Collaborative Authoring of Serious Games for Language and Culture

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Abstract. This paper describes progress toward developing a set of collaborative authoring tools that support the rapid construction and adaptation of game-based courses for learning foreign language and culture. Earlier versions of these tools were used to create Tactical Iraqi[TM], a highly successful serious game for learning Iraqi Arabic language and culture, which is being used by tens of thousands of trainees in the U.S. military. They have since been extended to support the creation of multiple courses for different languages and user groups, and the adaptation of existing courses. On one extreme, these courses are designed to support distributed multidisciplinary teams in the creation of entirely new courses. On the other extreme, our goal is to enable individual instructors to configure and adapt courses to meet their particular needs. They must support the creation of simulation-based practice scenarios as well as lesson and exercise materials that prepare learners to engage in those practice scenarios. Finally, they must support the delivery of content on a range of platforms, from networked videogame PCs to iPods and other handheld devices. These authoring tools have been used on a range of authoring projects, e.g., to adapt Tactical Iraqi[TM] and Tactical Pashto[TM] for use by the Australian Defense Forces, to create a study supplement for Tactical Iraqi[TM] on iPods, and to create a pilot game to help preserve the Cherokee language and culture.

1. INTRODUCTION

Language and culture learning is an excellent application area for serious game technology. It is now possible to create game worlds in which learners must communicate in foreign language with other characters in order to succeed at the game. Such game experiences provide learners with rich opportunities to practice in the context of typical tasks and situations, much more so than in ordinary classroom instruction. The game format also helps motivate learners who otherwise might be intimidated by the prospect of learning a foreign language.

Alelo Inc., and its defense products subsidiary Alelo TLT, LLC, have created several game-based learning environments for foreign language and culture. These are complete course packages, including interactive lessons, simulation-based practice scenarios, reference materials, and course management tools. They may be used by individuals for at-home study, or may be incorporated into blended learning programs. They are developed through an integrated process of instructional design and game design, yielding learning systems that are interesting and fun to play, yet yield measurable learning outcomes. They are intended to help beginners with no prior knowledge of the language quickly acquire enough skill to be able to communicate effectively as part of particular tasks and missions. This contrasts with conventional training methods that require large amounts of training and instructor time, and frequently fail to produce effective job-relevant communication skills.

The first complete course developed using this paradigm, and the most successful one to date, is Tactical Iraqi[TM], which is used by coalition military forces to learn Arabic language and culture. Tactical Iraqi[TM] has been used by tens of thousands of soldiers and marines prior to their deployments to Iraq. It contains hundreds of hours of training material, and altogether teaches a vocabulary of over two thousand words of Arabic. Yet it also incorporates focused programs of instruction that enable learners with just a few hours of training time to develop skills that are most relevant to their particular job responsibilities.

Tactical Iraqi[TM] is a winner of multiple awards, most recently of the Serious Games Challenge at I/ITSEC 2007. There is substantial evidence to date of its effectiveness. An independent evaluation of trainees at Ft. Riley, Kansas found that trainees rated all components of the system favorably, and a third of them felt that they could effectively in Arabic in a final role playing exercise after only forty hours of blended training [11]. Reports from the field suggest that the knowledge gained from the course has been saving lives. For example, the 3rd Battalion, 7th United States Marines trained extensively with Tactical Iraqi[TM] prior to deployment in Iraq, and completed its tour of duty without a single combat casualty. Reports indicate that the 3/7 was able to engage the local populace and build trust immediately upon arrival in Iraq, and this helped secure the local people's cooperation and assistance.

From the beginning of this effort, as a research project at the University of Southern California, it was recognized that authoring tools would be critical to its success. It simply would not be possible to create complete courses with tens or even hundreds of hours of training materials without authoring tools to facilitate their creation. The fundamental challenge is to make course development faster, more reliable, less expensive and with increased quality. Also important is to make authoring "scalable" – to support creation of ever larger courses – and to encode the expertise necessary to

create the system so that a wide range of personnel can participate the in the authoring process. Ultimately, our goal is to turn the Tactical Language system into a platform that we as well as others can use to author courses that use our technology.

We have continuously improved our authoring tools and used them to create a number of courses and supporting materials. Military courses include Tactical Pashto[TM] and Tactical Dari[TM] for Afghanistan, and Tactical French[TM] for French-speaking sub-Saharan Africa. These were first created to support US Army and Marines, and have since been adapted to support the Australian Defence Forces and other coalition military forces. A nonmilitary course named Mission to Iraq[TM] has been developed, and pilot courses for other languages have been developed. Increasingly these courses are being developed in partnership with other organizations.

This paper gives an overview of the authoring toolset used to create Alelo courses. These tools are designed particularly to support multidisciplinary, often cross-organizational teams of developers, who create a rich variety of learning resources. This is particularly challenging since Alelo courses contain a variety of advanced technologies such as automated speech recognition, human-computer dialog, and learner modeling. At the other extreme, we are working to allow individual instructors to use authoring tools to customize and configure courses to meet their particular training needs. For example, this will make it possible to integrate Arabic-speaking non-player characters into mission rehearsal exercises created using authorable mission rehearsal development packages such as Virtual BattleSpace 2 (VBS2) or RealWorld®.

2. COMPONENTS OF A TLCTS COURSE

Tactical Iraqi[TM] and similar courses are built and delivered using a common platform, known as the Tactical Language and Culture Training System (TLCTS). The following is a brief summary of the main components of TLCTS courses. More examples can be found in other publications, e.g., [9].

TLCTS courses run on a videogame-capable personal computer, equipped with a noise-cancelling headset microphone and mouse. Each TLCTS course includes a Mission Game in which learners navigate through 3D worlds in which they must speak with non-player characters in the target language in order to accomplish their missions. As learners play the game they are scored both in terms of the game objectives they achieve and how effectively they use language.

Each course includes resources that help learners to develop their language and cultural skills, so that they can play the game more effectively. A Skill Builder includes interactive lessons that teach common words and phrases and cultural norms. The Skill Builder lessons make extensive use of speech recognition technology so that learners can practice and develop their conversational skills. They incorporate dialogs of varying complexity in which learners can converse with non-player characters. Interactive exercises also focus on language subskills, such as pronunciation, vocabulary recall, morphology, syntax, and pragmatics of social interaction. Most courses also include additional casual games that allow learners to practice their language skills in more focused contexts. A Reference Wizard provides glossaries of vocabulary and phrases used in the lessons.
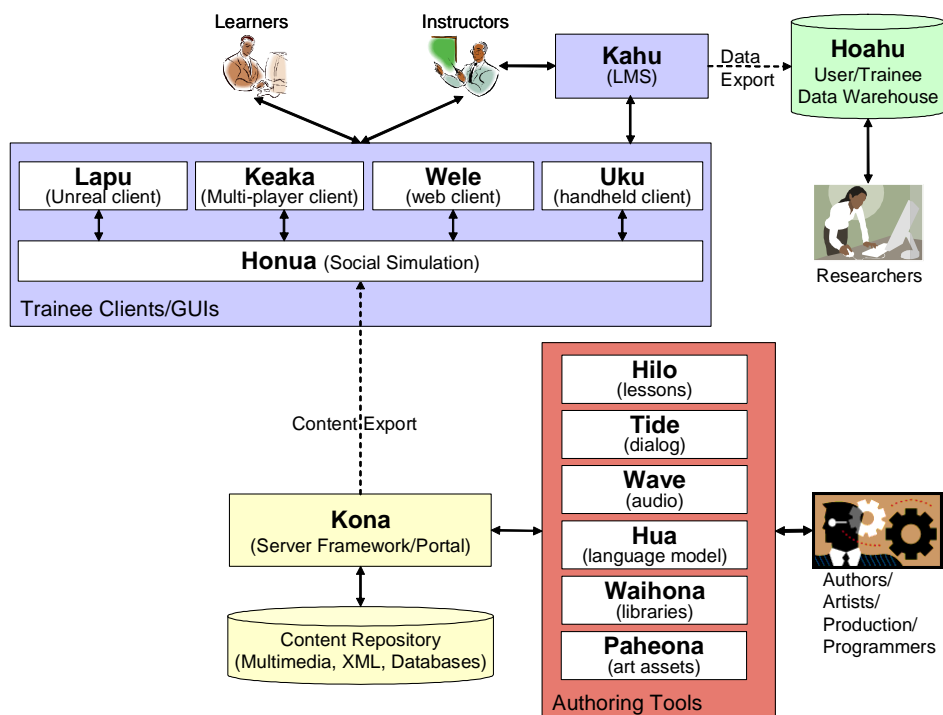

Figure 1. TLCTS architecture

3. ARCHITECTURE OVERVIEW

Figure 1 gives an overview of the current TLCTS architecture, and the toolset used to create training systems utilizing the architecture. This architecture has undergone progressive revision based upon feedback from users, as well as expanding and changing user needs. Further detail about earlier versions of the architecture can be found in other publications [7], [12].

All content in TLCTS courses, including specifications of game scenes, Skill Builder lessons, and supporting content libraries, are specified in XML. A server portal named Kona[1] maintains the repository and provides access to teams of developers (authors, animators, media editors, and programmers). Each course specification in Kona is a "book", containing as "chapters" specifications of individual lessons and game scenes. Team members can check out chapters, edit them, and then check them back in; an underlying version control mechanism prevents conflicts. Authors are supported by a collection of authoring tools, each of which focuses on a particular type of content specification, while providing access as needed to other content specifications that these refer to.

To create individual TLCTS learning systems for a particular delivery platform, content is automatically converted into file formats required for that platform. Currently the primary delivery platform is the Unreal 2.5 PC game engine, however other platforms are playing an increasing role. For example, a learning supplement has been developed for iPod (Figure 2); this allows learners to continue to practicing their language and culture skills when they are away from a computer. We are currently using the TLCTS architecture to develop non-player characters for Virtual BattleSpace 2 (VBS2) mission rehearsal scenarios. Details regarding multi-platform authoring may be found in [8].

Figure 2. iPod AudioBook supplement

This need to support multiple platforms poses a challenge for the authoring toolset. The tools, and the authors, cannot assume a single delivery platform, with specific display characteristics. To the extent possible, the tools need to support authors in creating content that can be displayed on multiple devices. The authoring

problem is further complicated by the role of advanced technology in TLCTS. Although other language learning systems employ speech recognition technology, natural language dialog technology, and intelligent tutoring technology [1],[2],[3],[4],[5],[6], TLCTS is unique in that it employs a combination of these technologies in complete courses that teach face-to-face communication skills.

4. COLLABORATIVE AUTHORING

TLCTS authoring tools are designed to support collaborative authoring and development by interdisciplinary teams. Subject matter experts in language, culture, and mission skills collaborate with artists, game designers, and programmers to create engaging serious games that achieve clear training objectives. The tools therefore must support coordination and efficient division of labor.

Our particular interest has been in developing authoring tools to empower subject matter experts to define simulations that are capable of spoken dialog with users. Although simulation authoring tools (e.g., [10]) are widespread, they typically focus on system behavior instead of virtual human behavior. We have been incrementally extending the authoring tools with validation and code generation capabilities, so subject matter experts can rely less and less on programmer support. We are also providing support for creating libraries of art assets, which subject matter experts can use to create lesson and game content. The art assets themselves are developed using common art production tools, such as Maya and UnrealEd.

5. SCENE AND DIALOG AUTHORING

The Tide authoring tool is used to specify dialogs throughout TLCTS. Dialog specifications are used in the TLCTS Mission Game to describe how non-player characters in the game react to and respond to players. Dialogs are also used extensively in the Skill Builder. The following types of dialogs are authored in the Skill Builder: example dialogs, which illustrate communicative skill between characters (as in Figure 2), mini-dialogs, which allow learners to practice short dialog exchanges with non-player characters, and active dialogs, in which learners engage in extended conversations with non-player characters.

The major challenge of dialog authoring is providing authors with the means to describe complex conversations, without having to learn specialized programming languages. We developed a tool called Tide (Tactical language Interactive Dialog Editor) which provides a number of views and components to help users specify interactive dialogs. Tide provides a range of methods to allow authors to build complex dialogs out of smaller parts and components.

A key element of Tide is the ability to author the behavior of interactive characters in two layers. In the first layer, authors specify *utterances* that users can

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[1] System components in the TLCTS architecture, as well as the Alelo Inc. itself, have names with Hawaiian origins, reflecting the Hawaiian connections of the first author (e.g., see http://www.longmountainkona.com).

speak. In the second layer, we manage the possible *acts* the user can perform. Tide provides tools for authors to specify both of these and their connections, i.e. which utterances mean the performance of each act. We have recently implemented a more complex specification of the utterances through *utterance templates* [13] – mini grammars of possible ways to perform each communicative act.
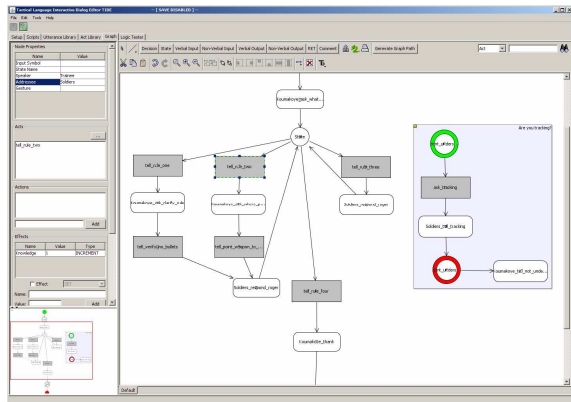

Figure 3: Tide authoring tool.

Tide allows authors to specify dialogs in two main ways: as *scripts* and *interactive dialogs*. Scripts are linear sequences of communicative acts (usually involving an utterance being spoken by a character). Scripts can be used directly as the basis for example dialogs in the Skill Builder, as well as paths inside larger, interactive dialogs. Interactive dialogs are currently specified as a special type of graph. Figure 3 shows a screenshot of Tide displaying an interactive dialog graph. Because it resembles on the surface a flowchart, this type of graph makes it easier for authors to learn and visualize the interaction flow. At the same time, we designed specific graphical constructs that allow the construction of complex interactions in a concise way. An example of such construct is a Range-Enabled Transition or RET. RETs provide users with the ability to create snippets of interactions and reuse them by activating and deactivating them in certain regions of a larger dialog. This is used, for example, to easily intersperse in many different paths dialog interchanges that do not directly move the story forward (although they may have side effects that can affect outcomes, e.g. increasing or decreasing trust).

6. SKILL BUILDER AUTHORING

We built a tool called Hilo to author the Skill Builder. Hilo allows users to edit all the elements of lessons, such as instructional pages, exercises, etc. Some pages contain links to dialogs they display, such as example and active dialogs. Each page type has its own editor. Special emphasis is paid to blocks that contain utterances in the foreign language. Utterances are modeled in different channels – the native orthography of the foreign language, an "ez-read" transliteration that is intended as a phonetic transcription in Roman characters, a phonetic transcription used by the speech

recognizer, and a translation in English. Entries in the displayable fields can be colored and marked-up to help in instructional contexts. Each utterance is also linked to the language model library (see below) so it can be centrally managed. Additional per-language tools are provided to support creation of some channels based on others. For example, a tool is provided for authoring French that proposes phonetic transcriptions for utterances written in standard French orthography. The tools also allow authors to link multimedia assets to a page or page components, including voice recordings of native speakers, images and videos.

Figure 4 shows a screenshot of Hilo authoring a French instructional page. Notice that channels are displayed in fields with different colors.
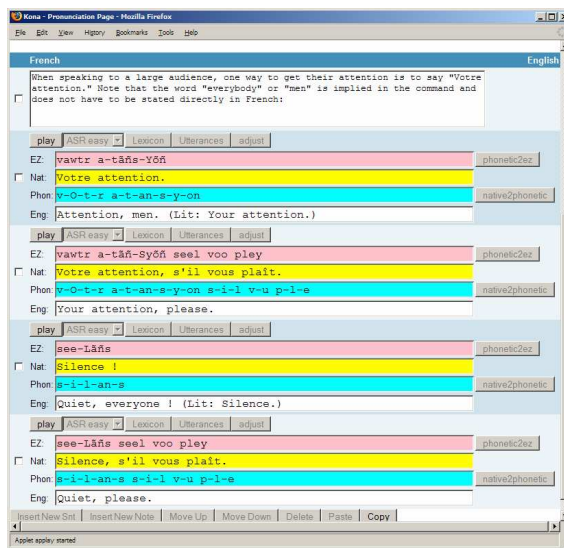

Figure 4: Hilo Lesson Authoring Tool.

In order to help manage activities from many different authors, the system provides version control mechanisms that "lock" lessons while they are being edited by an author, and save each revision. There are also mechanisms to tag pages so we can create and manage variants at the page level that are intended for a specific client (e.g., the ADF) or a specific target platform (e.g., the AudioBook).

7. LIBRARY AUTHORING

As the courses become larger, it becomes harder to manage large numbers of components and abstractions that need to be authored and used in different parts of the courses. These problems affect authoring (e.g., how can we make sure we are using in the game vocabulary that was taught in the Skill Builder?), production (e.g., how can we efficiently produce and link large number of recordings from native speakers), art (how can we manage the myriad of images and models used in the 3D world) and software configuration management (e.g., how can we make sure no multimedia assets are missing from a released system).

We have created different tools for specific libraries. First, the Hua tool manages the language model, which

contains the library of words and utterances that are taught in the course. Second, the Wave tool helps produce and manage voice recordings (the courses use specially produced recordings from native speakers instead of a speech synthesizer). Third, Paehona manages multimedia files – images, videos, sounds. Finally, the Waihona tool provides editors and manages abstract entities such as game characters, acts, skills, scene blockings, etc.

These library tools allow us to increase the speed of authoring and production processes, improve the quality of the delivered system, and reduce costs by improving reuse. A specially important role is to allow the creation of automated tests that analyze the content of the system and find possible inconsistencies and bugs – missing image, mismatched recordings, misspelled words, etc.

8. RESULTS TO DATE

As these improved authoring tools have been developed and put into use, they have yielded increases in the quantity and quality of material produced, and reductions in the time required to author new materials.

Table 1 shows how improvements in authoring tools have increased authoring productivity. It compares Tactical Iraqi version 3.1, developed in 2006, Tactical Iraqi 4.0, developed in 2007, and Tactical French, also developed in 2007. The new authoring tools have made it possible to double the content in Tactical Iraqi, as measured by the number of lesson pages, vocabulary words, dialogs, and Mission Game scenes. Tactical French, which was not started until after Tactical Iraqi 3.1 was released, already has approximately as many lesson pages and vocabulary words as Tactical Iraqi 4.0, and more active dialogs. Authoring productivity for Skill Builder materials has thus increased substantially. Authoring productivity for Mission Game scenes has increased somewhat less rapidly, reflecting the fact that these scenes continue to make heavy use of tools such as Maya and UnrealEd for creating models and game levels, and these tools have not substantially changed.

Table 1: Content size of TLCTS courses.

Content Metric	TI 3.1	TI 4.0	TF 1.0
Lessons	35	52	40
Lesson pages	891	2027	1920
Words	1072	2214	1820
Example dialogs	42	85	67
Active dialogs	13	29	36
Scenes	8	18	9

Because the TLCTS authoring toolset makes it easier to produce interim versions of learning systems, we are increasingly able to provide external experts with interim versions of our training systems. For example, Dari experts working for the Defense Language Institute have been reviewing interim versions of a new Tactical Dari course which is under development, and providing us with feedback. This will help to ensure that by the time the course is completed it will already be fully validated and ready for use in training.

We are also increasingly using our authoring tools in collaborative projects with other organizations. Thornton Media Inc. licensed the TLCTS platform, and used it, without Alelo's support, to create a pilot game named *Rez World* that requires players to speak in the Cherokee language in order to play the game. Other versions for other Native American languages may be developed in the future. This is intended as a vehicle to help preserve Native American language and culture. These projects are useful interim steps toward the goal of enabling external organizations to license the TLCTS toolset and create their own training courses and games.

Another indication of the effectiveness of these authoring tools is the effectiveness of the training systems they have been used to create. For the example, the 3rd Battalion, 7th Marines (3/7 Marines) assigned two members of each squad to spend a minimum of 40 hours of training in Arabic, using a combination of Tactical Iraqi[TM] and classroom instruction. After returning from Iraq, the officers of the 3/7 reported that Tactical Iraqi[TM] definitely increased the unit's operational capability.[2] They were able to perform more operations without relying on interpreters, increased their tempo of operations, increased their understanding, and most importantly improved their relationship with the Iraqis.

9. NEXT STEPS

Work on the TLCTS authoring tool suite continues, to further reduce the reliance on programmer expertise, to increase the sophistication of the authored content that is produced, and to increase the range of learning environments that can be authored. The following sections describe two examples of ways in which the authoring tools are being extended: to author content for higher language proficiency levels, and to author mission rehearsal exercises.

9.1 Authoring content for higher proficiency levels

As learners are gaining knowledge of foreign language with TCLTS, there are increasing demands for advanced language training, so that Marines can score highly on spoken proficiency tests and even obtain college credit. We are therefore extending the content in Tactical Iraqi[TM], Tactical French[TM], and other TLCTS courses to help learners achieve intermediate-level language proficiency. This in turn requires us to extend the capabilities of our authoring tools to support more complex exercises and more complex language.

A hallmark of intermediate-level language production is the ability to use language in unrehearsed contexts, without reliance on memorized phrases. Accordingly, we are extending Tide and Hilo to support more complex dialog. Authors will be able to author nondeterministic dialog models, in which non-player characters can choose randomly from among a range of possible communicative acts, and randomly select different utterances for realizing those communicative

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[2] Marine Corps Lessons Learned study, in preparation.

acts. On the input side, we are introducing *utterance templates* into dialog models, i.e., grammars that specify a variety of possible ways of expressing each communicative act. Learners will no longer be limited to a specific set of phrases in the foreign language, but will be able to express their intentions in a variety of different ways, using the vocabulary and grammatical structures that they have learned.

As we increase support for high proficiency learners, it is important to continue to support learners who have limited training time and more modest learning objectives. We are therefore extending the Skill Builder authoring tools to mark material according to training objectives. If a learner indicates that he or she desires to achieve higher proficiency levels, the Lapu Unreal client will automatically propose training programs with more instructional content, including lesson materials that provide an in-depth grounding in language and culture, and exercises and dialogs that challenge learners to apply their communication skills in relatively unrehearsed situations.

9.2 Mission rehearsal authoring

As military trainers recognize the increasing importance of communication skills in military operations, there is an increasing demand for simulation-based training systems that combine foreign language skills with other military skills. Accordingly, we are developing a multi-player mission rehearsal platform named Keaka that allows military teams to engage in simulated exercises that require them to communicate with multiple non-player characters in foreign language. Trainees will be able to develop their communication skills in TLCTS learning systems, and then test their skills in Keaka. Keaka utilizes multi-agent simulation and communication middleware that can integrate with multiple game engine platforms. The first version integrates with the Lapu Unreal client, and we plan in 2008 to integrate with RealWorld and VBS2 as well.

Our goal is to provide trainers with the ability to author and configure scenarios including non-player characters that communicate in foreign language. This will require close integration between existing Keaka authoring and the authoring tools of the host training platform. For example, we will augment the VBS2 scenario editor so that trainers can populate virtual worlds with non-player characters, specify the roles that those characters play, and the dialog models that they should employ. We will provide authors with a prebuilt library of dialog models, which can also be modified and extended using the TLCTS authoring toolset. We will also provide a range of generic dialog capabilities, so that all characters will be able to engage in conversations on a range of topics, limited by their internal knowledge of the world and their degree of trust in the player characters.

ACKNOWLEDGMENTS

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