Commercial Robot Puppets

Robotic puppets on vehicles

- **Jeep/fire engine $5,000**
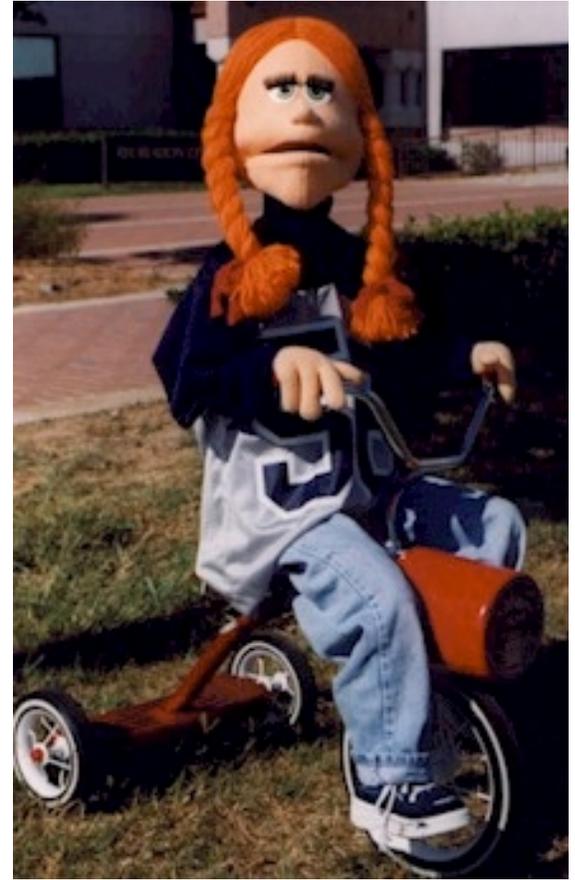
Motorcycle $4,500

Wheel Chair $5,000

Tricycle $4,000

Commercial advertisement example

- "You can remotely make these things drive, and talk, or even sing to music that is remotely activated!

- All you have to do is steer them. In fact, the mouth moves with your words by voice activation, or can lip sync by itself to a tape; just talk into the microphone or press play!

- Not to mention, some of them come equipped with sirens and lights that are also remote controlled.

- It looks like the robot is doing it all by itself with no wires or speakers visible; and the way it is made, it even looks like he is pedaling or steering or driving!

- The wheelchair can do wheelies!

- You can remotely carry on conversations with kids who talk to this puppet/robot, and any Innova™ puppet head can be put on!

- **Custom heads available!**

  - Tricycle Motorcycle   Wheelchair   Jeep
                                Firetruck

    - 48" tall

    - 35lbs

    - Welded steel tricycle frame   50" tall

    - Rubber tires-police motorcycle

    - Remotely controlled strobe lights/ siren/headlights Remotely controlled wheelchair

    - Removable robot

    - Joystick motion

    - Remotely controlled strobe lights/ siren/headlights

    - Modular name brand components

    - Robot and Transmitter come with rechargeable batteries

    - Arms steer handlebars left and right

- <u>Body moves</u> forward and back

- Includes cassette player/recorder

- Head can be rotated independently left and right

- Variable speed control for forward and reverse motion

- High power amplifier for quality voice and tape audio

- All mechanical components and sound systems are hidden from view.

- Heads are easily interchangeable.

- Clothing can be changed easily. (wears size 6 child's clothing)

- Mouth moves in synch with voice or with tape for realistic motion

- <u>**Used by:**</u> * Walt Disney World - Epcot Center * Universal Studios * IBM * Kraft * Sony * General Motors - Buick * Toshiba America * TWA * Proctor & Gamble * Siemens * AT&T * GTE * Delta Airlines * US Border Patrol * Hong Kong Royal Police * and over 100 US Law enforcement agencies

- **Please call for details.** 1-800-854-2151

Max

- Puppetumes™ are a high tech puppet/costume hybrid. The mouth moves by radio-control.

- A person wears the Puppetume™ on their head, and a separate operator runs the remote control.

- All our puppetumes come with a fan-cooled head, wireless remote control, and matching gloves.

- You supply the clothing.

- 12 AA batteries are required, and not included, for operation.

- What better way to make an impact than to walk out on stage with one of these!

Innova Style
$649.00 ea

- **Mrs. Pitz**
- **Felicia**
- **Major Buzz**
- **Mr. Wanco**

$499.00
Ralph (orange head)

- **Elmer (blue head)**

Regular Style
$399.00ea

Heads for easy exchange

Remote Controlled Dalmatian
$799.00
(+ $40.00 shipping and handling)

- Move the character's mouth by means of radio control from up to hundreds of yards away.

- Comes with radio controlled, fan-cooled head and matching gloves, prerecorded audio tape with seven fire safety songs and instrumental tracks with fire prevention lessons.

- **Dalmatian Character Costume** 860566011 **$650.00** **(+ $40.00 shipping and handling)** Comes with fan cooled head and matching gloves.

Robot Theater Accessories

The Performance Animation Controller (PAC).

The PAC is the umbilical cord between the performer and the animatronic character.

The Performance Animation Controller (PAC).

– The PAC is the umbilical cord between the performer and the animatronic character.

– Ergonomically designed input devices, convey signals from the fingers, hands and wrists which are arranged by the PAC into a delicately orchestrated group of electronic commands.

- These signals instruct the motors that provide the movement and expressions of the animatronic character.

- This ballet of movement happens in real time, responding immediately to new direction.

– The PAC has many performance options and can record and playback the exact action of a previous rehearsal or take.

- Sections of a recording can be re- recorded or played live.

- A further feature of the PAC allows the performance of computer graphic images.

The Performance Animation Controller (PAC).

- Adding a PAC editor to the system allows the performer to revisit the movements of any one motor and through a graphical interface re- adjust it's position throughout the entire recorded performance.

    – Lip synchronisation and all other movement can be tuned to perfection using the PAC editor.

- The PAC represents the most advanced and versatile form of animatronic manipulation and performance available to film makers today.

palm pilot robot kit

palm pilot robot kit (PPRK)

- We need inexpensive and fun robots.

- What if you could build a robot that could be strapped to a Palm Pilot, or a GameBoy or TI Calculator?

- CMU created one such robot, using exclusively off-the-shelf parts.

- The novice roboteer can build their pprk in about two hours after acquiring about $120 in parts.

palm pilot robot kit

- They have a website where you can find the bill of materials and step by step pictures and instructions for building your own pprk.

- The site also provides software and a few simple demo programs for your enjoyment.

Literature and WWW Links

Literature

- This list attempts to provide a broad survey of the literature in the area of believable agents, ranging from the animation issues to models of emotion and cognition. It is by no means a complete list, and many if not most of these authors have more work available on the subject. However, we felt that it is representative of much current work and a good starting point for reading.

  - Comments and suggestions are most welcome at pdoyle@cs.stanford.edu.

- LaPalme, J-P. and Belanger, M. (1991). A puppet robotic theater, constructed and programmed by students with the help of the Android language, 2(4), 81-89.

- L. Abbott. Active Acting: Exercises and Improvisations Leading to Performance. Star Publishing Company: Belmont, CA, 1987. *See also: Johnstone, 1992; Nachmanovitch, 1991.*

- E. Andre, Ed. Notes of the IJCAI-97 Symposium on Animated Interface Agents: Making Them Intelligent, Nagoya, Japan, Aug. 1997. *Representative survey of current work on animated agents, covering issues in effective presentation, affective modeling, social impact, and character design. See also: Lester et al., 1997; Elliott et al., 1997.*

- N. Badler, "Real-Time Virtual Humans," in Proc. 1997 Pacific Graphics Conf., Seoul, Korea, 1997. *Survey of issues in creating real-time animated human figures, with focus on design of Jack architecture and discussion of systems that employ it. Used by: Rickel and Johnson, 1997. See also: Smith et al., 1997.*

- G. Ball, D. Kurlander, J. Miller, D. Pugh, T. Skelly, A. Stankosky, D. Thiel, M. Van Dantzich, and T. Wax, "Lifelike Computer Characters: the Persona Project at Microsoft Research," in Software Agents, J. Bradshaw, Ed. AAAI Press: Menlo Park, CA, 1997. *Overview of Microsoft work on building animated, conversational assistants. Focus on Peedy, a parrot that processes spoken requests for music. Emphasis on technical issues (e.g., voice recognition, animation, etc.). See: Lester et al., 1997b; Rist et al., 1997.*

– J. Bates, A. B. Loyall, and W. S. Reilly, "Integrating Reactivity, Goals, and Emotion in a Broad Agent," in Proc. 14th Ann. Conf. of the Cognitive Science Society, Bloomington, IN, July 1992. *Describes the Oz architecture, especially the interface between its emotion model and action-selection system. Brief, but useful introduction to issues in the use of emotion to drive behavior. Elaborated in: Bates et al., 1992b.*

– J. Bates, A. B. Loyall, and W. S. Reilly, "An Architecture for Action, Emotion, and Social Behavior," Tech. Report CMU-CS-92-142, School of Computer Science, Carnegie Mellon University, Pittsburgh, July 1992. *Describes the Oz architecture, including its reactive action planner (Hap) and emotion model (Em). Analyzes a sample interaction between a user and Lyotard, an agent with simple emotional intelligence. Good introduction to technical problems of building emotional intelligence. Extends: Bates et al., 1992a.*

– J. Bates, "The Nature of Characters in Interactive Worlds and The Oz Project," Tech. Report CMU-CS-92-200, School of Computer Science, Carnegie Mellon University, Pittsburgh, Oct. 1992. *Summarizes the Oz project's motivation and goals. Discusses possible types of interaction between users and believable agents. Primarily of historical interest.*

– J. Bates, "The role of emotion in believable agents," in Comm. of the ACM, vol. 37(7), pp. 122-125, July 1994. *Summarizes techniques Disney animators used to convey emotion in animated characters. Illustrates derivative heuristics for interactive agents with the "Edge of Intention" system. Widely cited introduction to artistic antecedents and resources for technical audience. See: Thomas and Johnson, 1981.*

– B. Blumberg, "Action-Selection in Hamsterdam: Lessons from Ethology," in Proc. Third Int. Conf. on Simulation of Adaptive Behavior, Brighton, England, 1994. *Presents computational model of agent behavior based on biological factors, e.g. hunger, fear. Interesting alternative to psychological and artistic metaphors.*

– B. Blumberg, "Old Tricks, New Dogs: Ethology and Interactive Creatures." Ph.D. Thesis, Media Lab., Massachusetts Inst. Technol., Cambridge, MA, 1996. *Presents an ethnologically-inspired architecture for synthetic characters. "Silas T. Dog" incorporates virtual vision, learning, and simple goals/motivations in animated agent. First chapter provides excellent motivation for building believable characters in general. Extends: Blumberg, 1994.*

– P. Curtis, "Mudding Social Phenomena in Text-Based Virtual Realities," in Proc. 1992 Conf. on Directions and Applications of Advanced Computing, Berkeley, CA, May 1992. *Describes the origin and user activities of LambdaMOO, the most famous of the text-based virtual worlds. Focuses on social phenomena, e.g. community building, interpersonal relations, conflict resolution. Widely cited classic reference.*

- P. Doyle and B. Hayes-Roth, "Guided exploration of virtual worlds," in Network and Netplay: Virtual Groups on the Internet, F. Sudweeks, Ed. MIT Press: Cambridge, MA, 1997. *Introduces concept of "annotated environments" that encode structured domain descriptions in virtual worlds for use by intelligent agents. Emphasis on increasing agent believability through enhancing domain intelligence. Sample dialogs in educational children's environment. Extended by : Doyle and Hayes-Roth, 1998. See also: Norman, 1993.*

- P. Doyle and B. Hayes-Roth, "Annotating Virtual Worlds," in Proc. 1998 Virtual Worlds and Simulation Conf., San Diego, CA, Jan. 1998, pp. 195-200. *Details of possible annotations of virtual spaces to support believable agent intelligence. Draws parallels with HCI concepts of affordance and natural design. Several examples drawn from educational text world. Extends: Doyle and Hayes-Roth 1997a. See also: Norman 1993.*

- C. Dyer, "Interpersonal goals and satisfaction with interactions." Ph.D. Thesis, Dept. of Communications, Stanford Univ., Stanford, CA, 1993. *Provides evidence that people seek out more interaction with people whose personalities complement (rather than resemble) their own. Complementary means opposite on dominance/submissiveness axis and similar on affiliation index.*

- L. Egri, The Art of Dramatic Writing. Simon & Schuster: New York, 1949. *Discussion of effective techniques for writing drama, particularly applicable to scripts and playwriting.*

- C. Elliott, "The Affective Reasoner: A Process Model of Emotions in a Multi-Agent System." Ph.D. Thesis, The Institute for the Learning Sciences, Northwestern Univ., 1992. *Thesis presents comprehensive computational model of emotion and reasoning system based on work of Ortony, Clore, and Collins. Agents reason about one another through emotional models, including expectation, conflicting emotion, and relationships. Widely cited system. Extended by: Elliott, 1993; Elliott, 1997a, 1997b. See also: Elliott, 1995; Elliott, 1997c.*

- C. Elliott, "Using the affective reasoner to support social simulations," in Proc. 13th Int. Joint Conf. on Artif. Intell., Chambery, France, Aug. 1993. *Summarizes Affective Reasoner architecture. Discusses issues involved in creating distinct emotional personalities in that system. Demonstrates both flexibility and limitations of system and underlying theory. Best high-level technical view of Affective Reasoner. Extends: Elliott, 1992.*

– C. Elliott, "Research problems in the use of a shallow Artificial Intelligence model of personality and emotion," in Proc. 12th Natl. Conf. on Artif. Intell., Seattle, WA, Aug. 1995, pp. 9-15. *Presents open research issues in building computational models of emotion. Examples of affective user modeling and using emotions to model relationships. Argument for emotional intelligence to create believable characters. Extensive references to literature.*

– C. Elliott, J. Lester, and J. Rickel, "Integrating Affective Computing into Animated Tutoring Agents," in Notes of the IJCAI '97 Workshop on Animated Interface Agents: Making Them Intelligent, Nagoya, Japan, Aug. 1997, pp. 113-121. *Describes approaches to integrating Affective Reasoner into existing agent systems. Examples of enhancing didactic value of characters through use of emotion. Creatively ties together three large projects. In: Andre, 1997. See also: Lester et al., 1996; Rickel and Johnson, 1997.*

– C. Elliott, "I Picked Up Catapia and Other Stories: A Multimodal Approach to Expressivity for 'Emotionally Intelligent' Agents," in Proc. 1st Int. Conf. on Autonomous Agents, Marina del Rey, CA, Feb. 1997, pp. 451-457. *Study using emotional expressivity to disambiguate spoken speech. Emotionally intelligent agents outperform human actors in clearly conveying intended emotions. Interesting motivation for incorporating emotion into agents beyond characters. Expands on: Elliott, 1992.*

– C. Elliott, "Hunting for the Holy Grail with 'emotionally intelligent' virtual actors," to appear in ACM Intelligence. *Presents broad, shallow emotional model for building entertainment agents. Examples of affective impact in storytelling. Describes "virtual actor" experiments with Affective Reasoner. Broadest survey of Elliott's work. Extends: Elliott, 1997a.*

– S. Fiske and S. Taylor, Social Cognition. McGraw-Hill: New York, 1991. *Chapter 7 discusses people's desire to use schemas in dealing with one another in order to predict/understand behavior.*

– L. Foner, "What's An Agent, Anyway? A Sociological Case Study," Agents Memo 93-01, M.I.T. Media Lab., Massachusetts Inst. Technol., Cambridge, MA, May 1993. *Categorizes agency in terms of social abilities and groundedness in context. Lengthy transcripts of an agent, Julia, interacting with users in a text-based virtual world. Emphasis on believability. A classic paper on agency and believability.*

– D. Goleman, Emotional Intelligence. Bantam Books: New York, 1997. *Defines and compares rational vs. emotional behavior. Explores skills of "emotional intelligence," and argues it is key to human success, rather than simply rational thinking.*

- B. Hayes-Roth, L. Brownston, R. Huard, B. Lent, and E. Sincoff, "Directed improvisation," Tech. Report KSL-94-61, Knowledge Systems Lab., Stanford Univ., Stanford, CA, Sept. 1994. *Implementation and operations of directed improvisation system. Description of agent designs in CAIT. Best introduction to early Virtual Theater work.*

- B. Hayes-Roth, "Directed Improvisation: A New Paradigm for Computer Games," in Proc. 9th Computer Game Developers' Conf., Santa Clara, Apr. 1995, pp. 36-43. *Application of Virtual Theater "improv puppets" to computer games. Overview of CAIT system describes potential uses of semi-autonomous characters as avatars or other characters in games. See also: Hayes-Roth and van Gent, 1996.*

- B. Hayes-Roth, "Agents on Stage: Advancing the State of the Art in AI," in Proc. 1995 Int. Joint Conf. on Artif. Intell., Montreal, Canada, Aug. 1995, pp. 967-971. *Argument that AI should take a comprehensive approach to building intelligent agents, and that interactive characters is a promising area as it demands integration of all major components. Position paper rather than technical.*

- B. Hayes-Roth, R. v. Gent, and D. Huber, "Acting in character," in Creating Personalities for Synthetic Actors, R. Trappl and P. Petta, Eds. Springer-Verlag: Berlin, 1997. *Casts improvisational drama in computational terms. Detailed examination of master-servant status scenarios according to personality and status variations of autonomous characters. Good bridge between improvisation literature and computation.*

- B. Hayes-Roth and R. van Gent, "Improvisational Puppets, Actors, and Avatars," in Proc. Computer Game Developers' Conf., Santa Clara, 1996, pp. 199-208. *Applications of improvisational computer puppets and actors to computer gaming. Discussion of "improv avatars" as intelligent combination of computer- and user-control of avatars in multi-player environments. Speculations about future avatar design. See also: Hayes-Roth 1995a.*

- B. Hayes-Roth and R. van Gent, "Story-Making with Improvisational Puppets," in Proc. 1st Int. Conf. on Autonomous Agents, Marina del Rey, CA, Feb. 1997, pp. 1-7. *Short survey of Virtual Theater work on "improv puppets." Brief summary of developmental psychology experiments using puppets, relation to other Virtual Theater work. See also: Hayes-Roth et al., 1994.*

– B. Hayes-Roth, L. Brownston, and R. van Gent, "Multiagent collaboration in directed improvisation," in Proc. 1ˢᵗ Int. Conf. on Multi-Agent Systems, San Francisco, 1995; Reprinted in Readings in Agents, M. Huhns and M. Singh, Eds. Morgan-Kaufmann: San Francisco, 1997. *Presents directed improvisation; users influence but do not control autonomous, emotional agents. Description of agents in CAIT system. Collaborative storytelling under dynamic user constraints. Reprinted.*

– B. Hayes-Roth, "Mask and Cyber Mask," in Proc. Computer Game Developers' Conf., Santa Clara, CA, 1997. *Reviews traditional concepts of Mask as a source of manifestation of both persona and animus. Discusses techniques for creating Cyber Mask, incorporating these elements, to facilitate people's role-play in online dramatic environments.*

– B. Hayes-Roth, G. Ball, C. Lisetti, R. Picard, A, Stern. "Affect and Emotion in the User Interface," in Proc. Conf. on Intell. User Interfaces, San Francisco, Jan. 1998, pp. 91-96. *Panel position papers discuss the role of affect in both perception and expression of behavior.*

- A. Horton. Writing the character-centered screenplay. University of California Press: Berkeley, CA, 1994. *Process and recommendations for developing strong characters, then building a narrative around them. Draws examples from contemporary film.*

- R. D. Huard and B. Hayes-Roth, "Children's collaborative playcrafting," Tech. Report KSL-96-17, Knowledge Systems Lab., Stanford Univ. Stanford, CA, May 1996. *An examination of children's social interactions on a computerized story activity. Analyzed the user's interaction style and how it affected the learning process. Good discussion on future directions for research in children's collaborative computer work. See also: Huard, 1996b; Hayes-Roth and van Gent, 1997.*

- R. D. Huard and B. Hayes-Roth, "Children's play with improvisational puppets," Tech. Report KSL-96-27, Knowledge Systems Lab., Stanford Univ., Stanford, CA, Nov. 1996. *Examines the importance of play and storycrafting experiences in children's learning and development. Provides criteria for creating intrinsically motivating learning environments for young children using interactive storytelling and autonomous puppets. See also: Hayes-Roth and van Gent, 1997.*

– R. Huard, and B. Hayes-Roth. "Character mastery with improvisational puppets," in Notes of the IJCAI '97 Workshop on Animated Interface Agents, Nagoya, Japan, Aug. 1997, pp. 85-90. *Experimental study of children's play with three kinds of toys: commercial art software, traditional puppets, and improvisational puppets that have animate minds and animated bodies. Results show that children enjoy all three kinds of toys, but only play with improvisational improves their master of characters and their performance on associated measures of social understanding, story comprehension, and storycrafting.*

– K. Isbister. "Personality in Interactive Computer Characters: The Importance of Consistency," unpublished manuscript. *Reports evidence that people prefer consistent personality traits to inconsistent personality traits, even when the consistent value is not preferred. Consistency refers to similarity of passive/dominant mode in verbal and physical behaviors. See also: Isbister and Hayes-Roth, 1998.*

– K. Isbister, and B. Hayes-Roth. Social Interaction with Characters. Submitted to J. of Applied AI, Special Issue on Animated Interface Agents, 1998. *Analysis of transcripts from web site visitors interacting with an animate character, Erin the Bartender. Results indicate that a character's role-appropriate behavior can induce role-appropriate behavior in users.*

- W. James, Psychology. Holt: New York, 1900. *Classic, comprehensive view of the science of psychology. Introduces concepts and terminology in general use today. Still widely cited.*

- L. Johnson and B. Hayes-Roth, Eds. Proc. 1st Int. Conf. on Autonomous Agents, Marina del Rey, CA, Feb. 1997. *Broad survey of current work on autonomous agents, but several sessions focus specifically on believable agents and actors. Good general view of current work.*

- K. Johnstone, IMPRO: Improvisation and the Theater. Routledge: New York, 1992. *Describes issues and methods in improvisational theater. Presents clear theory for modeling certain improvisational interactions. Excellent background reading for issues in character interaction.*

- C. Jones, Chuck Amuck: The Life and Times of an Animated Cartoonist. Avon Books: New York, 1990. *Biography of author of Road Runner cartoons et al. Survey and anecdotes of character design, early problems and evolved solutions in creating believable animated characters. Widely cited artistic reference. See also: McCloud, 1993; Thomas and Johnson, 1981.*

– E. Jones, Interpersonal Perception. W. H. Freeman & Co.: New York, 1990. *Discusses the psychological effects of social interaction, with particular emphasis on how humans influence and are influenced by perceptions of others; significance of context in social perception; "expectancy effects" in interactions. See also: Dyer, 1993; Fiske and Taylor, 1991; James, 1900.*

– M. T. Kelso, P. Weyhrauch, and J. Bates, "Dramatic Presence," PRESENCE: The Journal of Teleoperators and Virtual Environments, vol. 1(1), pp. 133-138, 1992. *Preliminary paper on the Oz project. Introduces concept of "interactive drama," theory of plot construction, principles of interactive story design. Describes real-world tests measuring engagement in acted stories with limited sophistication, including transcripts and commentary. Best paper motivati ng principles of the Oz project.*

– H. Kitano, Ed. Notes of the 1996 AAAI Workshop on Entertainment and AI/A-Life, Portland, OR, Aug. 1996. *Range of papers on entertainment issues not limited to agents; include theater, pedagogy, logical formalisms for believability, environments to support characters, social aspects of AI. Some unusual points of view. See also: Andre, 1997.*

– J. Lasseter, "Principles of traditional animation applied to 3D animation," in Proc. SIGGRAPH '87, Anaheim, FL, July 1987, pp. 35-44. *Summary of Disney animation principles and explanation of how they apply to computationally generated 3D believable characters. Examples and images drawn from "Luxo Jr." short film et al. Excellent bridge between traditional and computational character animation. See also: Pixar, 1986; Thomas and Johnston, 1981.*

– B. Laurel, "Interface Agents: Metaphors with Character," in The Art of Human-Computer Interaction Design, B. Laurel, Ed. Addison-Wesley: Reading, MA, 1990. *Presents key characteristics of interface agents. Examines arguments pro and con; emphasis on anthropomorphism, dramatic character of agents. Considers motivations for building such agents. See also: Laurel, 1993.*

– B. Laurel, Computers as Theatre. Addison-Wesley: Reading, MA, 1993. *Explores metaphor of computer as theatrical device. Computational context for engagement, drama, story. Widely cited support for interactive agents in computing.*

– J. Lester, M. O'Leary, and B. Stone, "Animated Pedagogical Agents for Intelligent Edutainment," in Notes of the AAAI Workshop on Entertainment and AI/ALife, Portland, OR, Aug. 1996, pp. 44-49. *Describes method for sequencing believable behaviors amidst pedagogical activities. Categorizes kinds of behaviors by sensory impact; provides algorithm for sequencing. Illuminating approach to integrating believability with substantive acts. Extended by: Stone and Lester, 1996; Lester and Stone, 1997a.*

– J. Lester and B. Stone, "Increasing Believability in Animated Pedagogical Agents," in Proc. 1st Int. Conf. on Autonomous Agents, Marina del Rey, CA, Feb. 1997, pp. 16-21. *Details of action-selection in "Design-A-Plant" system via competition-based approach. Defines criteria for techniques to enhance believability in actions of pedagogical agents. Novel approach emphasizing sensory impact of actions. Extends: Lester et al., 1996.*

– J. Lester, S. Converse, S. Kahler, T. Barlow, B. Stone, and R. Bhogal, "The Persona Effect: Affective Impact of Animated Pedagogical Agents," in Proc. CHI '97 Conf., Atlanta, GA, Mar. 1997. *Large-scale user testing of believable pedagogical character in "Design-A-Plant" system. Details of study concluding personality and character enhance user engagement and retention of learned material. See also: Lester et al., 1996; Lester and Stone, 1997a.*

- J. Lester, J. Voerman, S. Towns, and C. Callaway, "Cosmo: A Life-Like Animated Pedagogical Agent with Deictic Believability," in Notes of the IJCAI '97 Workshop on Animated Interface Agents: Making Them Intelligent, Nagoya, Japan, 1997, pp. 61-70. *Presents framework for building believable pedagogical agents. Emphasis on "deictic believability," ability to refer to objects and entities in context of discourse. Examples of planning deixis in Internet tutoring system "Cosmo."*

- A. B. Loyall and J. Bates, "Hap: A Reactive, Adaptive Architecture for Agents," Tech. Report CMU-CS-91-147, School of Computer Science, Carnegie Mellon University, Pittsburgh, June 1991. *High-level technical description of Hap architecture underlying Oz agents. Plan memory, theory of activity. Comparison to other agent architectures. Best technical summary of Oz agent system.*

- Lucasfilm Ltd. Computer Graphics Division, The Adventures of Andre and Wally B., (film), 1984. *Early computer-animated short film. Attempt to apply traditional animation principles in computer graphics. Largely of historical interest. See also: Lasseter, 1987; Pixar, 1986.*

- P. Maes, T. Darrell, B. Blumberg, and A. Pentland, "The ALIVE System: Full-body Interaction with Autonomous Agents," in Proc. Computer Animation '95 Conf., Geneva, Switzerland, Apr. 1995. *Presents ALIVE system for wireless full-body interaction between humans and animated virtual agents. Approach to interface through video sensing and wall-sized display without intrusive hardware. Interesting alternative approach to building immersive environments.*

- P. Maes, "Artificial Life Meets Entertainment: Interacting with Lifelike Autonomous Agents," in Comm. of the ACM, vol. 38(11), pp. 108-114, Nov. 1995. *Summarizes research in lifelike agent systems as distinct from believable agent systems. Overview of ALIVE project and tools for physical interactivity with virtual agents. Widely cited, general if brief survey. Details in: Maes et al., 1995a.*

- H. Maldonado, A. Picard, P. Doyle, and B. Hayes-Roth, "Tigrito: A Multi-Mode Interactive Improvisational Agent," in Proc. 1998 Int. Conf. on Intelligent User Interfaces, San Francisco, CA, Jan. 1998, pp. 29-32. *Describes implementation of Tigrito, an affective computer pet. System supports several modes of interaction with characters (avatar, disembodied, "movie" mode). Focus is effectiveness of different modes at producing a sense of engagement.*

- M. Mauldin, "ChatterBots, TinyMUDs, and the Turing test: Entering the Loebner prize competition," in Proc. 12th Natl. Conf. on Artif. Intell., Seattle, WA, July 1994, pp. 16-21. *Description of ChatterBot "Julia," a MUD agent capable of limited conversation. Details conversational model and response design. Analysis of interaction in a limited Turing test, with comparisons to ELIZA and PARRY. Provides useful insights into heuristics for conversational believability. See also: Curtis, 1992; Weizenbaum, 1966.*

- S. McCloud, Understanding Comics: The Invisible Art. HarperPerrenial: New York, 1993. *Introduction to comic strip design. Discusses details of presentation, image emphasis, separation of text and graphics, focus, and flow. Excellent alternative view of interface, story, and believability. See also: Thomas and Johnson, 1981; Jones, 1990.*

- Y. Moon, "Can computer personalities be human personalities?" in Int. Journal of Human-Computer Studies, vol. 43, pp. 223-239, 1995. *Summarizes evidence that people prefer individuals with personality attributes similar to their own. Includes review of studies of a range of relationships, e.g. marital satisfaction, roommate relationships, interest in strangers.*

– J. Murray, Hamlet on the Holodeck: The Future of Narrative in Cyberspace. The Free Press: New York, 1997. *Examination of interactive narrative as a medium. Computational limitations, interface design issues, and problems of creating satisfying interactive experiences. Ties together narrative theory and computer-designed experiment. Conceptual rather than technical.*

– S. Nachmanovitch. Free Play: Improvisation in Life and Art. Jeremy P. Tarcher, Inc.: Los Angeles, 1991. *Explores the origins of the creative process, arguing that improvisation is the key to creative expression. Broadly motivating, non-technical.*

– C. Nass, J. Steuer, and E. Tauber, "Computers are Social Actors," in Proc. CHI '94 Conf., Boston, MA, Apr. 1994. *Introduces thesis that interaction with computers is fundamentally social. Brief analysis of experiments in which users work with and then evaluate computer tutoring systems. Often cited psychological justification for character-based interfaces. Expanded by: Nass et al., 1995.*

– C. Nass, Y. Moon, B. J. Fogg, B. Reees, and C. Dryer, "Can computer personalities be human personalities?" in Int. Journal of Human-Computer Studies, vol. 43, pp. 223-239, 1995. *Study supporting thesis that people prefer to interact with others of similar personality. Results indicate personality can be conveyed by simple, superficial cues. Some summary of psychological literature. Expands on: Nass et al., 1994.*

– A. Newell. Unified Theories of Cognition. Harvard University Press: Cambridge, MA, 1990. *Newell puts forth the proposition that the field of AI should focus on building integrated intelligent agents. He illustrates the goal and process with a detailed report of his own group's work on the Soar architecture.*

– D. Norman, Things That Make Us Smart. Addison-Wesley: Reading, MA, 1993. *Emphasizes design of systems to match human strengths, rather than adapting humans to computers. Many concepts apply to design of spaces for intelligent characters. Widely cited HCI reference. See also: Doyle and Hayes-Roth, 1998.*

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– K. Perlin, "Real time responsive animation with personality," IEEE Transactions on Visualization and Computer Graphics, vol. 1, 1995. *Technical details of character animation system. System is concerned with physics and dynamics of representing animated characters, rather than internal motivation. Extended in: Perlin, 1996.*

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- *pdoyle@cs.stanford.edu*   April 22, 1998

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- The following publications are available from their respective publishers. If a CMU technical report number is shown (CMU-CS-xxx), the report may be ordered for a small fee by contacting:

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- ` Carnegie Mellon University        e-mail: reports@cs.cmu.edu`
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- ` Pittsburgh, PA 15213-3891`

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