

Glossary

Aural Manager (AUR)	Optional special manager that interfaces to sound generation hardware and provides a number of services to help manage the aural representations of entities. The nature of the hardware is irrelevant since the services provided are flexible enough to accommodate all forms of sound generation.
Computer Image Generator (CIG)	Special-purpose hardware that is dedicated to the task of generating three-dimensional graphics. A CIG may take the form of anything ranging from a stand-alone unit to a single printed-circuit board card. A CIG is connected to a general-purpose host that runs software controlling access to the CIG's features (often in the form of a graphics library).
Console	Hybrid special manager and entity used for administrative purposes within a USS. It can be used to create/terminate system processes, introduce UML code into the simulation, etc.
Entity (ENT)	One of the essential system components. The state of the simulation is represented by the sum of each entity's state. Core ENT functionality is quite simple, primarily consisting of processing monitor requests, periodically updating its state, and sending state updates for those monitored components that have changed value. An entity's functionality may be extended through the use of UML code.
Implementation Language (IL)	The language that the system processes have been implemented in, i.e. C++. This term is used to avoid confusion with the modeling language used, i.e. UML.

Master USS (MUSS)	The system in the prototype that manages the routing of messages from one (slave) system to another. It is also the first system to start in the network and is contacted by all other systems after they have finished their initialisation.
Master UM (MUM)	<i>see</i> Universe Manager
Node ID (NID)	Unique identifier used to represent a USN within any given system. The prototype supports 32,768 nodes in one system.
Process ID (PID)	Unique identifier for a process within a USN and is used to contact and communicate with the specified process. The actual meaning of this identifier is implementation and node specific.
Process Management Layer (PML)	Software library used to abstract each operating system's differences to increase portability of the prototype USS. Services are currently restricted to message passing but could be extended to include time management, etc.
Resource Manager (RM)	Required manager that manages access to all resources on the node it is executing on. Contains a dynamic deadline scheduler to ensure that all processes complete their allocated workload on time, each simulation step. Aids the MUM in its system-wide load balancing duties by nominating processes that are consuming too many local resources.
Resource Profile (RP)	Data structure that can be used to hold details of the resource consumption of either an individual process or a node. An RP is the unit of communication between all processes when transferring information regarding resource usage. The resources monitored are: CPU, memory, backing storage and network bandwidth.
Spatial Integrity Manager (SIM)	Special manager that is used to monitor an entity's position and volumetric information. If one or more other entities should "collide" with each other, they are informed of the event and then left to resolve the situation amongst themselves.
Special Manager	All special managers are optional system components, but the usefulness of a system without them is limited. Often managers are used to control displays, e.g. VIS, but they may also simply provide essential services to entities, e.g. SIM.

SUM	<i>see</i> Universe Manager
System ID (SID)	Unique identifier used to represent a USS within a network of systems. The prototype permits a maximum of 32,768 such systems to be networked together.
Universal Configuration Language (UCL)	Simple variable-value language with a hierarchical structure that is used to describe all configuration information within the prototype system.
Universal Modeling Language (UML)	The language used to describe the Virtual Environment to be simulated. Structured as one or more related universes, each containing a number of constants and properties that are used by the defined functions. Enables description of the entities inhabiting the simulation and their unique behaviour. UML code may be passed between processes at run-time and, through interpretation, issue service requests to managers, redefine an entity's behaviour, and so on.
Universal Process Identifier (UPID)	Unique address of a process within all systems. This identifier is composed of a unique system ID, node ID and process ID. Two UPIDs are present in every message transmitted between processes, one detailing the sender and the other specifying the destination for the message.
Universal Simulator Node (USN)	The building block of a USS. A single USN can execute a complete simulation on its own but is commonly networked with other nodes to form a larger, more powerful system. The bandwidth available to processes is at its highest within a USN and latency is at its lowest. A USN is a user's gateway into the simulation of a Virtual Environment. Each node supports one UM, one RM, a number of entities, and zero or more special managers.
Universal Simulator System (USS)	A USS is composed of one or more USNs and distributes the simulations amongst them in order to increase simulation speed, manage larger simulations, increase system fault tolerance, and permit multiple user interaction. One node in every system is nominated as a master and runs the MUM which manages communications with other systems. Each system within a network replicates the simulation workload and they keep each other informed of their users' actions within the simulation.

Universe Manager (UM) The UM is the heart of each node. Most communications within a node pass through the UM. Those intended for other nodes are sent to the UM at the destination through the Master UM (MUM). The services that are most in demand are: progressing the local simulation; satisfying requests to monitor state information issued by managers; routing state information sent by entities; routing messages from local processes to remote nodes and *vice versa*.

The Master UM has the same responsibilities as a normal UM, but in addition it also manages system-wide scheduling (including the coordination of entity migrations from one node to another). Other special services include progressing the simulation within the system, coordinating communications with other systems, and controlling individual node activation and deactivation. All UMs on other nodes in the system are known as Slave UMs.

Visual Manager (VIS) Optional special manager that interfaces to a CIG and provides a number of services to help manage visual representations.

Bibliography

Airey J., Rohlf J. and Brooks F. (1990) Towards Image Realism with Interactive Update Rates in Complex Virtual Building Environments. *Computer Graphics* 24(1): 41-50.

Anderson B. (1993) Graphical Interfaces Considered as Representations of the Real World: Implications of an Affordances-Based Model. In *Studies in Perception and Action II*: 89-93. (London: Lawrence Erlbaum Associates).

Andersson M., Carlsson C., Hagsand O. and Ståhl O. (1995) DIVE - The Distributed Interactive Virtual Environment Technical Reference Manual.

Astheimer P. (1993) What You See is What You Hear - Acoustics Applied in Virtual Worlds. *IEEE Symposium on Research Frontiers in Virtual Reality*, October 25-36, San Jose, CA: 100-107.

Barfield W. and Hendrix C. (1995) The Effect of Update Rate on the Sense of Presence within Virtual Environments. *Virtual Reality: Research, Development and Applications* 1(1): 3-16.

Barzel R. (1992) *Physically-Based Modeling for Computer Graphics: A Structured Approach* (London: Academic Press).

Bellenot S. (1990) Global Virtual Time Algorithms. *Proceedings of the SCS Multiconference on Distributed Simulation*: 122-127.

Benford S. and Fahlén L. (1993) A Spatial Model of Interaction in Large Virtual Environments. *Proceedings of the Third European Conference on Computer Supported Cooperative Work (ECSCW '93)*, Milano, Italy, September.

Betz D. (1991) Your Own Tiny Object-Oriented Language. *Doctor Dobbs Journal*, September: 26-33.

Bhagwat P., Mishra P.P. and Tripathi S.K. (1994) Effect of Topology on Performance of Reliable Multicast Communication. *IEEE INFOCOM '94: Conference on Computer Communications*, Ch. 175, Vols 1-3: 602-609.

Birman K., Joseph T. and Schmuck F. (1987) *ISIS - A Distributed Programming Environment, Version 2.1 - User's Guide and Reference*.

- Bliss B. (1991) Interactive Steering using the Application Executive. On-line paper. <ftp://sp2.csr.d.uiuc.edu/pub/ae.tar.Z>
- Bloomer J. (1992) Power Programming with RPC. O'Reilly & Associates, Inc. ISBN 0-937175-77-3
- Boisseau M., Demange M. and Munier J. (1995) An Introduction to ATM Technology. International Thomson Publishing, London.
- Bouma W.J., Vanecek Jr G. (1991) Collision Detection and Analysis in a Physically Based Simulation. Proceedings of the Eurographics Workshop on Animation and Simulation, Vienna, Austria: 191-203.
- Boutaba R. and Folliot B. (1993) Load Balancing in Local Area Networks. IFIP Transactions C - Communication Systems, 13: 67-78.
- Bowman M., Peterson L.L. and Yeatts A. (1990) Univers: An Attribute-based Name Server. Software Practice and Experience, 20(4): 403-424.
- Braden R. (1992) TIME-WAIT Assassination Hazards in TCP. RFC 1337.
- Bradner S. and Mankin A. (1995) The Recommendation for the IP Next Generation Protocol. Network Working Group, RFC 1752.
- Bryson S. (1991) Interaction of objects in a virtual environment: a two-point paradigm. Stereoscopic Displays and Applications II, SPIE Proceedings. Vol. 1457: 180-187.
- Brethauer H., Christaller T. and Kopp J. (1989) Multiple vs. Single Inheritance in Object-oriented Programming Languages. Microprocessing and Microprogramming 28: 197-200.
- Broll W. (1995) Interacting in Distributed Collaborative Virtual Environments. Proceedings of the IEEE VRAIS'95 - Virtual Reality Annual International Symposium: 148-155.
- Caird J.K. and Hancock P.A. (1993). The Application of Ecological Human Factors Principles to Virtual Environment Interface Design. In Proceedings of VIIth International Conference on Event Perception and Action: 36.
- Calvin J., Dickens A., Gaines B., Metzger P., Miller M., Owen D. (1993) The SIMNET Virtual World Architecture. Proceedings of the IEEE VRAIS '93 Conference: 450-455.
- Cameron, S. (1990) Collision Detection by Four-Dimensional Intersection Testing. IEEE Transactions on Robotics and Automation, 6(3): 291-302.
- Carlson N.R. (1986) Physiology of Behaviour (3rd Edition). (Allyn and Bacon, Inc.)
- Carlsson C. and Hagsand O. (1993) DIVE - a Multi-User Virtual Reality System. Proceedings of the IEEE VRAIS '93 Conference: 394-400.
- Checkland P. (1994) Systems Thinking, Systems Practice. John Wiley & Sons. ISBN 0-471-27911-0

- Cheng S. (1988) Scheduling Algorithms for Hard Real-Time Systems - A Brief Survey. Hard Real-Time Systems (eds.: John A. Stankovic and Krithi Ramamritham). ISBN 0-8186-0819-6
- Cleary J., Gomes F., Unger B., Zhong X. and Thudt R. (1994) Cost of State Saving & Rollback. Proceedings of the SCS Multiconference on Distributed Simulation: 94-101.
- Coco G.P. (1992) The VEOS Project: Tool Builders Manual. Internal Report, Human Interface Technology Lab, University of Washington.
- D'Souza L., Fan X. and Wilsey P. (1994) pGVT: An Algorithm for Accurate GVT Estimation. Proceedings of the 8th Workshop on Parallel and Distributed Simulation: 102-109.
- Dana P. (1995) An Overview of the Global Positioning System (GPS). On-line document. <http://www.utexas.edu/depts/grg/gcraft/notes/gps/gps.html>
- DIWG - Distributed Interactive Simulation Working Group (1993) Communications Architecture for DIS. Institute for Simulation and Training, University of Florida, U.S.A.
- DIS (1994) Standard for Distributed Interactive Simulation -- Application Protocols. Version 2.0, Fourth Draft. Institute for Simulation and Training, University of Florida, U.S.A.
- Division (1994) dVS v2.0.4 Technical Overview. Manual.
- Dunnett P., Harwood R.M., Brookes G.R. and Wills D.P. (1995) Use of a Modified Kalman Filter for a Visually Coupled System Application. Virtual Reality: Research, Development and Applications 1(1): 57-68.
- Ellis S.R. (1991) Pictorial Communication in Virtual and Real Environments. (Taylor & Francis Ltd.)
- Ellis S.R. (1994) What Are Virtual Environments? IEEE Computer Graphics & Applications, January 1994: 17-22.
- de Figueiredo L.H., Ierusalimsky R., Filho W.C. (1994a) The design and implementation of a language for extending applications. On-line paper.
- de Figueiredo L.H., Ierusalimsky R., Filho W.C. (1994b) Reference Manual of the Programming Language Lua. On-line paper.
- Friedmann M., Starner T. and Pentland A. (1992) Synchronisation in Virtual Realities. Presence Teleoperators and Virtual Environments 1(1): 139-144.
- Funkhouser T. and Séquin C. (1993) Adaptive Display Algorithm for Interactive Frame Rates During Visualization of Complex Virtual Environments. Proceedings of SIGGRAPH '93: 247-254.
- Gavish B. and Sridhar S. (1994) Algorithms for Load Balancing in Distributed Computer Systems. Computers and Operations Research, 21(3): 239-248.

- Geist G.A. and Sunderam V.S. (1991) The PVM System: Supercomputing Level Concurrent Computations on a Heterogeneous Network of Workstations. Proceedings of the Sixth Distributed Memory Computing Conference, Portland, OR: 258-261.
- Gettys J. (1996) Simple MUX Protocol Specification. On-line paper, <http://www.w3.org/pub/WWW/TR/WD-mux>
- Ghosh K., Panesar K., Fujimoto R.M. and Schwan K. (1994) PORTS: A Parallel, Optimistic, Real-Time Simulator. Proceedings of the 8th Workshop on Parallel and Distributed Simulation (PADS'94), July 6-8, Edinburgh, UK.
- Gibson J.J. (1979) The Ecological Approach to Visual Perception. (London: Lawrence Erlbaum Associates).
- GNU (1995) G++ FAQ. <http://www.cis.ohio-state.edu/hypertext/faq/usenet/g++-FAQ/plain/faq.html>
- Gosling J. and McGilton H. (1995) The Java Language Environment: A White Paper. <http://java.sun.com/whitePaper/java-whitepaper-1.html>
- Grimsdale C. (1993) Virtual Reality Evolution or Revolution. Proceedings of the third annual conference on Virtual Reality, London, April: 15-18.
- Grünsteidl G. and Kopetz H. (1992) A Reliable Multicast Protocol for Distributed Real-Time Systems. Real Time Programming, 1: 19-23.
- Hagsand O. (1995) SID2 Interface Specification. On-line document, SICS. <http://www.sics.se/~olof/sid2.html>
- Halang W.A. (1992) Load Adaptive Dynamic Scheduling of Tasks with Hard Deadlines Useful for Industrial Applications. Computing, 47(3): 199-213.
- Harvey E., Schaffer R. and McGarry S. (1991) High Performance Fixed-Wing Aircraft Simulation using SIMNET Protocols. Proceedings of the 1991 SCS Conference, 23rd Annual Summer Computer Simulation Conference: 965-970.
- Hawkes R. (1993) Virtual Environment Laboratory, University of Edinburgh. Proceedings of Virtual Reality Systems Fall '93, New York, October 19-21.
- Hawkes R., Rushton S. and Smyth M. (1995) Update Rates and Fidelity in Virtual Environments. Virtual Reality: Research, Development and Applications, 1(2): 85-94.
- Hemmje M. and Strohmer P. (1993) Towards Agent-Based Modelling of Time and Dynamic Behaviour of Graphical Objects within Virtual Scenes. Eurographics First Workshop on Virtual Reality, Barcelona, Spain: 103-112.
- Holloway R. (1992) Viper: A Quasi-Real-Time Virtual-Worlds Application. Technical Report TR92-004, UNC, Chapel Hill. <ftp://ftp.cs.unc.edu/pub/techreports/92-004.tar.Z>
- IEEE (1987) IEEE Standard for Radix-Independent Floating-Point Arithmetic.

- Jacobson V., Braden R. and Borman D. (1992) TCP Extensions for High Performance. RFC 1323.
- Jefferson D. and Sowizral H. (1985) Fast concurrent simulation using the time warp mechanism. Proceedings of the SCS Multiconference on Distributed Simulation: 63-69.
- Jense. G.J. and Kuijper Ir. F. (1993) Virtual Environments for Advanced Trainers and Simulators. In Proceedings of the International Training Equipment Conference and Exhibition. London, May 4-6: 49-57.
- Kanarick C.M. (1991) A technical overview and history of the SIMNET project. Proceedings of the SCS Multiconference on Distributed Simulation: 104-111.
- Karamcheti V. and Chien A. (1994) FM: Fast Messaging on the Cray T3D. <http://www-csag.cs.uiuc.edu/projects/communication/cray-messaging.html>
- Katz W. (1994) Military Networking Technology Applied to Location-Based, Theme Park and Home Entertainment Systems. ACM Computer Graphics 28(2): 110-112.
- Kazman R. (1993a) HIDRA: An Architecture for Highly Dynamic Physically Based Multi-Agent Simulations. International Journal of Computer Simulation, 1993.
- Kazman R. (1993b) Load-Balancing and Latency Management in a Distributed Virtual World. Proceedings of the 3rd International Conference on Cyberspace, May 1993.
- Kazman R. (1993c) Making WAVES: On the Design of Achitectures for Low-end Distributed Virtual Environments. IEEE Symposium on Research Frontiers in Virtual Reality, October 25-36, San Jose, CA: 443-449.
- Kazman R. (1993d) Problems of Scale: Moving Beyond Toy Virtual Worlds. Unpublished paper.
- Kim K.H. (1995) Action-Level Fault Tolerance *IN* Advances in Real-Time Systems. (ed. Sang H. Son) Prentice-Hall, Inc.
- Latta J.H. and Oberg D. J. (1994) A Conceptual Virtual Reality Model. IEEE Computer Graphics Applications, January 1994: 23-29.
- Laubach M. (1994) Classical IP and ARP over ATM. Network Working Group, RFC 1577.
- Le Saché B. and de Medeuil C. (1993) Simulator Networking: An Application for Fighter Aircraft Simulators. Proceedings of the International Training Equipment Conference and Exhibition (ITEC '93), May 4-6, London: 357-366.
- Lee D.N. (1976) A theory of visual control of braking based on information about time to collision. Perception 5: 437-439.
- Lee D.N. (1978) *IN* Modes of Perceiving and Processing Information. (London: Lawrence Erlbaum Associates).

- Lee D.N. (1993) Body-environment coupling IN Neisser U. (ed.) The perceived self: Ecological and interpersonal sources of self-knowledge (Cambridge University Press): 43-67.
- Levine J.R, Mason T. and Brown D. (1992) lex & yacc. O'Reilly & Associates, Inc. ISBN 1-56592-000-7
- Liang J., Shaw C. and Green M. (1991) On Temporal-Spatial Realism in the Virtual Reality Environment. Proceedings of the 4th Annual Symposium on User Interface Software and Technology: 19-25.
- Lipton R.J. and Mizell D.W. (1985) Time Warp vs. Chandy-Misra: A Worst-Case Comparison. Proceedings of the SCS Multiconference on Distributed Simulation: 137-143.
- Liskov B. (1993) Practical Uses of Synchronised Clocks in Distributed Systems. Distributed Computing, 6: 211-219.
- Locke C.D., Tokuda H. and Jensen H.D. (1985) A Time-Driven Scheduling Model for Real-Time Operating Systems. Technical Report, Carnegie-Mellon University.
- Locke J. (1992) An Introduction to the Internet Networking Environment and SIMNET/DIS. On-line paper, <ftp://taurus.cs.nps.navy.mil/>
- Long T. (1992) ICI Technical Description. On-line paper, <ftp://ftp.su.edu.au/pub/ici.tar.Z>
- Luciani A., Jimenez S., Florens J., Cadoz C., Raoult O. (1991) Computational Physics: A Modeler - Simulator for Animated Physical Objects. Proceedings of the European Computer Graphics Conference and Exhibition: 425-436.
- Macedonia, M., Zyda, M., Pratt, D. and Barham, P. (1995) Exploiting Reality with Multicast Groups: A Network Architecture for Large Scale Virtual Environments. Proceedings of the IEEE Virtual Reality Annual Symposium, 11-15 March, North Carolina.
- Macedonia, M., Zyda, M., Pratt, D., Barham, P. and Zeswitz, S. (1994) NPSNET: A Network Software Architecture for Large Scale Virtual Environments. Presence - Teleoperators and Virtual Environments 3(4).
- Mastaglio T. and Callahan R. (1995) A Large-Scale Complex Virtual Environment for Team Training. Computer 28(7): 49-56.
- McCarty W., Sheasby S., Amburn P., Stytz M. and Switzer C. (1994) A Virtual Cockpit for a Distributed Interactive Simulation. IEEE Computer Graphics & Applications, January 1994: 49-54.
- Milenkovic M. (1992) Operating Systems - Concepts and Design, Second Edition. McGraw-Hill, Inc.
- Mills D. (1992) Network Time Protocol (Version 3) Specification and Implementation. Network Working Group, RFC 1305.
- Minsky M., Ouh-young M., Steele O., Brooks F. and Behensky M. (1990) Feeling and Seeing: Issues in Force Display. Computer Graphics, 24(4): 235-243.

Mon-Williams M., Wann J.P., Rushton S. (1993) Binocular Vision in a Virtual World: Visual deficits following the wearing of a head-mounted display. *Ophthalmic and Physiological Optics* 13(4): 387-391.

Motorola (1992) Motorola 88110 User's Guide. Manual.

MPI (1993) MPI Final Draft. <http://www.mcs.anl.gov/mpi/mpi-report/mpi-report.html>

NPSNET (1995) NPSNET IV.7J System Overview. Manual.

Ouh-young M., Pique M., Hughes J., Srinivasan N. and Brooks F. (1988) Using a Manipulator for Force Display in Molecular Docking. *Proceedings of the IEEE International Conference on Robotics and Automation*: 1824-1829.

Pausch R., Crea T. and Conway M. (1992) A Literature Survey for Virtual Environments: Military Flight Simulator Visual Systems and Simulator Sickness. *Presence Teleoperators and Virtual Environments* 1(3): 344-363.

Paxson, V. (1993) The Glish User Manual. *On-line paper*, <ftp://ftp.ee.lbl.gov/glish/>.

Permobil Meditech, Inc. (1993) Operating and Installation Manual for the Ober/2 12 bit Parallel System.

Pimentel K. and Teixeira K. (1993) Virtual Reality: Through the New Looking Glass. Intel/Windcrest/McGraw Hill. ISBN 0-8306-4064-9

Piscitello D. and Lawrence P. (1991) The Transmission of IP Datagrams over the SMDS Service. Network Working Group, RFC 1209.

Postel J. (1981a) Transmission Control Protocol - DARPA Internet Program Protocol Specification. RFC 793.

Postel J. (1981b) Internet Control Message Protocol - DARPA Internet Program Protocol Specification. Network Working Group, RFC 792.

Pullen J.M. (1994) Networking for Distributed Virtual Simulation. *Computer Networks and ISDN Systems*, 27: 387-394.

QNX (1993) QNX System Architecture. Manual.

QNX (1994) Using Shared Libraries in QNX 4.21. Technical Note.

QNX (1995) Technical Note on Configuring the QNX 4.22 Process Manager.

Reddy M. (1995) A Survey of Level of Detail Support in Current Virtual Reality Solutions. *Virtual Reality: Research, Development and Applications* 1(2): 85-88.

Robinet W. (1992) Synthetic Experience: A Proposed Taxonomy. *Presence* 1(2): 229-247.

Roehl B. (1995) Some Thoughts on Behaviour in VR Systems. On-line document. <http://sunee.uwaterloo.ca/~broehl/behav.html>

- Rönngren R. and Ayani R. (1994) Adaptive Checkpointing in Time Warp. Proceedings of the SCS Multiconference on Distributed Simulation: 110-117.
- Rotithor H.G. (1994) Taxonomy of Dynamic Task Scheduling Schemes in Distributed Computing Systems. IEEE Proceedings - Computers and Digital Techniques, 141(1): 1-10.
- van Rossum G. (1994a) Extending and Embedding the Python Interpreter. On-line manual, <ftp://ftp.cwi.nl/pub/python/doc/postscript.tar.gz>
- van Rossum G. (1994b) Python Reference Manual. On-line manual, <ftp://ftp.cwi.nl/pub/python/doc/postscript.tar.gz>
- van Rossum G. (1994c) Python Library Reference. On-line manual, <ftp://ftp.cwi.nl/pub/python/doc/postscript.tar.gz>
- Rushton S., Wann J. (1993) Problems in Perception and Action in Virtual Worlds. Proceedings of the third annual conference on Virtual Reality. London, April: 43-55.
- Schachter E.J. (1981) Computer Image Generation for Flight Simulation. IEEE Computer Graphics and Applications, 1: 29-68.
- SGI (1995) IRIS Performer Programmers Guide.
- Sha L. and Sathaye S.S. (1995) A Systematic Approach to Designing Distributed Real-Time Systems *IN* Advances in Real-Time Systems (ed.: Sang H. Son). Prentice-Hall, Inc. ISBN 0-13-083348-7
- Shaw C., Liang J., Green M. and Sun Y. (1992) The decoupled simulation model for virtual reality systems. Proceedings of the CHI'92: 321-328.
- Shaw, C. and Green, M. (1993) The MR Toolkit Peers Package and Experiment. IEEE Symposium on Research Frontiers in Virtual Reality, October 25-36, San Jose, CA: 463-469.
- Smets G.J.F., Overbeeke K.J. and Stappers P.J. (1993) Modelling Objects in a Virtual Environment: About Direct Manipulation and Affordances. In Proceedings of VIIth International Conference on Event Perception and Action: 34-35.
- Smets G.J.F., Stappers P.J. and Overbeeke K.J. (1994) Designing in Virtual Reality: Implementing Perception-Action Coupling with Affordances. In Proceedings of the Virtual Reality Software & Technology '94 Conference: 97-110.
- Snowdon D.N. (1995) AVIARY: A Model for a General Purpose Virtual Environment. PhD Thesis. Department of Computer Science, University of Manchester.
- Snowdon D.N. and West A.J. (1994) AVIARY: Design issues for future large-scale Virtual Environments. Presence, 3(4).
- Snowdon D.N., West A.J., Howard T.L.J. (1993) Towards the next generation of Human-Computer Interface. Proceedings of Informatique '93: Interface to Real & Virtual Worlds. Montpellier, France, March 24-26: 398-408.

- Spero S.E. (1996) Analysis of HTTP Performance Problems. On-line paper, <http://www.w3.org/pub/WWW/Protocols/HTTP-NG/http-prob.html>
- Stankovic J.A., Ramamritham K. and Cheng S. (1985) Evaluation of a Flexible Task Scheduling Algorithm for Distributed Hard Real-Time Systems. Hard Real-Time Systems (eds.: John A. Stankovic and Krithi Ramamritham). ISBN 0-8186-0819-6
- Swawe M. (1989) Is Multiple Inheritance Necessary? Dr. Dobbs Journal 14(3): 107-110.
- Talpede R. and Ammar M.H. (1995) Single Connection Emulation (SCE): An Architecture for Providing a Reliable Multicast Transport Service. Proceedings of the International Conference on Distributed Computing Systems, Ch. 62: 144-151.
- Templ J. (1993) A Systematic Approach to Multiple Inheritance Implementation. ACM SIGPLAN Notices, 28(4): 61-66.
- UVa User Interface Group (1995) Alice: Rapid Prototyping for Virtual Reality. IEEE Computer Graphics and Applications 15(3): 8-11.
- UVa User Interface Group (1995) Alice: Rapid Prototyping for Virtual Reality. IEEE Computer Graphics and Applications 15(3): 8-11.
- SGI (1996) The Virtual Reality Modeling Language Specification 2.0. <http://www.sgi.com/moving-worlds.index.html>
- Verissimo P. and Marques J.A. (1990) Reliable Broadcast for Fault-Tolerance on Local Computer Networks. Proceedings of the 9th Symposium on Reliable Distributed Systems, Ch. 18: 54-63.
- Wang, Q., Green, M. and Shaw, C. (1995) Environment Manager (EM) - User Manual.
- Watcom (1995) Watcom C/C++ Compiler Tools Reference Manual.
- Webb R. and Gigante M. (1992) Using Dynamic Bounding Volume Hierarchies to Improve Efficiency of Rigid Body Simulations. Proceedings of CGI '92, Tokyo: 825 - 841.
- Wheeler A., Ellinger J. and Glicker S. (1993) The Design and Implementation of an Experimental Virtual Acoustic Display. On-line paper.
- Wloka M. (1993) Dissertation Proposal: Time Critical Graphics. Department of Computer Science, Brown University, Providence, Rhode Island. CS-93-50.
- Zyda, M.J., Monahan, J.G. and Pratt, D.R. (1992a) NPSNET: Physically-Based Modeling Enhancements to an Object File Format. Chapter in Creating and Animating the Virtual World. Springer-Verlag, Tokyo, 1992: 35-52.
- Zyda M.J., Pratt D.R., Monohan J.G. and Wilson K.P. (1992b) NPSNET: Constructing a 3D Virtual World. Proceedings of the 1992 Symposium on Interactive 3D Graphics: 147-155.

Zyda M.J., Pratt D.R., Osborne W.D. and Monahan J.G. (1993) NPSNET: Real-time Collision Detection and Response. *The Journal of Visualization and Computer Animation*, special issue on Simulation and Motion Control, 4(1): 13-24.