Utilizing Tenor to Improve Human Performance

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ABSTRACT

The Training and Education Network On Request (TENOR) is an intelligent and adaptive information PROCESSING AND distribution system designed to increase the skill level, performance and critical thinking of military personnel. It consists of multiple interacting servers providing dynamically generated, interactive, HTML-based content to clients running on any platform with a browser, including the wirelessly connected PDA. The server determines the client's browser type and dynamically generates appropriate information content including text, images, audio, video, and interactive programmatic objects such as JavaScripts, Java applets, and ActiveX objects. For example, TENOR replaces audio narrations with text narrations for certain clients without capable speakers, and TENOR omits Java applets if the client browser does not have a Java virtual machine.

TENOR works interactively with the trainee or student. It supports multiple versions of lesson content that vary along some continuum, such as detail or level of difficulty. Subject Matter Experts (SMEs) develop content and create quizzes that TENOR will administer during lessons. Based on the student's performance TENOR can take any of several actions, such as allowing the student to move on, forcing the student to repeat the material, presenting the material at a different level of difficulty, reformatting and re-presenting the material, or notifying an author, manager, or instructor of the student's performance and progress. Lesson content is enriched with multimedia elements, accessory links, and chat rooms and message boards for discussing material with other students or instructors. A student moves through the lesson material at his or her own pace, passing quizzes that review, reinforce, and evaluate comprehension. TENOR adapts to the way individual students learn and customizes content for each student.

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TENOR consists of three basic parts: 1. a relational database which stores content in reusable, scalable, updatable knowledge elements; 2. a relational database that stores lesson structure and formatting elements; and 3. a server based program that builds lessons on the fly from the lesson database. TENOR applications include:

1) ***Real-time instruction and decision aid:*** *A soldier beyond the immediate reach of medics will receive basic care from another soldier who has little or no medical training. Via a handheld, TENOR gives a step-by-step decision tree and instructions for procedures such as cleansing, dressing, and immobilizing a trauma.*

2) ***Just-in-time training platform:*** *Troops who are given short notice that they will be deployed to a particular region are given TENOR lessons to complete on their laptop or handheld computers. In down time, such as on a transport flight or bus, they complete a series of lessons briefing them on the region of deployment and the mission.*

3) ***Ongoing education/training platform:*** *Mechanics complete lessons about new technologies they will need to master for repair and maintenance. After finishing a lesson and successfully completing its quizzes and exam, the mechanic is certified for that task.*

This paper will examine the unique system architecture, customization abilities and features that make TENOR superior to other systems, and easy to use in various military, commercial and academic applications.

1.0 INTRODUCTION

1. The **T**raining and **E**ducation **N**etwork **O**n **R**equest (TENOR) is an intelligent and adaptive information processing and distribution system designed to increase the skill level, performance and critical thinking of military personnel, students, trainees and others using Advanced Distributed Learning (ADL) techniques.

Some advantages that TENOR provides are:

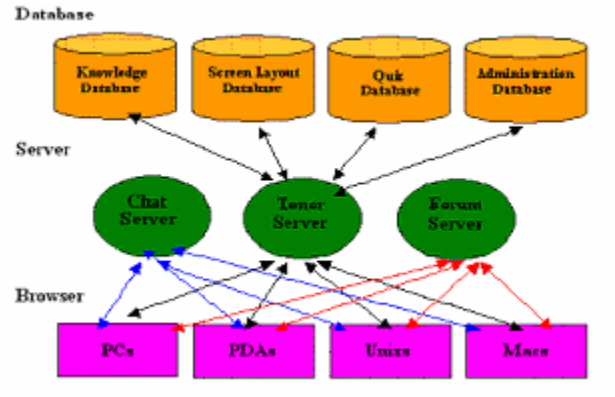
- **Platform flexibility.** By using web-based training, and by formatting the training material for different browser systems, TENOR supports multiple platforms, from desktop to wireless handheld.
- **Trainee level of expertise** which enables the material presented to the trainee to be created "on the fly." Consequently, the lesson is easily tailored in real time to accommodate the capabilities of the individual trainee.
- **Trainee customization** means the system is customized to the individual trainee. As the individual advances, changes responsibilities, etc., the system tracks the trainee's requirements for future training needs.
- **Decoupling of lesson content and presentation; database-driven, dynamically generated lessons,** meaning that knowledge and display elements are easily updated, and updates to lesson content are automatically expressed in lesson display without additional work.
- **Flexibility of training material.** TENOR can accomodate any type of training material that can be put onto a web page, including text, graphics, audio, video, interactive HTML form elements or JavaScript.

2.0 ARCHITECTURE – OVERVIEW

The following is a high-level view of the TENOR architecture:

Databases-Knowledge Database

Knowledge elements – small bits of information such as text, text files, images, audio or video – are stored in the Knowledge Database. You may want to use a naming convention for the element that matches the Lesson structure, but no naming convention is enforced. Knowledge elements can contain titles and keywords, and elements are searchable by keywords.



The KnowledgeBuilder application is used to enter and modify information in the Knowledge Database, add new elements, assign keywords, do searches, etc. SCORM compatibility is also provided.

Screen Layout and Quiz Database

We present these as two logical databases, though in our current implementation they are combined into the Screen Database.

The Screen Layout portion of the database contains both the structure of the lesson and the actual content of the Lesson. It contains the lesson, track, segment, browser, screen and quiz structure of the lesson and also contains the individual elements which are generally either pointers to elements in the Knowledge Database or else formatting elements which correspond to HTML tags or other objects. It also keeps track of which quiz applies to which track or segment.

The quiz portion of the database contains the information for generating the quizzes which are found at the end of each track or segment.

The Administration Database

This database contains information on the overall administration of the system, as well as information for each student that is part of the system. It contains the following information:

- Student usernames and passwords
- Student names, IDs, addresses, phone numbers, email, birthdate, etc.

- Browser student is using
- Information on the students' trainers
- Which training module(s) the student is working on or has completed
- Student expertise level
- Grading and scoring information

Servers

The TENOR system is comprised of three server applications. At the core is the TENOR server which is a web server that interacts with students and, using the Knowledge, Screen, Quiz and Administration databases, generates the lessons on the fly.

The TENOR system also includes Chat and Forum servers, where students can chat with each other or join forums.

Browsers

The TENOR system provides support for multiple browser types on multiple platforms which are connecting with different bandwidths. It is designed to determine the student's browser type and generate a display based on the capabilities of that browser and bandwidth. For example, a student using a desktop PC will receive different web pages than a student (even the same student) viewing the same lesson on a PDA. Things like audio, video and images will be included or excluded or their presentation modified (for example, the HTML tags used to render them may differ) depending on the browser's characteristics.

By using web standards and providing customization for a wide variety of browser, device and platform types, the TENOR system aims to provide material for as large a target audience as possible.

3.0 LESSON STRUCTURE

The TENOR lesson structure consists of the following Modules, Lessons, Tracks, Segments, Screens and Quizzes.

Modules

Modules are a particular area of training, and are collections of lessons. For example, the Air Force might want a module on India in the event that troops may need to be stationed there.

Lessons

Lessons teach the required information. A module can contain any number of lessons. For example, within the India module, there might be lessons on Country Overview, History, Geography, Ethnic Makeup, Religion, Travel, Language, Defense Organization and Economy.

Tracks

Each lesson may contain one or more tracks. Tracks divide lessons by another dimension, such as expertise or detail. Tracks could also be divided into other criteria, such as security clearances, rank, etc.

Each track of a lesson provides material on substantially the same subjects or concepts, but geared towards the different capabilities or attributes of the students.

For example, if tracks were divided according to levels of detail, a track at a low level of detail for a lesson on routine auto maintenance might only include information on when to perform oil changes, rotate tires, replace air filters, etc. A track at a higher level of detail might explain how to actually perform the various tasks. Expertise can be used in the same way: an experienced mechanic might just need to know how often to perform an oil change; a novice would need step-by-step information on how to do it. Tracks divided by security clearances might omit sensitive information for students not having an appropriate clearance level.

Note that a student might be able to change tracks during a lesson, for example move to a track with more detailed material.

Segments

Segments divide lesson content much like chapters in a book. Each segment follows consecutively one after another. Each segment ends with a quiz.

Each track of a lesson generally contains the same or similar number of segments, and generally the same segment in each track covers the same material, but at a different level of expertise, detail or other criteria.

Quizzes

At the end of each segment and track, there is a quiz which tests the student's understanding of the material. Quizzes can be in the form of multiple choice, text input, true/false, matching and ordered lists or other kinds of tests.

TENOR uses quizzes to make the learning experience interactive, ensure that the student is learning the material, track the student's progress, and tailor the layout of the material for the student. Frequent quizzes keep the student alert and reinforce the student's memory.

Based on the feedback from quizzes, TENOR can adjust the teaching by repeating segments, changing tracks, changing layouts or alerting the instructor to problems.

Screens

Each segment is made up of various screens. These are the actual web pages that display the content. They are made up of elements from the Knowledge Database along with formatting elements to display the material in an attractive and organized way.

Screens are tailored for various target browsers. For example, if the student is using a PDA which supports only text, the TENOR system will generate a screen that omits audio, video and images. Other browsers may support certain HTML elements but not others; the TENOR system can generate the appropriate HTML.

The following table shows a typical TENOR lesson structure. The levels correspond to tracks.

A Lesson in Two Segments and Three Levels													
	Lesson Segment 1			**Quiz 1**			**Lesson Segment 2**				**Quiz 2**	
High Level	High Level Segment 1 Screen 1			Quiz on Segment 1, Screen 1	Quiz on Segment 1, Screen 2	Quiz 1 review with answers	High Level Segment 2 Screen 1			High Level Segment 2 Screen 2	Quiz on Segment 2, Screen 1	Quiz 2 review with answers
Medium Level	Medium Level Segment 1 Screen 1		Medium Level Segment 1 Screen 2				Medium Level Segment 2 Screen 1	Medium Level Segment 2 Screen 2	Medium Level Segment 2 Screen 3			
Low Level	Low Level Segment 1 Screen 1	Low Level Segment 1 Screen 2	Low Level Segment 1 Screen 3				Low Level Segment 2 Screen 1	Low Level Segment 2 Screen 2	Low Level Segment 2 Screen 3	Low Level Segment 2 Screen 4		

4.0 AUTHORING TOOLS

To create and manipulate the information stored in the various TENOR databases, four tools are offered. These are Windows applications that interact with the Access databases to create the knowledge elements, modules and lessons, screens and quizzes and perform administrative and student-specific functions.

KnowledgeBuilder

KnowledgeBuilder is a Windows application that is used to enter knowledge elements into the Knowledge Database. Each element may be a line of text, a text annotation file, an image or an audio or video object. These elements form the building blocks used to create the lessons. An advantage of breaking up the content into these elements is that they are reusable. For example, different tracks of the same lesson, while perhaps presenting differing levels of detail or expertise, will probably share many knowledge elements in common. Keeping them in one place allows for reuse and for the ability to edit an element and have it update in all the places it is used.

In KnowledgeBuilder, you add elements, giving them a descriptive, identifying name. They then have a title as well as a content. The content can be text or else a filepath that points to a media file. Elements can have keywords and KnowledgeBuilder provides the ability to do searches based on these keywords. Elements can also be related to other elements. KnowledgeBuilder also provides SCORM support for knowledge elements.

ScreenBuilder

ScreenBuilder is a Windows application that is used to create the lesson structure and lesson displays using elements created in KnowledgeBuilder. ScreenBuilder allows you to create, edit and delete lessons, tracks, segments and screens and add quizzes to tracks and segments. It allows WYSIWYG, drag-and-drop editing and formatting of elements dragged in from KnowledgeBuilder to produce displays much as one would with a word processor or a web editor such as FrontPage. Currently ScreenBuilder provides support for features such as colors, fonts, paragraphs, tables, lists, alignment, embedded audio and video, etc. There is also a preview

feature whereby the actual HTML is generated and displayed in a web browser, just as it will appear when generated by the TENOR server during an actual lesson.

ScreenBuilder also includes the ability to adapt displays for different target browsers. For example, you can create a screen targeting a fully featured desktop browser, such as Internet Explorer, Netscape, etc., and copy-and-paste it to target a browser for a handheld device, such as the PocketPC or Palm. ScreenBuilder will convert certain elements, such as audio, graphics or video, to have the most appropriate representation according to the capabilities of the target browser.

QuizBuilder

QuizBuilder is a Windows application that is used to create the quizzes, or tests, that are typically found at the end of each track and segment. You can define various types of quizzes, such as multiple choice, true/false, text input, list ordering and list matching. You can define the difficulty of the quiz, the percentage of questions a student needs to get correct in order to pass the quiz, impose time restraints, etc. Question pools are defined containing various questions; at runtime, the TENOR server will randomly choose which questions to actually display, so that the student will always get a different set of questions.

Administration Tool

This is a web-based (ASP.NET) tool to allow administration of the TENOR system as well as editing and viewing information specific to each student. For example, it can display a list of all students in the system with their contact information, level of expertise, which module they are currently assigned to, etc.

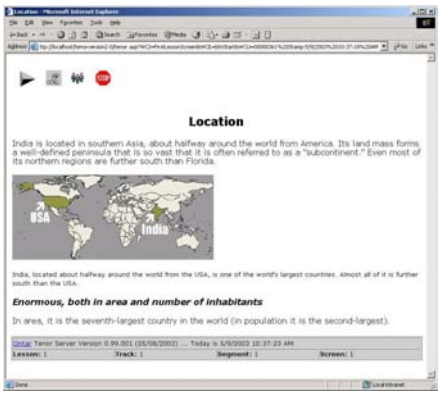
This tool is about half complete as of the end of the current “Tenor 1” Phase II contract, and will be completed as part of a “Tenor 2” contract.

5.0 TRAINING CONTENT

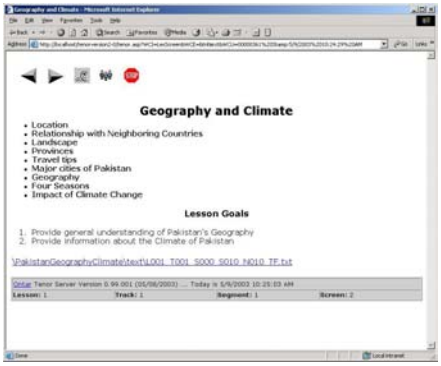
The TENOR system is currently being used to implement training for three applications: training in the culture, geography, and history of countries in the to support the US Air Force in Force Protection; training in medical protocols to support the US Air Force Research Laboratory; `and trains in RF signal identification to support the US Special Operations Command (SOCOM).

USAF Force Protection Training

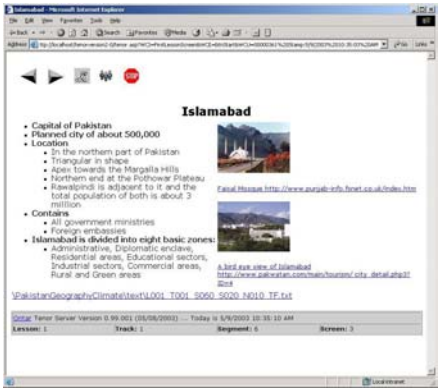
To the left and below are some example screen shots from various TENOR modules implemented to date. We start with the opening screen, which welcomes users to the training site and allows them to make a lesson selection. This screen identifies the training site and provides general information to the user about TENOR. This is the first step in the training system, requiring the student to log on and provide information that will be stored with the system for future sessions.



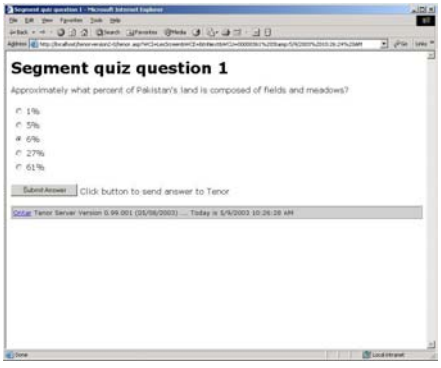
Next is an example of one of the screens from the lesson on India. Screens can be very simple, with a small amount of text and no visuals, to quite complex with photos, graphs, maps and audio and visual links. The selected screen to the left is one of the beginning screens in the lesson on India, therefore it contains some general information on the location and size of India. Each screen also contains navigation buttons at the top, allowing the user to easily move back and forth throughout the lesson screens.



Looking at the third screen, which is from the Pakistan lesson, you will see a difference in presentation style, screen layout and content from the previous screen to the left. This screen would be presented earlier in the lesson than the previous screen, as it gives an overview of the lesson's goals and the material that will be covered in the lesson. At the bottom of each screen is information identifying the screen through a unique series of numbers and letters.

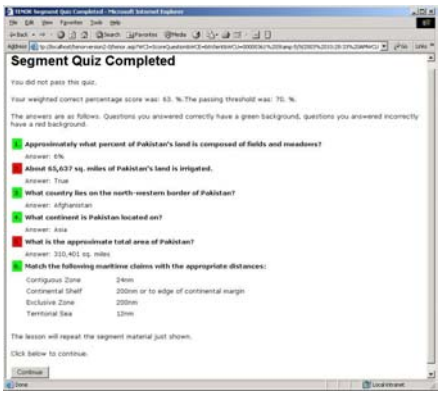


This screen provides much information to the user. It highlights the information considered most important, and identifies the material that will be covered in the lesson. It also contains photos, with links that will take the student to sites with additional, related information.



Finally, the navigation buttons and screen-identifiers are prominently displayed.

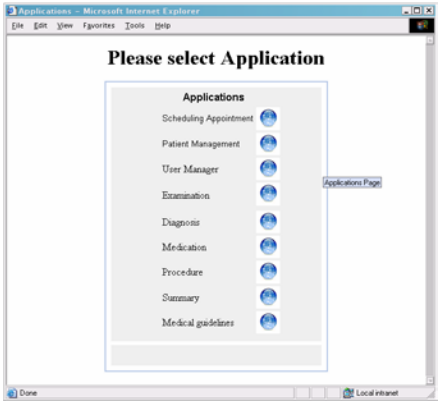
At the end of each lesson segment, the student will be given a quiz, as represented by the screen to the left. These quizzes vary in content, difficulty and presentation method, allowing for differences in learning styles. The content providers or lesson creators will define the quiz materials and weight the answers accordingly.



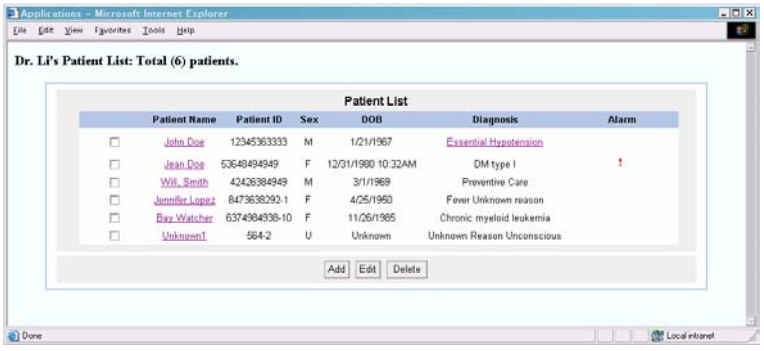
Once the student has completed the quiz and submitted it as per the screen instructions, another screen will appear. It will tell the student if he has passed or failed the quiz, and will provide correct answers to questions the student answered incorrectly. This status screen is an important part of the student's training, as it provides reinforcement and repetition necessary to learn and retain material.

US Air Force Research Laboratory

This work is developing a distributive and deployable training module that teaches military and counterpart civilian medical personnel an approved treatment protocol for interacting with physicians and other health care professionals.



Below and to the left are some screen shots showing a selection of patient encounter screens and follow-up procedures. We begin with a screen showing various choices for the healthcare professional to initiate the patient encounter. These choices include scheduling an appointment, making a diagnosis and arranging for follow-up tests or procedures. The button selected will bring the user to the next screen along the decision tree and provide additional information and resources where necessary.



This screen allows the healthcare professional to select the patient from a list. It also provides basic information to identify the patient by unique identifiers such as social security number, date of birth and gender, and provides a line for initial diagnosis and any alerts.

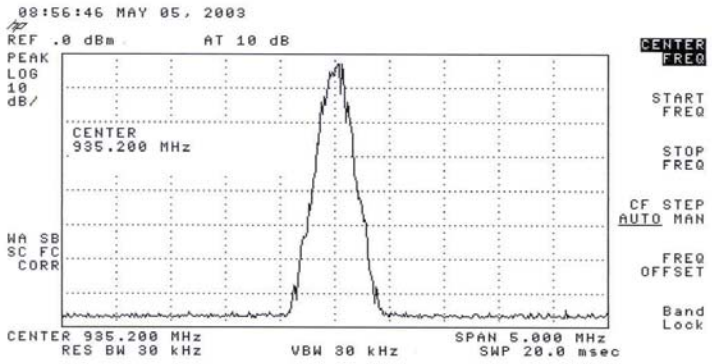
The problem screen provides spaces for the healthcare provider to input information he observes or is told by the patient. There is space for both objective and subjective observations, social history (such as whether the patient is a cigarette smoker or not) and patient assessment. Within each category, there is an "action" button,

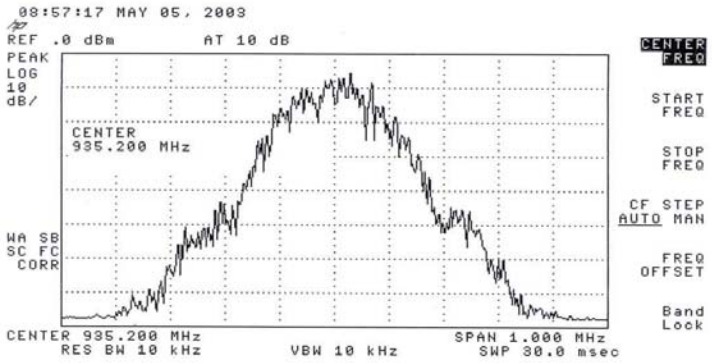
which allows the user to proceed to another action, such as seeking further information or prescribing treatment. The information screen to the right provides links to related reference material, symptom lists and descriptions, and treatment and decision aids.

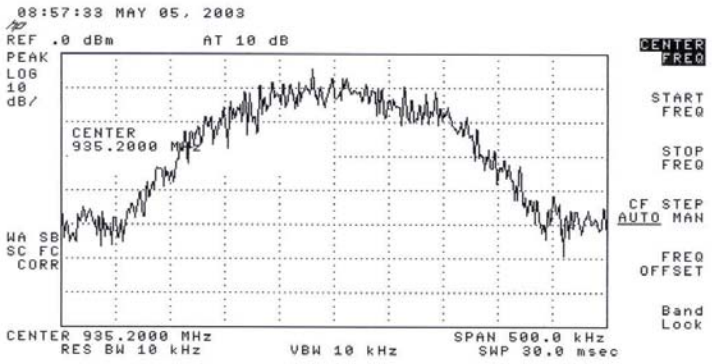
Finally, the Patient Appointment screen, far right, provides additional space for the healthcare practitioner to make annotations, schedule additional procedures and tests, and recommend follow-up visits. It also has links to related information and educational resources.

US Special Operations Command (SOCOM)

This work is developing a portable, lightweight threat warning training system that will fulfill the need for experienced threat warning soldiers. There is a need in the modern military to train soldiers in the detection and identification of RF signals such as cellular, radar, INMARSAT, military communications, etc. Currently soldiers are given what amounts to “on the job” training in signal recognition. There is no specific training system for this application. More specifically there is no system that would allow a soldier to train on these signals either in an informal setting, a formal “school house” setting, or in the field under simulated battlefield conditions.







This work is implementing a system to meet the signal identification training requirements of the modern military. The systems provides for informal video game-type training, formal classroom training, and transmission mode for field exercises.

The trainee has four modes of training: 1. Training by RF signal type; 2.Training by signal characteristics, e.g. frequency, bandwidth, number of tones, and modulation type; 3. Training by location, eg. country, local topography; 4. Training to recognize signals.