# Evaluation of Adaptive Hypermedia Systems' Conversion

Alexandra Cristea
Information System Department,
Faculty of Mathematics and Computing Science,
Technical University Eindhoven,
Den Dolech 2, PO Box 513,
5600 MB, Eindhoven, The Netherlands
+31 402474350
a.i.cristea@tue.nl

Craig Stewart
School of Computer Science and IT,
University of Nottingham, Jubilee Campus,
Wollaton Road, Nottingham,
NG8 1BB, UK
+44 115 8466505
cds@cs.nott.ac.uk

Helen Ashman
School of Computer Science and IT,
University of Nottingham, Jubilee Campus,
Wollaton Road, Nottingham,
NG8 1BB, UK
+44 115 9514231
tjb@cs.nott.ac.uk

Paul Cristea
Digital Signal Processing Laboratory,
"Politehnica" University of Bucharest,
Spl. Independentei 313,
Bucharest 77206,
Romania
pcristea@dsp.pub.ro

## ABSTRACT

Conversion between different adaptive hypermedia systems has barely been proposed, yet alone tested in realistic settings. This paper presents the evaluation of the interoperability of two adaptive (educational) hypermedia systems, MOT and WHURLE. The evaluation is performed with the help of a class of thirty-one students enrolled in the fourth year of the "Politehnica" University of Bucharest, who were taking a one-week intensive course on Adaptive Hypermedia. This paper describes and interprets our first experiments of the "write once, deliver many" paradigm of adaptive hypermedia creation.

## Categories and Subject Descriptors

I.2.4 [**Artificial Intelligence**]: Knowledge Representation Formalisms and Methods; H.5.4 [**Information Interfaces and Presentation**]: Hypertext/Hypermedia - *architectures, navigation, user issues*; H.3.3 [**Data**]: Data Structures - *distributed data structures, graphs and networks*; K.3.1 [**Computers and Education**]: Computer Uses in Education - *distance learning.*

## General Terms

Experimentation, Human Factors, Theory, Verification.

## Keywords

adaptive hypermedia, authoring, interoperability, evaluation.


*Conference'04*, Month 1–2, 2004, City, State, Country.


## INTRODUCTION

Adaptive Educational Hypermedia (AEH)[3] deals with the issue of providing a personalized educational experience. Rather than a learner having to read through every piece of content whether or not it is appropriate, an AEH system will adapt its presentation of content to the learner's needs – this adaptation being informed by a User Model.

However the creation of adaptive content can be a complex and time consuming task. Imagine an AEH system that adapts around the learners Visual::Verbal Learning Style [5], at its simplest an author would have to create 2 instances of the same lesson, one for those students who learn more effectively from primarily visual information and one for those who are more inclined to textual or verbal learning. Therefore authoring for a personalized AEH learning experience is labour-intensive. One of the issues that aggravates the problem of AEH authoring is the fact that often each AEH has its own authoring system. Materials authored for a given system are only viewable within that system. As AEH systems undergo research and improvement [3], it can be almost impossible for a non-technical author to stay up to date. In response to this we have proposed a new paradigm for AEH authoring, 'write once, use many' [8], whereby an author only has to learn to author for a single AEH system, and the materials from this system can be converted into any other AEH system, future-proofing the content. So far we have used the AEH system MOT as an authoring system for three other Educational Hypermedia systems, AHA! [4], WHURLE [6] and the commercial system Blackboard [7]. It is hoped that each conversion will reveal the fundamentals required for a more generic conversion system. However each conversion system needs to be tested with the audience it has been designed for — the AEH authors themselves — as the aim of this work is not only to reduce author load but to ensure that the authoring process itself is as easy and trouble free as possible. In this paper we describe an experiment in which we examine the authoring process.

A class of 31 students has been introduced to authoring for MOT & WHURLE in an intensive short course, and their progress and responses to this new methodology were recorded in a series of questionnaires.

The remainder of this paper is structured as follows: Sections 2 & 3 introduce the two AEH systems involved (MOT as an authoring environment and WHURLE as the delivery environment), with Section 4 briefly describing the conversion system [8]. Section 5 details the experimental settings, and Section 6 the hypotheses we evaluated. Section 7 presents the results. Finally we conclude in Section 8.

# 1. MOT PRESENTATION

MOT [4] is a web-based generic adaptive hypermedia authoring system based on the LAOS framework [4]. For the purpose of our current paper, this means that MOT allows the creation of domain concept maps (DM), containing the actual resources clustered as content alternatives, and the creation of lessons (GM), based on these domain maps, that allow a restructuring and filtering of the contents. One of the interesting features of the GM, which was of use to the students during the tests presented in this paper, is the functionality of pedagogical labelling of previous concepts from the DMs. Concepts (containing conceptual alternatives, such as text, figure, etc.) can be weighted and pedagogically labelled (e.g., a figure concept labelled 'vis' for visual, and a text concept 'ver' for verbal, as per the ILS questionnaire [5]). For more information on MOT, refer to [4].

# 2. WHURLE PRESENTATION

WHURLE is an XML based, on-line integrated learning environment, which is designed to deliver content that is personalised to the needs of the learner. The learner is presented with a lesson, which is constructed from a collection of underlying educational resources. Resources in WHURLE are objects called *chunks*. Each chunk is a conceptually discrete piece of information with no links to other resources (such as external web pages). Owing to the flexibility provided by WHURLE's use of chunks (through the conditional transclusion of chunks appropriate to each learner [6]), adaptation may be implemented at the content level to determine which chunks are made available to each class (group or 'stereotype') of learner.

# 3. MOT TO WHURLE CONVERSION

Authoring materials in MOT (section 2) and delivering these materials in WHURLE are both simple tasks. In the former an intuitive web-form-based process is used to create and order materials. With the later, the learner has only to register for a given lesson and the relevant materials are adapted for personalized delivery. The conversion itself is currently slightly more complex than either of these processes. Initially the correct weights have to be applied to each MOT concept. As detailed in Section 2, MOT's GMs can have their concepts identified by both a *label* and a *weight* (see Table 1). It is by using these that the MOT to WHURLE converter can identify which concepts are to be delivered to a given learner. Whilst there are a range of weights and labels that can be used during the conversion the students in this exercise were told to use the weights and labels in Table 1 to keep the authoring process straightforward.

**Table 1: MOT weights & labels used to identify which concepts would be appropriate for learners with a given preference for the ILS learning style [5].**

| MOT Concept Weight | MOT Concept Label | WHURLE learner group |
|---|---|---|
| 0 | n/a | Everyone |
| 35 | Vis | Visual preference |
| 75 | Ver | Textual preference |

Using these weights and labels to group concepts for similar types of learners, the conversion system maps the MOT structure into a similar structure in WHURLE. Each of MOTs lesson concept groups are associated and transformed into WHURLE chunks, with each chunk being appropriate for a given learning preference.

**Table 2: Creation of WHURLE chunks from MOT concepts.**

| MOT components | | | WHURLE components | | |
|---|---|---|---|---|---|
| *Attribute* | *Weight* | *Label* | *'every-body' chunk* | *Visual prefs chunk* | *Textual prefs chunk* |
| Title | 0 | | ✓ | ✓ | ✓ |
| Keywords | 0 | | ✓ | ✓ | ✓ |
| Introduction | 0 | | ✓ | ✓ | ✓ |
| Text | 75 | Ver | | | ✓ |
| Conclusion | 0 | | ✓ | ✓ | ✓ |
| Figure | 35 | Vis | | ✓ | |
| | | Chunks: | C1 | C2 | C3 |

Table 2 shows how, using the concept labels as described in Table 1, the conversion process will create three WHURLE chunks (C1, C2 & C3) by associating: all of the weights of '0' (C1), associating all of the weights of '0' and '35' (C2) and associating all of the weights of '0' and '75' (C3). Once these weights and labels have been established, the conversion program will automatically convert the MOT lesson into a WHURLE LP with chunks, and register the LP within the WHURLE mysql database. More details on this conversion process can be found at [8].

# 4. EXPERIMENTAL SETTINGS

A class of 31 students, in the 4th year of study for a technical Masters at the University of Bucharest, Romania attended an intensive weeklong course on AEH. The week started with two half-day lectures, whereby the basics of the subject were introduced, followed by a three-day assignment. The assignment was performed by breaking the class down into six groups of 5-6 students. Each group had to use MOT to create a series of DMs then a single GM from them. This GM was then converted into a WHURLE LP, and the entire process evaluated.

Further details of the task each group undertook and the questionnaires can be found at:
http://wwwis.win.tue.nl/~acristea/AH-Ro/

# 5. HYPOTHESES AND EVALUATION GOALS

We have decided to evaluate various aspects of the experimental setup. The focus described in this paper was to test the ease of use of the AEH creation process using MOT, MOT-to-WHURLE and WHURLE. To this end we used the SUS [2] questionnaire for a comparative evaluation of each system, and a separate questionnaire to determine the students evaluation of the authoring process. Our hypotheses were:

1 *The systems (MOT, mot2whurle, WHURLE) are simple and intuitive, can be used with a minimum amount of explanation.*
2 *The students used MOT purely for authoring adaptive hypermedia, and perceived it as such.*
3 *The students used WHURLE solely for delivering adaptive hypermedia, and perceived it as such.*
4 *Students consider automatic conversion between one-to-many or many-to-many adaptive hypermedia systems useful.*
5 *Using MOT, MOT2WHURLE and WHURLE makes authoring for AH a simple task.*

Beside these hypotheses, the aim of the evaluation and testing was to gain information for further development of the conversion system in particular, and the other two systems.

# 6. EXPERIMENTAL RESULTS

*Hypothesis 1:* The SUS scores (a percentage value used to *compare* the scores between each system) validate to some degree hypothesis 1. We conclude that, as MOT received the highest SUS score (75%), we have chosen a comparatively simple and 'usable' system for authors to create AEH materials within. WHURLE received a slightly lower SUS score (67%), which supports the view that using MOT for authoring is advantageous for the author. Finally the MOT2WHURLE conversion system had the lowest SUS score (61%) and as such requires, comparatively, the most work to ensure ease of use for AEH authors. Hypothesis 1 is also validated by the qualitative fact that the students were able, during one-week, to produce content with MOT, and visualize it in WHURLE.

*Hypothesis 2:* is validated by the majority of students (25 from 29) preferring MOT to be an AEH authoring system (an additional student classified it as an AEH hypermedia system, the rest did not answer).

*Hypothesis 3:* is validated by 21 students preferring WHURLE to be an AEH delivery system.

*Hypothesis4:* is validated as the students' replies were very positive with an average of 4.57 (out of a maximum of 5), and variance of 0.77.

*Hypothesis 5:* The hypothesis is validated by examining the responses from the questionnaire to MOT, MOT2WHURLE and WHURLE. With MOT the students almost unanimous that they understood how the system works (average 4.92 out of 5) and their direct admission that MOT was easy to use (4.6 out of 5). Students also understood the MOT2WHURLE conversion (4.3 out of 5), they considered it useful (4.25) but were less sure about its ease of use (3.4 out of 5). A great majority of students (4.5 out of 5) declared they understood how WHURLE works; that the system is useful for adaptive hypermedia delivery (4.2 out of 5); and that they would want to experiment with it later on (4.1 out of 5).

# 8 DISCUSSION & CONCLUSION

This paper is, to our knowledge, the first attempt to empirically test the conversion process between two adaptive hypermedia systems, by using one system for authoring and another for delivery of AEH materials. We have gathered data about the process, some of it validating goals to:

1. strive towards a *write once, deliver many* paradigm
2. create an easy to use conversion system between a given AEH system (MOT) and others, such as WHURLE

The comments gathered from our test authors validate our primary goal, that using a single authoring platform to write materials for multiple delivery systems is indeed greatly desired by authors of AEH content. Even novice authors with only a modest introduction to the subject understand the issues involved and that the level of re-use of AEH materials offered by the approach is valuable. The SUS results indicate that comparatively the conversion system was the hardest part of the authoring process and as such requires the most work. However that the students results show that they understood the entire process, and overall found it easy to use, validates our secondary goal

This paper gives only a brief outline of the results gained from this experiment, but the authors believe that it demonstrates that interfacing multiple systems is both a) possible and b) desirable for AEH authoring.

# 9 ACKNOWLEDGEMENTS

This work is supported by the Minerva Socrates project ADAPT [1] (101144-CP-1-2002-NL-MINERVA-MPP), and the Socrates mobility exchange program.

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