CRIM: Curricular Resources in Interactive Multimedia[1]

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Introduction

A search of the World Wide Web for multimedia jobs, using the search terms "interactive, multimedia, and career", indicates over 9 million pages which discuss, provide or offer placement in a career which in some way incorporates the use of Interactive Multimedia. The sites involved range in discipline coverage from medical areas to space-related jobs to areas of security—and all technical and business-related pathways in-between. McGee and Russell report a serious shortage of Information Technology workers by the year 2005 with the most sought after jobs requiring Internet, Java and Web-centric skills [4][5]. On the other hand, a search for courses or syllabi for materials on Interactive Multimedia (IM), using search terms of "interactive, multimedia, and syllabus" yields less than 5,000 hits. The demand is outpacing the supply.

Interactive Multimedia covers some of the most technologically important areas in the broad field of information technology, computing and communications. Enormous investment has been made in the last decade to develop faster networking, tailored computer systems, usable authoring software, edutainment packages, and a wide variety of applications. Low cost storage and ubiquitous networking have moved multimedia access into the mainstream of the rapidly growing World-Wide Web. Requirements for multimedia streams are helping drive our society toward Internet 2. Tens of billions of dollars of our economy relate to these technologies, that now underlie the Information Age and flow over the Information Highway. Some of the most innovative work in the science/engineering world deals with solving hard problems in compression, processor design, computer interfaces, and communications (with acceptable quality of service) [6][7][8][9][10].

The serious lack of trained personnel in this field [4] is due in large part to the lack of education and training available at the undergraduate level. The reasons for this are many-fold. First, the typical computing curriculum [1], especially within CSAB accredited schools, is highly structured. It is not easy for new courses to make their way into the curriculum (though the first author will work to incorporate IM-related changes in Curriculum 2001; these will be reported in the final version of this paper). Secondly, there are many fields that lay claim to Interactive Multimedia: education, computer science, graphic design and communication to name a few. The polysemeous nature of multimedia has made it difficult to build a cogent core of curricula materials. Additionally, many of the faculty interested in these curricular areas are

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not well versed in the issues related to interactive multimedia and even for those that are, there is little promotion and tenure incentive for new course development.

There are no comprehensive guidelines or even collections of materials available for curricula in this field. Few universities have courses in the area, and those courses suffer from a severe lack of suitable textbooks. This leads to a vicious cycle: publishers are reluctant to publish textbooks until there is a market for them, and courses are hard to introduce unless they can be supported by a good textbook that fits with the instructor's goals. New instructors often start from scratch to construct course notes or to design the laboratories that are important for hands-on experience with tools or to support group projects. There are no comprehensive readings volumes or bibliographies. There are few collections of case studies or projects, few sets of exercises, and no large test banks. Popular interest and curiosity has created a tremendous demand for knowledge that is largely unfulfilled, and many misconceptions or limited understandings have resulted. For example, developers of multimedia applications are unaware of key concepts and tools prepared by those researching into authoring systems that would provide a framework and support for their efforts.

Given the complex and varied nature of the field and the varied practitioners involved, no one set of curricular materials would be easily adopted by all parties. There is much less agreement on learning objectives regarding interactive multimedia than about data structures. Furthermore, complete materials created for a multimedia course in graphic arts or educational technologies would not adapt directly to a course in computer science. The key concept of the Curricular Resources in Interactive Multimedia (CRIM) project is to improve CS education by building and providing a repository of curricular materials that can be used in a variety of ways. This draws upon the concept of Knowledge Modules developed in Curriculum 91 and from the SIGCHI project [3], which seems particularly appropriate for interactive multimedia.

CRIM will adopt and adapt many of the features of the ACM SIGCHI educational development model. SIGCHI commissioned a group to work on curricula in the human-computer interaction field, which led to very influential guidelines [3]. The CRIM materials will include all educational resources from a complete syllabus used to build an entire course to a single example that could be used as part of a lecture. Individuals should be able to add or enhance modules to existing courses to introduce concepts from the IM field, add or enhance undergraduate level courses in or related to IM, and add or enhance curricula and programs in the IM area. Given an extensive and comprehensive repository, a new methodology for developing curriculum and courseware in high tech areas will be perfected.

Digital Library / Repository

The CRIM project collection is based on the concept that materials should be adaptable to courses or parts of courses. Table 1 indicates an organization of materials on such topics as multimedia overview, the impact of multimedia on culture (and vice-versa), the description

of media (including text, audio, video, graphics and animation), the production of interactive multimedia projects, their maintenance, and their distribution. These topics might be available in a multitude of courses, such as Multimedia Design, Data Structures, Artificial Intelligence, Algorithm Development, and Ethics and Social Issues, to name a few. The concept is to provide materials at such granularity and with index information to allow, e.g., a faculty member working in software engineering to find material to use in their course. Such a course item might be an extended waterfall production model of multimedia, that can be used to augment a lecture on waterfall designs in software engineering. Further, a faculty member teaching a course in human factors might be able to find a complete lecture in the CRIM repository that (s)he could use to discuss the role of culture in interface design.

Topics	Multi media Design	Human Factors	Data Stru cture	Softw are Engin eering	AI	Prog ram ming Lang	Algo rith ms	Natural Lang. Processi ng	Ethics and Social Issues	Hard ware Devel
Overview	*	*							*	*
Culture	*	*						*	*	
Media	*	*	*		*	*	*	*		*
Production	*	*		*		*	*		*	*
Maintenance	*			*			*			
Distribution	*	*			*			*	*	*

Table 1: Typical Topics and Courses related to Interactive Multimedia materials

The original design for CRIM [http://www.seas.gwu.edu/guest/crim/cgi/snglsrch.html] allowed users to select the course, the content, and the type. The courses listed included among others: Multimedia Design, Multimedia Product Development, Audio/Video Media Production, Human-Computer Interfaces, Data Structures and Algorithms, Software Engineering, Artificial Intelligence, Programming Languages, Natural Language Processing, Software Quality Assurance, and Graphics. The content included overview topics, cultural topics, and items about text, graphics, audio, video, and maintenance. The types listed included: syllabi, lecture notes, illustrations, discussion questions, exercises, projects and test questions. This prototype was presented at the ACM Multimedia'98 meeting at Bristol at a workshop designed to get potential user input to help direct the creation of the CRIM repository.

Based on the user reaction and in order to prepare the CRIM repository, a mechanism was needed to describe each submission. Using the Dublin Core metadata elements as a starting point, the standard 15 items were extended with supplements using names to clarify the intended meaning. Table 2 explains the syntax and semantics.

Note that many of the Dublin Core (DC) elements have easily understood semantics. However, for the Type element, we have devised a specialized scheme suitable for IM, shown in Table 3. In other words, users can enter a top level type, like Image, and a second level type, like Photographic, to describe a resource.

DC Element	CRIM Description	Supplements/Fields
Title	Title of the work product	
Creator	Primary author of the work product (with contact details), plus the name and email for other authors	Primary.PersonalName.LastName, Primary.PersonalName.FirstName, Primary.Email, Primary.MailingAddress, Primary.Institution, Primary.Department, PersonalName.LastName, PersonalName.FirstName, Email
Subject	Keywords or phrases describing subject/content, including 2 types of ACM controlled vocabulary	ACMClassification.TopLevel, ACMClassification.SecondLevel, ACMCurriculum
Descrip-tion	Textual description (e.g., abstract)	
Publisher	Publisher or distributor	
Contribu-tor	Others beside creators to be acknowledged	
Data	Date submitted/published	
Type	Category of resource: see Table 3; also MIME-types	
Format	Media and platform info.	Programming Language, Platform, Tools
Identifier	Unique ID	
Source	Source (e.g., ISBN of book from which adapted)	
Language	Language code (3 letter)	
Relation	Relation to other items in the repository	
Coverage	Coverage in terms of geography or time	
Rights	Rights management, terms and conditions for use	

Table 2: Dublin Core (DC) Elements, Sub-elements, and CSTC Fields

Top Level	Second Level
Data	Numeric, Spatial, Spectral, Statistical, Structured-text
Image	Graphic, Photographic
Interactive	Chat, Games, Multimedia, VR
Moving	Animation, Video
Sound	Ambient, Effect, Music, Narration, Speech
Software	Executable, Source
Text	Article, Monograph, Proceedings, TechReport, Serial, Syllabus, Thesis (Bachelors, Masters, Doctoral), Typography,

Table 3: Adapted Items from Dublin Core "Type" Options

In addition, the standard MIME-types (e.g., video/mpeg) can be entered. Moreover, an item described as text at the top level could at the second level be described by the nature of the textual unit, including the typography. Due to their frequency, it is especially important in the study of IM to identify details of materials including textual elements.

Using these meta-tags, a document could be submitted to the CRIM repository and retrieved in a number of ways. For example, a faculty member could query the repository looking for a PowerPoint lecture on petri nets for use in an algorithms course. Figure 1 shows part of the user interface for categorizing a resource.

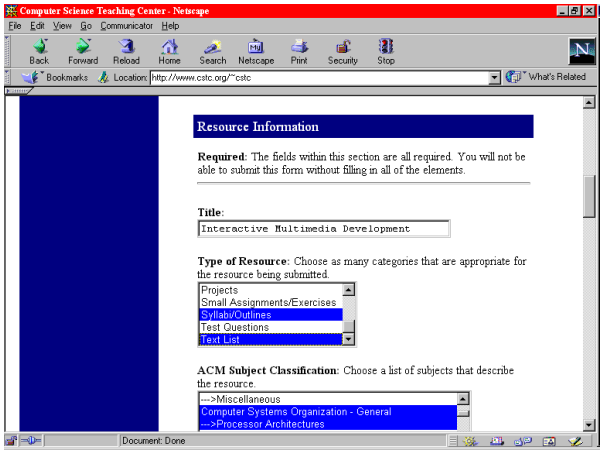

Figure 1. Screen capture of the submission form.

The final design decision for the repository was the presence of reviews and vetting of the material. There is a range of philosophies for collecting materials, as was discussed in-depth in connection with planning for NSF's work on a Science, Mathematics, Engineering, and Technology Education digital library to support undergraduate education (http://www.dlib.org/smete). At one end of the spectrum, only material that has been rigorously reviewed and revised, much like the process in a peer-reviewed journal, could be accepted. On the other end of the spectrum, all material submitted could be accepted. Additionally, some level of review or annotation in between could also direct the collection and use, so that some works would be labeled with various types of certifications indicating utility, validity, and verification. Each level of review, from none to extremely rigorous, has its merit and drawbacks. When including only those materials that have been highly reviewed and praised, the collection will have high quality materials, but will grow slowly as review guidelines must be developed and reviews collected. Furthermore, the presence of a strong, controlling review process could suggest an elitism that might, in fact, work in direct opposition to the aim of a widely distributed or accessed repository. On the other hand, if all material is accepted without any concern for merit, the repository is in danger of becoming a sort of multimedia attic where researchers and educators will rarely go.

It was decided that CRIM would have three levels or indicators of the quality of the included materials. The first level would be an indication of usage. Each time an item is retrieved from CRIM a log entry is made and a count of accesses updated in the resource display. From this, users can infer that others deemed a particular resource useful. The next indication would be an annotation made by a user of the materials. These informal notes could speak to the content

(e.g., whether this was a worthwhile example or syllabus) or to the content (e.g., there is an error in Diagram 2 in the PowerPoint slide lecture). The final indication would be a solicited, formal review based on developed criteria. This three level quality marker system will allow the CRIM repository to grow quickly without direct barriers to submissions. It also will allow the repository to mature based on formal reviews. In addition to the reviewers, annotators, and users of the material, there also are notations from the managing editors of CRIM and from area specialists recruited to help publicize and extend the reach of CRIM.

Resource Collection

The CRIM Web site and collection software were developed at Virginia Tech. They are based on a prototype of CRIM at George Washington University and on work on the Networked Digital Library of Theses and Dissertations (NDLTD, see www.ndltd.org) at Virginia Tech. CRIM is included as part of the Computer Science Teaching Center project (see www.cstc.org) funded by NSF and ACM, and uses the software developed for that project in conjunction with work at The College of New Jersey and University of Illinois, Springfield.

The first organization of CRIM was presented at the ACM Multimedia conference in Bristol, England in September 1998. Based on the concerns at that workshop, the CRIM design at George Washington was extended to suit the first materials for CRIM. The current CRIM Web site is shown in Figure 2.

The actual materials included in CRIM were seeded from a search of the Internet. Materials were identified and, with permission of the authors, entered into CRIM. Additionally, an email communication was sent to over 100 faculty who are actively teaching multimedia, announcing CRIM and asking for resources to be entered into the repository. Finally, postings also were made to non-multimedia specific listservs, such as Systers, requesting resource material.

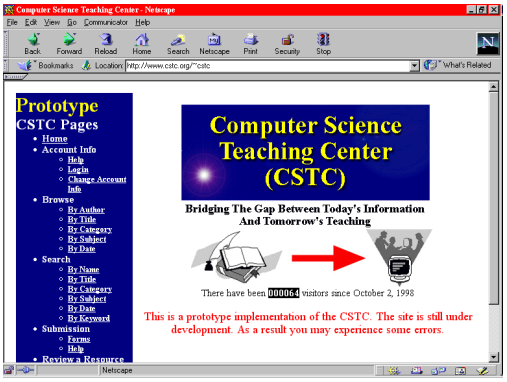

Figure 2. Screen capture of CRIM

Curriculum

Plans for curriculum recommendations for IM are currently under development. Virginia Tech has provided cost-sharing for the CRIM project by way of a room-type VTEL system with an ATM connection through Net.Work.Virginia to vBNS. All interested in participating in the process are invited to schedule a videoconference discussion.

One related effort is the development of a readings volume for the multimedia field [11]. In addition to identifying key topics (that should lead to a list of Knowledge Modules for IM [12] – see Table 3), work on that volume has identified a number of focussed needs for learning about IM (see Table 4).

Our strategy in developing curricula recommendations is to begin with sets

for the most popular contexts (see Table 5). These will be circulated and refined in Spring and Summer 1999 and presented at ACM Multimedia '99.

Multimedia areas (3): processing and retrieval; systems; applications
Audio: psychoacoustics, engineering, coding, retrieval, navigation, interfaces
Digital images and video: coding, data embedding, indexing, retrieval, servers, querying, skimming, databases, models
Compression: speech, audio, image, video; compressed domain processing
Operating systems: resources, streams, schedules, admissions, disks, files, load balancing, placement, control, caching
Networking: unicast, multicast, jitter, QoS, thin/light-weight, scaling, sync
Authoring: visual programming, structure, markup, interfaces, temporal issues, scenarios, libraries/components
Presentation: styles, rendering, sync, AI constraints, (information) visualization, multimodal, multi-view, collab.,VR
Hypermedia: Web, Dexter, Amsterdam, link databases, navigation/browsing
Collaboration: videoconferencing, floor control, sharing applications, bandwidth
Application development: integration, design, measuring quality, evaluation

Table 3. Key Topics

Application development: Web, games, training/education, business, government
Hardware development: DSPs, codecs, servers, disks, cards, networking
Software development: authoring tools, computer systems, networking systems

Table 4. Needs for Learning about IM

Multimedia itself: ugrad, grad, adv grad
CS: Computer graphics, Database, Data structures, HCI, Image processing, Networking, OS, Software engineering
Other: Art, Communication, Education. technology, Electrical/computer engin., Human factors, Music, …

Table 5. Contexts for Curricula

Future Work

The CRIM repository is newly seeded and supporting the initial collection of materials. It is expected that the repository will grow further over the following months as efforts are underway to publicize the presence of the repository and to promote participation. Such growth will allow the evaluation of the decision to provide a 3-level quality assurance technique. The managing editors and area specialists (concerned with particular topical or tool-focused resources) will review and tabulate the usage indicators. Qualitative reviews will be made of the annotations to categorize them based on content analysis. These two measures, taken together, will help the managing editors identify candidates for formal reviews. Additionally, from time to time, in an effort to improve the usefulness of the repository, users will be polled to see what they find useful in the CRIM Web site and what they find lacking. The CRIM Web site itself will be reviewed for its user friendliness and usability, and refined accordingly. Eventually, though, the key evaluation of CRIM will be undertaken by way of measuring its impact on learning about IM.

References

[1] ACM: IS'97: Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems. http://www.acm.org/education/curricula.html#IS97

[2] ACM 91: ACM Curricula Recommendations Volume I: Computing Curricula 1991: Report of

the ACM/IEEE-CS Joint Curriculum Task Force. http://www.acm.org/education/curr91/homepage.html

[3] SIGCHI 92: http://www.acm.org/sigchi/cdg/cdg2.html

[4] Marianne Kolbasuk McGee. "Talent Hunt Gets Hotter--Companies Strive to Find Technology Workers as Demand Continues to Outrun Supply." *Information Week,* Issue 715, Jan. 4, 1999.

[5] Joy Russell. "Study Finds IT Staffing Shortage Could Impact Economy." *InternetWeek,* Oct. 24, 1997.

[6] Borko Furht, Raymond Westwater, Jeffrey Ice. "Multimedia Broadcasting over the Internet: Part I." *IEEE Multimedia,* Vol. 5, No. 4 (October - December 1998), pp. 78-82.

[7] Bruce Schneier. "Cryptography: The Importance of Not Being Different." *Computer,* Vol. 32, No. 3 (March 1999), pp. 108-9, 112.

[8] Lira Nikolovska and Jacquelyn Martino. "Spatial Browsing to Retrieve Multimedia Information." *IEEE Multimedia,* Vol. 5, No. 2 (April - June 1998), pp. 78 - 83.

[9] Roy T. Fielding, et al. "Web-based Development of Complex Information Products." *Communications of the ACM,* Vol. 41, No. 8 (August 1998), pp. 84 - 92.

[10] George Lawton. "The Internet's Challenge to Privacy." *Computer,* Vol. 31, No. 6 (June 1998), pp. 16 - 18.

[11] Brian Smith and HongJiang Zhang. *Readings in Multimedia Computing.* Morgan Kaufmann Publishers, San Francisco, 1999, in preparation.

[12] E. Fox and L. Kieffer. Multimedia Curricula, Courses and Knowledge Modules. *ACM Computing Surveys,* Dec. 1995, 27(4): 549-551