MAT8 Interactive Assessment

Design Document

Prepared for Harcourt Educational Measurement
By Human Code, Inc.

MAT8 DESIGN DOCUMENT TABLE OF CONTENTS

Credits

The document you're holding represents the work of weeks of many people's time.

Material for this document was written, drawn or provided by Kristin Alexander, Janey Fritsche, Michele Josephs, Adam Kane, Ryan Koo, Chris Madison, Simone Pia, Alexander Scholz, Kerstin Sjoquist, Peter Stein, Nicole Tatem, and Laura Kinley from Human Code, and Harvinder Saluja from R Systems.

Jim Hill and other members of the MAT8 team at Harcourt Educational Measurement provided invaluable assistance.

1. Introduction

1.1 Document Overview

We are pleased to present this design document for the MAT8 interactive assessment system. This document marks the completion of the design process and provides a production blueprint for the project. Outlined here is the functionality for all aspects of the product and a visual style guide for the interface. Technology specifications and implementation methods are provided as well as the results of user testing that was performed with paper prototypes of the interface.

This design document further details the specifications set forth in the MAT8 Requirements Document and is informed by comprehensive discussions and collaboration between Human Code and Harcourt Educational Measurement (HEM) team members.

While this document is intended to be complete and comprehensive, we recognize the impossibility of specifying every detail in advance of implementation. The design document is best treated as a living document to be modified frequently based on further work, such as the usability assessment, and agreement on the part of HEM and the implementation team. Anything not addressed in this document will be agreed upon by both parties and covered as an addendum.

1.2 Project Overview and Scope

The MAT8 interactive assessment product is one of several Harcourt Education Measurement (HEM) initiatives for Computer Based Testing (CBT). HEM has had many customer requests for CBT products, as customers are looking to gain efficiencies in their

testing processes. A CBT system can supply learning institutions with instant raw score feedback, faster turnaround on normative score reports, and reduce the paper flow that exists with current printed testing systems.

Development of this product will provide experience that will help to construct effective CBT products in the future, including one for SAT10. This project represents phase one of this process. Any ideas born during the design and implementation phases that are beyond the scope of this project will be reserved for later phases, i.e., future products. This document outlines the design for phase one only.

1.3 Project Goals

- This product is an interactive subset of the MAT8 print product that delivers Reading Comprehension, Math Problem Solving, and Math Computation testing.
- The target audience is elementary and middle school students in 3rd, 4th, 5th, 6th, 7th and 8th grades.
- The product will be a positive experience for kids, with a friendly, age-appropriate interface.
- The interactive test experience will be similar to the paper version of MAT8.

2. Business Model

Norms tables developed by HEM allow it to provide its customers complex, aggregated score reports based on any number of data elements. This is a specialized service and is at the core of the revenue model for products like MAT8.

The MAT8 interactive assessment product will provide a more robust mechanism for tracking product use by controlling access to the assessment based on the quantity a customer has ordered. In addition, it will collect all data needed by existing HEM scoring systems that produce normative score reports. The electronic delivery of the data will increase the turnaround time for producing these reports. This will allow HEM to maintain existing revenue streams and increase efficiency.

2.1 Summary of Components

The MAT8 Interactive Assessment System consists of several components. The main component is the assessment module, which provides a computer interface for the students to view and answer the questions that compose each subtest. Additional components include a proctor utility that provides registration and scoring functionality, and a database that holds each student's demographic and test data. A typical use scenario will proceed as follows:

- A school or school district orders a quantity of the MAT8 CBT product. Order information is added to the MAT8 database.
- A test proctor accesses the registration utility and types in the demographic information for every student who will take the test, referencing the order. The data is uploaded into the database.
- Each student logs in separately and takes the test. Their responses are uploaded to the database at the conclusion of the assessment.
- The proctor uses the scoring utility to view and print the scores of the students who have completed the assessment. Score data is downloaded from the database.

3. Style Guide

3.1 Writing Guidelines

In a standardized testing environment, it is essential to use language that is clear to every student. With this in mind, the language used on any assessment module screen should be understandable to the youngest student, but not condescending to the oldest student. The target audience ranges from third grade to eighth grade, so writing should be geared at the third grade level while keeping in mind the sensibilities of the eighth grader. Someone who is knowledgeable about elementary school reading levels should evaluate screen language and user testing should be performed to further verify that language is appropriate.

The writing displayed on the screens in this design demonstrates these principles. As it is not possible in the design phase to compose every script, similar care should be taken during the implementation phase to ensure that any new or modified screen language adheres to these guidelines.

3.2 Visual Style Concepts

The visual style of the computerized MAT8 assessments is clear, clean and appealing and maintains the integrity of the test booklets. It is designed to be "kid friendly".

The look is clear and clean. The style keeps in mind at all times that this is a test. While it is tempting to add some fun elements, animations, etc., it would be distracting from the purpose of the project, which is testing. And because the focus must be on the questions and answers, that part is centered on the screen and bounded with enough white to a form a visual frame. The global navigation buttons are clearly defined at the bottom of the screen, with the look and feel tied into the color and graphic elements at the top of the screen. All of the screen elements are visually integrated by using a common color palette based on an accent color.

The look is appealing. The design incorporates several key elements from the test booklets and reinterprets them for a light, airy feeling. Portions of the Tree of Learning graphic, which appears on the cover of the test booklets, are used as design accents that provide a natural, open and appealing look. Each grade level has a different color accent that is also based on the cover of the associated test booklet. These colors are slightly modified for screen display and a rich gradient is applied to give a beautiful and inviting tone to the tests.

The look is kid friendly. The buttons look like they would be fun to click. They have a soft, active feel to them and are pleasing shapes and sizes that tie in with the rest of the graphic design. Shadows and highlights on the buttons provide a 3D look that signals that they are clickable. Text on buttons is kid friendly in size and content. Buttons provide visual feedback when they are clicked. Additionally, using a tree graphic (from Tree of Learning) as a visual accent links in a part of nature that is generally familiar and comforting to kids.

The look maintains the integrity of the test booklets. The new screen version design is based on the test booklets in numerous ways. The questions and answers are taken directly from the test booklets, as are the sample questions and the instructions. No additional graphics are added. Graphics that are to be measured or assessed in some way, especially in the mathematics sections, are included in their entirety, and maintain the appropriate size relationship for the question. The serif and sans-serif font distinctions that are set up in the booklets are maintained.

3.3 Screen Layout

For the Style Guide, we will review the Question/Answer Screens and the sample screens. The same style will be implemented with the remaining screens. Also covered are the basics for screens that include a ruler, the summary screen, and the stop screens. Note: details of drop shadows, fonts, etc. refer to parameters set in Photoshop 5.5. These Photoshop files are available with the Design Document, in addition, printed versions of the most important screen shots are included with the addenda of the hard copy.

All screens are 640 x 480 pixels in size. Browser context does not appear on the screen. Instead, there is a full screen interface without browser back/forward buttons. There are no animations or sounds. Harcourt Educational Measurement will appear on every screen. The header shows which test is currently being taken. There are no full color graphics available from the test booklets (other than the Tree of Learning), so duotone images are modified to the appropriate color accent.

3.3.1 Global elements used throughout the testing portion

The top title bar contains no elements that are clickable.

3.3.1.1 The Harcourt Educational Measurement name and logo

The logo is supplied by HEM. (It is scaled to approximately 16 pt font Advert Bold.) It is indented 13 pixels from the left. Drop shadow : mode multiply, color black, opacity 40%, angle 140, distance 1, blur 3.

3.3.1.2 The grade level and subtest name
Font: Advert Bold 10 point, tracking 20, anti-alias crisp, color = 666666.

3.3.1.3 A reworked portion of the Tree of Learning graphic
The artwork is a separate layer within each Photoshop screen file.

3.3.1.4 A gradient background specified color for each grade
The gradient is 42 pixels in height. There is an additional single pixel line of color 999999 dividing it from the white portion of the screen. For gradient color information, see the Screen Color Specifications section below.

Bottom navigation bar contains all the navigation buttons. These buttons are designed to have a soft 3D effect that looks inviting to click and "kid friendly". They are a darker version of the basic color being used for each particular grade. The drop shadows for all of the buttons in the navigation bar are: mode multiply, color black, opacity 75%, angle 140, distance 3, blur 4. All of the buttons and features below are centered horizontally within the bottom gradient bar.

3.3.1.5 Stop button
The art is a 39 x 39 pixel circle that is indented 48 pixels from the left border. The font is Lucida Sans Bold, 11 point, tracking 20, anti-alias crisp, color white. Drop shadow for text: mode normal, color black, opacity 50%, angle 140, distance 0, blur = 1.

3.3.1.6 Sample Question button
The Sample Question button is shaped like a leaf and visually connects with the Tree of Learning graphic in the upper right corner. The art is 99w x 41h pixels and is indented 105 pixels from the left border. The font is Lucida Sans Bold, 11 point, tracking 20, anti-alias crisp, color White. Drop shadow for text: mode normal, color 33FF00, opacity 50%, angle 140, distance 1, blur 1.

3.3.1.7 Test Review button
Like the Sample Question button, this button is shaped like a leaf. The art is 99w x 41h pixels and is indented 221 pixels from the left border. The font is Lucida Sans Bold, 11 point, tracking 20, anti-alias crisp, color White. Drop shadow for text: mode normal, color 33FF00, opacity 50%, angle 140, distance 1, blur 1.

3.3.1.8 Progress Window
The window contains a progress bar that indicates how many questions have been answered and also shows the total number of questions. The green color of the progress bar (33CC33) blends with the green color (00CC33) of the pressed selection button for multiple choice questions. The art is 101w x 32h pixels and is indented 333 pixels from the left border. The font is Advert Regular, 9 point, tracking 0, anti-alias Crisp, color black.

3.3.1.9 Go Back button

The art is 65w x 35h pixels and is indented 449 pixels from the left border. The font is Lucida Sans Bold, 10 point, tracking 20, anti-alias crisp, color white. Drop shadow for text: mode normal, color 33FF00, opacity 50%, angle 140, distance 1, blur 1.

3.3.1.10 Go On button

The art is 65w x 35h pixels and is indented 525 pixels from the left border. The font is Lucida Sans Bold, 10 point, tracking 20, anti-alias crisp, color white. Drop shadow for text: mode normal, color 33FF00, opacity 50%, angle 140, distance 1, blur 1.

3.3.1.11 A gradient background with specified color for each grade

The gradient is 48 pixels in height. There is an additional two pixel line dividing it from the white portion of the screen. The top pixel is color CCCCCC, and bottom pixel is 999999. For gradient color information, see the Screen Color Specifications section below.

3.3.2 The Question/Answer Screens

The Question/Answer Screens include the top and bottom bars described above and the middle section, where the questions and answers are.

The middle section may be a single centered column, or it may be a double column, as used by the Reading Comprehension subtest. In that case, the reading passage is on the left hand side, with a scroll bar if the passage is long. The right side contains the question and answer. Other examples where a double column is needed are the Mathematics Concepts and Problem Solving where a short reading passage and graphic are needed for more than one question. These parts are located on the left side of the screen.

Generally, the question/answer box should be centered on the screen and have a white border of no less than 30 to 50 pixels around all four sides. Any graphics that directly relate to the passage (i.e. graphs, tables, etc.) will be preserved with the passage.

For math related questions and answers, the minus sign is positioned higher than the negative sign. Fractions are vertically stacked. Special fonts (like Mathematical Pi 4) are used for computational questions. Graphs, etc. are preserved exactly.

The question/answer section contains the following parts:

3.3.2.1 The question

The text for the question may be art, or it may be rendered. Further tests during implementation will determine which. The font used in the test booklets is Sb 1Stone Serif Semibold 11 pt, plain. If the text stays art, this font could be used, or another serif font such as New Century Schoolbook Bold 12 pt, anti-alias crisp, leading 12. The latter font is a heavier font and it separates the question from the answer a little better.

3.3.2.2 Multiple choice answers

As with the question, this text may be art or it may be rendered. The font used in the test booklets is 1 Stone Serif 11 pt, plain. Another good option is New Century Schoolbook Regular 12 pt, anti-alias crisp, tracking 20, leading 12, if New Century Schoolbook Bold is used for the question.

3.3.2.3 Letters A,B,C,D for the multiple choice answers

These letters are a little larger than the ones used by El grade levels booklets, and a little smaller than the ones used by the other grade levels. The focus needs to be on the selection buttons rather than the letter, but the letter needs to be clearly readable. The font used is Folio Bold 9 pt, anti-alias crisp.

3.3.2.4 Selection buttons for each possible answer

The Selection buttons are 16w x 12h pixels. This shape is reminiscent of the portion of the answer sheet the students are used to filling in with a pencil. Unselected buttons have a gray center, and the selected button has a green center. The drop shadow on the unselected buttons: mode multiply, color black, opacity 50%, angle 140, distance 3, blur 4. The drop shadow on the selected button: mode multiply, color black, opacity 100%, angle 140, distance 1, blur 1. The selected button looks depressed into the screen.

3.3.2.5 The Bookmark button

The Bookmark button is a leaf-shaped design, corresponding to some of the navigation buttons, and also to the Tree of Learning graphic at the top. It is 62w x25h pixels. It is positioned at the top of the question, close to the question number and to the right side of the question, where the question box will be "folded" in the corner to indicate when the question is bookmarked. The circle behind the question number will be filled with yellow (or a more readable color for when the color palette is golden-orange, as for grade I3) for bookmarked questions. The font is Advert Bold, 9 point, tracking 40, anti-alias crisp, color white. Another layer of the text is added in Photoshop with the opacity set at 50%. This gives the small text a little more punch without blurring.

3.3.2.6 The Erase Answer button

The Erase button is also leaf-shaped and 62w x 25h pixels, as the Bookmark button above. It is positioned at the bottom of the question box, close to the Selection buttons, where it functions to erase any selected answer. The font is Advert Bold, 9 point, tracking 40, anti-alias crisp, color white. Another layer of the text is added in Photoshop with the opacity set at 50%.

3.3.2.7 The question number in a circle

The inside of the circle containing the question number is white, unless the question is bookmarked, when it is yellow FFFF00. The outside of the circle repeats the three color bands used around the question box that are based on the color accent for the current grade. The entire circle is 38 pixels in diameter, while the inside white or yellow part is 32 pixels in diameter. The font is Myriad MM Regular 705 WT 700WD, 20 point, anti-alias crisp, color black. Drop shadow for text: mode multiply, color black, opacity 75%, angle 140, cistance 1, blur 1.

3.3.2.8 All the above within a question box

The question box is a rectangle holding all of the question and answer components described above. It has a border of 3 pixels that uses the color accent for the current test. It also has a drop shadow to set it off from the rest of the page. This is "where the action is", so it needs to stand out. Currently, the question box and drop shadow are art, and are not rendered. The question box has the top right corner "turned down" for bookmarked questions.

3.3.2.9 Note for double column Question/Answer Screens

For double column screens, both the left and right margins should be set in about 50 pixels from the borders to align with the navigation buttons below, and to give the screen "breathing" room. If possible the left and right columns should have no less than 50 pixels in between them. If possible, try to keep the top and bottom margins no smaller than 30 to 50 pixels.

3.3.2.10 Reading passage

If there is a reading passage, it will be in the left column, and have a scrolling bar if it is long. The font for the title of the reading passage is Verdana Bold 14pt, tracking 30, no anti-aliasing. The font for the passage itself is Verdana Bold 10 pt, tracking 30, no anti-aliasing.

3.3.3 The Sample Screens

The Sample screens include the top and bottom bars described above plus the middle section, where the Sample question/answers are. This middle portion is double column, and should be centered on the screen and have a border of approximately 50 pixels on the left and right side.

The sample screens are like the Question/Answer Screens and the Global Elements described above with the following exceptions:

3.3.3.1 The bottom navigation bar

The bottom navigation bar is mostly faded out to indicate that it is not active with these exceptions. For Sample A questions, the "Go On" button remains active; for Sample B questions, the "Go Back" button remains active.

3.3.3.2 The background color

The background for the Question/answer section is a web-safe color that is light and subdued and blends well with the accent color for the current grade level. This change of background color is a quick identifier that this is a sample question, not a real one. The background of the question box and the area behind the instructions and any reading passage is white.

3.3.3.3 The instructions

The font for the "What to Do" title is Futura BT Bold 18 point, anti-alias crisp. The instructions are Futura BT Bold 12 pt, anti-alias crisp.

3.3.3.4 Sample lozenge divider

The art is 112 w x 28 h pixels. The sample text is Futura BT Bold, 18 pt, tracking 20, anti-aliasing crisp.

3.3.3.5 Reading passage

If there is a long reading passage, it will have a scroll bar. The font for the title of the reading passage is Verdana Bold, 14 pt, tracking 30, no anti-aliasing. The font for the passage itself is Verdana Bold, 10 pt, tracking 30, no anti-aliasing. There should be an indicator at the end of the reading passage to signify that it is complete. The indicator should be created using text characters, for example, a double horizontal line created with the underscore character.

3.3.3.6 Sample A / Sample B identifier

Instead of having a circle with the number in it, the sample question is identified with a gray lozenge shape and text for Sample A or Sample B. The sample text is Futura BT Bold, 18 pt, tracking 20, anti-aliasing crisp.

3.3.3.7 Instructions to get to Sample B
Instructions to click "Go On" button are in font Lucida Sans Bold, 10 pt, anti-aliasing crisp.

3.3.3.8 Return to Test button
The Return to Test button is shaped like a leaf and is the same size as the Sample Question button in the navigation bar. This button appears on the Sample B screen, and also on the Sample A screen when the user has arrived there by clicking the Sample Question button. The art is 99w x 41h pixels and is centered under the question box. The font is Lucida Sans Bold, 11 point, tracking 20, anti-alias crisp, color white. Drop shadow for text: mode normal, color 33FF00, opacity 50%, angle 140, distance 1, blur 1.

3.3.4 Screens with a Ruler

Some of the questions for the mathematics subtests require the student to use an onscreen positional ruler to measure onscreen items. The section below covers the look and feel of the ruler and its related parts. The rest of the screen is the same as described in Global Elements and Question/Answer Screens above.

3.3.4.1 The ruler
There are two different rulers: one for Elementary 1 and one for the remaining grades. The ruler in our examples is scanned; but to achieve better clarity, the image should be based on the digital files that HEM has. The size of the ruler must be relative to the size of the graphics that are being measured. These graphics should not be changed in size from the originals used in the booklets. The background color of the ruler should be subdued; in our examples, we used color FFFF99. This distinguishes it from the white background and still allows for the text on it to be easily readable.

3.3.4.2 The cursors
When the cursor is over the center section of the ruler, the arrow cursor turns into a hand cursor with all the fingers extended, indicating that the ruler can be moved by clicking and dragging. When the cursor is over the end sections, the cursor turns to a rotation type icon, indicating the ruler can be rotated by clicking and dragging. These icons should be about twice the size of the standard arrow cursor.

3.3.5 Summary Screen

The Summary Screen will have the same Global Elements described above. However, all but the Stop and Sample Question button will be faded out on the bottom navigation bar.

3.3.5.1 Summary title

The font is Lucida Sans Bold, 16 pt, anti-aliasing crisp. It is centered in the 55 pixel high white space above the triple column chart containing the summary.

3.3.5.2 Three column summary chart

There is a maximum of 52 questions, so the first and second column list 18 questions each, and the last column lists a maximum of 16 questions. Each question number is clickable and will take the student directly to that question. Special attention needs to be paid to indicate that the number is clickable. Maybe it is a button, maybe it is a larger font that stands out. The current example shows "answered", "not answered", and has a star indicating which questions have been bookmarked. During the implementation phase, we suggest redesigning this a bit to make it less wordy. Maybe just show the letter A,B,C, or D indicating questions that have been answered. Maybe leaving the unanswered questions blank and having that question number stand out by use of color, etc. Instead of using a star to indicate the bookmarked questions, we suggest using a yellow circle, which also coincides with the yellow circle that appears behind a question number when a question is bookmarked.

3.3.5.3 Yellow circle

Under the chart, there is a note showing a yellow circle (in the example it is a star) followed by: " = Question marked for review". The wording should be changed to "Question bookmarked for review", to be consistent with the Bookmark button. The font is Verdana Regular, 10 pt, tracking 20, no anti-aliasing.

3.3.5.4 Return to Test button

This is the same button described above in the Sample Screens section.

3.3.6 Stop Screens

The two Stop screens have the same top menu bar as described in the global elements above. The bottom navigation bar has been eliminated. The two Stop screens differ only in that the first one is reached by the student clicking "Go On" at the last question. This screen has an extra line below the Stop sign that says, "You've reached the end of the test." The font is Lucida Sans Bold, 12 pt, anti-aliasing crisp. Otherwise, both screens have the following items in common.

3.3.6.1 Stop sign

The art work for the stop sign should be authentic looking (not like our quick mockup) with the sign being red and an even-sided octagon. The font for the Stop text is Frutiger Bold, 52 pt, tracking 20, anti-aliasing strong.

3.3.6.2 Test Review button
This is the same button described in the Global Elements above.

3.3.6.3 Return to Test button
This is the same button described in the Samples Screens above.

3.3.6.4 Finish button
This button should look identical to the other two buttons but with the text Finish on it.

3.3.6.5 Pop-up screen
When the Finish button is clicked, a pop-up screen asks "Are you really finished?" with a Yes button and No button. The style should fit in with the rest of the screen. The size of the box in the example is 317 w x 165 h pixels. This allows part of the Stop sign to show above it, and part of the other screen buttons to show below it, and thereby keeps the student oriented on the screen.

3.4 Screen Color Specification

There is a primary accent color used throughout the screen design that is different for each grade level. That color is taken from the color of the cover of the associated test booklet. The colors are the following C,M,Y,K specifications for the printed booklets:

Elementary 1 - 31C / 94 Y
Elementary 2 - 65 M / 80 Y
Intermediate 1 - 70 C / 30 Y
Intermediate 2 - 20 C / 80 M
Intermediate 3 - 38 M / 76 Y
Intermediate 4 - 35 C / 45 M

These colors are modified for screen display. First they are converted to RGB format, and then to web safe colors. Because there are only 216 such web safe colors, some of the matches were not that close. For the 3 examples we developed (Elementary 1, Elementary 2, and Elementary 3, it was necessary to first build a hybrid color based on 2 web safe colors that approximated the CMYK color. For example, the lime green color for Elementary 1 was composed of alternating pixels of CCFF33 and 99CC33. These hybrid colors provide a slightly richer texture and tone than a single web safe color would.

Because these basic colors are a bit too overwhelming in a large area, a gradient effect is applied to give them a light, airy feeling for the top and bottom bars. The gradient generally does not go all the way to white, but rather to a light yellow, and is about 50% transparent. The idea is to develop a rich and interesting color that is still light and not distracting, but sets an inviting tone for the coloration of the rest of the screen.

The color of the buttons is a darker tone of the basic color, with the highlights picking up some of the lightest tones. The green buttons were made using Kai's Power Tools 5 ShapeShifter filter. However, the blue and copper buttons were created by adjusting the hue / saturation, and color balancing in Photoshop of the green buttons.

The duotone graphics within the question/answer section of the screen are also adjusted to the designation accent color. Generally, the dominant tone is a little darker, similar to the buttons. Other graphic elements, such as the border around the question box, are also the same accent color.

3.5 Palette Specifications

Each grade level will have a separate palette of 256 colors that is based on the dominant accent color described above. The actual palette determination is beyond the scope of this document, and will be developed in the implementation phase.

3.6 Fonts

All the grades use the same font sizes and there is no requirement for specific fonts on the students' machines. Most of the font specifics are covered above in the Screen Layout section.

Generally, the fonts were selected for easy readability on the screen. When it comes to smaller screen text, the field of appropriate font candidates narrows. Often a font that works well for medium size text can be nearly unreadable on screen for small size text. Also, fonts were selected that reflect the spirit of the fonts used in the test booklets, and yet are more readable on screen than the original booklet fonts would be. The actual questions and answers are serif fonts, while the reading passages and instructions are sans-serif fonts. For the reading passages, such as in the Reading Comprehension subtests, and some of the Samples, Verdana was selected. It is a font fairly commonly used by both Macs and PCs online and good for free flowing text that is scrollable. It takes the design a step closer to an eventual web-based system, where the font specification would probably be a choice of whatever is present of Verdana, Ariel, Helvetica, and San-Serif, with Verdana generally being the easiest to read of the group. The text for the buttons will all be art and the fonts were specified above in the Screen Layout section.

3.7 Cursor Design

There are 3 different cursor designs. One is a basic arrow design. The other two were covered above in the Screens with a Ruler section. These two are a hand with fingers extended and an icon that infers rotation. Details of these cursors will be covered during implementation. Generally, they are kid friendly and of a style consistent with the rest of the design.

3.8 Risks / Concerns

The mockups screens were created using 16 bit color and thereby allowed for smooth color transitions. When each grade level is reduced to a palette of 256 colors, there may be unsightly banding in the gradient areas and on the buttons. Careful palette preparation may get around this. Since each test is primarily focused on just one color, it may be possible to get a workable palette of 256 colors. Otherwise some of the screen areas may need to be altered.

Preliminary prototyping was done in Director to assess the proper building and production process of the screens. When further testing is done, we may learn some parts of the screens may be difficult to build and have them look right, and therefore, adjustments will have to be made.

HUMAN CODE

4. Art Production Process for the Assessment Module

4.1 Converting Test Workbooks into Computer Based Format

The objective of the art production process for the assessment module of the MAT8 project is to define a clear path of art and text extraction followed by processing with delivery via server to the software engineers. Working with these MAT8 files of different formats, along with the new files being created, requires four software packages: Adobe Illustrator, Adobe PhotoShop, Microsoft Word and Quark Xpress.

The MAT8 print archive CD-ROMs contain two types of files: the Quark Xpress Document (.QXD) and the Encapsulated PostScript (.EPS) vector format.

The copy will be obtained from the Quark files while the graphics, charts, and graphs will come from the EPS. Rich Text Format (.RTF), EPS, and Graphic Interchange Format (.GIF) files will be created during the process.

4.2 Process

Using the existing MAT8 print files, the extraction, process and output for each question screen in the MAT8 interactive assessment has been interpreted as these steps:

4.2.1 Extracting the Text

- Open Word and create a new document.
- Open QXD file in Quark Xpress, select text using Text Selection tool and then copy by hitting ctrl-C, taking note of formatting.
- Alt-Tab to Word and then paste by hitting ctrl-V. Select all text and set font and size.
- Select areas for special formatting, usually title sentences, and set bold, underlined, etc.
- Save document as Rich Text Format .RTF with appropriate naming convention.

4.2.2 Extracting the Graphics

- Open PhotoShop. Open the design template file.
- Open Illustrator and open the EPS file containing the graphic. Press ctrl-A to select all.
- Press ctrl-shift-G to ungroup. Press ctrl-shift-A to deselect.
- After selecting the appropriate graphic, pressing ctrl-C then ctrl-N followed by ctrl-V will copy the art, create a new illustrator file, then paste the art into it.
- This file will be saved as an Illustrator EPS. After saving, ctrl-A, ctrl-C, and then ctrl-W.

4.2.3 Creating GIF's

- Alt-Tab to PhotoShop and hit ctrl-V. The art is pasted as anti-aliased pixels onto a new layer in the template.
- Position the graphic using the template. Set the white layer to visible.
- Press alt-I and then the letter D. This duplicates the template file. The layers are flattened to make an 640x480 image, the graphic is against an R253, G253, B253 background.
- This file is then saved as a paletted GIF using a palette appropriate for the grade.

Custom palettes will be created for each grade level using standard windows rules regarding first and last 10 colors. Off white and off black are used for palette index 10 and 245. Special attention is given to maintaining duotone art's quality during palette construction.

4.2.4 Encryption

Finally, a proprietary encryption engine created to maintain security involving graphic files will process all images. This encryption will be reversed at run time.

4.2.5 Naming Convention

All files created during this process will utilize the existing naming convention established and documented by MAT8. We don't believe we will require any additional digits (other than _1, _2, etc. for multiple graphics) due to the fact that the file extension does the work for us. ZEE2P5 folder could contain a *.cfg, *.gif, *.rtf, and *.eps file.

4.3 Art Production Point Specifics

4.3.1 Files

4.3.1.1 The use of RTF

The copy that is contained within the RTF maintains formatting when imported via code into Director for presentation. The look of the copy is maintained and controllable. This allows for localization, font and size changes, along with a manageable archive of separate assets.

4.3.1.2 Saving new EPS files

Saving new EPS files allows fixes or scaling to be done easily, without pixelization. The naming convention will make it easier to find a specific graphic file. Our local database will contain everything needed for localization and asset archive.

4.3.1.3 Design template files

This is a PhotoShop file containing a flattened user interface design with guides set up to establish the column structure. It forces the processor to match the graphic to the design, registering its location appropriate to the interface. It also allows multiple processors to work using a fixed method.

4.3.2 Registration

4.3.2.1 Flattened against white

It is important that the images are flattened against white because the image is imported into Director and is given a registration point. The fact that the image is always 640x480 means that every piece of art has the exact same location of registration. The white background color is easily made transparent within Director allowing the images to be layered.

4.3.3 Screen Assets

4.3.3.1 Global graphics

New art for the question number graphic will be created. These spheres, ellipses, diamonds and such will then be processed with a number added to the graphic and then the file saved as per the naming convention. This will create an archive of various graphic elements that are numbered in sequence.

4.3.3.2 Math problems

The solution to the math equation copy lies in treating it as if it were a graphic. This allows the font look to be retained, yet it can be scaled for better visualization. An example would be to use the left column to display an enlarged graphic of the math equation while allowing the right column to display the list of answers to choose from. Alternatively, the original layout of the equation fitting within the question frame is easily replicated with this process. If answers are equations, they will also be treated as graphics and processed similarly.

4.3.3.3 Answers

The question and answers are typed into a basic text .CFG file that allows Director to display the copy in the appropriate location dynamically. This allows for better control of content. There will be artwork created to represent buttons in normal, highlight, and depressed states. These graphics will be self-registered against white, the Director code will place them onscreen.

4.3.3.4 Translating into screen format

It would be most efficient to have a series of grid templates to allow the processor and programmer to judge where graphics and artwork should lie. Within the CFG file a template will be referenced by name along with all of the elements in that question. These templates would allow the configuration file to correctly lay out the graphics in a predictable manner - the images will observe the template's rules. Using a set of templates to exemplify the choices available for positioning sets a standard that solidifies the process. These templates will be created during full production. The greatest advantage is that the processor is doing everything in one fluid path.

4.3.4 Path Breakdown

QXD – to – CFG – called and displayed by Director = Question & Answer Copy Data
QXD – to – RTF – called by CFG – displayed by Director = Extra Copy Data
EPS – to – EPS – to – PSD – to – GIF – displayed by Director = Question Artwork

5. Design Phase User Testing

The impetus for performing the user test during the Design Phase was to validate design decisions about screen layout, user interface, and navigational language, and to verify that general usability principals are being met. Overall the tests were very successful. We found the user interface to be easy to navigate and understand. Areas of concern were identified and will be addressed through refinement and additional testing on a working prototype in the Implementation Phase. See the following documents for additional detail.

5.1.1 Addendum A: Test Plan

The Test Plan is the "blueprint" for the user testing process. Written prior to testing, it documents the purpose and goals of the test along with the issues we sought to investigate and the methodology we intended to use. It includes characteristics of the test participants as the y map to the user profile, evaluation measures, and the role of the test monitors.

5.1.2 Addendum B: Participant Guidelines

The Participant Guidelines document details those characteristics and qualities we sought in the children taking part in the tests. It was used as a hand-out to the school administrators to assist them in choosing appropriate test participants.

5.1.3 Addendum C: Background Questionnaire

The Background Questionnaire was used to record specific information about each participant and to ensure that they matched the user profile appropriately.

5.1.4 Addendum D: Orientation Script

The Orientation Script was used by the test monitors to ensure that each child was given the same introduction to the testing process and that information was presented in a uniform manner.

5.1.5 Addendum E: Task Process

The Task Process document provided step-by-step detail of the proceedings of a test. Used during the actual testing process, it includes a list of materials needed, test questions and procedures including correct answers, hints for the monitor, and what to do if something goes wrong. The Task Process also doubled as a data collection log for portions of the test.

HUMAN CODE

5.1.6 Addendum F: Data Collection Log

The Data Collection Log is used to record performance measures. As it is filled out by hand, a blank one is attached as an example. Originals used in the test can be found with test documentation in the project files.

5.1.7 Addendum G: Results Summary

The Results Summary document is a synopsis of the data gathered on the Data Collection Log during the test process. It allows an across-the-board look at how each participant responded to each step of the test process.

5.1.8 Addendum H: Findings and Recommendations

The Finding and Recommendations document summarizes the results of each problem statement and proposed changes or suggestions for further investigation for items at issue.

5.1.9 Addendum I: Screens Used in Test Process

The screens shown here were used as a basis for discovery. They have been accordingly updated and improved upon.

5.2 Implementation Phase Testing

As noted in the Findings and Recommendations document, there are additional items that need to be user-tested to resolve outstanding issues. We recommend that the scenario for the user test consist of participants actually partaking in an interactive assessment. The scenario should mimic a "real" assessment situation as closely as possible. This would consist of the navigation tutorial, a series of questions at a challenging level, and the final screens. Participants would receive no help during the test unless they are clearly unable to proceed without intervention. User tests should be conducted on the full age spectrum of the user profile.

In addition to the items noted for further testing in the Findings and Recommendations document, the following items/issues should be tested on a prototype during the implementation phase:

- Is there sufficient feedback when a question is answered or do users need more feedback/reinforcement?
- Are users able to navigation between multiple sample questions? Are they able to move between sample questions and regular test questions without confusion?
- In questions containing graphics, such as a graph, is it obvious to users that the graph itself is non-interactive?
- Are the answer-select buttons sufficiently large to not cause users additional stress?
- Does the ruler obscure other parts of the screen, such as the answers, in a way that hinders the student?
- As the test progresses, are there navigational elements that the students need to consistently think about to remember how to use? (For instance, it may take a bit longer to remember how the test summary or bookmark works the first time, but these elements should get more familiar as the test progresses.)
- Do users scroll reading passages if there is additional text not shown on the screen?
- Do students use the bookmark feature appropriately as a test-taking technique?
- Do the graphics enhance or detract from the experience of taking the test?

Along with a scenario test, the specific functionality of the following should be tested:

- General usability of the ruler: is it obvious how to drag/rotate and switch between inches and centimeters?
- Ruler rotation point: which is the most intuitive location, in the center, on one of the corners, or along one of the sides?
- Do the students understand how the progress bar changes as the test progresses? Can they accurately tell what it represents?
- Do the students notice and understand the meaning of each cursor change (drag ruler, rotate ruler, etc.)?

The Navigation Tutorial has the following items that should be tested:

- Is the tutorial an appropriate length?
- It the amount of information conveyed too little, OK, or not enough?
- Test on the youngest and the oldest students in the target audience to determine if it is appropriate for the entire audience range.
- Should the teacher read along?
- Does the tutorial cause undue stress or anxiety because it contains questions even though it is not part of the actual test?
- Do we need to take additional measures to prevent the student from starting the test without the teacher's permission? (Note: this design document provides ideas regarding how this could be implemented.)

6. Navigation Tutorial Functional Design

The navigation tutorial will ensure that students taking the MAT8 interactive assessment are familiar with, and capable of executing the concepts introduced in the interface. The tutorial will consist of several areas of desired competence and their associated tasks.

6.1 Tutorial Context

The students will not be able to access the assessment until they have successfully completed all tasks presented in the navigation tutorial. The order of events for the complete assessment is as follows:
- Students log in with password to gain access to the test.
- Students are presented with a selection screen and asked to choose a subtest.
- Students are presented with a verification screen that the test proctor will read aloud to confirm that they have selected the correct test.
- Students are presented with the navigation tutorial.
- Students are hold on a screen until the teacher allows them to proceed.
- Students are presented with a sample question screen. The teacher reads the instructions aloud and the student then continues with the assessment.

6.2 Tutorial Process

Concepts will be conveyed through instruction and then tasks will be presented to verify the student's comprehension. Students will not be able to progress beyond a certain screen/concept without successfully completing each associated task. The tutorial will allow three attempts to complete each task correctly before the student is asked to get help from the test proctor. Only one concept is presented on a single screen.

6.3 Desired Competence

6.3.1 Use Interface Buttons

- How to Exit
- How to use the Sample Question
- How to Bookmark for Review
- Toggling the Bookmark
- How to use Test Review Screen
- Using Go On/Go Back

6.3.2 Use Question Elements

- Selecting an answer
- Changing an answer
- Erasing an answer
- Feedback regarding correct answers is not provided
- Dragging the ruler
- Rotating the ruler
- Reading Comprehension questions: using the scroll bar

6.3.3 Understand and Use the Test Review Screen

- Definitions
- Proceeding to a question

6.4 Structure of the Tutorial

The navigation tutorial is essentially the same for all three subtests (Reading Comprehension, Math Concepts, and Math Problem Solving). There will be several variable screens that may or may not be used depending on which subtest is being accessed. The tutorial will be identical for each subtest except for question screens that are specific to its associated subtest. That is, they will contain identical instruction for all of the global concepts, but the specific concepts will be "swapped out" depending on the subtest. This will allow the student to focus only on concepts that are relevant to the test they are about to take. For example, students taking the Reading Comprehension subtest need not be taught how to use the ruler, but they need to understand the scroll bar on the reading passage.

6.5 Interface Specification

The following documents detail specific features of the interface:

6.5.1 Addendum J: Screen Specification

The Screen Specification document details:

- Screen Functionality
- User Interface Requirements
- Programming Requirements
- Successful outcomes

6.5.2 Addendum K: User Flow

The User Flow document shows the course of the user path, in relation to the Error Message/Correct Answer process.

6.6 Implementation

As with the Interactive Assessment, the Navigation Tutorial will be implemented in Director, and will be part of the same executable file as the assessment.

6.7 User Testing

The Navigation Tutorial should be fully tested for usability during the Implementation Phase. Specific elements to be tested are listed in the User Testing section of this document. Care should also be taken that any design or functional changes made to the Assessment due to user testing or design revision should be reflected in the Navigation Tutorial.

7. Assessment Module Functional Design

The MAT8 assessment component is a Director executable that runs from a CD-ROM. There is no installer. The executable has three main modules: the login sequence, the assessment section and the test review section. The login sequence prompts the student for a name and password, allows them to select and verify a subtest, and presents them with the navigation tutorial. At the start of the sequence, login information is sent to the server for validation and, if acceptable, is responded to with a confirmation message. The assessment section is the primary experience and is composed of a number of multiple choice question screens that replicate the order of the questions in the printed MAT8 test booklet. During the test, on the test review screen, the stored data is displayed in the form of a table containing information about each question, such as whether it's been answered. At the conclusion of the test, the student's responses are sent to the database server.

Communication with the server is accomplished via Director's http postNetText command.

7.1 Interface Design and Functional Specifications

The focus of the user interface design is to provide the students with a comfortable way to enter the tests, to navigate within the tests, to answer questions, to bookmark questions, to request test review information, and to complete a test. Special care was taken so that the interface would not distract the students from the testing process. The user interface specifications for test presentation within the MAT8 interactive assessment system are listed below in general to specific order, with the flow related to what the students will encounter chronologically when they sit down to take the tests.

7.1.1 General Functionality of the Assessment

- There is sequential navigation (forward and back) between items.
- The navigation is the same throughout all grade levels.
- Students are able to change their answers until they are finished with the entire test.
- Only one answer per question is allowed at any time.
- Students can skip questions and are able to submit their responses without filling in all the answers.
- Students can mark an item for review.
- A test review is available to tell the students which questions they have answered, which questions they haven't answered, and which questions they have marked.
- Students can "hot-navigate" directly from the test review to whatever question they choose.

- Students will have access to the test review at any time during the test, as well as at the end of the test, before they submit responses to the server.
- The test review is available on each test question screen and final screen by clicking on a Test Review button.
- Unless specified otherwise, the interface specifications that follow refer to all subtests created for this project, including Reading Comprehension, Math Computation, and Math Problem Solving.

7.1.2 Global Navigation Elements in the Assessment

At the bottom of the assessment screens is the navigation bar, which contains all the global navigation buttons and allows the student full access to the entire subtest. On certain screens, some portions of the navigation bar are not relevant and are not active. Such cases are noted below. The navigation bar is not available on the Stop Screens. Note: if a button is designated as inactive, the art work is faded in appearance to indicate that it is not active.

The Go On button and the Go Back buttons are used for <u>sequential</u> navigation within the Question/Answer Screens, and within the Sample Screens. If a student clicks the Go On button while on the last question of a subtest, that is considered a sequential navigation to the Stop 1 Screen, and that is where the student is taken. The Go On button and Go Back button used in the Sample Screens can navigate only between the Sample A and Sample B screen. More information is provided below.

7.1.2.1 Go Back button
The function of this button varies:

- If the student is on a Question/Answer Screen, then the Go Back button takes the student to the previous question. If the student is on question 1, the Go Back button is inactive.
- If the student is on the Review Test Screen, the Go Back button is inactive.
- If the student is on the Sample A Screen, the Go Back button is inactive.
- If the student is on the Sample B Screen, the Go Back button takes the student to the Sample A screen.

7.1.2.2 Go On button

The function of this button varies:

- If the student is on a Question/Answer Screen, then the Go On button takes the student to the next question. If the student is on last question, then the Go On button takes the student to the Stop 1 Screen.
- If the student is on the Test Review Screen, the Go On button is inactive.
- If the student is on the Sample A Screen, the Go On button takes the student to the Sample B screen.
- If the student is on the Sample B Screen, the Go On button is inactive.

7.1.3 Assessment Module Screens

Following is a functional description of every screen that appears in the assessment modules, including:

- Login
- Test Selection
- Test Verification
- Sample Questions
- Question/Answer
- Test Review
- Stop 1
- Stop 2
- Congratulations

7.1.3.1 Login Screen

The login screen allows the student to gain access to the assessment by typing in their ID and password. This information is sent to the database for password authentication.

If the password is correct:

The database returns confirmation that the password is correct, and sends information regarding which subtests are available to the student, based on whether they have taken them before, the state of override flags, etc. The assessment advances to the test selection screen.

If the password is incorrect:

A message window appears asking the student to raise their hand and ask the teacher for help. It also specifies the nature of the error, to the extent possible, e.g., incorrect password, or trouble communicating with server, etc. When the test proctor comes over to help the student, they will need an error message that is as informative as possible. The message window has an "OK" button. When this button is clicked, the message window disappears and the student is able to re-attempt login.

7.1.3.2 Test Selection Screen

The test selection screen allows the student to select a subtest to take. A student only takes one subtest with each login, and each subtest can only be taken once. The screen displays a list of the subtests available to the student, as indicated by the database communication at the login screen. The subtests offered by this product are Reading Comprehension, Math Concepts, and Math Problem Solving. The test proctor tells the student which test they should choose. The student is able to click on the name of a subtest (and/or its associated button) to select it and advance to the test verification screen for that subtest.

7.1.3.3 Test Verification Screen

The test verification screen allows the student to confirm they have selected the correct test, as instructed by the test proctor. There is one verification screen per subtest, each containing text that identifies the selected subtest. The test proctor will read the appropriate text aloud and ask the students if that is, in fact, what they are seeing on their screens. A unique symbol or icon may be helpful to ease the confirmation process.

The screen contains a "start test" button and text that instructs the student to "Please wait here until the teacher tells you what to do next." To prevent students from going forward without the permission of the teacher, the button should be as inconspicuous as possible. This will need to be user tested, but possible solutions are:

• Upon clicking the button the student sees a confirmation dialogue box asking, "Did your teacher give you permission to start the test? Yes/No"
• Create a rollover effect on the button that confirms the teacher gave permission to begin the test.
• Hide the button until the proctor tells them to move the mouse to the lower right corner, at which time it will appear
• Hide the button for 10 seconds (long enough for students to read the message and look away from the monitor), and gradually fade the button onto the screen.

Note that a similar method will be used to prevent the students from advancing beyond the navigation tutorial without confirmation from the proctor. The same method should be used in both instances.

7.1.3.4 Sample Question Screens

General notes:

- Sample questions for each subtest will be the same as the current sample questions found at the start of each subtest in the printed booklet.
- Students will be able to return to the test sample as it provides instructions.
- The instructions for taking the sample questions are included at the start of the subtest, and a proctor will talk the students through it.
- There will be no additional help functionality during the test.

The student arrives at the Samples Screens in the following ways:

- The student has just started a subtest, and the Sample A Screen appears.
- The student clicks the "Samples Question" button in the navigation bar.

The Sample Screens provide instruction to the student on how to take the tests and give an example question A and B, which are both already answered. The active buttons are:

- Go Back button

  - If the student is on the Sample A Screen, the Go Back button is inactive.
  - If the student is on the Sample B Screen, the Go Back button takes the student to the Sample A screen.

- Go On button

  - If the student is on the Sample A Screen, the Go On button takes the student to the Sample B screen.
  - If the student is on the Sample B Screen, the Go On button is inactive.

- Return to Test button

  This button appears on the Sample B Screen, and on the Sample A Screen any time except the first time the screen is visited, at the beginning of the subtest. The button takes the student back to the last question viewed.

Note: the Erase button appears on the screen, but it is inactive since its function is irrelevant.

7.1.3.5 Question/Answer Screens

Notes:

- The order of the questions will replicate the order found in the test booklets.
- There will be one test question per screen.
- Each question will have the question number displayed.
- For the Reading Comprehension subtest, the reading passage will be on the screen for each related question. (The passage remains constant as the questions change.) This is also true for some of the mathematical subtests that have reading passages/art that apply to more than one question.
- For the Mathematics Concepts and Problem Solving subtest, an onscreen ruler will be available for the questions requiring a ruler, and not available otherwise. The ruler is parked vertically on the right side of the screen for the necessary questions. The student moves the ruler across the screen by clicking and dragging the center of the ruler (where the cursor becomes a hand) to the desired location. The student orients the ruler to the proper angle by positioning the cursor over either end of the ruler (where the cursor becomes a rotation-type icon) and dragging it so it rotates to the desired angle. The rotation point will be determined through user testing.

The student arrives at a Question/Answer Screen in the following ways:

- The student has just started a subtest, and completed the Sample Screens; the Question/Answer Screens follow sequentially.
- The student clicks the Return to Test button on the Test Review Screen, the Stop Screens or the Sample Screens.
- The student clicks a specific question number on the Test Review Screen.

The navigation buttons at the bottom of the Question/Answer Screens are all active:

- Stop button

The Stop button takes the student to the Stop 2 Screen.

- Sample Question button

The Sample Question button takes the student to the Sample A screen.

- Test Review button

The Test Review button takes the student to the Test Review screen.

- Progress Indicator

The progress indicator appears as an "indented window" and contains a progress bar. This bar indicates how many questions have been answered and also shows the total number of questions. This is not a button and is not clickable.

- Go Back button

The Go Back button takes the student to the previous question. If the student is on question 1, s/he stays on question 1.

- Go On button

The Go On button takes the student to the next question. If the student is on last question, then the Go On button takes the student to the Stop 1 Screen.

There are three other kinds of active buttons on the Question/Answer Screens, that are not global or navigational in nature. Rather, they apply to the current question and are therefore located on or in the question box:

- The Answer Selection buttons

Each question has a choice of four possible answers, which are labeled A, B, C, and D. Beside each of these letters is an Answer Selection button. The student selects the answer that seems the most appropriate by clicking its related Answer Selection button. When a button is clicked, the gray center turns green, and the button appears depressed into the screen. If the student decides another answer is better, s/he can click its related button. Only one button can be selected at a time. Another way a student can de-select an answer is to click the Erase Answer button, which is described below.

- The Erase Answer button

The Erase button is a straight forward way for the student to deselect an Answer Selection button. Only one answer can be chosen at a time. The student could also change an answer by just clicking on another Answer Selection button.

- The Bookmark button

The Bookmark button is a way for a student to mark a question that s/he wants to return to for further consideration. The Bookmark button is positioned at the top of the question box, close to the question number and close to the top right side of the question box. When the student clicks the Bookmark button, the white circle area behind the question number turns yellow and the top right side of the question box is "folded" in the corner much like a page in a book is folded when it is bookmarked. Both of these indicate to the student that this question is marked. When the student goes to the Test Review Screen, a round yellow button will be beside this question indicating that it has been marked for review.

To unmark the question, the student just needs to click the Bookmark button again. It works like a toggle. The circle behind the question number will be white again, the "folded" corner of the question box will be unfolded, and the yellow circle beside the question on the Test Review Screen will be removed.

Design Note: When the screen is further developed, it may be preferable to remove the bookmark button in favor of clicking directly on the question number. This is contingent on the ability to appropriately design states for the question number so that it is obvious that it is clickable and it is obvious when the bookmark is activated. User testing will also help in determining the best method for the bookmark feature.

7.1.3.6 Test Review Screen

The Test Review Screen gives the student an overview of the entire subtest by listing all the question numbers, indicating which questions have been answered, and which questions have been bookmarked for review. The student can go directly to any question by clicking the question number. (When this screen is further developed, there may be other ways to make a question "hot".) The student has access to the Test Review Screen at any time during the test, as well as at the end of the test, before the responses are submitted to the server. Note: although the Test Review Screen doesn't show it, the Progress Indicator will be in the navigation bar at the bottom indicating the number of answered questions.

Design Note: When the screen is further developed, it may appear as a pop-up window. This will help with the student's orientation with respect to the test question screen.

The student arrives at the Test Review Screen by clicking the Test Review button on a Question/Answer Screen or a Stop Screen.

The other active buttons (besides the "hot-navigate" to question) are:

- Stop button

The Stop button takes the student to the Stop 2 Screen.

- Sample Question button

The Sample Question button takes the student to the Sample A screen.

- Return to Test button

The button takes the student back to the last question viewed.

7.1.3.7 Stop 1 Screen and Stop 2 Screen

The student arrives at the Stop 1 Screen by clicking "Go On" at the last question. The student arrives at the Stop 2 Screen by clicking the Stop button on the navigation bar from a Question/Answer Screen or the Test Review Screen. The two stop screens are the same except the Stop 1 Screen has an extra line of text below the stop sign that says, "You've reached the end of the test."

The student has a choice of three buttons on both stop Screens:

- Test Review button

The button takes the student to the Test Review screen.

- Return to Test button

The button takes the student back to the last question viewed. Note that in the case of the Stop 1 screen, this is actually the last question in the test.

- Finish

When the Finish button is clicked, a pop-up screen appears with a message "Are you really finished?" and a Yes button and a No button are displayed. The Yes button takes the student to the Congratulations Screen. The No button closes the pop-up window, and the student again has a choice of the three buttons: Test Review button, Return to Test button, and Finish button.

7.1.3.8 Congratulations Screen

The student arrives at the Congratulations Screen by clicking the Finish button on a Stop Screen. The test is over and the student responses are uploaded to the server. There is one button on this screen that allows the student to exit the program entirely. It should be called "Quit" or "Goodbye".

7.2 Test Interruption Scenarios

There are a number of scenarios that cause unintentional interruption of the assessment. These include system failure due to an operating system crash or power outage, and a student unintentionally submitting their answers before they have completed the test. The interface has been designed to avoid early student exit, but this is nevertheless a possibility.

The assessment application will work in conjunction with database overrides provided by the proctor utility to allow the student to restart a test in the event of an interruption. These are explained in detail in the Section 11.1.5, Test Interruption Flags. Allowing the student to restart is then left in the hands of the test proctor, who can decide if it appropriate for the student to restart the assessment or if they will be required to take a makeup test on paper.

In the event of test interruption and restart, the student will be required to start the test again from the beginning. Although it is possible to save the state of the test to the hard drive and restore it when they log in again, this is not recommended as it creates identity concerns and security concerns, as well as creating additional logic to determine the exact state to restore the assessment. The greatest concern lies in matching the identity of the student that is currently logged in with the item responses that have been saved to the hard drive. Such a system is beyond the scope of this project.

7.3 Time Tracking Eliminated

As a result of discussions between Human Code and HEM, the time tracking feature has been eliminated from the design for this phase of the MAT8 product for the following reasons. It can be added in a later product development stage.

7.3.1 Interface

Experts in user interface design for kids say that the movement of an onscreen timer is distracting. It also will add pressure to the kids because they will think it's a timed test and they won't believe that it's not. This does not give the kids additional information that they need to take the test. In addition, it creates a difference from the paper test and it breaks the "no animation" rule.

7.3.2 Statistical Integrity

There are a number of test interruption scenarios that would require pausing the timer or that would affect the elapsed time statistic. Examples of scenarios that would affect the integrity of the time statistic are: student accidentally powers off computer; student takes a break; student asks teacher for help; student hits the pause button even though they are not really paused; student doesn't click "finish" at the end, so the timer is going until the teacher exits the program for the student. As there is currently no plan to use the statistic, its goals are unknown. Without knowing the goals of the data, it is difficult to design features that handle each scenario so the statistic is valid for its desired purpose. Each pause of the system needs to be hand-coded and each feature needs to be designed separately, so nothing is gained from designing and implementing these now, before we know how the statistic will be used.

7.3.3 Future Versions

It seems that this statistic would be easier to control if we had a teacher-monitoring utility that was active as the student was taking the test. This would give the teacher control over pauses and entering information regarding reasons for pausing. Perhaps a monitoring utility can be considered in future product development phases.

HUMAN CODE

8. Assessment Module Technology Specification

8.1 System Requirements

8.1.1 Platform compatibility

The MAT8 interactive assessment will run on both the PC and Macintosh platforms. Director applications are created on a single authoring platform and then compiled to PC and Mac executables. The final CD will be created in what is called a hybrid format so that it can be read on both platforms. While there will be separate Mac and PC executables, both will pull from the same folder of assets.

8.1.2 Windows

Windows 95 or Windows 98
Pentium 200 MHz
32MB RAM
5MB free hard disk space
Quad speed CD-ROM drive
256 color, 640x480 display
Mouse

Note: the Xtras that are used to implement the security features are not fully supported on Windows NT or Windows 2000, so these platforms are not supported by the application.

8.1.3 Macintosh

System 8.0 or later
100 MHz Power PC
32MB RAM
5MB free hard disk space
Quad speed CD-ROM drive
256 color, 640x480 video display
Mouse

8.2 Program Architecture

Director version: Director 8.0
Director Xtras: Buddy API, XML, NetLingo

The physical arrangement of the assessment CD is as follows: there will be six executables per platform (one for each grade-level). Each of these executables will further be divided into three files. One for each subtest. These divisions will make the production process more efficient if it is necessary to have multiple programmers working in parallel. All Xtras will be embedded in the executables, providing all functionality necessary to run the application in the same bundle.

Data folders for each subtest will contain text and image assets. The format options for the images in the data folders are: .PCT, .GIF or .JPEG.

Ideally the project will consistent of a single set of master source files that are compiled to platform specific executables. By avoiding "forking" the source files we eliminate the need for duplication of effort when making changes and updates.

A generalized architecture will make the project more modular and would allow for multiple programmers to work on it if the schedule demanded.

8.3 Implementation Techniques

8.3.1 Screen Elements

Contents of each question screen will be specified by a configuration file. There will be a series of templates that define possible screen layouts, and the configuration file will specify all of the parameters necessary to fill the template. The actual templates will be defined as the layouts are being performed, to ensure that there are enough templates to handle every layout possibility.

The configuration file is a text file and will contain the following properties: template identifier, question text, four blocks of answer text, file name of copy block (for reading passages, etc.), list of file names for any onscreen graphics. The onscreen graphics listed in the configuration file are in addition to the standard global graphics that are present in each screen.

Templates will match the style guide as closely as possible while still allowing dynamic import of assets from a data folder. The number of templates created will be balanced between flexibility of layout and amount of programming. There will be enough templates to accommodate a number of different layout schemes, but not so many that it will require what amounts to custom programming for each screen.

To avoid the unattractive system style scrollbars for large text block, custom graphical scroll bars may be implemented.

In order to preserve the formatting of equations, these will be pulled into director from source asset files as graphics.

Each assessment screen will have a number of common interface elements and functionalities. These global graphical elements will be shared between screens to limit redundancy, including interface buttons, the progress bar, header assets, etc.

8.3.2 Screen Resolution

The application will not attempt to automatically switch the screen resolution of the monitor. The user should be instructed to set the recommended resolution prior to when the student takes the assessment. Note that a change to optimum screen resolution is recommended but not necessary. The application can be viewed at any resolution at or above the minimum required resolution. At higher resolutions, the image will appear centered on the screen against a black background, the standard presentation.

8.3.3 Ruler

Some of the assessment questions will require an onscreen virtual ruler. This will be implemented with a rotatable sprite. If the user drags the middle of the ruler, it will move, if they drag either end, it will rotate. The ruler will have a screen border beyond which it cannot move. This will make it impossible for a student to move the ruler off screen and then not be able to recover it.

8.3.4 Text Highlighting

It is possible to create a high-lighting effect as the cursor is dragged over a reading passage. However, this functionality is not built-in to Director and would have to be coded by hand, changing the background color to match the cursor movement. It is recommended that this feature be considered for elimination if it becomes necessary to re-examine the scope of the project.

8.3.5 Cursors

There are a few options for cursor implementation. The first is to use system cursors. These have size and color restrictions but are the most straightforward to implement and have the best performance. The second option is to use what is called a sprite cursor. In this scenario, the system cursor is hidden and a sprite graphic is used to represent a cursor. It is our recommendation to use a system cursor if possible.

8.3.6 Palettes

A custom 256 color palette will be used for each grade-level executable. All graphic elements within the grade level should be mapped to this palette. All palettes will conform to the Windows standard 236 color scheme: the first 10 colors and last 10 colors of the palette are reserved for Windows and should not be used.

True black (palette index 255) and true white (palette index 0) should NOT be used in any of the graphics. Instead, palette index 245 is used for black as R2 G2 B2, and palette index 10 is used for white as R253 G253 B253.

8.3.7 Fonts

Custom fonts can be imported into Director, which assures that a given font will be available. Sizing and anti-aliasing are also supported, as well as all of the standard formatting; for example: bold, underline, italics, etc. Director also supports kerning and leading, but we will try to avoid creating layout templates that will require custom kerning and leading. In order to maintain font size consistency across platforms, it is important to embed all styles of a given font. For example, if using the bold face of an embedded font, the bold font set must be explicitly embedded.

8.4 Communication with Server

In order to communicate will the backend server, POST commands are used to send ASCII data or name/value pairs. Since it can be unreliable, the program will not attempt to detect whether or not there is an active internet connection. If there is not, the computer will automatically try to connect as it would do with any application that makes a network request in this situation.

Director has limited support in regards to communication through a web proxy server. The options here are:

a) assume that none of the schools connect to the web via a proxy server,
b) provide an option allowing the proctor to configure the application for the proxy server. (This would be a similar process to the school's web browser setup process.)
c) investigate developing a hand-coded proxy detection scheme.

Some especially restrictive types of proxy servers (authenticated proxy servers) are not supported at all by Director.

At the time of login, data is exchanged with the server to perform password authentication. When the assessment is completed, the data is sent to the server in one transmission. No additional transmissions are required. This scheme is advantageous in that it minimizes the number of transmissions to the server.

8.4.1 Errors in Data Communication

As the test progresses, item responses will be stored in a file on the hard drive. In the event that the server is unavailable at the conclusion of the test or there is an error in data transmission, the file on the hard drive will be available for upload at a later time. The file will be stored in encrypted form, using the encryption methods described in Section 9, the security portion of this document. Once the data is successfully uploaded, the server will send back confirmation and the item response file will be deleted.

8.5 Programming Tasks

The main programming tasks for this project are as follows: Write screen layout engine, write client to server communications code along with documentation of communications calls and parameters, create intro. login sequence, create summary screen and build final executables and create CDs for delivery. A more detailed list follows.

8.5.1.1 Programming task list
- Write database communications code.
- Build layout engine.
- Build intro. (splash screen login sequence, test selection)
- Build extro. (summary screens, quit confirmation screens)
- Integrate all assessments screen by importing layout data generation by assistant programmer or production artist.
- Build executables for delivery and write readme file.

8.6 Web Portability

Although Director can write to a web format called Shockwave, we are relying on a number of Xtras that are not supported within the browser context. These are mainly security features, as described in the security section of this document. For that reason, a browser delivery is not recommended even in future phases. An alternative would be to simply make the CD contents a file that would be downloaded and installed before the testing session.

Additional alternatives exist that allow the use of a Director executable in conjunction with a web server to hold assets, but leaving a browser out of the scenario. These options can be examined in later phases of the project.

9. Security

9.1 Preventing Screen Captures

For security of test content, specifically to prevent distribution, students must be prevented from capturing test items off the screen. Implementation for this is as follows:

9.1.1 PC

On the PC the following system keys must be blocked: Esc, Alt-tab, Alt-Esc, Cntrl-Esc, and the Windows menu key. All of these can be blocked either directly by Director or indirectly via BuddyAPI. Although PrintScrn cannot be blocked, it can be detected and the clipboard overwritten immediately after it is pressed. This effectively defeats attempts to capture a screen shot.

9.1.2 Macintosh

On the Macintosh, we need to block Cntrl-C, option-command-3 and option command-4, command Q. Again this is possible either directly by Director or via Buddy API. The only difference is how we defeat screen shots: at the beginning of the assessment we will determine the latest screen shot on the hard drive. These are called by convention Picture 1, Picture 2, etc. At the end of the assessment we will use Buddy API to delete any new screen shots created during the assessment session.

9.2 Encryption of Local Data

In the final product, we will use the protected Director file type .DXR as opposed to the editable source code type .DIR. Data stored in director's linked format (called casts) should be of type .CXT as opposed to the unprotected type .CST.

In order to store item response data locally FileIO access and text encryption are necessary. The FileIO is provided by a Director Xtra call Buddy API. This Xtra allows us to create, open, write and close files. Encryption can also be handled with this Xtra or could use the same manual encryption that is being used for transmissions to the server. It should be noted that these Xtras are not portable to Shockwave, the web version of Director.

Another security issue to be considered is the graphics stored on the assessment application CD. With the graphics, a student could potentially piece together the assessment questions. To prevent this, graphics will be "encrypted" by rearranging them like a sliding puzzle. These graphics will be decrypted by reversing the process just before display.

9.3 Level of Local Security

Although these technologies create a secure test environment in most situations a number of ways remain to foil the PC security. For example, if a third party screen capture application is started before the test, a screen shot could be acquired. Also, if the student presses ctrl-alt-delete, he or she would be able to choose "End Task" and quit the assessment.

On both platforms extreme measures could be taken to defeat security attempts, for example a dump of system RAM could be used to get blocks of text from the assessment.

It is believed that such attempts are generally beyond the means of a student in the target age range using the software available in a classroom and that the presence of a proctor to monitor the test will prevent such attempts. It is important the proctor monitor the students to ensure that extreme measures are not being enacted by the students.

9.4 Secure Data Transmissions

For security of transferred data text encryption can be implemented. Both the client and the server would have preset keys that are stored for decryption.
The complete set of encryption alternatives is as follows: a) Client and server both know a single encryption key. b) Client sends messages along with a flag indicating which of five encryption keys is being used. Server also has a copy of the five encryption keys.

9.5 Passwords
A password is required for students to gain access to the assessment. This protects the assessment content on the CD by preventing unauthorized access outside of the testing situation. Please see section 10.2 for more detailed information.

A password is required for anyone to gain access to the proctor support utility. This protects student demographic data, etc. Please see section 10.3 for more detailed information.

10. Process Flow Descriptions

10.1 Order Process

The entire process of the MAT8 Interactive Assessment system is initiated when the HEM Order Department receives an order from a customer, typically a School District or a School. They will order a quantity of tests, where a single test allows one student to take all three subtests: Reading Comprehension, Math Concepts, and Math Problem Solving.

Key information regarding the order is submitted by the order department to the MAT8 Oracle database table, including:

- Product Id
- Form or the version of the product
- Quantity of products (tests) ordered
- Date the order was placed
- School Code or District Code of the customer who placed the order
- Email contact information for the order

The system then keeps track of how many tests are taken in relation to a specific order. A test is considered "taken" with respect to the order when a student is registered through the registration utility. In the event the number of registered students exceeds the number of tests requested, the system allows the proctors to register additional students but displays a negative quantity in the "Orders Filled" field of the database to indicate the number of tests ordered was exceeded.

Every time a proctor registers a student for a test, they must type in an order ID that will be identified with the students registered in that session. For each student that is registered, the orders filled attribute is incremented and the orders filled date is updated. If the number of students registered exceeds the number of tests ordered, a negative number in the "Orders Filled" attributed is updated, for e.g. if the value of this attribute is – 45, this means that the number of tests ordered exceeded by 45.

In the event that the school enters a new order, a new entry for the order is created. The total orders placed is a summation of all the orders of a school for a particular product and form.

10.2 Student Password

To gain access to the assessment, each student must enter an ID and password to verify that they have been registered and are authorized to take the test. Each student may have their own password, which is stored in the database with respect to the system student id. The passwords are stored in an encrypted format and the key is stored in the system parameters table in the database. The passwords are created by a database utility at the time of student registration.

10.2.1 Purpose of the Password

The student password protects the content on the CD. In the event that a CD is acquired outside of the test environment, the test content on that CD cannot be accessed without a valid ID and password.

10.2.2 Acquiring the Password

At the time of registration, the database generates a password for each student. The test proctor can then use the registration utility to acquire a list of ID's and corresponding passwords for each student. When the test is given, the passwords are handed out to the students.

10.2.3 Security of Password Information

The passwords are stored in the database in an encrypted format. The Unix password encryption utility is used to encrypt the passwords. Decryption occurs at the time of password authentication.

A password on the CD creates a secure product, but there are some ways to bypass the security measures. Passwords are assigned per student, not per subtest. This means that once the password is given out, that password is still valid and could be used to access subtests that the student has not yet taken. For this reason, it is still imperative that the CDs be securely stored to prevent theft, as is the case with the paper booklets, and that the students' activities are closely monitored during every test session. Initiating a more stringent password system would greatly complicate the design, implementation, and use of this product.

10.3 Proctor Password

A proctor needs a password to gain access to the system for registering the students, changing or editing the demographic data or requesting the raw scores. Proctor passwords are stored in the database with respect to the order ID. To gain access to the Proctor Support Utility functions, a school official must type in a valid order ID and matching password.

Proctor passwords are database-generated and stored in one database repository. The passwords are stored in an encrypted format and the key is stored in the system parameters table in the database.

10.3.1 Purpose of the Password

The proctor password protects all functions accessible through the Proctor Support Utility, including viewing student passwords, viewing and editing student demographic data, and retrieving raw score data.

10.3.2 Acquiring the Password

The HEM Order Department will advise the customer of a password for an order and log email contact information.

10.3.3 Forgotten Password

In the event a password is forgotten, a proctor can request that the password be sent back to the corresponding email address stored in the database. In case there is no email address in the database, the password will not be sent back and the Order Department at HEM will be contacted for the password. At that point, positive identification of the customer and secure communication of the password is at the discretion of the HEM Order Department.
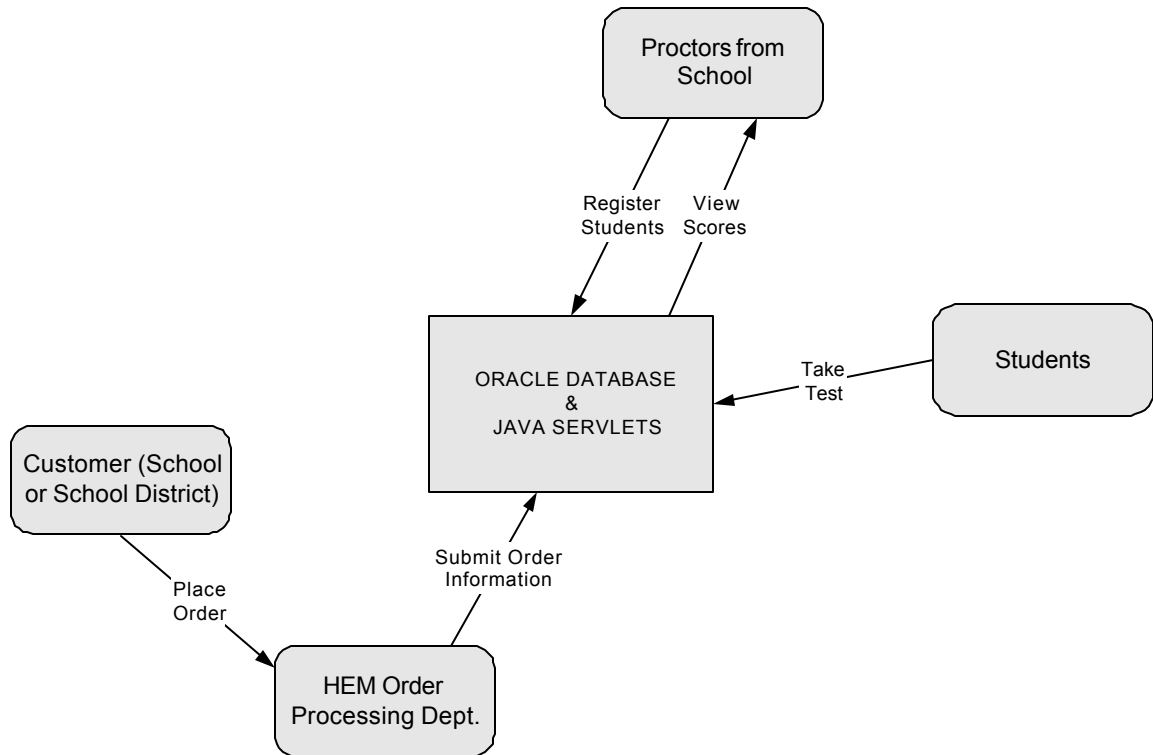
10.3.4 Security of Password Information

The passwords are stored in the database in an encrypted format. The Unix password encryption utility is used to encrypt the passwords. Decryption occurs, as with the student passwords at the time of password authentication.

High Level Data Flow Diagram

10.4 Description of High Level Data Flow Diagram

The High Level Data Flow diagram depicts the High Level flow of data and events in the system. The entities and processes covered High Level Model are described below.

10.4.1 Customer (School or School Disctict)

Places an order for a specific quantity of the MAT8 product.

10.4.2 HEM Order Department

Submits the pertinent order information to the MAT8 database.

10.4.3 Proctors from a School

Register the students for the test and administer the test. Functions include editing the student demographic information and verifying that the students have submitted the test scores.

Proctors can also view the raw scores from the database.

10.4.4 Oracle Database and Java Servlets

Main repository for data, including student demographic data, test data, score data and the ancillary data that helps to deduce the results.
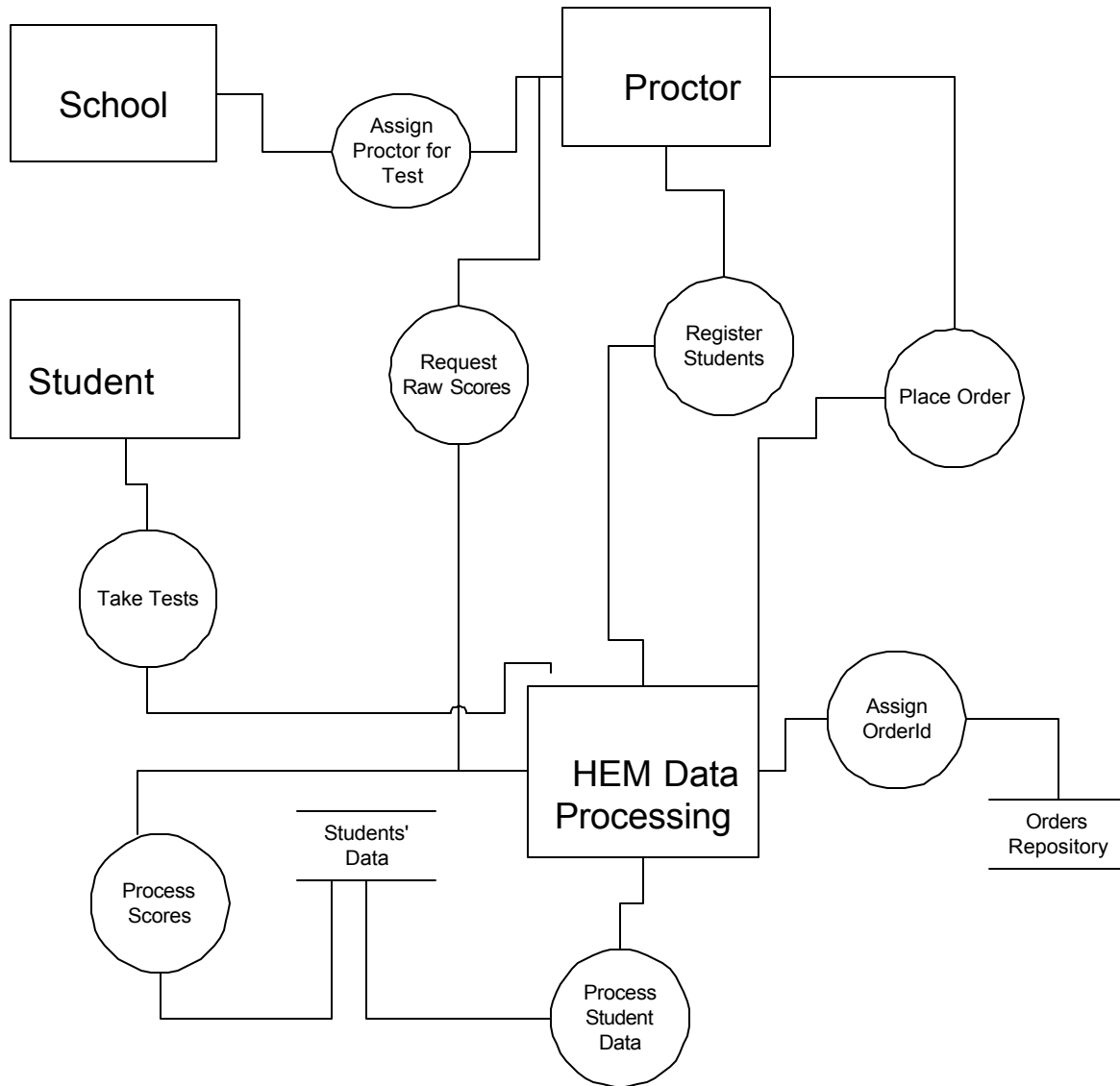
Processes the data for the student, including functions such as keeping track of tests that a student has taken and authenticating passwords, as well as processing raw score data for proctors and school authorities.

10.4.5 Students

Take the tests and submit the scores to the database.

Level II Data Flow Diagram

H U M A N C O D E

10.5 Description Level II Data Flow Diagram

This section describes the Level II Data Flow Diagram, its entities and processes. The external entities in the MAT8 systems are the schools, proctors and students

- School places an order for a test.
- HEM takes the order, assigns an order id and creates an entry in the database.
- The school assigns a proctor to administer the test.
- Proctor registers the students for the test.
- Registration data is stored in the database.
- Students Takes the test and submit responses.
- Item responses are stored in the database.
- Proctor requests raw scores.
- Database generates raw scores and displays the results for the proctor.

11. Proctor Support Utility Functional Design

11.1 Feature Specification

The Proctor Support Utility allows the test administrator (or other school official) to register students, edit student profile data and students passwords, and access scores. The school official will gain access only after password identification. Following is a description of each feature.

11.1.1 Log in Screen

School Officials use the log in screen to gain access to the proctor support utility. Please also refer to the Proctor Password Section (9.3).

11.1.2 Registration

The registration process will allow school officials to enter demographic data for the school and students prior to the student taking the test. This will free the students from having to enter this data themselves.

Data entered in the registration process includes the following school/test group information:

- School District Code
- School District Name
- School Code
- School Name
- Building Code
- Building Name
- Group Code
- Group Name
- Grade
- Level

Student data entered during the registration process includes:

- Student ID
- First Name
- Middle Name
- Last Name
- Date of Birth
- Gender

11.1.3 Edit Student Information

This process allows school officials to edit the personal information of the students as detailed above. Although each student in the database will have a unique ID, this field is not required to select a particular student's record for editing. A student can be identified by a unique entry such as the student ID, or by a combination of 2-3 fields, such as name and date of birth. Only one student record can be edited at a time and only student personal information is available for editing, not responses or any other database fields.

11.1.4 Access Scores

This process allows school officials to access raw scores. Complex and normative scoring will continue to be computed at HEM and acquired by the customers using existing paper-based methods. This is not intended to be an electronic version of the normative score report order form.

Scores displayed include the following data, per student:

- Total number of questions
- Number of correct responses per sub-test
- Number of correct responses per categories within sub-tests

The scoring utility also provides a raw score table for a roster of students from the same class, showing a list of student names and their raw scores.

- As classroom level statistics are not tracked by the database, aggregation of raw scores by the client only go as high as the grade level.
- The roster includes the same data that is available through the individual student's raw score reports.
- The score report can be downloaded as a local text file.
- The local file is **not** encrypted.
- Score reports can be printed.

11.1.5 Test Interruption Flags

The proctor may use one of the following flags in the event of test interruption:

11.1.5.1 Make-up Flag
The student needs to quit the test before completion, and therefore must submit their responses in order to exit the program. The proctor will then set the Make-up Flag to denote that these responses are invalid and should be ignored. The student will not be able to retake the Interactive Assessment, but must take the paper-based make-up test instead.

11.1.5.2 Override Flag
The student unintentionally leaves the test before completion (for example, the student prematurely submits their scores or the system crashes), but will immediately re-start the test. The proctor will then set the Override Flag so the student may reenter the test. Each flag is good for only one login. I.e., once the flag allows the student to login again, the flag is cleared.

The use of these flags is at the proctor's discretion, but it is assumed that if there is any possibility that the student could have obtained answers during an interruption, the makeup flag will be used (as the make-up test is comprised of different questions).

11.1.6 Student Password View

This Password View process allows school officials to access and print student passwords prior to testing. Passwords can then be handed out to students just prior to the test so each student can log into the system. A password table can be obtained for an individual student or for a grade level (similar to accessing scores).

11.2 Interface Specifications

11.2.1 Addendum L: Proctor Support Utility

This addendum contains detailed technical specifications concerning the content and functionality of the Proctor Support Utility interface.

12. Database & Backend Processing

The primary function of the database is to hold all of the data associated with the MAT8 interactive assessment. This includes school information, student demographic information, student item responses, and any ancillary data needed to support the processing and functionality of each of the client modules. Contained in this section and its related addenda is a detailed description of the database, a schema in the form of a physical data model, and diagrams that show the context of the database in the system.

12.1 Database Assessment and Evaluation

After a careful evaluation of more than five relational database model systems (RDBMS), it was decided to use Oracle 8I with inter-media capabilities. The choice of this RDBMS allows for scalability of additional objects and enhancements in future phases, and can be easily integrated into existing Oracle-based systems at HEM.

To handle the data and data warehousing requirements of the MAT8 project, Oracle on UNIX platforms is the most robust and reliable solution. The internal multithreaded Oracle architecture allows faster queries by providing its developers with objects like indexes and allowing clustering of the database objects.

The inter-media capabilities provide the development and maintenance programmers with a wide range of features to maintain and enhance database functionality in future product phases. These include stored procedures, stored functions, Java stored procedures and SQL J (SQL CODE embedded in Java) for fast and reliable middle tier development. In addition, the database has the capability of storing web pages and images in a number of formats, including TIFF, JFIF, BMP, TARGA, PCX, PICT, GIF, CALS RASTER, Sun, and Flashpix.

12.2 Entity Relationship Diagram

The relationship between different entities in the MAT8 system is represented in the entity relationship diagram (ERD). The ERD depicts a high level representation of entity attributes is the basis of the physical data model.

The external system entities and their attributes are listed below.

- Schools
- School District Code
- School District Name
- County
- State
- School Code
- Building Number
- Building Name

Proctors who register the students and administer the tests
- Group Code
- Group Name
- IP Address
He also defines if a student may use a calculator

Students who take the test and submit their scores to the database
- Student ID
- First name
- Middle Name
- Last name
- Date of Birth
- Gender

The internal system entities and their attributes are listed below.

- Orders that have been place by the customer
- Order Id.
- Order Date
- Order Filled
- Filled Date

- Tests and their scores
- Product id
- Form
- Level
- Sub-test
- Score of the candidate.

The mode in which the entities are related to each other is called a *Relationship.* The relationships in the system are the basis of the database design and its physical data model. The physical data model is the exact representation of the database schema.

Following is a description and diagram of the ERD for the MAT8 system.
There is a one-to-many relationship between the school and the proctor. This suggests that a school may have more than one proctor responsible for administering the tests.

A proctor may have more than one student to register and to administer the test, so there is a one-to-many relationship between the proctor and the student.

Many students may take more than one subtest of the product. Thus, there is a many-to-many relation ship between test and a student.

An order-id is always for one customer (proctor); a proctor may place more than one order.

H U M A N C O D E
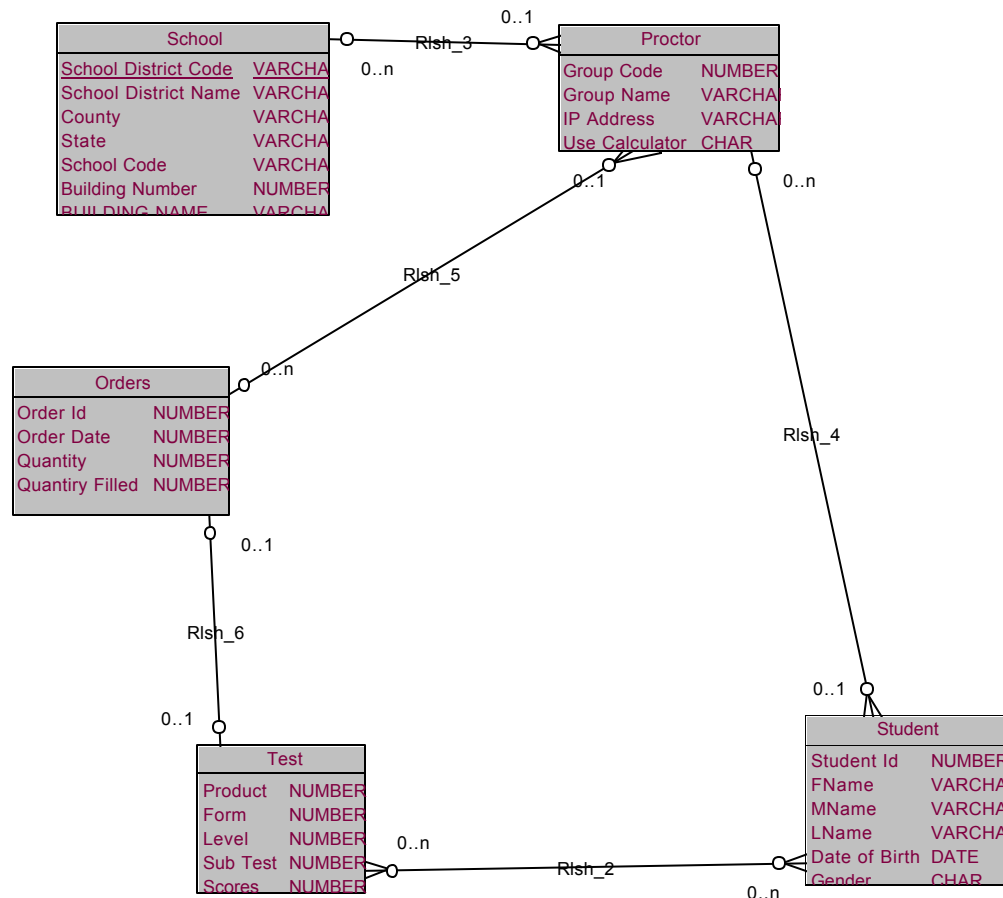
12.3 SUMMARY OF TABLES & SCREENS

Following is a tabular representation of the various database tables that will be used by the MAT8 system and the screens and servlets that will be used to access the tables. Most screens will be developed using Oracle Forms 6.0 or HTML, but student login and student score submission screens will be developed using Director technology. The middle tier will be developed using Java Servlets.

Table Name	Screen Type	Screen Name
tbl_GroupsMaster_HEM	ORACLE FORMS	frmGroupsMaster
tbl_SchoolDistrictsMaster	ORACLE FORMS	frmSchoolDistricts
tbl_SchoolsMaster_HEM	ORACLE FORMS	frmSchoolsMaster
tbl_LevelsMaster_HEM	ORACLE FORMS	frmLevelsMaster
tbl_StudentDetails_HEM	HTML Form	htmlRegistration
tbl_SchoolStudents_HEM	HTML Form	htmlRegistration
tbl_StudentTestDetails_HEM	HTML Form	htmlRegistration
tbl_subTestsMaster_HEM	ORACLE FORMS	formSubTests
tbl_DocumentsMaster_HEM	HTML Form	formDocuments
tbl_FormsMaster_HEM	ORACLE FORMS	FormForms
tbl_StudentTestDetails_HEM	HTML Form	htmlGetScore
tbl_studentTestDetails _HEM	HTML Form	htmlSetOverride
tbl_StudentDetails_HEM	DIRECTOR Technology	dirStudentIdentify
tbl_studentTestDetails_HEM	DIRECTOR Technology	dirStudentScoreSubmission

12.4 Addendum M: Schema and Physical Data Model Description

Addendum M contains the schema and physical data model description for the database. It outlines the contents of each table and depicts relationships between tables.

12.5 Database Implementation

The database will be created using the Data Definition Language (DDL) and the handling of data will use the Data Manipulation Language (DML). In both cases, the actual language used will be SQL. Oracle offers an extension to ANSI SQL called SQL PLUS. Conventions and standards for the naming and programming of database objects are outlined below.

12.6 Database Standards

12.6.1 Table Naming Standards

All the database tables start with an extension "tbl_" to denote that the object is a table. This will be followed by the information that the database object holds, e.g. the database object to hold School Districts Master Information will be "SchoolDistrictsMaster", this will be suffixed with "_HEM" to denote Harcourt Educational Measurement. The name of the table have the following format:

tbl_SchoolDistrictMasters_HEM

12.6.2 Index Naming Conventions

All the indexes will be named as IXD_XXXX_HEM, where

IDX: is used to denote Index. In case the index is of Unique Type, UDX will be used as a prefix.

XXXX: is used to denote Table Name and the name of the column on which the index will be based.

HEM: is used to denote Harcourt Educational Measurement.

12.6.3 Stored Procedure Naming Convention

All the stored procedures will have a prefix sp_ to denote the stored procedure. In case of Java Based Stored Procedures while using Oracle 8i, use spj_ as a prefix.
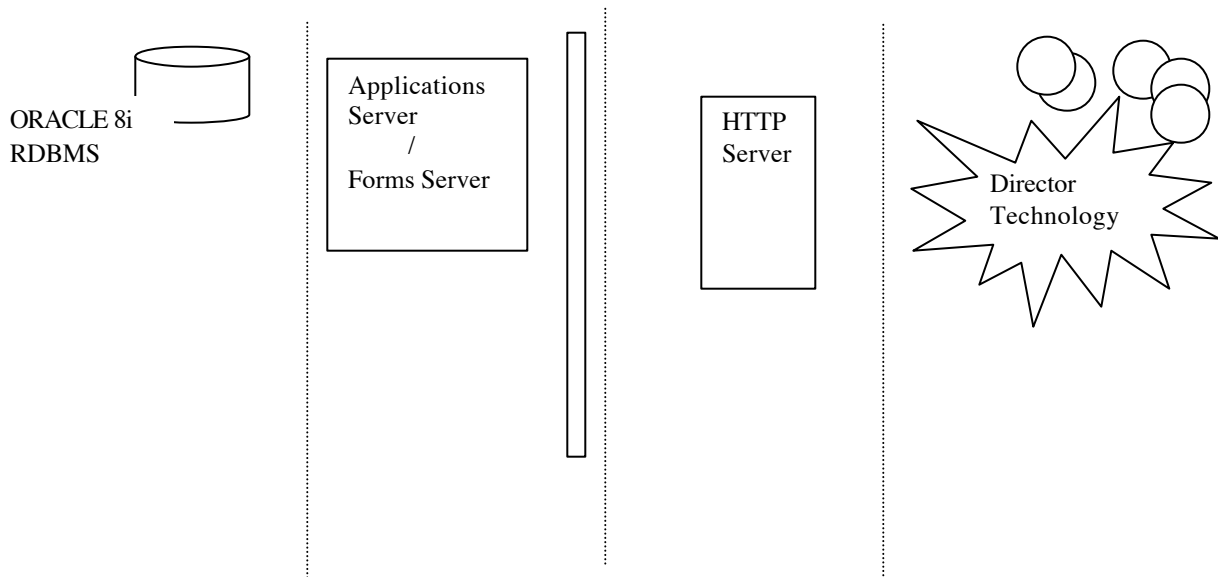
Stored Functions Naming Conventions

All the stored functions will start with sf_. In case of Java Stored Functions, sfj_ is used as a prefix.

12.7 System Architecture

The complete system, as diagrammed below, shows the layers between the Director client modules and the Oracle database.

12.8 Addendum N: Description of Servlets

Java Servlets will be used to communicate between the client modules and the database. Servlets can be called using Get and Post methods through http and used to pass form data to the database server.

Addendum N contains detailed functional descriptions of the main Servlets that will be used by the system.

12.9 Addendum O: Database Maintenance Screens

To ensure validity and consistency of data in the database, the database architecture has foreign key constraints. This ensures three layers of validity of data being inserted into the database:

The user interface level implemented by the scripts.
The Middle tier Level ensured by the Java Servlets.
The database level ensured by the foreign key constraints.

To implement the database level validity, the data needs to be entered in the master tables prior to entering in the transaction tables, e.g. the proctor who is trying to register the students or trying to edit the student demographic data should have a valid group code. This Group Code should already exist in the "tbl_GroupsMaster_HEM" so that it can be conveyed as contents of a list box.

This will be accomplished by using maintenance screens to create new master data information and Java-based backend programs that transfer the existing data.

Addendum O contains a detailed functional description of the screens and java programs used for database maintenance.

12.9.1 Server Difficulties

To avoid server session failures during connectivity or scheduled maintenance, it is suggested that Hot Standby Systems or Replication Servers be implemented. A Replication Server will have an exact image of the production server database. This will be updated on a timely basis. In the event that the connection is not able to be established with the database, the code will be written so that the Replicated Server is contacted instead of the production server.

The replicated database will be marked to indicate the records that have not been written to the production database. Eventually, the production database will be updated.

13. Test Administration Documents

Any actions that are performed by the proctor during a paper-based assessment will continue to be performed by the proctor during the interactive assessment. The existing MAT8 Directions for Administration (DFA) outlines these actions. This design document mentions additional activities assigned to the test proctor for this product. Documentation of those activities in the DFA as well as any additional manuals or technical support necessary for the interactive assessment will be provided by HEM.

14. Risk Analysis and Management

14.1 Setting a Standard

The MAT8 project has the potential to set a standard for future CBT products developed by HEM for the same audience. For this reason, it is critical that the user interface provides an effective and non-intrusive experience for students taking the test. User testing is a vital component in this endeavor, as well as the involvement of experts in the field. Special attention should be paid to the implementation of the assessment interfaces to ensure that the usability of the designs is upheld and appropriate user testing is conducted.

14.2 Environmental Compatibility

As every school may have different network, communication and desktop configurations, including possible security software, it will be impossible to guarantee the compatibility of this product with every possible permutation. Compatibility testing should be conducted to determine a known set of working configurations. These can then be documented and provided to the customers.

14.3 Design Changes

This design is the result of a comprehensive process of research and collaboration, and this document is believed to be a complete solution for the resulting product definition. Once the implementation phase has begun, changes to this design (outside of the normal changes that result from the usability assessment) will inhibit the production process and risk the development schedule and budget. Careful attention should be paid to maintaining the scope and vision of the product. Ideas for new features should be reserved for future products.

14.4 Dependencies

Any complex undertaking requires enormous collaboration, and the implementation of this product is no exception. Throughout the implementation phase, it is critical that HEM and the development team synchronize all production activities. Timely release of deliverables and prompt response to approval requests are critical components in the development process and are necessary to produce the product on time and on budget.

15. Approval Form

This is the **Design Document** for the MAT8 Interactive Assessment. This Design Document form must be signed by Harcourt Educational Measurement to approve this Design and a copy returned to Human Code for project records.

The creative and technology directions currently proposed in this document need to be signed and approved by the appropriate client representative by Wednesday, June 7, 2000.

Please print out, sign, and fax this document to Simone Pia c/o Human Code at (415) 454-6992.

Harcourt Educational Measurement   *Date*

Human Code, Inc   *Date*

P R O P R I E T A R Y   A N D   C O N F I D E N T I A L