

STEPHEN H. LANE
38 Cherry Brook Drive
Princeton, New Jersey 08540
(609) 466-5972
shlane@cis.upenn.edu

EDUCATION:

Princeton University, Dept. of Mechanical and Aerospace Engineering
Ph.D. Degree, 1988.

Thesis Title: Theory and Development of Adaptive Flight Control
Systems Using Nonlinear Inverse Dynamics.

Master of Arts Degree, 1984.

University of California (UCLA), Dept. of Engineering Systems
Master of Science Degree, 1982.

Thesis Title: Microprocessor Implementation of a Two-Axis Inertially
Stabilized Platform.

Cornell University, Dept. of Mechanical and Aerospace Engineering
Bachelor of Science Degree, 1980.

EMPLOYMENT:

University of Pennsylvania

Department of Computer and Information Science

2001 - Present

Professor of Practice

Director, Computer Graphics and Game Technology Masters Program

Dr. Lane joined the faculty of the Computer and Information Science Department at the University of Pennsylvania in the fall of 2001. Dr. Lane is currently a Professor of Practice and the Director of the Computer Graphics and Game Technology (CGGT) Masters Program. Drawing on his background and experience in the computer gaming industry, Dr. Lane teaches courses on Computer Animation (CIS462/562), Advanced Topics in Computer Graphics and Animation (CIS660) and Game Design and Development (CIS564). Dr. Lane also supervises the Game Design Practicum (CIS568) capstone project course required to be completed by all CGGT students. CIS462/562: Computer Animation provides students with a solid technical foundation for developing, animating and controlling articulated systems used in interactive computer games, virtual reality simulations and high-end animation applications. The course balances theory with practice by “looking under the hood” of a number of popular commercial animation packages and exams the technologies and techniques used from both a computer science and engineering perspective. CIS660: Advanced Topics in Computer Graphics and Animation exposes students to the current state-of-the-art of research in the fields of computer graphics and animation in a seminar-like setting. CIS564: Computer Game Design and Development provides students with a solid theoretical understanding of the core creative principles, concepts, and game play structures and schemas underlying most game designs. The course also examines game development from an engineering point of view, including: game play mechanics, game engine software and hardware architectures, user interfaces, design documents, play testing and production methods. In the past Dr. Lane also co-taught CSE377: Virtual World Design, with Dr. Norman Badler, which exposed students to the creative design, software development and human/computer interface aspects of creating innovative interactive 3D virtual worlds and game applications.

Recent Research Projects:

- ***NailedIt*** – An Augmented Reality (AR) Surgical Navigation System comprised of a networked desktop application with a graphical user interface, an augmented reality head mounted display (HMD) and spatially tracked instruments and surgical devices that provides surgical guidance for a variety of orthopedic surgical procedures.
- ***Bubble Interface*** – A patent-pending Extended Reality (XR) user interface that represents hierarchically organized information as a set of nested augmented reality bubbles which surround the user in the physical world. Just as a user can descend into deeper and deeper folders and subfolders in a typical file system, so too can they traverse the XR bubble hierarchy by entering bubbles and sub-bubbles.
- ***KAT User Interface*** – Patented Keyboard Alternative Technology (KAT) that allows users to enter all the alphabetic, numeric, and other characters found a typical mobile device keyboard using simple sequential finger movements (e.g. left, right, hold, up or down) that are tracked on the back facing side of the mobile device.

2016 - Present Venturi Labs, LLC. – Princeton, NJ

President and Founder

Dr. Lane founded Venturi Labs as a catalyst and new outlet for commercializing cutting edge technologies in graphics, games, simulation, training, education and healthcare developed using state-of-the-art mobile, augmented reality (AR) and virtual reality (VR) user interfaces. Affiliated with the Penn Center for Innovation (PCI) at the University of Pennsylvania, Venturi Labs provides a natural bridge between Penn's academic programs and industry partners interested in tapping Penn's incredible pool of student talent.

1999 - 2020 soVoz, Inc. – Princeton, NJ

President and Founder

Dr. Lane originally founded soVoz, Inc. to develop character-based intelligent agent products and services that provide web sites with a more “human-like” interactive medium for “real-time” sales assistance, customer service as well as corporate training and education. The first two services developed, known as Character-on-Demand™ and Price-on-Demand™, enabled retailers to re-introduce the notion of the salesperson to the online selling process. The services featured animated intelligent sales agents that personalized the online shopping experience by negotiating pricing and other terms with consumers in real time. The unique client/server design that was developed enabled these agents to be deployed on websites with virtually no modifications required to the contents of the site. soVoz also developed a suite of products and services using this technology and the behavioral animation and 3D game technology developed at Robicon Systems and Katrix (see below) for online training and education applications. The products and services, known as ProScena Studio™, feature high-level authoring tools, libraries of off-the-shelf components known as “actors,” “behaviors” and “events,” , and a scalable content management system that allows the creation, storage, delivery and playback of interactive 3D content across a broad range of operating systems, hardware devices and networks. soVoz also developed a next generation Virtual Reality (VR) user interface, in the spirit of the Nintendo Wii and Wii Fit, for Interactive Fitness (i.e. exergaming) and Immersive Training applications. Specifically, a suite of products supporting both the physical and visual immersion of users in 3D computer-generated worlds.

- Responsible for initial business concept, business plan and financial models.
- Raised angel financing to develop Price-on-Demand™ products and services.
- Recruited technology development and management teams
- Managed technology R&D and software development efforts
- Successfully deployed Character-on-Demand™ and Price-on-Demand™ intelligent agent services on beta test site
- Successfully developed ProScena Studio™ products and services
- Successfully developed VLController™ and VLCruiser line of virtual training and exergaming products
- Awarded Phase I and II SBIR contracts with the Office of the Secretary of Defense to apply soVoz intelligent agent technology to the development of Reusable 3D Components for Virtual Environments. Project title: “Technology and Tools for the Creation of reusable 3D content in e-Learning Systems”
- Awarded Phase I SBIR contract with the Office of Naval Research to apply ProScena technology to the development of haptic device interfaces. Project title: “Behavior-based Approach to the Generation of Haptic Feedback in Virtual Reality Training Systems”.
- Awarded contract from the Advanced Distributed Learning (ADL) Joint Co-Lab to develop a prototype Emergency Response Team training scenarios with the ProScena Studio toolset. Project title: “Design and Development of a 3D Simulation Component Repository Supporting ADL Training and Education Applications”
- Awarded Phase I, Phase II and Phase III SBIR contracts with US Army RDECOM – STTC to develop a virtual locomotion controller (i.e. VLController) for controlling interactive characters in 3D environments. Project title: "Control Interface for Driving Interactive Characters in Immersive Virtual Environments"

1993 - 1999

Katrix Inc. – Princeton, NJ

President and Co-Founder

Co-founded Katrix Inc. to commercialize robotics and artificial intelligence technology developed at Robicon Systems Inc. (see description below) for use in interactive entertainment and computer animation markets. These commercialization efforts resulted in the series of development contracts and technology licenses that follows. During the period 1993-1998 Katrix also acquired Millennium Rush, LLC, which became the production division of Katrix and licensed its advanced animation and artificial intelligence technology to companies such as Hasbro and Microsoft.

Internal Development Projects

Katrix Behavioral Animation Technology

- Responsible for functional requirements and design of software architecture of behavioral animation technology enabling the creation of “directable” 3D interactive characters

WebCharacter Creator Authoring Tool

- Managed the design and development of a Windows-based authoring tool enabling non-technical users (i.e. Web designers) to easily configure and

deploy these directable 3D characters as hosts, tourguides, salespersons and customer support representatives on Internet Web sites

External Development Projects

Hasbro

- Facilitated the introduction of Hasbro to David Sarnoff Research Center resulting in Hasbro commissioning development of a \$40M consumer virtual reality entertainment system at the Sarnoff Labs in Princeton, NJ
- Licensed Katrix's proprietary artificial intelligence (neural network) technology to Hasbro for inclusion in their VR system
- Directed development of a sword fighting game, "Nero Zero", one of the five original games for the Hasbro VR system

AT&T

- Directed the development of an Olympics Decathlon game for AT&T that shipped with the debut of their WorldNet Internet service. Utilized first version of Microsoft DirectX in the game's development.

Microsoft

- Licensed Katrix's unique inverse kinematics technology to Microsoft for inclusion in DirectX/Chrome, an advanced 3D Web browser that was in development at that time.

Disney

- Directed development of technology used in the attraction "Ride the Comix", a location-based virtual reality sword fighting game that opened in Orlando, FL at DisneyQuest in June 1998.

MetaCreations

- Directed development of technology used in a unique interactive rhythm and action game known as "Dance Studio", developed by Katrix's wholly owned subsidiary, Millennium Rush, and published by MetaCreations
- Dance Studio was rated one of the top ten family entertainment products

Intel Corporation

- Katrix invited to participate in two different components of Intel's Developer Relations program
- Katrix shows three demos of its products and technology as part of the Intel Pentium III launch in Feb., 1999
- Katrix (Web)character browser plug-in to be distributed as part of the Pentium III WebOutfitter program

US Army

- Wrote proposals resulting in the awards of Phase I and Phase II SBIR contracts with the US Army Simulation, Training and Instrumentation Command (STRICOM)
- Project Title: "Interactive Augmentation of Computer Generated Force (CGF) Behaviors Based on Cooperative and Reinforcement Learning"
- Directed the development of robotic skill acquisition technology for distributed interactive simulations enabling the creation of "smart opponent" and "virtual teammate" computer generated forces (CGFs) that could continuously learn from their interactions with manned forces, human instructors, and their own mistakes.

1988 – 1993 Robicon Systems Inc. – Princeton, NJ

President and Co-Founder

Co-founded Robicon Systems to develop advanced technologies in the areas of robotics and artificial intelligence based upon biological principles. Through research funded by contracts and grants from DARPA, NSF, the Franklin Institute of Philadelphia, RCA's David Sarnoff Research Center and Princeton University, Robicon created state-of-the-art robotic skill acquisition technology (using neural networks, expert system techniques and a sophisticated form of inverse kinematics known as limb coordination) that laid the foundation for Katnix's later commercialization efforts in the area of interactive 3D character animation.

1990 - 1993 Princeton University

Research Scientist

Human Information Processing Group

Department of Psychology

Princeton, New Jersey

1987 - 1989 SRI International, David Sarnoff Research Center

Technical Consultant

Adaptive Systems Group

Princeton, New Jersey

1982 - 1987 Princeton University

Doctoral Student/Research Assistant

Department of Mechanical and Aerospace Engineering

Princeton, New Jersey

1980 - 1983 Hughes Aircraft Company

Member of the Technical Staff

Control Electronics Departments

Electro-Optical and Data Systems Group

Space and Communications Group

El Segundo, California

PROFESSIONAL SOCIETIES, SCHOLARSHIPS AND HONORS

Member, Institute of Electrical and Electronics Engineers

Member, International Neural Network Society

Member, Association for Computing Machinery

ARCO Fellowship, Princeton University

Hughes Aircraft Company Masters Fellowship

Dean McMullen College Scholarship, Cornell University

New York State Regents Scholarship

Eagle Scout

RECENT CONFERENCES, WORKSHOPS AND PANELS

- Penn Immersive XR (AR/VR) Conference, April 2018 – Program committee and panel moderator
- Game Developers Conference, 2018 – AR/VR summit and roundtable participant
- Augmented Reality in Action (ARIA) Conference, MIT Media Lab, Boston, MA, Jan. 2019 – Invited
- ACM SigGraph Conference, Los Angeles, CA, Aug. 2019
- Game Developers Conference, 2020
- ACM SigGraph Conference, 2020 – Appy Hour presenter
- Microsoft Mixed Reality Developer Conference, 2020

- Game Developers Conferences, 2021, 2022
- ACM SigGraph Conferences, 2021, 2022

RELEVANT PUBLICATIONS

- [1] Lane, S. H. (1982). *Microprocessor Implementation of a Two-Axis Inertially Stabilized Platform*, Masters Thesis, University California at Los Angeles (UCLA).
- [2] Lane, S. H. and Stengel, R.F. (1987). "Nonlinear Inverse Dynamics - A Sampled Data Approach," *Proc. 1987 American Control Conference*, Minneapolis, Minn., June.
- [3] Lane, S. H. and Stengel, R.F. (1988). "Flight Control Design Using Nonlinear Inverse Dynamics," *IFAC Automatica*, Vol. 24, No. 3, July.
- [4] Lane, S. H. (1988). *Theory and Development of Adaptive Flight Control Systems Using Nonlinear Inverse Dynamics*, Ph.D. Dissertation, Princeton University.
- [5] Huang, C. Y. and Lane, S. H. (1988). "A Heuristic Approach to the Travelling Salesman Problem," *AIAA J. Guidance, Control and Dynamics*, vol. 11, no. 1.
- [6] Lane, S. H., Handelman, D. A. and Gelfand, J. J. (1988). "A Neural Network Computational Map Approach to Reflexive Motor Control," *Proc. 3rd IEEE Symposium on Intelligent Control*, Arlington, VA, Aug.
- [7] Lane, S. H., Handelman, D. A. and Gelfand, J. J. (1989). "Development of Adaptive B-Splines Using CMAC Neural Networks," *Proc. Int'l. Joint Conference on Neural Networks*, IEEE Press, New York, June.
- [8] Handelman, D. A., Lane, S. H. and Gelfand, J. J. (1989). "Integrating Knowledge-Based System and Neural Network Techniques for Robotic Skill Acquisition," *Proc. Int'l. Joint Conference on Artificial Intelligence*, Morgan Kaufmann, San Mateo, CA., Aug.
- [9] Handelman, D. A., Lane, S. H. and Gelfand, J. J. (1990). "Integrating Neural Networks and Knowledge-Based Systems for Intelligent Robotic Control," *IEEE Control Systems Magazine*, April, pp. 77-87.
- [10] Lane, S. H., Handelman, D. A. and Gelfand, J. J. (1990). "Can Robots Learn Like People Do?" *Proc. of the SPIE Conf. on Applications of Artificial Neural Networks*, Orlando, FL., April.
- [11] Lane, S. H., Handelman, D. A. and Gelfand, J. J. (1990). "Reinforcement Learning and Optimization in Intelligent Robotic Control Systems," presented at *5th IEEE Symposium on Intelligent Control*, Philadelphia, Sept.
- [12] Handelman, D. A., Lane, S. H. and Gelfand, J. J. (1990). "Focusing Attention within Adaptive Hybrid Controller Hierarchies for Robotic Skill Acquisition," *5th IEEE Symposium on Intelligent Control*, Philadelphia, Sept..
- [13] Handelman, D. A., Lane, S. H. and Gelfand, J. J. (1990). "Goal-Directed Training of Neural Networks for Vehicle Guidance and Control," *NSF Workshop on Aerospace Applications of Neurocontrol*, St. Louis, Oct.
- [14] Flax, M. G., Gelfand, J. J., Lane, S. H. and Handelman, D. A. (1990). "Integrating Neural Network and Tree-Search Approaches to Produce an Autosupervised System that Learns to Play Games," *Proc. Aerospace Applic. Artificial Intelligence Conf.*, Dayton, OH, Oct.
- [15] Lane, S. H., Flax, M. G., Handelman, D. A. and Gelfand, J. J. (1991). "Multi-Layer Perceptrons with B-Spline Receptive Field Functions," *Advances in Neural Information Processing Systems 3*, Morgan Kaufmann.

- [16] Lane, S. H., Flax, M. G., Handelman, D. A. and Gelfand, J. J. (1991). "Function Approximation in Multi-layered Neural Networks with B-Spline Receptive Fields," Princeton University Cognitive Science Lab Report no. 42, February.
- [17] Lane, S. H., Handelman, D. A. and Gelfand, J. J. (1991). "Higher-Order CMAC Neural Networks - Theory And Practice," *Proc. 1991 American Control Conf.*, Boston, June.
- [18] Lane, S.H., Handelman, D.A. and Gelfand, J.J. (1991). "An Architecture for Robotic Skill Acquisition Incorporating Structural and Behavioral Aspects of the Human Motor Control System," *IEEE Expert*.
- [19] Handelman, D.A., Lane, S.H. and Gelfand, J.J. (1991). "Goal-Directed Encoding of Task Knowledge for Robotic Skill Acquisition," *Proc. 6th IEEE International Symposium on Intelligent Control*, Arlington, VA, Aug., pp. 301-328.
- [20] Handelman, D.A., Lane, S.H. and Gelfand, J.J. (1992). "Robotic Skill Acquisition Based on Biological Principles," in Kandel, A. and Langholz, G. Eds., *Hybrid Architectures for Intelligent Control*, CRC Press, Boca Raton, FL pp. 301-328.
- [21] Lane, S.H., Handelman, D.A. and Gelfand, J.J. (1992). "Theory and Development of Higher-Order CMAC Neural Networks," *IEEE Control Systems Magazine*, April.
- [22] Gelfand, J.J., Flax, M. Endres, R., Lane, S.H., and Handelman, D.A. (1992). "Acquisition of Automatic Activity Through Practice: Changes in Sensory Input," *Proc. 10th National Conf. on Artificial Intelligence*, San Jose, CA.
- [23] Lane, S.H., Pearson, J.C., and Sverdlove, R. (1992). "Neural Networks for Classifying Image Textures," *Proc. Gov't Neural Network Applications Workshop*, Dayton, OH, Aug.
- [24] Lane, S.H., Handelman, D.A. and Gelfand, J.J. (1993). "Robotic Motor Synergy Modulation Using Reinforcement Learning Optimization," *Neural Networks in Robotics*, Bekey, G. and Goldberg, K. Eds., Kluwer Academic Publ., Norwell, MA.
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- [26] Gelfand, J.J., Flax, M. Endres, R., Lane, S.H., and Handelman, D.A. (1993). "Senses, Skills, Reactions and Reflexes: Learning Automatic Behaviors in Multi-Sensory Robotic Systems," *Neural Networks in Robotics*, Bekey, G. and Goldberg, K. Eds., Kluwer Academic Publ., Norwell, MA.
- [27] Gelfand, J.J., Flax, Handelman, D.A., and Lane, S.H. (1993). "Multiple Sensory Modalities for Learning and Control," in *Perceptual Robotics*, Venkataraman, T. and Gulati, S., Eds., Springer-Verlag, New York.
- [28] Handelman, D.A., and Lane, S.H. (1993). "Human-to-Machine Skill Transfer Through Cooperative Learning," in Gupta, M.M., and Sinha, N.K., Eds., *Intelligent Control Systems*, IEEE Press, Piscataway, New Jersey.
- [29] Handelman, D.A., Lane, S.H., and Gelfand, J.J. (1993). "Prospects for Cooperative Learning in Intelligent Vehicles," *Proceedings of the 1993 IEEE Regional Conference on Control Systems*, New Jersey Institute of Technology, August.
- [30] Apostolos, M.K., Littman, M., Lane, S.H., Handelman, D.A., and Gelfand, J.J. (1996). "Robot choreography: an artistic-scientific connection," *Computers and Mathematics with Appl.*, Vol:32.
- [31] Gullapalli, V., Gelfand, J.J., Lane, S.H. and Wilson, W.W. (1996). "Synergy-based learning of hybrid position/force control for redundant manipulators," *Proceedings of the 1996 IEEE Int'l Conference on Robotics and Automation*, Minneapolis, MN.

- [32] Lane, S.H. and Thomasino, V. (2003) "Technology and Tools for the Creation of Reusable 3D Visualization and Simulation Content in e-Learning Systems," *2003 IITSEC Proceedings*, Orlando, FL, Dec.
- [33] Lane, S.H., Marshall, H. and Roberts, T., (2006) "Control Interface for Driving Interactive Characters in Immersive Virtual Environments," *Proceedings of the 2006 Army Science Conference*, Orlando, FL, Nov.
- [34] Lane, S.H., Schnurr, J. and Roberts, T., (2010). "Virtual Locomotion Controller for Embedded Training Applications," *Army Science Conference*, Orlando, FL
- [35] Lane, S.H. and Maag, P. (2011). "Recognition of Hand Signal Gestures Utilizing Inertial Sensor Inputs," *2011 Interservice/Industry Training, Simulation, and Education Conference (IITSEC)*, Orlando, FL Dec. 2011.
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- [37] Lane, S., Boyd-Surka, M. and Bai, Y. (2020). "Step into the Bubble," *SigGraph 2020*, Washington, DC, Aug. 2020

PATENTS

- [1] US Patent Application No. 17/412,197: Methods, Systems, and Computer Readable Media For Extended Reality User Interface, August 25, 2021
- [2] US Patent No. 10, 387, 032 B2, "User Interface Input Method and System for Handheld and Mobile Devices," Lane, S.H., Kong, J.H., Aug 20., 2019.
- [3] US Patent No. 19,067,097 B2, "Virtual Locomotion Controller Apparatus and Method," Lane, S.H., Schnurr, J., Satyanarayana, H. and Zhao, L., June 2015.
- [4] US Patent No. 6,057,859, "Limb coordination system for interactive computer animation of articulated characters with blended motion data ," Handelman, D.A., Lane, S.H. and Gullapalli, V., May 2, 2000.
- [5] US Patent No. 6,088,042, "Interactive motion data animation system," Handelman, D.A., Lane, S.H. and Gullapalli, V., July 11, 2000.
- [6] US Patent No. 6,191,798, "Limb coordination system for interactive computer animation of articulated characters," Handelman, D.A., Lane, S.H. and Gullapalli, V., Feb. 20, 2001.