffered a manufacturing flaw that resulted in poor indoor reception. However, audio quality and conditional access features worked as intended. Conditional Access technology used in the study was based on pre-commercialization systems and was found to be cumbersome for field deployments at the three radio reading services involved (WETA-FM/HD3 in Washington, D.C.; WXXI-FM/HD3 in Rochester, NY, and KANU-FM/HD-3 in Lawrence, KS). Subsequent to the completion of the PAIS project, it has been reported that the IAAIS has received legal advice indicating that the added costs of conditional access may not be necessary for the migration to commercially available (open channel) HD receivers, since the Copyright Act exemption applies to services “primarily intended for” use by blind consumers without a specific requirement of restricted access.

A key remaining issue for a migration movement will be the availability of HD Receivers with accessibility features as achieved in the DICE-ITR-100A, but with the manufacturing problem resolved for reliable indoor reception comparable to existing SCA receivers. IAAIS is working directly with HD Radio manufacturers to achieve the

needed price-point for a mass commitment to these receivers and to identify possible matching funds to assist consumers with such purposes.[3]

Development of PAIS

The goals of the PAIS project were to define, develop and demonstrate a service that would address the consumers' suggestions listed above. We were interested in assuring that the listening experience was individualized, that consumers could get programming on-demand, and provide more choices of program material. Converting the service to HD digital radio would address issues of audio quality and allow broadcasters to integrate emergency announcements.

Specific goals for the PAIS project were to:

1. Define best operating practices for manufacturers and audio information service installations;
2. Develop accessible interface and menu navigation design to allow consumers to efficiently select and navigate through desired content.
3. Develop a customization scheme for preference-based content aggregation. This includes on-demand time shifting functionality and preference-based aggregation functionality.
4. Demonstrate PAIS tag transmission, reception, and receiver behaviors in a broadcast, over-the-air pilot test, and
5. Analyze results to further refine the system.

[3] See *Guide to Accessible Consumer Electronics Manufacturing Practices for Blind and Low-Vision Consumers* at http://www.nprlabs.org/media/research/ar/BestManufacturingRecommendationsForLowVisionUsers.pdf

Initial PAIS Design

Surveys

Accessible products in the marketplace

To ensure that the PAIS interface was using best practices as established by existing accessible products, early in the process we conducted several surveys intended to guide our design. The first of such studies was an exhaustive search of communication products in the marketplace. Appendix 1 lists a range of accessible devices we found specifically geared for blind consumers. This list informed the PAIS development to accessible devices' conventions---such as switch and button behaviors, menu structure, and voice prompting---all of which users expect when operating accessible devices.

Additionally, we focused on several devices that were reviewed by the American Federation of the Blind magazine AccessWorld. These devices had varying degrees of accessibility.

Some of the most popular electronic devices we found were portable music players. Although iPod is one of the most well known, we found a number of other portable digital music players offering superior accessibility. Additionally, there were players that are completely inaccessible to the blind. One of the biggest offenders was the iPod Touch. This portable music player with its large touch screen offered no tactile or audio feedback, rendering it useless to blind consumers. Similarly, the Microsoft Zune had buttons that provided some tactile feedback, but the menu system looped endlessly, making it impossible to tell the position of the cursor. Additionally iTunes and Zune software did not work with screen reading software. There was a script package allowing JAWS to work with iTunes, but that came at an additional cost of $75.

On the bright side, there were three mainstream players offering full accessibility: the Zen Stone, the MuVo T100, and the iPod Shuffle. All three had similar controls to access saved audio -- In the center of 5 buttons was a large circular button, surrounded by 4 smaller buttons. The center button was the Play/Pause button and the surrounding buttons on the left and right were used to skip tracks. The top and bottom buttons controlled the volume.

Initial Consumer Input

Simultaneous with our product search, we began to gather information on the ways in which blind consumers interacted with their media devices. In an effort to reach consumers from all walks of life we recruited approximately 300 individuals nation-wide.

Participants were asked a variety of questions about their experiences with media devices, including.

- preferences of and complaints about accessible devices
- examples of products with good user interfaces
- the ways in which devices could be improved
- the most important features of accessible devices, and
- preferred methods for interfacing with the devices.

In order to encourage a variety of participants to participate (i.e., not just early adopters of technology), we collected responses over e-mail correspondence and via telephone interviews. For e-mail, we were careful to present questions in formats that were easily interpreted by computer screen readers. With regard to phone, participants were contacted at their preferred time, were asked all survey questions and experimenters recorded all answers. In total, of the 300 initial responders, 215 completed the survey --

60% were male and 40% were female. Ages ranged from 18 to 75, with three-quarters over the age of 40. Sixty-one percent reported they were blind, 32% reported they were legally blind, and 6% reported they had low vision. Almost all of our respondents considered themselves technology enthusiasts or frequent technology users, and 73% used Braille for reading. Only 27% used Radio Reading Services, and of these people, only half were satisfied with the service.

Results showed that an overwhelming majority (92%) were in favor of spoken prompts, as opposed to 8% being in favor of beeps and other non-voice feedback. Human voices were preferred by approximately half of the respondents, although the other half felt that synthetic speech was acceptable. Additionally, almost 80% felt changing the speed of the voice was important, so that individuals could listen more efficiently if they so chose. As would be expected, a majority felt having tactile feedback was important, and 71% preferred the numbered keypad style of interface.

Respondents were asked about storage and playback functionality for a PAIS-like device. Seventy-six percent felt that they would record more than 1 hour of programming a day for later listening, and 94% wanted to keep programs for one week or more. 71% reported that it was important to save programs onto a computer and there was an overwhelming preference (92%) for being able to record in real-time. Finally, 65% of respondents wanted to be able to pause live broadcasts. Appendix 2 lists the questions asked of respondents and Appendix 3 lists results.

PAIS HD Receiver Functionality

Based on our product search, consumer feedback, and collaborative discussions with IAAIS, PAIS was designed to recognize the Radio Reading Service (RRS) service

token and record RRS streams to non-volatile memory, co-existing with associated Program Associated Data (PAD). Users could initiate a manual RRS record at any time, recordings would be kept within the receiver but could not be “exported” to external media. No music indexing would be within subject matter definitions. PAIS data would conform to iBiquity’s published PSD documentation, and would not require additional licensing from iBiquity Digital Corporation.

As conceived, over-the-air RRS transmissions would send Program Service Data indicating the category and description of the transmitted audio. PAIS category data and descriptive text was designed to fit within the ID3v2 comment field. Initially it was thought there would be only several dozen subject categories. Further work with IAAIS and its Radio Reading Service members determined that 109 program categories would provide a base “working set” from which a local Radio Reading Service station could adopt and modify it to suit local needs (see below in "Radio Reading Services - Category definitions"). Within PAIS functionality, the user could select any or all desired RRS categories using menu prompts, and the categories would be stored on non-volatile memory. When the receiver detected a RRS category tag, it would compare that tag to the user’s list and if there was a match, the receiver would record the stream. Alternatively, the receiver could continuously record the audio stream, and at the next received PAIS tag would take one of the following actions: (a) stop recording if the program category has *not* been selected by the user; or (b) if the category has been selected by the user, close and save the current file to memory, and begin recording a new file for the user’s convenience.

Additionally, it was decided that the PAIS system should have a voice synthesis module to give the user audible feedback on button presses, selections and receiver responses. It would recognize HD Radio conditional access functionality and include an approved low-bitrate audio codec to transmit and receive the audio. NPR has separately tested the appropriate bit rates for audio quality in the PTFP-Radio Reading Services Conditional Access study.[4]

Radio Reading Services - Category definitions

In order to compile categories, we collected data in two stages. First, we conducted a survey of Radio Reading Service Station offerings around the United States to collect information on the types of programming material that were being read. See Appendix 4 for a complete listing. From there, a series of meetings were held with the IAAIS steering committee to identify and logically group all of the main offerings from RRS services around the country. Nine major categories were identified:

- Newspapers
- Feature sections of newspapers
- Magazines
- Books
- Local information
- Special programming
- Shopping
- Just for fun
- Non-English programming

[4] See http://www.nprlabs.org/media/publications/20101230%20Final%20Report.pdf

Within each of these categories, selections could be identified by local radio stations that consumers would be able to access and store in their local radios. Appendices 5 and 6 shows the PAIS menu structure flowchart and navigation routes. Appendix 7 details the subcategories.

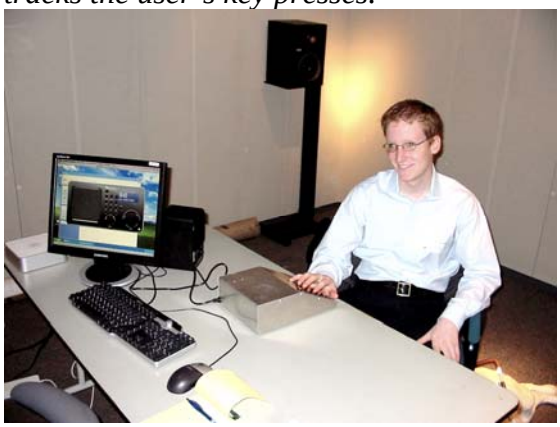
Receiver prototyping and alpha testing

Once categories were established at all levels, an in-house PAIS prototype was developed to test both navigation and interface design. The prototype included 11 buttons and one large knob (see Figure 1). The arrangement of buttons simulating a telephone key-pad was chosen for two reasons: (a) we were interested in modeling a metaphor used ubiquitously by blind consumers and employed by NFB-Newsline, and (b) we wanted to stay as close to the DICE Electronics' ITR-100A[5] radio as possible, This radio already had accessible features that were recommended by IAAIS in their *IAAIS STANDARDS FOR ACCESSIBLE HD RADIOS* (StAR) document.[6]

[5] The DICE ITR-100A is an accessible HD Radio with voice prompting.
[6] The StAR document can be read at http://iaais.org/StARv6.3FINAL.pdf

Figure 1. External keypad for user testing of PAIS receiver menu structure.

Figure 2. A test subject manipulating the PAIS simulator controls. The experimenter's station (at left) shows a graphical representation of the PAIS receiver simulation that tracks the user's key presses.



One test was conducted with eight blind participants using this prototype (see Figure 2 above). Appendices 7, 8 and 9 are for experimenter's questions and individual participant comments. Two months later, we conducted a test with 19 participants on an early version of the DICE-PAIS radio (see Figure 3).

Figure 3: Prototype PAIS radio for conducting final user assessments on the PAIS menu structure and operation.

During both testing sessions, participants were asked to complete a series of tasks intended to examine their efficiency at accomplishing the tasks and elicit their feelings about the interface. Tasks included:

- finding and pressing the Radio Reading Service Menu button to get radio into the PAIS mode,
- pressing the 5 key to invoke the Settings menu. Once in the settings menu,
    - entering the voice speed setting and adjusting it to the participant's preference
    - changing voice volume
    - changing the voice
- setting up a list of program categories to be saved on the radio using the category method.

- setting up a list of program categories be saved on the radio using the alphabetical list method.
- listening to stored favorites and playing selections.
- fast forwarding and rewinding the audio.
- selecting options to sort the audio.
- allowing the user to use the system freely and to offer any suggestions for improvement
- Exiting the system and turning the power off.

Responses are grouped into 3 areas: (a) settings, (b) creating favorites and (c) playing audio. With regard to *settings,* in the first round of testing, participants commented on including several voices (particularly important for people with hearing loss), changing the method required to change voice speed, having a period of time for deleting audio after which the system would automatically clean it out, being able to stop voice output, and rearranging the "0" function to navigate differently. In the second round of testing, participants additionally commented on button labeling, asked for more elaborated instructions when starting to use the PAIS features, and thought that using different colors and/or shapes for buttons would be extremely helpful.

With regard to *creating favorites*, participants wanted menus and submenus to be more clearly defined and some of the category names to be changed. They also wanted the top item of a list to be read immediately when a list feature was invoked instead of hearing nothing. Finally, they wanted to be able to record a live broadcast in real-time. In the second round of testing, participants were concerned with some of the voice feedback prompts (e.g., feedback should say "selected" or "category added" instead of

"check"), and wanted more functionality in navigating category sorting and listings. For example, one participant suggested being able to jump to a particular letter when using the alphabetic listing instead of having to scroll through the entire list, while another participant wanted to be able to go to a particular newspaper and scan all of the sections for that newspaper. Still another participant wanted the radio to list how many stories were stored in a particular category for that day (i.e., NYT business - 3 stories).

With regard to *playing audio*, participants wanted the option to permanently save a selection, and when the radio buffer was full, they wanted the system to alert them to delete some programs from favorites. They were particularly concerned about the rewind/fast forward feature, which did not allow users to jump ahead or back quickly enough. They suggested having the forward/rewind jump ahead at set intervals, but having the intervals lengthen the longer they held the button. They also felt it would be convenient to be able to set "markers" in the recorded audio to facilitate jumping to specific locations as needed. Finally, they felt the date stamp was overly cumbersome and suggested that selection file information only needed to include date and program title. In the second round of testing, participants additionally wanted to be able to speed up recorded audio so that they could listen to it more quickly and know how much storage capacity they had left.

In general, participants liked the concept and execution of the PAIS radio, and many commented that they would like to see the system be an add-on to existing radios. Additionally, the majority of participants were clearly interested in having PAIS functionality for all radio programming, not just radio reading services.

Resulting Interface features and Navigation

Figure 3 shows the resulting PAIS radio. The face of the radio contains all of the features necessary to interface with the PAIS simulation software. This device was created integrating an existing DICE itr-100a receiver with custom NPR Labs developed hardware and a custom front panel (See Appendix 14 showing the fabricated panel in assembly). The receiver plugs into the simulator computer's USB port, and the computer's sound card is connected to the receiver's AUX input. Users hear voice prompts and recorded audio coming from the receiver's speaker.

Users navigate and select features by pressing buttons on the receiver's telephone-style button keypad. Note that the telephone-style keypad arrangement is opposite of that found on computer keyboard keypads. Button behavior is consistent between all levels of the menu structure; that is, button "0" is always "Help"; buttons "4" and "6" are always "navigate 'left' or 'right' the menu structure; buttons "2" and "8" are always "navigate 'up' or 'down'" the menu structure, and so on. After every button press, the receiver informs users where they "are", and when appropriate, speaks the description of the category they have "highlighted"

There are five top logical UI levels. When the user presses "1", the UI speaks the functionality found at this level and prompts the user to browse the captured RRS programming. The list of audio files can be sorted by day-of-week, oldest first, newest first, or by category (sorted alphabetically by a human friendly description----not the four character PAIS tag). Pressing "7" will delete the recording from the PAIS receiver, after the user has confirmed the deletion.

When a file has finished playing, the user is prompted to play again, browse to a different file, or delete the file. As PAIS speaks to the user, the audio files are referred to as "stories", making the UI less about 'computers' and more about 'people'.

The top menu item gives the user the ability to create a "Favorites" list, by browsing and selecting categories from the PAIS Master List. It is important to note the Master List is not "static" and "unchangable" in a PAIS receiver; the RRS Station can modify, add to and subtract program categories at any time, and retransmit the Master List to all PAIS receivers tuned to that RRS Station. Typically a RRS Station would transmit its entire Master List at least once a day, thus synchronizing PAIS receivers to it. In this way, a PAIS receiver can change as the station's programming changes, and listeners can move from one area of the country to another confident their PAIS receiver will synchronize with their new RRS station. When a listener has selected a program category to the Favorites list, the program will be recorded automatically in the receiver when it is broadcast.

The concept of nine top-level *categories* is introduced in the menu structure: Each category corresponding to one of the keypad buttons 1 through 9. As noted earlier, every RRS Station can have a unique Master List, designed to serve the local needs of its listeners. An example of a RRS station "localizing" its PAIS Master List would be to include local---not chain---supermarket listings.

Once the user has selected one of the nine top-level categories, pressing the "up" and "down" keys navigate the 2nd level categories (if any), and pressing the "right" key navigates down to a 3rd level category (if any). After each button press, the PAIS receiver speaks a category description.

By pressing the "5" key, the category is added to the Favorites list, which will be captured at the next broadcast from the RRS Station. By pressing "7", the PAIS Receiver prompts the user to confirm he/she wants to delete the category from the Favorites list. Appendix 9 shows the categories, as grouped in the three-tier structure, along with the corresponding four-character PAIS tag code in Appendix 10.

Initially, the Master List could be browsed only in a multi-tier fashion, but consumer testing showed us that users wanted to experience the Master List of categories in a 'flat-file'. Sorting all categories alphabetically-by-description gave the users the ability to browse the *entire* Master Category list (109 categories). Categories could be added and deleted from the Favorites list, and browsed without navigating any multi-tiered menu structure. Using the "up", "down" keys, the user could find the category of interest, and press "5" to add the category to his/her Favorites list. Pressing "7" would prompt the user to confirm he/she wants to delete the category from Favorites, after confirmation the category is removed.

Additionally consumers wanted to browse their Favorites list to hear what categories they had selected, and remove categories they no longer wanted. Thus, a menu selection was created to navigate the Favorites list; where users could browse "up" and "down" the list, and request the category be deleted.

The last of the top five menu level items allows the user to configure and save various preferences, such as the following:

- Speed of spoken prompts.
- Normal or terse prompts.

- How long an audio file resides in storage before being purged.

- In the PC-based PAIS Simulator software, change the speaking voice.

Final Consumer Test

Nine participants were presented with the final version of PAIS and were asked to perform the same tasks as listed in Study 2. They were asked to get the radio into "PAIS" mode, find a category of show they would like to hear and store it in "favorites", find a show from a long list and store it in "favorites", play a stored show, rewind and fast forward it, and set the speed of the voice and various prompts.

For the final test, we asked participants to rate their experiences on a 1-5 scale as well as provide open-ended comments. Most participants rated PAIS highly, and thought it was intuitive, especially after using it for a few minutes. People's biggest stumbling block was that they didn't listen to the entire voice prompts, but people who listened thoroughly reported no problems completing the tasks. Many people left excited about the radio, and though it would be a great device. People liked the 2/8 4/6 controls once they understood the scheme.

On the other hand, people reported that they wanted the buttons to be larger and not located on the front. People were undecided about how best to handle the voice speed, voice selection and volume features. As currently configured, users would have to use one button and cycle through all of the levels (e.g., volume set on 3, button press would take it to 4, another button press to 5). Some participants felt fine with this, others

felt that two buttons would allow users to proceed forward and backward more easily and efficiently.

The majority of people did not intuitively know how to build their favorites using the "category list" method. It was suggested that we include tutorial information in the form of an audio CD or Braille instructions for products going to market. It is possible that the hierarchy was too deep in category selection, and this is something we would consider for future iterations.

Mechanically, people suggested that the rewind and fast forward functions did not move quickly enough and that they needed to press the buttons too many times for it to be a practical way of traversing through audio. This could be fixed by making these functions repeat the action when the button is held down, similar to the actions found is popular media players.

The table below shows participants ratings of various features. Finding subject by category was clearly the most difficult. Otherwise, participants felt using the PAIS interface was easy or very easy.

How would you rate the ease of adjusting the speed?	4.0 – Easy
How would you rate the ease of adjusting the volume?	4.7 – Very Easy
Ease of finding subject by category	3.0 – Not hard; not easy
Ease of playing audio clips	4.1 – Easy
Selecting between two sort options	4.1 Easy
How would you rate the ease of changing the voice?	4.8 – Very Easy
Ease of finding subject by list	3.8 – reasonably easy
Ease of using fast-forward and rewind	4.0 – Easy

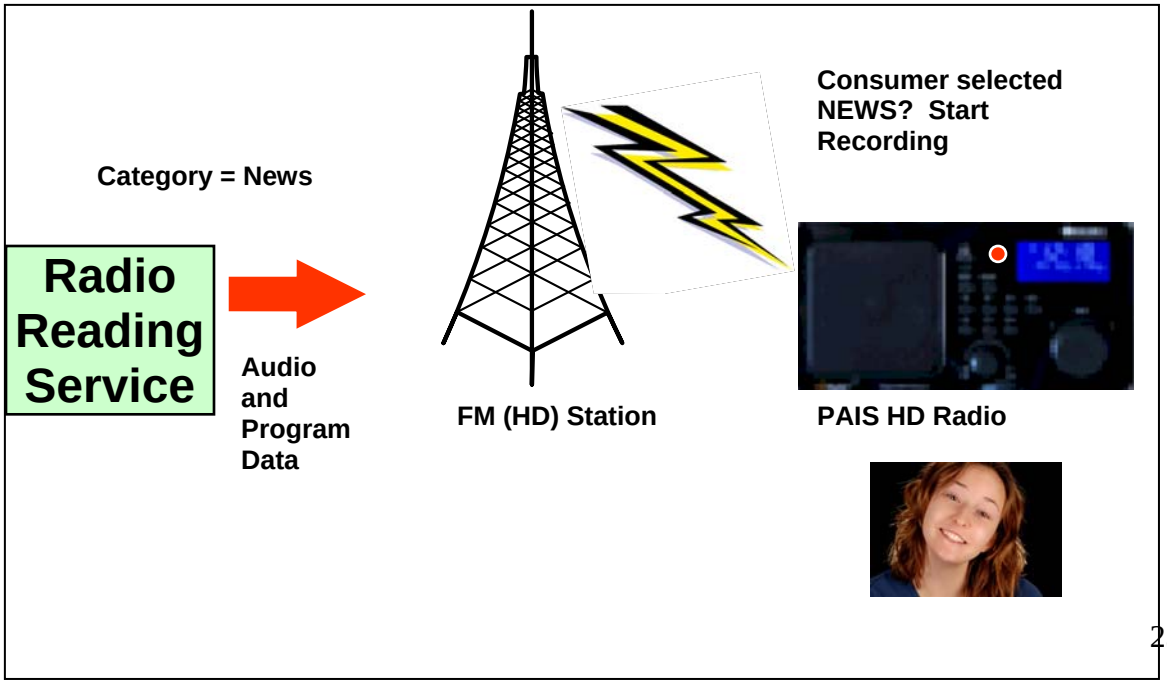
PAIS Transmission Architecture

PAIS allows Radio Reading Services to transmit audio with data tags identified at the start of each program. At the receiver end, when a listener has selected a particular category of program, the PAIS Radio records all of the selections that fit that category. The consumer can then listen to any of the selections on demand. Figure 1 shows the simplified transmission path.

PAIS was designed using HD technology on existing HD audio and data channels. As configured, Radio Reading services can use the host station's HD3 or HD4 channel for audio and data transmission. Conditional Access[7] allows Radio Reading services to selectively grant access so that only consumers with documented vision loss can receive the programs, thereby satisfying copyright exemption laws.

PAIS was designed to provide feedback to button presses and other user actions, such as knob turning and station selection. It gives the user the ability to instantly re-listen to audio that just passed, or jump ahead incrementally to a future point in the program.

Figure 1: Simplified PAIS transmission path

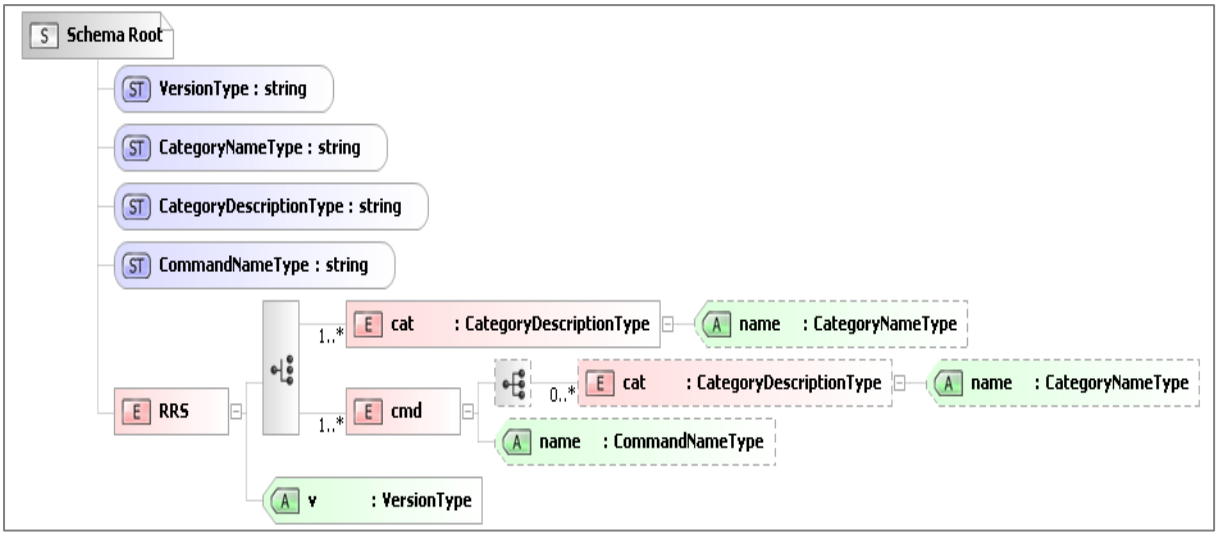


Building the PAIS Infrastructure

The essence of PAIS is XML tags transmitted in the Program Service Data of the HD Radio transmission. These tags command and inform the HD Radio receiver when a new RRS program is starting, when a new category is to be added to the master list of categories and when an emergency alert is coming through.

The PAIS Tag Structure

The PAIS XML schema used to define the tags is illustrated symbolically below:



There are two classes of PAIS tag: category and command. Table 1 shows tag elements for a typical category tag.

PAIS Category tag structure

The following is an example of a category PAIS tag used in the PAIS Project:

```
<RRS v="00"><cat name="ABAB">Sports, Local and Regional Newspapers</cat></RRS>
```

Table 1. The tag elements for a typical PAIS "category" tag.

PAIS Tag Element or Type	Description
<RRS v="00">	"RRS" denotes this is a PAIS tag. "v" denotes the PAIS tag version.
<cat name="ABAB">Sports, Local and Regional Newspapers</cat>	These simple types declare the PAIS tag as class "cat" ("category"). The name attribute is a four upper-case alphabetic character string from AAAA to ZZZZ, which is used to quickly sort and index the categories.
<cat name="ABAB">Sports, Local and Regional Newspapers</cat>	A human-friendly description, to be spoken by the receiver and shown on the receiver's display.
</RRS>	Denotes the end of the PAIS tag.

When the PAIS HD Radio receives a category tag it performs several checks:

- Is the category already in the receiver's copy of the Master List? If not, this new-to-the-receiver tag is added to the Master List within the receiver.
- Is the category already in the receiver's "Favorites" List? If so, close any recording in progress, and immediately begin recording the incoming audio in a new file until the next tag is received.
- Is the category one of three reserved category names, INFO, WARN or EMER? If so, immediately begin recording and alert the user.

PAIS *Category* tag hierarchy

As noted above, a three-tier category structure was created (see Appendix 7). Under each top-level category, a maximum of twenty-five 2nd-level categories are allowed, and under each 2nd-level category a maximum of 650 3rd-level categories are allowed. Table 2 describes the use of the four-character combination (AAAA-ZZZZ) to create these category levels.

Table 2. Creating category levels. The ? character is a "wildcard placeholder" that denotes any single character from A to Z.

Category Level *(used in menu navigation)*	Four-character combination *(for internally indexing the categories)*	Maximum number
Top Level Category	A??? through I???	9
2nd Level Category	?B?? through ?Z??	25
3rd Level Category	??AB through ??ZZ	650

Although this schema allows thousands of categories, PAIS as currently configured uses 109 categories, grouped among the three tiers.

Reserved Category Names

Three reserved category names cause a record and issue an alert to the listener by immediately routing audio to the loudspeaker. These categories cannot be assigned to a program, are hard-coded into the receiver, and cannot be deleted.

- **INFO** - For information messages from the RRS. These messages appear between regular programs. **INFO** is **not** intended to mark routine interstitial programming or station identification but are intended to announce important changes to the program schedule, times of broadcast, etc.

- **WARN** - Intended as a warning to imminent danger to life or damage to property.

- **EMER** - Intended as an Emergency where there is an immediate danger to life or damage to property.

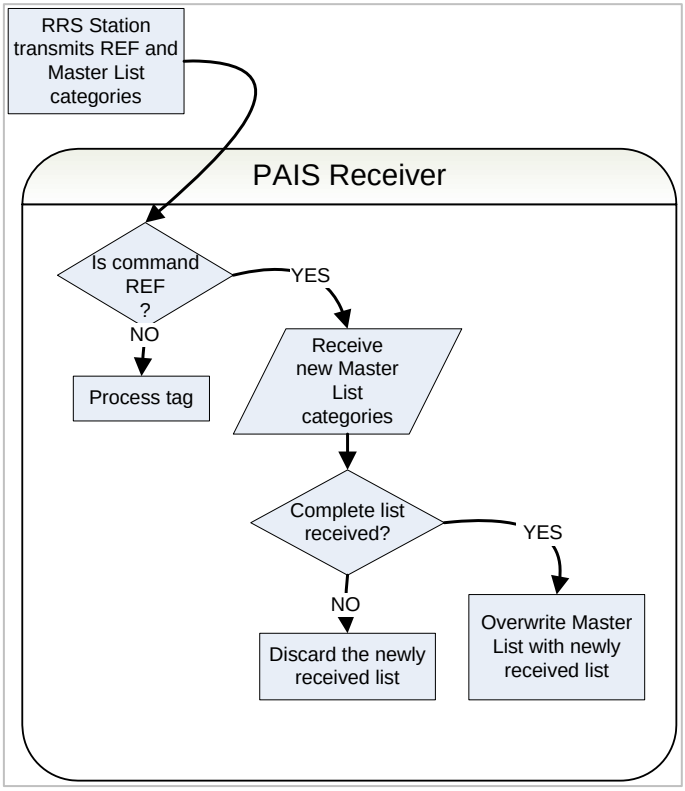
PAIS command tag structure

A RRS has the ability to send commands to the PAIS receiver, to cause the following actions:

- Add a single new category
- Delete a single category tag
- Modify a single category tag,
- Refresh the entire Master Category list, and
- Erase all categories from the user's PAIS receiver

Using the PAIS *command* tags

Because PAIS receivers can be tuned in at any time, a mechanism must exist for sending the complete master list into all receivers on a regular basis, so that users may begin to use the PAIS features and create their favorites list to begin capturing programming. It is suggested that an RRS Station transmit the REF (refresh) command once a day, along with the complete list of the station's categories. Built-in precautions reduce the possibility of inadvertently deleting the existing Master List, if for instance, the PAIS receiver is powered off during the load, or RRS Station reception is lost before receiving the new list.



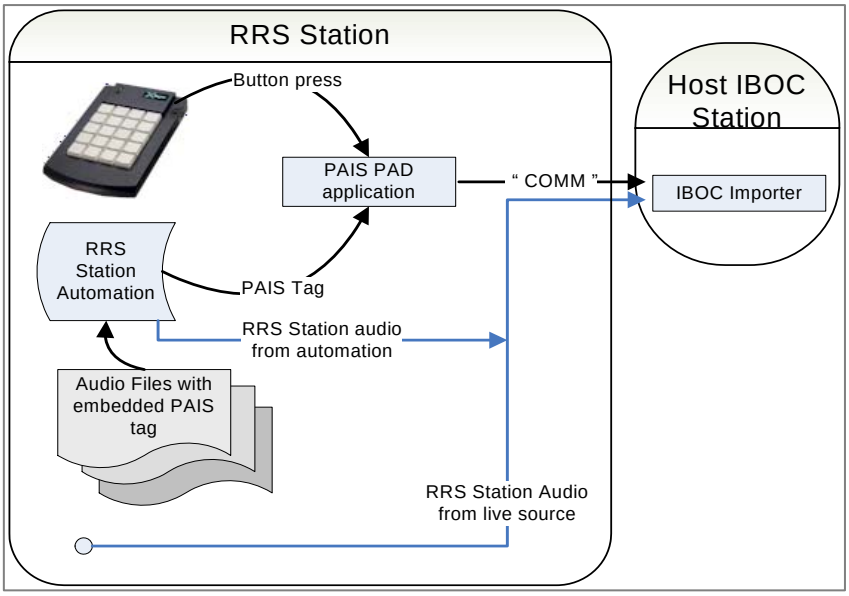
The logic flow, *above*, illustrates this protection.

Other commands allow the RRS Station to dynamically add a single category, delete a single category, and to remotely command the erasure of the PAIS receiver's Master List (the ERA command will side-step the Master List protections that the REF command uses, and as such,

is not intended for regular use until HD Radio Conditional Access makes targeting a specific PAIS receiver possible).

Transmitting the PAIS Tags Within The HD Radio Channel

The PAIS XML tags are intended to be sent within the COMment field of an HD Radio Channel. The COMment field is already implemented in iBiquity Digital Corporation's Importer/Exporter code, and does not require additional coding to transmit. HD Radio receivers already handle the COMment field, although it is not usually displayed. The illustration, *below*, shows the PAIS XML can originate from station automation and from manually pressing a button on a keypad. The PAIS PAD application translates the button press into the PAIS XML tag, and converts the XML tag (whether from keypad or automation) into the iBiquity-required PAD format and sends the result to the IBOC importer.



Originating the PAIS Tags During Live Programming

As shown above, PAIS tags can be generated "on-the-fly" by using a physical keypad coupled to a computer running the PAIS PAD application. In the illustration, an X-keys® Desktop keypad provides a 20 button interface, where the RRS Station has programmed each

of the twenty keys to trigger the creation of a specific, i.e. "most used" PAIS tag in the PAIS application.

Each RRS Station can customize its keypad layout by pre-configuring the PAIS Application, specifying the key and the PAIS category tag that is created when a particular button is pressed. For example, in our [hypothetical] RRS Station, the reading of the *Wall Street Journal Editorials* is about to begin. The reader presses the button on the keypad corresponding to Feature (Sections newspapers), Editorials just before speaking. The PAIS XML tag is created in the PAIS Application, formatted and sent to the IBOC importer, which in turn is transmitted over the air to the PAIS receiver. The PAIS receiver responds appropriately, either starting a new recording or ignoring the tag, depending on whither the tag was found in the receiver's *Favorites* list.

Originating the PAIS Tags with Pre-Recorded Programming

Pre-recorded RRS programming can contain PAIS category information, and once embedded with the audio, the PAIS XML tag will be sent automatically upon each playback. Popular file-playback automation systems typically offer a means of embedding ARTIST/TITLE/ALBUM/COMMENT "metadata" fields either within the body of the audio file, or linked to the audio file by an external database. RRS station staff manually insert the PAIS XML tag into the completed audio file (or associated database) after the file has been recorded and edited. The first broadcast automation system to fully support PAIS tagging is WireReady® (version 9.5 and later) from WireReady® Newswire Systems, Inc. (www.wireready.com). When these automation systems play the file, the metadata is made available in a serial data port or network data port, intended for the [broadcast] station's RDBS or HD Radio Importer/Exporter.

In PAIS, the PAIS XML tag must be sent from the automation system to the PAIS middleware application, where it is formatted and sent to the IBOC importer, which in turn is transmitted over the air to the PAIS receiver. The PAIS receiver responds appropriately, either starting a new recording or ignoring the tag, depending on whither the tag was found in the receiver's *Favorites* list.

Developing the PAIS HD Radio Receiver

To demonstrate a working prototype PAIS HD Radio Receiver, NPR Labs signed agreements with iBiquity Digital Corporation to acquire an iBiquity model 1282 HD Radio Reference Receiver. As shipped, the receiver is a HD Radio receiver circuit board coupled to a Microcontroller mother board with buttons, infrared remote sensor, LCD display, stereo audio outputs, antenna input, power input, and several connectors for in-depth debugging and testing. Complete microcontroller source code was provided to allow a developer to edit, modify and add to the receiver's functionality---making the 1282 one of the most flexible HD Radio development and prototyping platforms available. As the motherboard contains only 128kB of non-volatile memory, and its existing operating system uses 71% of that total, writing the PAIS functionality for the receiver required elegant and simple design. A selection of source code is included in Appendix 12, showing how the receiver processes an incoming PAIS tag and checks the My Favorites list for a possible match. The basic PAIS functionality consumed only 12% of the receiver's small non-volitile memory, leaving plenty of memory for future enhancements.

To house the receiver components, a custom enclosure was fabricated, and the electronics were installed within. Appendix 13 is the computer-aided design of the PAIS HD Radio enclosure.

NPR Labs demonstrated the PAIS Simulator and PAIS HD Radio at the National Association of Broadcaster's Radio Show in September 2010. The PAIS Radio was tuned to

local station WETA-FM's conditional access HD-3 channel and PAIS tags were triggered securely over the public Internet from the NPR Labs' booth. The photograph below shows the PAIS HD Radio receiver in operation; its display shows the call letters, channel, signal strength, conditional access status, and most importantly that it has been triggered to record the current program.

Demonstration

Results

IAAIS 09

Spring NAB 10

NAB Radio 10

NFB Maryland

NFB Virginia

CES 11 Wrap Up

Manufacturing Interest & Directions – Software Controlled Radios

Service Provider Interest & Directions

Suggestions for Future Activity

Appendix 1: Accessible Devices for Blind Consumers

Braille Products			
Printers and Embossers	http://www.independentliving.com/products.asp?dept=357&deptname=Embossers/Tactile+Image+Enhancers	Electric Perkins Brailler, Braille Blazer, Basic-S Embosser, Tiger Tactile Braille Embosser, Tiger Cub Desktop Embosser	$1050 to $9750
Refreshable Displays	http://www.freedomscientific.com/fs_products/displays_focus40-80.asp	Focus Braille Displays	$3495 to $6995
	http://fos.stores.yahoo.net/brailldisplay.html	Brailliant, BrailleConnect, BrailleStar	$1995-$8995
PDAs with refreshable displays	http://www.freedomscientific.com/PACMATE-HQ/PACmate2.asp	PAC Mate	$2395 to $5595
	http://fos.stores.yahoo.net/brailldisplay.html	Pocket Hal Maestro Braille Lite	$595 $1295 $1495
Translation devices	http://fos.stores.yahoo.net/duxforwin.html _____	Duxbury for Windows MegaDots	$595 $595
	http://www.freedomscientific.com/fs_products/software_open.asp	OpenBook	$995
Computer Products			
Screen readers	http://www.independentliving.com/products.asp?dept=15&deptname=Screen-Reading-Software	Zoomtext Jaws Window-Eyes Hal	$199 $895-$1095 $895 $1095
Scanners, CCTV	http://fos.stores.yahoo.net/scanandread.html	Kurzweil Handheld reader: $2595 Kurzweil 1000 text interpreting software: $995 ScannaR (Scan and Read):$2995 Scan and Read Pro software: $149	
	http://www.lssproducts.com/category/portable-cctvs	CCTV: $1495-$3895 Portable CCTV: $595-$2795	
Text to Speech software for mobile devices (cell phones, PDA, etc.)	http://www.enablemart.com/Catalog/Screen-Readers/Nuance-TALKS-3-Premium-Edition	Talks for Cell phones: $295	
	http://www.enablemart.com/Catalog/Screen-Readers/Mobile-Speak-Pocket	Mobile Speak Pocket: $499	
DAISY Related Products			
DAISY players	http://fos.stores.yahoo.net/digtalbookso.html http://www.enablemart.com/Catalog/Talking-Books		Price Range: $249-$895
Talking Devices			
Caller IDs,	http://www.marilynelectronics.net/products/visi	Phones: $30-$140	

Phones	on-impaired/index.htm http://www.sightconnection.com/telephones1.html		
	http://www.sightconnection.com/anmacandcali.html http://www.independentliving.com/products.asp?dept=204&deptname=Caller-IDs	Caller ID: $32-$125	
TV remotes	http://www.independentliving.com/products.asp?dept=147&deptname=Television-Remotes	Price Range: $11-$60	
Radios/Clock Radios	http://www.amazon.co.uk/PURE-SONUS-1XT-Digital-Feedback-Technology/dp/B0007UB4Z8	Pure Sonus-1XT-price: around $200	
	http://assistivedevices.net/alarm-clocks-for-visually-impaired.htm	Price: $20-$100.	
	http://www.independentliving.com/departments.asp?dept=129&deptname=Radios		
	http://www.maxiaids.com/store/ProdList.asp?idCategory=65&idstore=1&category=Radios	price range: $10- $200	
Bar Code Readers	http://fos.stores.yahoo.net/idmateomni.html	ID Mate Omni: $1299	
	http://www.freedomscientific.com/fs_products/scantalker.asp	ScanTalker: $985	
	http://www.independentliving.com/prodinfo.asp?number=999918DS	Scanacan: $550	
Recorders			
Cassette	http://www.independentliving.com/products.asp?dept=299&deptname=Portable-Cassette-CD-and-MP3-Players	price range: $75-$130	
	http://secure.nfb.org/ecommerce/asp/prodtype.asp?prodtype=40&ph=&keywords=&recor=&SearchFor=&PT_ID=	price range: $75-$175	
Digital	http://www.enablemart.com/Catalog/Misc-Low-Vision-Items/TapMemo	TapMemo: $159	
	http://www.sightconnection.com/divore.html	Digital Voice Recorder: $16.50	
	http://www.independentliving.com/products.asp?dept=44&deptname=Digital-Voice-Recorders	price range: $150-$369	

Appendix 2: PAIS Survey

What media devices do you currently use? If yes, please rate your satisfaction on a scale of 1 to 5 with 5 being highly satisfied and 1 being highly unsatisfied. (Circle)

Portable music player
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Tabletop Radio
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Computer
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Radio Reading Service Radio
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Other_____
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

What assistive devices do you currently use? If yes, please rate your satisfaction on a scale of 1 to 5 with 5 being highly satisfied and 1 being highly unsatisfied. (Circle)

Screen reader
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Screen magnifier
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Daisy player
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Accessible PDA
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Refreshable Braille Display
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Message or voice recorder
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Scanner or CCTV
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Other: please list
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Other: please list
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

Other: please list
1 2 3 4 5
How often do you use this device?
Daily Weekly Monthly
Where do you use this device?
Primarily on-the-go On-the-go and at home primarily at home

What assistive devices do you own that you feel are difficult to use? _____

_____

_____

_____

_____

Device 1 _____

a. Which of the following make the device difficult to use?
   - ☐ Poor user interface
   - ☐ Difficult to learn
   - ☐ Features missing
   - ☐ Features too complicated for what I need

b. Comments: _____

Device 2 _____

a. Which of the following make the device difficult to use?
   - ☐ Poor user interface
   - ☐ Difficult to learn
   - ☐ Features missing
   - ☐ Features too complicated for what I need

Comments: _____

Device 3 _____

a. Which of the following make the device difficult to use?
   - ☐ Poor user interface
   - ☐ Difficult to learn
   - ☐ Features missing
   - ☐ Features too complicated for what I need

Comments: _____

Device 4 _____

a. Which of the following make the device difficult to use?
   - ☐ Poor user interface
   - ☐ Difficult to learn
   - ☐ Features missing
   - ☐ Features too complicated for what I need

Comments: _____

What assistive devices have user interfaces that you like? _____

Device 1 _____

a. What features do you like about this interface?
   - ☐ Easy to navigate
   - ☐ Easy to learn

- Helpful manual
- Stable product – upgrades follow same patterns as older versions
- Follows conventions
- Interacts well with other products

Comments:_____

_____

_____

_____

Device 2 _____

a. What features do you like about this interface?
   - Easy to navigate
   - Easy to learn
   - Helpful manual
   - Stable product – upgrades follow same patterns as older versions
   - Follows conventions
   - Interacts well with other products

Comments:_____

_____

_____

_____

_____

Device 3 _____

a. What features do you like about this interface?
   - Easy to navigate
   - Easy to learn
   - Helpful manual
   - Stable product – upgrades follow same patterns as older versions
   - Follows conventions
   - Interacts well with other products

Comments:_____

_____

_____

_____

Device 4 _____

b. How do you think it could be improved?
   - Poor user interface
   - Difficult to learn
   - Features missing
   - Features too complicated for what I need

Comments:_____

_____

_____

_____

Do you use devices with an audible feedback system?

Yes
No

If yes, please answer the following.

Name of Device 1 _____

a. Do you like the way it works?
   Yes
   No
b. Why? _____

_____

_____

Name of Device 2 _____

a. Do you like the way it works?
   Yes
   No
b. Why? _____

_____

_____

How important is to have the ability to change the rate of speech of an audible feedback system?

Very important
Important
Somewhat important
Somewhat not important
Not Important

Would you like the ability to turn off the audible feedback system?

Yes
No

In an audible feedback system, which would you prefer

Spoken prompts
Series of beeps

Please rate the following items on a scale of 1 to 5, with 5 being very important and 1 being not important.

Ability switch between voices
1 2 3 4 5

Ability to change speed of voices
1 2 3 4 5

Human sounding voices
1 2 3 4 5

Ability to turn off voice feedback
1 2 3 4 5

Have you used any radios that are particularly well-designed?

Yes
No

If yes, please list what you liked.

_____

_____

_____

Have you used any radios that are not particularly well-designed?

Yes
No

If yes, please list what you disliked.

_____

_____

_____

Which of the following ways do you prefer to access a menu system?

- Numbered keypad
- Knobs
- Buttons
- Others: Please List

How important is tactile feedback in a physical interface?

- Very important
- Important
- Somewhat important
- Somewhat not important
- Not Important

When you first get an assistive device, how long do you think it should take to be able to use your device?

- Immediately
- Within 15 minutes
- Within 30 minutes

How do you prefer to learn to use your assistive devices?

- Listening to an audio manual
- Trial and Error
- Having someone teach you

Do you have a favored brand of assistive devices because they have good interfaces?

- Yes
- No
- If yes, please list:

Listening Habits and Preferences

We're envisioning a new audio information service that would allow radios to save stories that are interesting to you automatically, allowing you to listen to it at your convenience (like TiVO, but for the radio). First you would set up a profile of what you like. Then the radio would capture those programs, perhaps over night, so that they would be ready for you the next day. Then you could pick the stories you'd like to listen to.

If you were using this system, how many hours do you think you would like to record in a day?

- Under an hour
- 1 hour
- 2 hours
- 3 hours
- More than 3 hours

How many times or what period of time would you like to keep your recorded programs?

- 1 day
- 3 days
- 7 days
- Indefinitely

How important is it to be able to pause live broadcasts?

- Very important
- Important
- Somewhat important
- Somewhat not important
- Not Important

Would real-time recording (you hear something that you like and you press a button to record) be handy?

- Yes
- No

How important would it be to be able to save programs onto a computer?

- Very important
- Important
- Somewhat important
- Somewhat not important
- Not Important

Are there any other features that you think should be included?

Appendix 3: Results of the PAIS survey

Gender

	Frequency	Percent
Male	129	60
Female	86	40
Total	215	100

Vision Loss

	Frequency	Percent
Completely Blind	129	61
Legally Blind	68	32
Visually Impaired	13	6
Total	210	100

Age Range

	Frequency	Percent
18-29	23	11
30-39	22	10
40-49	40	19
50-59	81	38
60+	48	22
Total	214	100

Reported Technology Use

	Frequency	Percent
Tech Enthusiast	86	40
Frequent Tech User	117	54
Infrequent Tech User	10	5
Never Use Tech	2	1
Total	215	100

Yearly Household Income

	Frequency	Percent
Less than 20 K	51	24
20-40 K	48	22
41-75 K	68	31
75 K plus	49	23
Total	216	100

Education

	Frequency	Percent
Graduate	87	41
College	99	46
High School	26	12
Less than HS	2	1
Total	214	100

Employment Status

	Frequency	Percent
Work full time	82	41
Work part time	28	14
Work from home	22	11
Retired	52	26
Student	17	8
Total	201	100

Braille

Braille Use

	Frequency	Percent
Use	158	73
Do Not Use	57	27
Total	215	100

Frequency of Braille Use

	Frequency	Percent
Daily	120	76
Weekly	22	14
Monthly	15	10
Total	157	100

Reading Service Radio

Reading Service Radio Use

	Frequency	Percent
Use	57	27
Do Not Use	157	73
Total	214	100

Frequency of Reading Service Radio Use

	Frequency	Percent
Daily	25	44
Weekly	14	25
Monthly	18	32
Total	57	100

Reported Satisfaction with Reading Service Radios

	Frequency	Percent
Satisfied	28	50
Neutral	10	18
Unsatisfied	18	32
Total	56	100

Percent of those who reported using these Common Technological Devices

Computer	95
Music Player	70
Table Top Radio	80
Car Radio	43
TV	90
Home Stereo	67

Percent of those who reported using these Accessible Technological Devices

Screen Reader	86
Screen Magnifier	17
Daisy Player/ Book Reader	48
Accessible PDA	39
Braille Display	32
Audio Recorder	47
Scanner	66

Preferred Audio Feedback System

	Frequency	Percent
Spoken Prompts	184	92
Series of Beeps	15	8
Total	199	100

Importance of Switching Between Different Sounding Voices

	Frequency	Percent
Important	67	33
Neutral	59	29
Not Important	77	38
Total	203	100

Importance of having Human Sounding Voices

	Frequency	Percent
Important	113	56
Neutral	52	26
Not Important	37	18
Total	203	100

Importance of Changing the Speed of Voice

	Frequency	Percent
Important	161	79
Neutral	22	11
Not Important	20	10
Total	203	100

Importance of Having the Ability to Turn Off the Voice Feedback

	Frequency	Percent
Important	112	55.5
Neutral	31	15.3
Not Important	59	29.2
Total	202	100

Importance of Having Tactile Feedback

	Frequency	Percent
Important	156	73.5
Neutral	40	19
Not Important	16	7.5
Total	212	100

Preferred Method to Access Menu

	Frequency	Percent
Numbered Keypad	147	71
Knobs	15	7
Buttons	34	16
Other	12	6
Total	208	100

Expected Amount of Time Required to Learn New Accessible Device

	Frequency	Percent
Under 30 min	97	45
30 min	73	34
More than 30 min	44	21
Total	214	100

Preferred Method Used to Learn New Accessible Device

	Frequency	Percent
Listen to an Audio Manual	101	47
Trial and Error	35	16.5
Have Someone Teach You	32	15
Read a Braille Manual	46	21.5
Total	214	100

Preferred Number of Hours to Record in a Day

	Frequency	Percent
One hour or less	49	24
More than one hour	159	76
Total	208	100

Preferred Length of Time to Keep Saved Programs

	Frequency	Percent
One day	13	6
One week	70	34
One month	40	19
Indefinitely	85	41
Total	208	100

Importance of Saving Programs onto a Computer

	Frequency	Percent
Important	148	71
Neutral	30	14.5
Not Important	30	14.5
Total	208	100

Preference for Being Able to Record in Real-Time

	Frequency	Percent
Prefer	192	92
Does Not Prefer	17	8
Total	209	100

Importance of Being Able to Pause Live Broadcasts

	Frequency	Percent
Important	135	65
Neutral	54	26
Not Important	19	9
Total	208	100

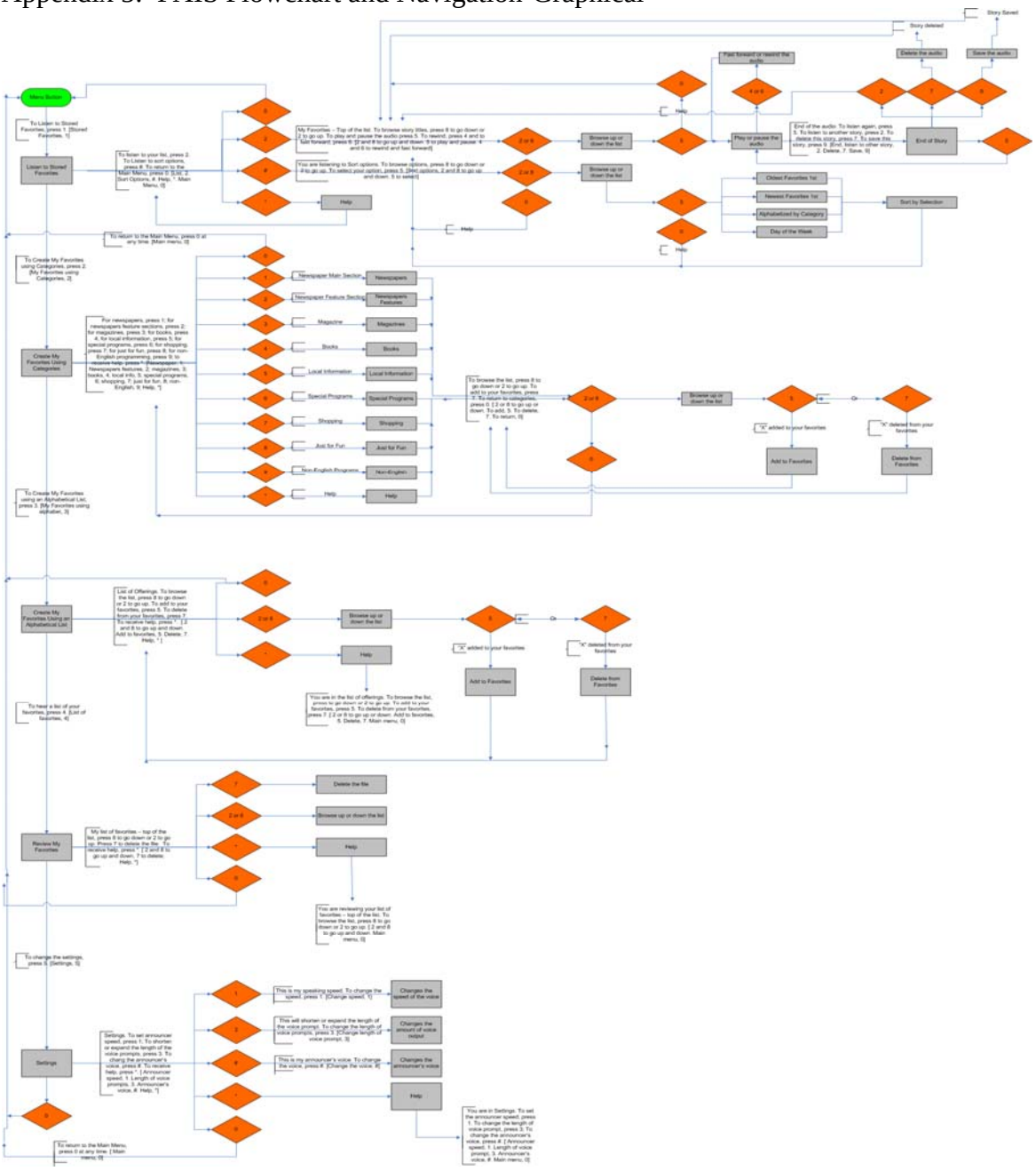
Preference for Having an Internal Speaker Included in Device

	Frequency	Percent
Prefer	194	93
Does Not Prefer	5	7
Total	209	100

Appendix 4: Radio Reading Services currently provided

Radio Reading Services	National	Local	Disability/ AARP/Health	Magazines	Religious	TV	Books	Ads	Stories	Exercise	Game Shows	Catalog	Prime Time	Spanish	Specific papers	Sections
Alabama Print Information Center	1	1	1	1	1	1	1	1		1			1		NYT, WSJ, USA	local news, editorials, obits, advice, features, sports, arts and leisure, business,
Sun Sounds of Arizona	1	1	1	1	1	1	1	1	1	1	1	1	1		WSJ, the Onion,	national, international, local and state news, sports, editorials, local business, comics, obits, advice, horoscopes,
Los Angeles Radio Reading Service	1	1	1	1			1		1	1					LA Times and Daily News	
KPBS Radio Reading Service	1	1	1	1		1	1	1	1						NYT, WSJ, LA Times	Front Page, Region, Editorials and Opinion, Business, Features, Comics, Sports,
Audio Vision	1	1	1	1			1	1					1		LA Times	
Radio Reading Service of the Rockies	1	1		1	1			1					1	1	NYT	
Connecticut Radio Information System	1	1	1	1		1	1	1					1		NYT, WSJ, USA	Front Page, Lives and Times, Sports,
WFSU-FM Radio Reading Service	1	1	1	1	1			1					1		NYT, WSJ, USA	Arts and Leisure, Book Review, Science, Weekend,
GaRRS	1	1	1	1	1		1	1							WSJ, USA,	
Idaho Commmission for the Blind and the Visually Impaired	1	1		1				1								Business, Life, Local, Obits/Death, Op Ed Letters, Sports, World and National
Minds Eye Information Service	1	1	1	1		1	1	1							USA, WSJ,	Local news, editorials, sports, obits, family, comics,
Tri-States Audio Information Services	1	1	1										1		NYT, WSJ, USA	Arts and Leisure, Life, Sports
WUIS Radio Reading Service	1	1	1	1	1		1	1		1					NYT, WSJ	
Indiana Reading and Information Services	1	1	1	1		1	1	1		1				1	USA, WSJ, NYT	
Iowa Radio Reading Information Service	1	1	1	1				1							NYT, WSJ	Arts and Leisure,
Kansas Audio-Reader Network	1	1	1	1	1	1	1	1							USA, NYT	Arts, Books, Travel, Business, Money, Sports, Life
Central Kentucky Radio Eye	1	1	1	1				1	1				1		NYT, WSJ	Science, Book Review, Arts&Leisure,
WRBH Radio	1	1		1			1	1	1						WSJ	
Maine Audio Information and Reading service		1		1		1	1	1								
Audible Local Ledger	1	1	1	1		1	1	1							WSJ, NYT, USA	Life, Money, Obits, Sports
Talking Information Center	1	1		1	1	1	1	1							WSJ, NYT, WashPost, USA	Book Reviews,
Audio Journal	1	1	1	1	1			1							NYT, WashPost, USA,	
Detroit Radio Information Service	1	1	1	1			1	1	1	1					NYT, WSJ,	Sports, Science, Dining, home and travel, Weekend
WKAR Radio Talking Book	1	1	1	1			1	1	1						NYT, WSJ, USA	
Radio Talking Book Network	1	1	1				1	1			1		1		WSJ	Sports, Health and Medicine
EIES of New Jersey	1	1		1			1	1							NYT, WSJ, USA	Sports, Health and Medicine
Audiovision	1	1	1			1	1	1	1						NYT, WSJ	house/Home, science, dining and arts, weekend,
WXXI Reachout Radio	1	1	1		1	1	1	1							NYT, WSJ, USA	business, editorials, living, sports
RISE	1	1	1	1	1		1	1	1						NYT, WSJ,	
Down East Radio Reading Service	1	1	1	1			1	1	1						NYT, WSJ	
Radio Reading Service of Eastern North Carolina	1	1	1	1				1	1				1		NYT, WSJ,	Dining and Arts, House and Home, Travel, Science, Weekend Section
Triad Information Reading service	1	1	1	1					1						NYT, WSJ	
Triangle Radio Reading service	1	1	1	1			1	1		1					NYT, WSJ, USA	
Radio Reading Services	1	1	1	1	1	1		1	1						NYT, USA,	opinions, editorials, sports, business
VOICEcorps Reading Service	1	1	1	1	1	1	1	1							WSJ,	
WORDS Radio Reading Service	1	1	1	1	1	1		1							WSJ	obits, sports, editorials, local and regional, lifestyle and entertainment
SRRS	1	1	1	1	1	1	1	1	1						USA, WSJ,	money, editorials, business,
Radprin	1	1	1	1		1	1	1	1				1		NYT, WSJ,	columns, editorials, horoscopes, lottery, weather, obits, book review, arts & leisure,
Radio Information Service		1	1			1	1	1				1				
WYPL				1			1	1								
Nashville Talking Library	1	1	1	1		1	1	1	1						NYT, WSJ,	
Virginia Voice	1	1	1	1	1	1	1	1	1						WSJ, USA,	obits, tv schedules, current affairs
Valley Voice	1	1													WashTimes, WashPost	
Written Communications Reading Service	1	1	1	1	1	1	1	1							WSJ,	
Washington Ear	1	1	1	1	1	1	1	1	1	1					USA, WashPost, WSJ,	
Totals																
46 stations	42	44	37	39	18	22	33	41	18	8	2	2	11	2	WSJ (34)	
	93.33	97.78	82.22	86.67	40.00	48.89	73.33	91.11	40.00	17.78	4.44	4.44	24.44	4.44	NYT (27)	
															USA (19)	

Appendix 5: PAIS Flowchart and Navigation-Graphical



Appendix 6: PAIS Flowchart and Navigation-Text Version

Overall Design Criteria:

1. All functions (by key) are consistent between menu options. Therefore, 5 is always used for play and select. 2 is always used for joystick up, 8 is always used for joystick down, 7 for delete, 9 for save.

2. All function keys are as close to Verizon/Comcast/AT&T/phone functions as possible (7 for delete for example).

3. All 0-level functions are separated at the MENU level.

4. The radio turns on when the On/Off button his hit. The menu button is only used for PAIS functionality

5. The volume is always controlled by the volume knob.

6. Radio station selection is always control by the Select knob.

LEVEL	Key	MESSAGE	Comments	Outcome/Travel to
0	MENU	Listen to Stored Favorites. To listen to your list press 2. To listen to List Sort Options press #. For help press *. To hear more options press Menu.	Message to orient listener and continue down the chain	2, * , #
1	2 (and 8)	My Favorites - Top of List. To browse story titles press 8 to go down or 2 to go up.	Titles start from top of list - "Broad category; Date (Month, Day); Title"	8, 2, 4, 5, 6, 7
	5	To hear or pause a story, press 5.	Individual Story Starts. "End of story - To listen to another story press 5; to delete this story press 7; to hear more titles, press 2" To save this story press 9. If story saved -- "Story saved. To hear more titles press 2".	2, 5, 7, 9

	7	To delete a story, press 7.	Story gets deleted. "Story deleted. To hear more titles press 2."	2, 8
	4	To rewind press 4	Hear story (back some frames)	No follow up
	6	To fast forward press 6	Hear story (forward some frames)	
0	#	You are listening to Sort options. To browse options press 8 to go down or 2 to go up. Press 5 to select your sort option.	"Sort Option selected. To return to your stored favorites press 2. To hear more options press Menu.	Oldest Favorites 1st Newest Favorites 1st Alphabetized by Category Day of Week
0	*	You are listening to Stored Favorites. To hear your list, press 2. To change to other menus, press Menu To listen to the radio, press ?? To exit the system, press ??		

LEVEL	Key	MESSAGE	OUTCOME	CAN TRAVEL TO:
0	MENU	Create favorites using categories. To hear possible categories press 0. To hear other options press Menu. For help at any time press *	List played	0
1	0	For newspapers, press 1; for features sections in newspapers press 2; for magazines press 3; for books press 4; for local information press 5; for special programs press 6; for shopping press 7; for just for fun press 8; for non-English programming press 9. (If no key is pressed after 10 seconds - To create favorites press 1-9.)	Work way down tree	Any number 1-9
1	1	Newspaper Main Section - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add selection to favorites press 5	"X Selection" Added	2, 8, 0
		To delete selection from favorites press 7	"X Selection" Deleted	2, 8, 0
1	2	Newspaper Feature Sections - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	3	Magazines - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	4	Books - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	5	Local Information - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0

		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	6	Special Programs - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	7	Shopping - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	8	Just for Fun - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
1	9	Non-English Programs - To browse sections press 8 to go down or 2 to go up. To return to categories press 0.		
		To add to favorites press 5	"X" Added	2, 8, 0
		To delete from favorites press 7	"X" Deleted	2, 8, 0
0	*	You are creating your favorites using categories. To hear your list, press 2. To change to other menus, press Menu To listen to the radio, press ?? To exit the system, press ??		

LEVEL	Key	MESSAGE	OUTCOME	CAN TRAVEL TO:
0	MENU	Create favorites using alphabetical list. To hear list press 0.	List played	0
1	0	List of Offerings. To browse list press 8 to go down or 2 to go up.		
		To add to favorites press 5. To return to List Offering press 0.	"X" Added	2, 8, 0
		To delete from favorites press 7. To return to List Offering press 0.	"X" Deleted	2, 8, 0
0	*	You are creating your favorites using an alphabetical list. To hear your list, press 2. To change to other menus, press Menu To listen to the radio, press ?? To exit the system, press ??		

LEVEL	Key	MESSAGE	OUTCOME	CAN TRAVEL TO:
0	MENU	Settings. To set announcer speed, press *; To set announcer voice, press #.		
1	1	This will be my speaking speed. Please change by pressing * until you are happy with my speed. To return to Menus press the Menu key.		
	#	This will be my announcer voice. Please change by pressing # until you are happy with my voice. To return to Menus press the Menu key.		
1	3	This allows you to change the amount of voice output that you will hear. You currently have full speech output. Press the 3 key to have shortened speech output.	Speech output setting is changed	
0	*	You are in Settings. To set announcer speed, press *; To set announcer voice, press #. To change to other menus, press Menu To listen to the radio, press ?? To exit the system, press ??		

LEVEL	Key	MESSAGE	OUTCOME	CAN TRAVEL TO:
0	MENU	Review Favorites. To hear list of favorites press 0.		
	0	My List of Favorites - top of list. To browse list press 8 to go down or 2 to go up. To change to other menus, press Menu		
0	*	You are Reviewing Favorites. To change to other menus, press Menu To listen to the radio, press ?? To exit the system, press ??		

Appendix 7: Experimenter script for interface designing testing

Experimenter - Welcome to our user-interface design test. We appreciate your input very much!

Today we are going to be letting you try out a prototype that was built to test user interface features we are thinking of putting into future Radio Reading Service radios. We call the system PAIS. The equipment you are working with is NOT a commercial radio, it just simulates what a radio might have to let you use this service - so it is experimental. However, the buttons you will press will do things, so you should be able to navigate through the tasks we ask you to do. Everything is speech driven, making this possible, however, we are here to assist you if you cannot figure out your next move. Since this is a task analysis, we will ask you to do things step by step, and not get ahead of us. We ask you to not only do the tasks but talk out loud as you do - tell us when something is really convenient or when it needs to be changed.. This will help us understand if we did our job correctly. At the end, you can give us feedback on what you would have expected the interface to have. Do you have any questions about the test before I introduce the radio to you?

The PAIS radio is a digital receiver that might one day replace analog SCA receivers that currently support Radio Reading Service transmission. Because the PAIS radio is built on a digital system, it will be come possible to easily and automatically record the audio broadcast by the Radio Reading Service. Users will have the ability to select their favorite types of programming, and the PAIS radio will automatically record these segments. Later on at the convenience of the user, the radio can playback any recorded material.

OK, now let's go through the set up in front of you. As you can feel, we have 12 buttons, and they are set up like a telephone key pad. 123 - 456 - 789 - *0#. There are another 2 buttons on the pad - one to the right which is the mode button which switches the radio between live, over the air programming and the PAIS setup and recorded playback mode. The other one above the keypad is the power button. The * button is the help button, which you can press at any time. The other important button is the 0, which is the menu button and will help orient you. Please try both buttons if you are stumped before asking me for help. However, feel free to ask the Experimenter if you are stumped. OK are you ready?

Tasks

1. Find Radio Reading Service Menu button and press the RRS menu button to get radio into the PAIS mode. (yes/no)

2. Press the 5 key to get into the Settings menu. Once in the settings menu, enter the voice speed setting and adjust that to your liking.

How would you rate the ease of adjusting the speed? 1 = very difficult, 2 = difficult, 3 = neutral, 4 = easy, 5 = very easy.

3. Now figure out how to change voice volume and adjust that to your liking.

How would you rate the ease of adjusting the volume? 1 = very difficult, 5 = very easy.

4. Now try changing the voice. How would you rate the ease of adjusting the voice?

1 = very difficult, 5 = very easy.

5. Now go back to the main menu. Try setting up a list of subjects that you would want to be saved on your radio using the category method. Include LOCAL AND REGIONAL NEWSPAPERS as one of your selections.

How would you rate the ease of using the category method? 1 = very difficult, 5 = very easy

6. Now go back to the main menu. Try setting up a list of subjects that you would want to be saved on your radio using the alphabetical list method.

How would you rate the ease of using the alphabetical list method? 1 = very difficult, 5 = very easy

7. Go back to the main menu and enter the "Listen to stored favorites" option and play the selection in LOCAL AND REGIONAL NEWSPAPERS.

How would you rate the ease of playing the audio clips? 1 = very difficult, 5 = very easy

8. Play the selection again. Try fast forwarding and rewinding the audio.

How would you rate the ease of doing this? 1 = very difficult, 5 = very easy

9. Now select the options to sort the audio. Which option to sort the audio did you like more? How easy was it for you to select the between the two sorting options?

1 = very difficult, 5 = very easy
10. Allow the user to use system freely and to offer any suggestions to improve. (Open ended text transcriptions)

11. Exit system. Turn power off.

Appendix 8: PAIS Version 1 User Testing Comments

Participant 1

-Voice Settings

-The ability to change the speed by going back and forth rather than cycle through might be useful

-Adding a lot of different voices would be nice but not necessary if they add to the cost

-Play My Favorites

-Liked the 3 second increments for the fast forward and rewind

-Sort Options

-Thought that the option Oldest Audio First was not that useful

-Liked the Sort by Category

-Thought that sorting by Day of the Week might not be useful, but liked the option for other people

-Add Favorites using Categories

-Thought the navigation was well done

-Liked the idea of having a "check" when a category is selected

-Liked the option of picking by general categories or specific categories

-Hardware

-Really liked the physical keys, round, large keys are good

Participant 2

-Settings

-Name the voices something better, eg. Dave, Sue

-Would like a setting that allows for audio to be deleted after a set period of time.

Example – audio would be deleted after a week, month, 10 days, etc……

-My Favorites

-Liked that it said what source that it came from

-Creating My Favorites

-Need a way to let users know that there is a submenu in some categories – could say something like "Has sub categories"

-likes the option of the alphabetical list

-Catalog shopping, Braille needs to be changed to Catalog shopping, Braille products

-Playing Audio

-Have the option to list audio clips that are permanently saved

-Would like to have the fast forward / rewind to jump ahead at set intervals, but if you hold the button longer it says “10 seconds, 30 seconds, 1 minute”

-Need to have the ability to delete / permanently save from this menu

-Would like to have an audio manual that goes along with the device

Participant 3

-Settings

-Setting the voice speed would be nice if 1 made it faster and 4 made it slower

-Hated the Microsoft Sam voice

-Would like to have a button that made the voice output turn off

-Set My Favorites – Categories

-When there is a submenu there needs to be some indication that it is there – “National newspapers – press 6 for sub menus”

-If selecting a general category – Local Newspaper – all subcategories should be “checked”. Would be nice to then be able to uncheck the subcategories that you don’t want.

-Set My Favorites – Alphabetical

-When entering the list, need to start on a blank spot. It doesn’t currently read the first item.

-All subcategories need to be checked if the main category is checked

-Play Audio

-liked the setup of the fast forward and rewind

-Need to be more clear about the playback functions in the help menu: “To play or pause the audio, press 5

-Need to say, press 7 to delete the audio

-Saving and Deleting Audio

-Permanently saved audio should be a category in the listen to my favorites

-Thought the idea of having a auto delete function would be nice

-When the memory is full, need to have a message at the beginning telling you that you need to delete some audio from your favorites

Participant 4

-Settings

-Being able to alter the tone of the voice might be a nice function

-Setting My Favorites

-At the end of the list, it should say “End of the list” not “bottom of the list”

-Would be nice to have the audio purged from my favorites after a user-selectable period of time

-If you remove something from your list of My Favorites, it should remove all the audio from that category from the recorded audio, except the permanently saved audio

-Playing My Audio

-Need to insert voice instructions that tell you the controls at the beginning of the menu

-Liked the fast forward and rewind functions

-Would like to be able to speed up fast forward the recorded audio

-Need something that says that it reached the end of the story

Participant 5

-Settings

-Thought that having one key for setting the speed of the voice output was fine

-Thought it would be helpful if some of the prompts were more clearly defined as to what they do

-Playing Audio

-Would be nice to be able to set “book markers” in the recorded audio, so that you could jump to specific locations in the recorded audio

-Would be nice to have “book markers” set in the recorded audio. You could then jump ahead to certain points. Example – book readings would have markers for every chapter.

-Create My Favorites – Categories

-Would like to be able to hit a button and then record a live radio reading service broadcast.

-Should then have a category in My Favorites called “Tagged Recordings” or “Live Broadcast Recordings”

-Sort Options

-Would like to be able to sort by time of day

Participant 6

-Settings

-When done with a setting, when you press 0 it goes back to the main menu – it should just go back to the previous menu

-For deleting the audio, have option to save audio permanently and then delete other audio in set intervals (every week, 10 days, every month)

-Create My Favorites – Categories
-When you press 0 – goes to main menu, should go back to the previous menu
-Would be useful to include an audio manual with the device for new users to the system

-Hardware
-Would like to have a USB port to save the audio on a USB thumb drive
-Would also like to place the recorded audio on an .mp3 player

-Listening to My Favorites
-The buttons should be laid out as such
1 – Stored Favorites Audio
2 – Permanently Saved Audio
3 – "Tagged" Live Broadcast Audio

Participant 7

-Settings
-Having a key to speed up the voice output and a key to slow down the voice output, like 1 and 4 would be helpful
-Having more good voices would be nice

-Create My Favorites – Categories
-Need to know when there are subcategories in the list

-Create My Favorites – Alphabetical
-Would be nice to be able to jump down the list – ex. Press 3 to jump up 10 entries, press 9 to jump down 10 entries. Could use the keypad to enter a letter that it would jump to similar to typing a text message.

-Listening to My Favorites
-Would like it if users could control the length that the fast forward and rewind skipped forward and back
-Would be nice if there was a simple way to delete all audio in My Favorites except the permanently saved audio

Participant 8

-Settings
-Need to change the name of the voices. The long names are unnecessary
-Speeding up and slowing down the audio is fine.

-Need a button that stops the voice output. Perhaps have the # key stop the audio with 1 press, and then give help with 2 presses

-Create My Favorites – Categories

-Seemed to be a little confusing at first. Maybe the voice prompts could be a little bit more clear

-Create My Favorites – Alphabetical

-Liked the alphabetical list because it listed a lot of categories that they wouldn't necessarily find going through the categories

-Listen to My Favorites

-Doesn't need to say the time that the audio was recorded. Just the date and program description would be fine

Appendix 9: PAIS Version 2 User Testing Comments

Participant 1

-Settings

-3 or 4 good voices would be fine. Helpful for some people to have a choice because they can't hear certain tones

-Stored Favorites

-Liked the different options to sort the stored audio preferred the category sorting options.

Participant 2

-Stored favorites

-Liked the ability to sort by the different options

-Might be easier when sorting by categories if the voice told you "Business, 3 stories" or "National newspaper, 6 stories" and then pressing 6 to play those stories.

-Create My Favorites using Alphabetical List

-Self-explanatory, liked using this method

Participant 3

-Changing the voice

-Not important to have a lot of voices. Important only to have a couple of good voices.

-Stored Favorites

-Would rather have the radio say selected or unselected rather than check.

-There is a learning curve involved. After having learned the system, it would be very easy to use the system.

-PAIS menu button was a little confusing – it would take you back to the radio. It would be better to call it the toggle button or something.

Participant 4

-Changing the Voice Prompt

-Liked the ability to be able to change the length of the voice prompts

-Need to have a pause button for the voice output

-Playing the Recorded Audio

-Likes it set up that FF and Rew skips ahead 5 seconds.

-Voice Output needs to tell you to press 4 and 6 to FF and Rew after you press the 2 key to hear the stories

Participant 5
-Settings Menu
-Setting the speed and volume of the voice output – Would rather have a two button operation such as the 2 and 4 rather than having the options cycle around.

-Setting My Favorites using Categories
-Need to tell people more instructions.
-Some categories are confusing when first entering
-Would like it better if the radio said "Category has been added to your list" rather than "Check"

-Playing Recorded Audio
-Don't need to say the seconds in the time that the audio was recorded.
-Need to speak more instructions about play options while in the list
-Liked the Category sorting option

-Putting colors on the different keys would be a good idea, make the PAIS/Radio and power keys a different color
-Different shape of the keys might be helpful to people
-Having a sleep function would be a good idea

Participant 6
-Settings
-Would like the ability to use two buttons to change the volume and speed of the voice

-Adding Favorites using Categories
-The radio doesn't tell people to hit 4 to go back

-Need a button to quiet the voice

-Playing the audio
-When you press the 2 button to play audio, the radio doesn't tell you to press 4 and 6 to FF and Rew

Participant 7
-Would like the system to be an add-on to existing radios

Participant 8
-Would prefer to have 2 keys to adjust the voice volume and speed

-When in the category method, the radio needs to say "4 to go back to the list of categories"

-When in the alphabetical list, would like to enter a letter to jump down the list or could have a key that would jump down a letter in the list

-When in the list to play the audio, it needs to say that “press 5 to play the audio”

-Would like the ability to speed up the recorded audio.
-The ability to set the time that the fast forward and rewind would jump would be a nice option.

Participant 9
-Would like to have 2 keys to change the voices and volume of the voice

-When in the category method, need to tell the user that you can press 4 and 6 to get in and out of categories

-Need to tell people that they can press 5 to play the recorded audio.

-Would like the ability to speed up the recorded audio

-Would like the option to change the length of the FF or Rew button per button press.

Participant 10
-Would need to have a button to silence the voice output

-In the category method, need to tell people that you can hit 4 and 6 to enter and exit menus

-Would rather hold down the 4 and 6 to FF and Rew rather than jumping ahead a set period of time

Participant 11
-Would rather have two keys to change the voice speed and voice volume rather than 1

-Don’t need to announce the complete voice’s name. Just call them Mike, Joe, Mary, etc.

-Need to tell people that they can hit 4 or 6 to go into or out of menus in the Category method.

-Would like the ability to hold down the buttons for FF and Rew rather than skipping ahead a set period of time.

Participant 12
-Liked the one button operation for the speed and volume of the voice

-Thought the titles of the My Favorites and Recorded Audio could be a little confusing

-Would rather hold down the FF and Rew buttons rather than press them once to have them jump a set period of time.

Participant 13

-Would rather have 2 keys to change the voice speed and volume.
-Could possibly have a toggle button that would give the controls a 2 key function.

-Would rather hold down the FF and Rew buttons, but the radio could then speak how far you were FF or Rewinding. (10 seconds, 30 seconds, 1 minute…….)

Participant 14

-Thought the voices should be more clear

-In the settings menu, thought it might be a good idea to have a confirmation button after selecting all the settings

-Thought it would be better to have 2 keys to change voice speed and volume.

-Need to tell people that you have to hit the 4 and 6 key in the category menu to get in and out of menus.

-Would rather hold down the button to FF and Rew

Participant 15

-Need to have a button to silence the voice.

-Wants the ability to pick specific sections from specific papers.
-Give each feature section a specific newspaper

-Would rather press and hold the FF and Rew and have the voice tell you how far you have jumped ahead

-Would like a way to jump to the beginning of the story from the middle of the story

-Need a way for the system to tell you how much memory you have left and how many total stories and memory you have used.

Participant 16

-Would rather have two buttons for changing the speed and volume of the voice

-Liked the size and the feel of the buttons

-Wanted a button that always goes to the main menu.

Participant 17

-If you try and delete a category from your list but it isn't in your list, then it says category not found and gets stuck. Needs to go back to the previous menu.

-Need a button to silence the voice output.
-To set the speed and volume of the voice, could use the 1-9 keys or would prefer 2 keys to adjust them.

-When playing audio, after selecting 2 – need to tell people that you press 5 to play/pause and 4 and 6 to FF and Rew.

-Wants the ability to select how far ahead the FF and Rew jump.

-Would like a button in the Settings menu to revert back to the default settings.

Participant 18
-Would like a confirmation key for the settings menu

-The ability to set bookmarks in the recorded audio would be nice
-Then have a list of all the bookmarks

-Would like to be able to set the length of the FF and Rew

-Would like to be able to transfer audio to an SD card and a USB output to interface with a computer

Participant 19
-Would like the option to set the length of the FF and the Rew.
-Thought the ability to skip by sentence would be helpful.

Appendix 10 – PAIS Categories in relationship to keypad presses

Telephone key pad entry #	1st Menu Level	2nd Menu Level	3rd Menu Level										
			1	2	3	4	5	6	7	8	9	10	11
1	NEWSPAPERS	Local/Regional	Sports	Business	Science	Money/Finance	Politics	Technology					
		National	Sports	Business	Science	Money/Finance	Politics	Technology					
		International	Sports	Business	Science	Money/Finance	Politics	Technology					
2	FEATURE SECTIONS (newpapers)	Travel											
		Weekend											
		Health/Medicine											
		Home											
		Dining/Food											
		Editorials											
		Arts/Leisure/Lifestyle											
		Disability News											
		Health											
		Religious											
		Family											
		Entertainment											
		Home and Garden											
3	MAGAZINE or JOURNAL	Magazine Articles											
		Sports											
		Business											
		Science											
		Money/Finance											
		Politics											
		Technology											
		Entertainment											
		Literary											
		Home & Garden											
		Kids & Teens											
		Women's											
		Men's											
4	BOOKS	FICTION	Book Reviews	Book Readings	Short Stories	Poetry readings							
		NON-FICTION	Book Reviews	Book Readings	Short Stories	Poetry readings							
5	LOCAL INFORMATION	TV Listings											
		Weather											
		Obituaries											
		Marriages											
		Births											
		Special Announcements											
6	SPECIAL PROGRAMS	DVS Movie											
		Old-Time Radio											
		Prime Time Radio											
		Holiday											
		Talk											
7	SHOPPING	Grocery	Piggly Wiggly	Giant Foods	Aldi	Safeway	Kroger						
		Retail	Drug Stores	Department Stores	Electronics	Office Supplies	Hardware	Superstores					
		Catalog	Special Aids	Department Stores	Electronics	Sports	Outdoors	Clothing/Shoes	Home/Garden	Gifts	Food	Audio Books	Braille
8	JUST 4 FUN	Lottery											
		Advice											
		Comics											
		Horoscope											
		Exercise											
		Game Shows											
9	NON-ENGLISH PROGRAMMING	Spanish*											

Appendix 11 – PAIS category codes used in transmission

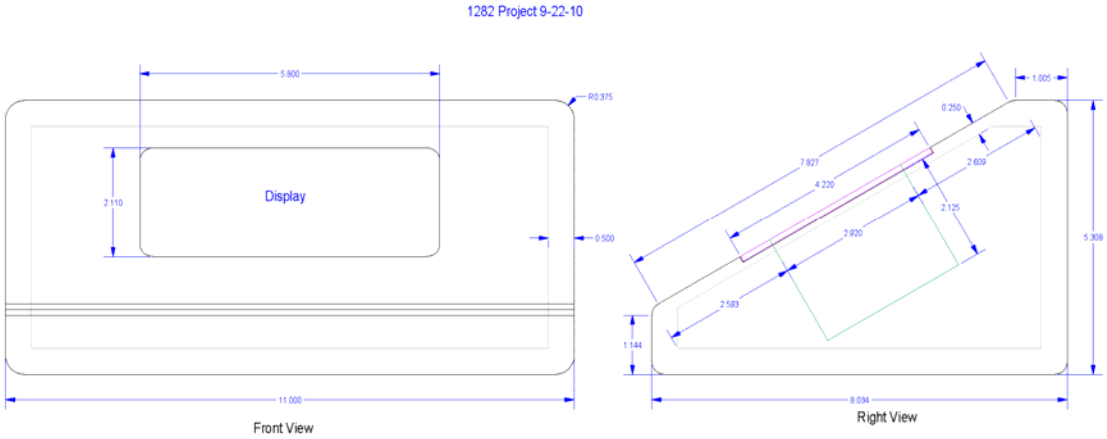
1st Menu Level	2nd Menu Level	3rd Menu Level										
		1	2	3	4	5	6	7	8	9	10	11
NEWSPAPERS AAAA	ABAA	ABAB	ABAC	ABAD	ABAE	ABAF	ABAG					
	ACAA	ACAB	ACAC	ACAD	ACAE	ACAF	ACAG					
	ADAA	ADAB	ADAC	ADAD	ADAE	ADAF	ADAG					
FEATURE SECTIONS (newpapers) BAAA	BBAA											
	BCAA											
	BDAA											
	BEAA											
	BFAA											
	BGAA											
	BHAA											
	BIAA											
	BJAA											
	BKAA											
	BLAA											
	BMAA											
MAGAZINE or JOURNAL CAAA	CBAA											
	CCAA											
	CDAA											
	CEAA											
	CFAA											
	CGAA											
	CHAA											
	CIAA											
	CJAA											
	CKAA											
	CLAA											
	CMAA											
	CNAA											
BOOKS DAAA	DBAA	DBAB	DBAC	DBAD	DBAE							
	DCAA	DCAB	DCAC	DCAD	DCAE							
LOCAL INFORMATION EAAA	EBAA											
	ECAA											
	EDAA											
	EEAA											
	EFAA											
	EGAA											
SPECIAL PROGRAMS FAAA	FBAA											
	FCAA											
	FDAA											
	FEAA											
	FFAA											
SHOPPING GAAA	GBAA	GBAB	GBAC	GBAD	GBAE	GBAF						
	GCAA	GCAB	GCAC	GCAD	GCAE	GCAF	GCAG					
	GDAA	GDAB	GDAC	GDAD	GDAE	GDAF	GDAG	GDAH	GDAI	GDAJ	GDAK	GDAL
JUST 4 FUN HAAA	HBAA											
	HCAA											
	HDAA											
	HEAA											
	HFAA											
	HGAA											
NON-ENGLISH PROGRAMMING IAAA	IBAA											

Appendix 12. Code Excerpt from the NPR Labs' developed PAIS Receiver.
This section detects and processes a received PAIS tag

```
/*****************************************************************************
 *     PAISProcessComment
 *
 *  Description : Parse the Comment PSD and determine if it's a PAIS tag, if so, take
action.
 *  Input       : None
 *  Output      : None
 *
 *  Reads/Writes: UINT8 Comment[ID3_COMMENT_LEN]
 *                (If no PAIS tokens are found, Comment is unchanged,
 *                 else Comment is a PAIS category description.
 *
 *  Calls       : SAP_RecordStart() and SP_Stop()

*****************************************************************************/
VOID PAIS_ProcessComment (VOID)
{

#if 1
  int n;
  // strstr returns a pointer.  If the substring is found in the searched string,
  // it points to where the substring was found in the searched string, else it returns a
NULL pointer.
  char * pch;
  // points to the end of the PAIS description (if any description exists in the tag
[it's optional]).
  char * desc_end;

    // points to our destination string when we copy the PAIS description from the
Comment
  char * dest;



  pch = strstr (Comment,PAIS_VALIDATION_TOKEN);
  if (pch != 0) // The PAIS token is present and correct
  {

    pch = strstr (Comment,PAIS_VERSION_TOKEN);
    if (pch != 0) // The PAIS Version is OK.  TODO: backward PAIS version compatibility?
    {

      // Now we have a valid PAIS tag and version, so let's look for a category or
command tag within.
      pch = strstr (Comment,PAIS_CATEGORY_TOKEN_START);
      if (pch != 0) // Found the token marking the presence of a PAIS CATEGORY.
      {

        // The category name begins after the PAIS_CATEGORY_TOKEN_START.
        // Move pch ahead so it will point to the first char of the category name.
        // Because we're already at the first char of the category token, we subtract 1
from LENGTH
        // eng<RRS v=\"00\"><cat name="ABAB">Sports, Local and Regional
Newspapers</cat></RRS>
        //                  ^ pch before
        pch += (LENGTH(PAIS_CATEGORY_TOKEN_START)-1);
        // eng<RRS v=\"00\"><cat name="ABAB">Sports, Local and Regional
Newspapers</cat></RRS>
        //                             ^ pch after
        current_pais_tag.category[4] = '\0';
        strncpy(current_pais_tag.category,pch,PAIS_TAG_CATEGORY_LEN);

        // If we have the same category, either it's a new program of the same kind (if
recording, we'd continue to record),
        // or the radio has received the same tag again (typical Importer behavior).
        // In both cases, there's nothing for us to do.
        if (strcmp(current_pais_tag.category,past_pais_tag.category) != 0)
        {
```

```
          // It's a new category, so regardless, stop recording.
          if (SP_isRecording())
          {
            SAP_Stop();
          }

          // Now compare this category against our user list.
          for (n=0; n<LENGTH(pais_master_list); n++)
          {
            if (strcmp(pais_user_list[n].category,current_pais_tag.category) == 0)
            {
              // We've found the PAIS tag in the master list.
              // Now let's get the description, bounded by >....and....<
              // pch is still pointing to the start of the cat name.
              pch = pch + PAIS_TAG_CATEGORY_SKIP_LEN;
              // eng<RRS v=\"00\"><cat name="ABAB">Sports, Local and Regional
Newspapers</cat></RRS>
              //                                  ^ pch after
              // pch now points to the start of the description,
              // so let's find the end of the [optional] description.
              desc_end = strstr (Comment,PAIS_CATEGORY_TOKEN_END);
              if (desc_end != 0)
              {
                // eng<RRS v=\"00\"><cat name="ABAB">Sports, Local and Regional
Newspapers</cat></RRS>
                //
^ desc_end after
                dest = current_pais_tag.description;
                // Copy the description from the Comment field into the
current_pais_tag.description.
                // We do this because the incoming description may differ from that in
our master list.
                while(pch != 0 && pch != desc_end)
                {
                  *(dest++) = *(pch++);
                }
                *(dest++) = '\0'; //terminate this incoming string so we don't see extra
junk.
              } else // No incoming description found; we'll use the description from the
master list.
              {
                cstrcpy(current_pais_tag.description,pais_master_list[n].description);
              }

              //TODO: Get the enabled bit from memory, not from FLASH.
              current_pais_tag.status.bytestatus = pais_user_list[n].status.bytestatus;
                //.  .bitstatus.isEnabled =
pais_master_list[n].status.bitstatus.isEnabled;
              strcpy(past_pais_tag.category,current_pais_tag.category);
              strcpy(past_pais_tag.description,current_pais_tag.description);

              if (current_pais_tag.status.bitstatus.isEnabled)
              {
                if (IsDigitalAudioAcquired() && !SP_isPlaying())
                {
                  SAP_RecordStart();
                }
              }
              break;
            } // No match with category
          } // looping thru the list
        } // Same PAIS tag has been received.
      } // No category token found.  TODO: Parse for a command category.
    } // Not a recognized PAIS version.

    // Return the Comment field containing a PAIS description.
    strcpy(Comment,current_pais_tag.description);
  } // No PAIS token.  Must be some sorta comment about something else.
  #endif
  return;
}
```

Appendix 13. Custom fabricated enclosure CAD design for PAIS HD Radio Receiver.



Appendix 14. Custom fabricated front panel for PAIS User Interface simulator.