Virtual Environments for Education, Research and Life

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Abstract

Virtual Environments for Education, Research and Life are interactive cyberspaces where many users can communicate and collaborate in various way. They also can build virtual artifacts like offices, books, blackboards, artificial persons and more. VEs should also provide optimal support for information storage, retrieval and manipulation.

This position paper will focus on education in order to limit its size. However many issues of importance to educational VEs concern research VEs as well. We also shall exclude discussions of the "life" aspect, but it has been mentioned in the title for the simple reason that VEs without a social and casual function don't make sense, else they are just **E**s and not **V**Es.

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This position paper is available over the WWW at:
http://tecfa.unige.ch/moo/paris96/papers/daniel.html

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[1] http://tecfa.unige.ch/moo/paris96/

1 Background: Text-based social virtual reality (Muds)

Our background in VEs are MUDs. Daniel Schneider is the founder of TecfaMOO[2], a Virtual Space for Educational Technology, Education, Research & Life at TECFA, School of Psychology & Education, University of Geneva. Richard Godard is its principal technical "wizard". We use this environment for a variety of purposes[3] and a few of them have turned into research subjects[4]. MUDs (and specially the MOO variant [Curtis, 1993]) can be be characterized by:

- Many persons can connect simultaneously to a server.
- The MUD has a spatial organization, e.g. people interact with people or objects primarily within "rooms".
- Within a MOO, many real time communication actions exist, like "saying" or "emoting" things publically to the persons in a "room", paging people elsewhere, "whispering" messages, using a "CB" channel, etc.
- Asynchronous communication tools include internal e-mail, Newsgroups, News papers, tutorial rooms, "notice boards", etc.
- MOOs are extensible, and most imaginable (text-based) objects and features can be programmed. Moos also can be used as backend for various network services. A good example are http servers.

2 VEs for education, research and life

VEs for education, research and life have have been discussed in various disciplines. While advanced multi-user educational VEs are still mostly speculation (e.g. [Loeffler, 1993]), simpler VEs based on standard technologies have ben in existence for some time. (e.g. [Hiltz, 1988], [Hiltz, 1993]) [Scardamalia et al., 1992] ,[Eisenstadt et al., 1995]). With the emergence of new CSCW collaboration tools (e.g. [Kindberg, 1996] , the explosion of Web, renewed interest in collaboration research (computer supported collaborative learning, groupware, etc.), and billions invested into telematics and computer graphics VEs will become fashionable on a larger scale. Many VE researchers stress the importance of collaboration and communication and experiment with currently available communication and information technology. A good example is the study of [Gay et Lentini, 1995] on the use of communication resources in a networked collaborative design environment. On the other hand, graphical VR research has mostly focused on the creation and manipulation of artificial 3-D worlds and the theoretical issue of immersion. Both approaches will probably soon meet on some middle ground but there will without doubt remain a large variety of interests and applications. In any case we argue that VEs have great potential for education and collaborative work, but we also want to point out the high quantity of "unknowns" and "ToDos".

Our own interests focus mostly on topics like "communication" and "collaboration" but we are also interested in the high potential of 3-D interactive graphics, especially for constructivist learning based on non-symbolic experience ([Winn, 1993] and data visualization. We would like to raise the following questions and/or postulates:

1. **VEs might be productive for several reasons**:
    - VEs are collaboration tools. Many studies have shown that collaborative learning and collaborative work is efficient, some conditions for either success or failure are well known, others are still unknown [Dillenburg et Schneider, 1995]. One major question to be adressed by VEs is *how to "encrypt" optimal conditions of collaborative learning*

[2] http://tecfa.unige.ch/tecfamoo/
[3] http://tecfa.unige.ch/moo/questions.html
[4] http://tecfa.unige.ch/moo/projects.html

or more generally how to enhance collaboration mechanisms within a VE. Research in this area is needed.

- Immersion in an experience is also often an enhancement factor for learning: As states [Ackermann, 1994a, p. 13], "interactivity is a key to learning" and "An increasing number of software designers, cognitive scientists and educators have come to the view that experience is actively constructed and reconstructed through direct interaction with the world, and that, indeed, knowledge *is* experience". Both social realities (e.g. MUDS where people can create their identities and habitats) and full VR sensory immersion amplify experience. However, it has yet to be shown *when* strong immersion is really effective for a given task. E.g. a recent study on VR as education tool [Byrne, 1996], showed significance of "interactivity" but not "physical immersion". On the other hand it's not clear in what cases social immersion into a VE is really desirable and effective (E.g. we are not aware of any serious MUD studies in this direction).
- Similar claims are made about situated learning (i.e. that learning involves making sense *in context* (see [Brown et al., 1989])) and the fact that VEs indeed can be tailored for situated learning. But again, a part from "learning how to program the VE", "how to deal with people" etc. not much efforts have been spent on creating situated learning environments.
- More generally, a large segment of researchers view VEs as a change to renew pedagogies (in the MUD world we can cite [Fanderclai, 1995] and [Moshell et al., 1995]). Transposing the traditional classrom into cyberspace (e.g. [Speh, 1994] for the MOO world) is interesting in many cases (e.g.for Distance Teaching), but we should grab the chance of doing things differently in a VE, e.g. integrate interactive learning objects into the VE and have people learn in the VE by *doing and communicating*.

2. **VEs should be "cyberspace desk tops" with multiple communication and media layers**:

   - One of the biggest problems today is the growth of various information, communication and manipulation tools and their relatively poor integration. VEs can make access to the appropriate tool for a given task easier.
   - **VEs need many media support**: Each media type (e.g. text, graphics, sound, etc.) has advantages. Let's just consider communication: MUD-based written synchronous communication does have it's advantages, (e.g. one can have several different conversation flows, talk to many persons over different channels, displayed text has a history mechanism, is mirrored and revisable ([Tognotti et al., 1995], [Young, 1994]). Speech and video allow for faster exchange but loose a few of those features and are much intrusive. Whiteboards are very useful for sketching out ideas, but do not handle very well flow nor many participants. Furthermore, multiple media favor grounding [Clark et Brennan, 1991] (people understanding each other), e.g. our recent recent study [Dillenbourg et al., 1996] involving a MOO and a white board has shown that one medium can help grounding the code or "language" used within an other medium.
   - **VEs need multiple communication channels** ... but they must be available on a basis of needs and availability, i.e. communication should not become intrusive but people should be able to use the right channel for the right task and a social practice for using different channels must be created (like the MOO practice to @knock before entering a private "home").
   - **Interfaces to "real" machinery are another issue**. One advantage of VEs could be to provide remote access to expensive and/or specialized laboratory hardware (e.g. [Johnston et Agarwal, 1995])

3. **VEs must adapt to the users and not the other way round**:

- VEs must plan for change, growth and transformation or else they die. ([Morningstar et Farmer, 1990] and [Farmer et al., 1994])
- As we hinted before, despite some "VEs for education and research" success stories, it is fairly unknown how to build such environments. It would be good practise to enhance current VEs with observation tools (within ethical limits that need to be established). There exist many studies of the MUD space on various subjects: e.g. of interest are writings on virtual communities (e.g. [Bruckman et Resnick, 1993], [Tognotti et al., 1995], [Curtis et Nichols, 1993], [Farmer, 1993]) but we are not familiar with systematic studies that could be used for building better VEs for education and work. There is a lot of interest (e.g. see the ARPA Workshops on MUDs and Education[5]) but not much has been done. This stands very much in contrast to the extensive studies of the (more restrained) "electronic classroom" (e.g. [Hiltz, 1993] or CSCW research.
- **Access, Security and Cyberspace politics are also imporant issues** but won't be discussed here. In order for many users to co-exist in virtual communities we do not only need technical means but also "social technology" adapted to the needs of the users (or at least to the organization to whom the VE belongs).

4. **VEs need objects that can be manipulated** If VEs are to be fully operational people must be able to "bring in" as many virtual objects as they need for work and communication.
    - VEs can be seen as a social context for propagating constructionism (e.g. students manipulating "symbolic physical" objects ([Moshell et al., 1995]) or "real virtual physical objects").
    - Interactive objects favor reflection which in turn favors learning ([Collins et Brown, 1988]).
    - VEs can be enhanced with artificial agents or more generally can integrate Human-Computer Collaborative Learning Systems (HCCLS) with Computer-Supported Collaborative Learning Systems (CSCLS).
    - Collaborative Information tools: Various issues need to be discussed but we leave details to others here. In short, we need collaborative hypertext ([Tennison, 1995] and in addition we must solve organizational problems ([Ackermann, 1994b]).
    - Researchers working together over the network must be able to share usual work tools (e.g. simulators) and be able to represent knowledge in structured form in order to optimally ground conversation.
    - VEs also show great potential for all sorts of social simulations. Embryonary examples in the MOO/WWW world are the historical scenes at the Miami MOO[6] or Kelley's Mexican/American border spaces in textual reality[7]. Some "RPG or social" MOOs, can be viewed as global social simulations (though education or social research are not the issues there).

5. **Navigation Interfaces** Navigation interfaces are a crucial issue: (see [Dieberger et Tromp, 1993], [Dieberger, 1994], [Girardin, 1995]).
    - An appealing aspect of VEs is the spatial metaphor since humans navigate quite well in space. Antropomorphed VEs a la [Stephenson, 1992] are probably easier on users than Gibson's ([Gibson, 1994]) abstract Computer Matrix.
    - However, as practise shows people can get lost and conversively experienced users who "know where to go" don't use step-by-step naviation or artificial transport artifacts that much. Therefore it is also very important to provide not only maps, but also "magical features" (Dieberger or Tromp?) to navigate outside "geometrical space" and various sorts of indexes.

[5] http://tinylondon.ucsd.edu/ cal/MUDshop.html
[6] http://MiamiMOO.MCS.MUOhio.Edu/moodesc.html
[7] http://actlab.rtf.utexas.edu/ moboid/mooweb.html

- An other issue we'd like to raise is how to build "geographies" of meaningful objects, e.g. ideas, possessions, projects. Such spaces are not euclydian, but could partly be organized within 2 or 3-D spaces.

6. **"Real" and "social VR" are complementary**

   "Real VR" presenting the user with the illusion of being in a 3-D world of computer generated objects (e.g. using goggles, gloves) and "social VR" (e.g. MUDs) are "worlds a part", though new formats such as VRML2 may offer a "terrain d'entente". As far as education goes one could qualify the further as inspired by Piaget's physical manipulation of objects and the other by Vygotsky's social construction of meaning. "Real VR" tricks your senses and "social VR" operating at the symbolic level tricks you into "being" with others. Both aspects are complementary. Both transform computers into extensions of ourselves and have a potential for "being there" at several levels. The question now is "what kind of VE do we really need for various aspects of education and collaborative work"? Could there be an integrating standard ?

3 Practical and technical issues for VEs

1. **VEs and the WWW is one of the question we must address in this workshop** Recent MOO/WWW interfaces offer some nice additions to the MOO experience. I.e. the ability to look at objects from the www, to use the www for navigation and object manipulation (in the case of WOOs). However command-line integration (MOO-> WWW) or synchronous communication do not work well due to the limits of http. Similar constraints are true for other kinds of VEs including the 3D kind. While the integration of the WWW in both directions is important, full WWW based VEs are not ncessearily a priority in the very near future. However with the evolution of browser standards (incorporation of VRML 2 and various communication tools (via either mobile code, plug-ins or integrated helpers) and the evolution of the HTTP standard, integration will be both feasible and desirable.

2. **VEs should be easy to use and minimize cognitive load** The basic functionalities of interfaces should be accessible to everyone and major commands be available in "GUI" fashion. E.g. the "low bandwidth" argument is no excuse for the current moo (mud) interfaces. Since VEs are more than just multi-channel distributed chat system, dealing with static text, objects, the help system and so forth should be dealt with in different windows / panes. Scrolling back and forth does not help productivity. The quintessence of MOOs are their flexibility and extensibility, but their major drawback is the lack of a generally accepted Moo-client protocol and according clients (now where is the JUPITER system?).

3. **VEs need to be scalable**, scalability means distribution of processing load, e.g. most current VEs are not (display a part).

4. **Cyberspace has its costs**

   As it has been pointed out on several occasions the use of Virtual Environments for Education and Work is not always cheap:

   - In education: On-line tutoring takes many resources (see e.g. [De La Vega et al., 1995] and preparation of learning materials for on-line use is time consuming. E.g. in distance teaching the minimum ratio is 10:1, in the cased of interactive learning environments it is hundreds:1. It is typical that multimedia in education mostly appears as either "books" or easy to do edutainment.
   - Training of Teachers, Students and researchers for on-line work is not easy and also may require important inital investments.

- Since VE "life" strongly appeals to some people, too much time may be spent on-line instead of doing "real" work. People must learn how to deal with "being connected all the time".
- Setup costs (at all levels), maintenance and adding new functionalities or interesting artifacts can be very expensive and/or time consuming. E.g. in the MOO world, most current development work is done at no cost by enthusiasts and most interactive educational artifacts are very unfinished. We expect 3-D worlds to "suffer" too from lack of development.

4 Organizational matters

Contrary to other people working in Telematics, workers in the domain of many-user interactive environments are badly organized. Let's change that. I suggest that at least Europeans form an "interest group for social virtual environments" or even better something like a "European VE Task Force" in order to prepare research proposals for the next rounds of the European research scene: The forth European framework is divided into 18 specific programs of which TELEMATICS, ATCS, ESPRIT and TMR may be of interest.

- Telematics2C (TELEMATICS Applications) Third call for proposals[8]: Publication 15.09.96 / Closing Date: 15.01.97. See also: The 4th RTD Framework Programme[9]
- Training and Mobility of Researchers (TMR)[10]: Publication: 15.09.1996 / Closing date: 01.02.1997
- Building the Information Society: the 1996 ESPRIT Workprogramme[11] (not too interesting maybe)

Other programs: Multimedia educational software[12] (any more information on this?) - Activities related to the establishment of the Information Society: MPACT, TEDIS, INFO2000, IDA, Community participation in the G-7 pilot projects. - Socrates (where is the on-line information ?) - See also:EC Information Society Project Office Webserver[13]

Last remark: **There have been recent other interesting workshops and conferences in the past** (though real documentation might be hard to get)

- the Doors of perception 3 conference[14] (VR oriented)
- The International Workshop on CSCW and the Web[15]
- European Workshop on Interactive Distributed Multimedia Systems and Services[16] (mostly technical issues)
- Cyberstar'95[17] (A competition on interactive concepts)
- Workshop on Simulation and Interaction in Virtual Environments[18]

[8] http://www.cordis.lu/cgi/node.pl?language=en&node=//telematics_2c/tele_prop2
[9] http://www2.cordis.lu/cordis/02.htm
[10] http://www2.cordis.lu/tmr/home.html
[11] http://www2.cordis.lu/esprit/src/wp96.htm
[12] http://www2.cordis.lu/cordis/cicu8011.html
[13] http://www.ispo.cec.be/
[14] http://www.design-inst.nl/DOME/workshops/reports.html
[15] http://orgwis.gmd.de/W4G/
[16] http://www.fokus.gmd.de/ws/idms/cfparticipation.html
[17] http://viswiz.gmd.de/VMSD/PAGES.en/actual.cyberstar.html
[18] http://www.cs.uiowa.edu/%7Ecremer/sive95.html

References

[Ackermann, 1994a] Ackermann, E. (1994a). Direct and Mediated Experience: Their Role in Learning. In LEWIS, R. et MENDELSOHN, P., (eds.), *Lessons from Learning*. North-Holland, Amsterdam.

[Ackermann, 1994b] Ackermann, Mark, S. (1994b). Augmenting the Organizational Memory: A Field Study of Answer Garden. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW'94)*, pages 243–252. URL: http://www.ics.uci.edu/ ackerman/docs/cscw94/cscw94.html.

[Brown et al., 1989] Brown, J., Collins, A., et Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, 18:32–42.

[Bruckman et Resnick, 1993] Bruckman, A. et Resnick, M. (1993). Virtual Professional Community: Results from the MediaMOO Project. In *Third Internation Conference on Cyberspace*, Austin, Texas. URL: http://lucien.berkeley.edu/MOO/mediamoo-3cyberconf.ps.

[Byrne, 1996] Byrne, C. (1996). *Water on Tap: The Use of Virtual Reality as an Educational Tool*. PhD thesis, Department of Industrial Engineering, University of Washington. URL: http://www.hitl.washington.edu/publications/dissertations/Byrne/.

[Clark et Brennan, 1991] Clark, H. H. et Brennan, S. E. (1991). Grounding in communication. In Resnick, L. B., Levine, J., et Teasley, S., (eds.), *Perspectives on Socially Shared Cognition*, pages 127–149. American Psychological Association, Washington.

[Collins et Brown, 1988] Collins, A. et Brown, J. (1988). The computer as a tool for learning through reflection. In Mandl, H. et Lesgold, A., (eds.), *Learning Issues for Intelligent Tutoring Systems*, pages 1–18. Springer Verlag, New York.

[Curtis, 1993] Curtis, P. (1993). LambdaMOO Programmer's Manual. Xerox Parc.

[Curtis et Nichols, 1993] Curtis, P. et Nichols, D. (1993). MUDs Grow UP: Social Virtual Reality in the Real World. In *Third International Conference on Cyberspace*, Austin, Texas. URL: http://lucien.berkeley.edu/MOO/MUDsGrowUp.ps, also: http://www.oise.on.ca/%7Ejnolan/muds/about_muds/mudsgrowup.

[De La Vega et al., 1995] De La Vega, F. M., Giegerich, R., et Fuellen, G. (1995). Distance Education Through The Internet: The GNA-VSNS BioComputing course. WWW VSNS BioComputing Division. URL: http://www.techfak.uni-bielefeld.de/bcd/welcome.html.

[Dieberger, 1994] Dieberger, A. (1994). Spatial environments to organize and navigate information and to communicate about this organization. In *Position Paper for the Workshop at the European Conference on Hypermedia Technology*, Edinburgh. URL: http://www.gatech.edu/lcc/idt/Faculty/andreas_dieberger/A.Dieberger.home.html. also at: http://www.cms.dmu.ac.uk/General/vr/VRPapers/tromp-qnr.txt.

[Dieberger et Tromp, 1993] Dieberger, A. et Tromp, J. (1993). The Information City project - a virtual reality user interface for navigation in information systems. In *Proc. of the Symposium Virtual Reality*, Vienna. URL: http://www.gatech.edu/lcc/idt/Faculty/andreas_dieberger/A.Dieberger.home.html also at: http://www.cms.dmu.ac.uk/General/vr/VRPapers/infocity.txt.

[Dillenbourg et al., 1996] Dillenbourg, P., Traum, D. R., et Schneider, D. K. (1996). Grounding in Multi-modal Task-Oriented Collaboration. submitted to the EuroAI&Education 96 conference. URL: http://tecfa.unige.ch/tecfa/tecfa-research/cscps/euroaied/murder-1.html.

[Dillenburg et Schneider, 1995] Dillenburg, P. et Schneider, D. K. (1995). Collaborative learning and the Internet. In *Paper presented to ICCAI 95*. URL: http://tecfa.unige.ch/tecfa/tecfa-research/CMC/colla/iccai95_1.html.

[Eisenstadt et al., 1995] Eisenstadt, M., Brayshaw, M., Hasemar, T., et Issroff, K. (1995). Teaching, Learning, and Collaborating at a Virtual Summer School. Technical report, Knowledge Media Institute, The Open University, Milton Keynes, MK7 6AA.

[Fanderclai, 1995] Fanderclai, T. L. (1995). MUDs in Education: New Environments, New Pedagogies. *CMC Magazine*, 2(1). URL: http://www.rpi.edu/%7Edecemj/cmc/mag/1995/jan/fanderclai.html, also: URL: http://sensemedia.net/sprawl/16880.

[Farmer, 1993] Farmer, F. R. (1993). Habitat Citizenry. In Loeffler, C. E., (ed.), *Virtual Reality: A Survey of Technology and Culture*. Van Nostrand Rheingold.

[Farmer et al., 1994] Farmer, F. R., Morningstar, C., et Crockford, D. (1994). From Habitat to Global Cyberspace. In *Proceedings from CompCon '94*. IEEE Computer Society. URL: ftp://sunsite.unc.edu/pub/academic/communications/papers/habitat/hab2cybr.txt.

[Gay et Lentini, 1995] Gay, G. et Lentini, M. (1995). Use of Communication Resources in a Networked Collaborative Design Environment. *Journal of Computer-Mediated Communication*, 1(1). URL: http://cwis.usc.edu/dept/annenberg/vol1/issue1/IMG_JCMC/ResourceUse.html.

[Gibson, 1994] Gibson, W. (1994). *Neuromancer*. Ace, New York.

[Girardin, 1995] Girardin, L. (1995). Cyberspace geography visualization. Technical report, The Graduate Institute of International Studies, Geneva. URL: http://heiwww.unige.ch/girardin/cgv/report/.

[Hiltz, 1988] Hiltz, S. R. (1988). Collaborative learning in a virtual classroom: Highlighs of findings. In Press, A., (ed.), *CSCW 88, Proceedings of the Conference on Computer Supported Cooperative Work*, pages 282–290, New York.

[Hiltz, 1993] Hiltz, S. R. (1993). Correlates of learning in a virtual classroom. *International Journal of Man-Machine Studies*, (39):71–98.

[Johnston et Agarwal, 1995] Johnston, W. E. et Agarwal, D. (1995). The Virtual Laboratory: Using Networks to Enable Widely Distributed Collaboratory Science. A white paper submitted to the NSF vBNS and Networking and Application Researchers workshop. URL: http://www-itg.lbl.gov/ johnston/Virtual.Labs.html.

[Kindberg, 1996] Kindberg, T. (1996). WWW: Departement of computer science, University of London, also Proceedings of The International Workshop on CSCW and the Web. URL: http://www.dcs.qmw.ac.uk/ timk/Mushroom/CSCWWeb.html.

[Loeffler, 1993] Loeffler, C. E. (1993). Distributed Virtual Reality: Applications for education, entertainment and industry. STUDIO for Creative Inquiry, Carnegie Mellon University (found on a Norvegian WWW server). URL: http://www.nta.no/telektronikk/4.93.dir/Loeffler_C_E.html.

[Morningstar et Farmer, 1990] Morningstar, C. et Farmer, F. R. (1990). The Lessons of Lucasfilm's Habitat. On-Line Publication, (also published in: M.Benedikt (ed.) Cyberspace: First Steps, MIT Press, 1991). URL: ftp://sunsite.unc.edu/pub/academic/communications/papers/habitat/lessons.txt, also: http://www.uni-koeln.de/themen/cmc/text/metz.94.txt.

[Moshell et al., 1995] Moshell, J. M., Hughes, C. E., et Kilby, M. (1995). Virtual Academy: The Educational Model. VC95.4, Computer Science Department and Institute for Simulation and Training University of Central Florida. URL: .

[Scardamalia et al., 1992] Scardamalia, M., Bereiter, C., Brett, C., Burtis, P. J., Calhoun, C., et Smith, Lea, N. (1992). Educational Applications of a Networked Communal Database. *Interactive Learning*, 2(1):45–71.

[Speh, 1994] Speh, M. (1994). A Virtual Programming Course using the MOO. *The Diversity University Journal of Virtual Reality Education*, 1(1):21–27. URL: http://info.desy.de/www/gna/DUVEJ.html, ASCII: http://tecfa.unige.ch/edu-comp/DUJVRE/vol1/DUJVRE.1.1.text, email: (Marcus) marcus@andersen.co.uk.

[Stephenson, 1992] Stephenson, N. (1992). *Snow Crash*. Bantam.

[Tennison, 1995] Tennison, J. (1995). Living Documents: adding collaboration to information systems. In *Proceedings of the 1995 Postgraduate Conference*. AI Research Group, Department of Psychology, University of Nottingham. URL: http://www.psyc.nott.ac.uk/aigr/papers/Living-Documents/paper.html.

[Tognotti et al., 1995] Tognotti, S., Schneider, D., et Mendelsohn, P. (1995). Analysis of MOO and Woo Environments. Technical report, TECFA, FPSE, University of Geneva. URL: http://tecfa.unige.ch/moo/VMDL/VMDL-1.html.

[Winn, 1993] Winn, W. (1993). A Conceptual Basis for Educational Applications of Virtual Reality. Technical Report TR-93-9, Human Interface Technology Laboratory, Washington Technology Center, University of Washington. URL: http://www.hitl.washington.edu/publications/tech-reports/tr-93-9-winn.html.

[Young, 1994] Young, Jeffrey, R. (1994). Textuality in Cyberspace: Muds and Written Experience. On-Line publication, From jryoung@phoenix.Princeton.EDU. URL: ftp://sunsite.unc.edu/pub/academic/communications/papers/muds/Textuality-in-Cyberspace.