

# KURTIS KELLER

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## Research Engineer

### Mechanical Design of Optical and Electrical Systems

Medical Equipment design – FDA 510K.	Optical projector, HMD & endoscope design
Electronic cooling & vibration	Micro and telescope optical accessories
Electro-opto-mechanical system design	Manufacturing optimization

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#### Education:

1994 M.S. North Carolina State University, Integrated Manufacturing Systems Engineering,

1988 B.S. North Carolina State University, Mechanical Engineering.

Post grad & Business MBA (*27 of 33 credits – started company*):

Launching the Company Series, UNC's Kenan Flagler Business School

Optical Perception, UNC

Patent Law (2 classes), NCSU, UNC

Optical Mounting, U Arizona.

Business Law, NCSU

#### Professional:

2003 - President to Engineering Director & COO, InnerOptic Technology Inc. Chapel Hill, NC (split time with UNC).

1993 - Research Engineer, Microelectronic Systems Laboratory, Department of Computer Science, University of North Carolina Chapel Hill. (split time with InnerOptic).

2000 – 2001 3rdTech, Senior Mechanical Engineer, Chapel Hill, NC (part time).

1988 – 1993 Mechanical Engineer, Matrix Corporation, Raleigh North Carolina.

1984 – 1987 Machining, CNC programming, Kamtec Incorporated, Mebane, NC, Summers.

1983 - 1984 President, Kwest Robotics Incorporated, Mebane, NC.

#### Principal Investigator Activities:

P.I. on NSF 2005 & 2008 grant 0422102 A & B. "Phase II & Phase IIB, Three-Dimensional (3D) Laparoscope"; \$430,000 & \$125,000.

P.I. on NSF 2003 grant 0319710. "Phase I, Three-Dimensional (3D) Laparoscope"; \$98,000.

#### Major Projects: *Optical - Mechanical*

Very Large Telescope Optical mounts. Designed & built mechanisms for SOAR telescope, 162" aperture. Co-designed ADC optical system of 12" optics, mounted winter 2009, Chile. UNC

HiBall Ceiling Tracker. PC design, layout and mechanical design of world's largest & accurate virtual / augmented reality tracker. Six, IR shared path sensors for 5 arc minute rotation accuracy, 1400 updates/sec. Co - designed multi-sensor optical tracker. UNC and 3rdTech Inc.

Head Mounted Displays. Designer and co-designer of 12 HMDs including optical and video see-through and 6 display per eye very WFOV Kaiser HMD. Several medical HMD designs. Co-designed projectors for research use. UNC.

Magnetic force microscope. Lead mechanical and optical design for real-time magnetic force microscope. Includes design of microscope stages, top and lower optics, magnetic coils and circuit boards, optical interfaces, thermal regulation and other. From lab designs to optimized, manufacturable design. UNC.

Laser range finder and imager. Mechanical design of scanning 3D laser scanner for room-sized scans. Commercial product used extensively in crime scene reconstruction. UNC and Delta Sphere, Inc.

Very Large Telescope spectrum analyzer. Co-designed IFU multi pickup spectrum analyzer. Uses 240 optical fibers and 4 miniature X-Y motion platforms for SOAR telescope. Chile. UNC.

Multiview. Designed multi-camera 180° FOV shared nodal point camera system. System has six cameras with shared, apparent virtual location by use of use of mirrors and overlapping apertures. Used for effective virtual, wide angle presence and telecollaboration. UNC.

Manager of UNC Prototype Machine shop. 20 years of experience of running a prototype machine shop along with 4 years in production shop. Lathes, mills, CNC programming, stereo lithography prototyping, sheet metal, etc. UNC.

Miniature video see-through HMD. Co-designed, built, patented and sold miniature video see-through HMD. Used from medical procedures, especially surgery. UNC and licensed to InnerOptic Technology, Inc.

Stereo Endoscope Design: Designed patent-pending micro, 5mm diameter dual path endoscope with wide IPD separation, single HD imager, and compact and economical camera interface for surgery use. InnerOptic Technology, Inc.

Projector and 3D display detailed evaluation and analysis. Performed studies on both commercial and UNC's own custom-designed DLP and LCD projectors along with 3D display empirical and user study evaluations. UNC. Also, expert witness for several projector patent cases.

High-speed optical cancer detection device. Design for a high-speed optical cancer detection apparatus for cancers. Optical design in the visible and IR with multiple, parallel digital cameras and computer. For cervical, prostate and throat cancers. InnerOptic Technology, Inc.

Endoscope camera head for stereo and mono endoscopes: Patent-pending design allows a single camera head to attach to both standard mono- endoscopes and miniature stereo endoscopes providing HD quality imagery. InnerOptic Technology, Inc.

### **Major Projects: *Electro- mechanical:***

Medical Device FDA and FCC approval process. Worked with team for preparing and submitting 510K of surgical, electronic medical device. Received clearance Fall 2009. Also included detailed UL 60601-1 and 60601-2 electromagnetic design, test and safety approvals. InnerOptic Technology, Inc.

Pixel Flow 8KW Graphics super computer (commercialization with Hewlett Packard). Head Mechanical Engineer for \$30 million project. Provided all thermal design, air flow analysis, custom processor heatsink designs, backplane layout (256 bit wide, 12,000 pin, 8 layer), test board designs, co – layout main PC (44 processors, 18 layer board). Hewlett Packard & UNC.

*Detailed thermal and vibration design* airflow and FEA cooling analysis, for trunkline real-time encryption computers. Detailed MTBF and FITs calculations, design and parts optimization for improving reliability. Cooling design of system for unattended, very high security and reliability encryption computers. For Telcom industry - required *system* MTBF of over 3 years. Much thermal/FEA simulations and re-laying out of enclosures to meet MTBF requirements. Performed tests at testing labs. Cipher Optics and Secant Corp.

Rugged & Military Computer Series. Designed VME PC board mechanical designs for ultra high vibration, shock and temperature (-40 - +85C) environments. Designed enclosures and systems for MIL, UL & FCC. One series designed to survive & function through depth charge blasts. Matrix Corp.

Custom Motion Platforms. Designed and co-designed and constructed three different motion platforms. Capacities from 10 lbs to 60 lbs. X-Y linear, XY rotational and X-Y-Z linear. Stepper motor and servo motor control. UNC and InnerOptic.

InVision Computer assisted surgical system. Lead Engineer for commercial system that combined tracked ablation needles and ultrasound in a full 3D stereo, real-time display to assist surgeons. From conception to fully FDA approved system. InnerOptic Technology Inc.

Custom Surgical Trackers: Designed, simulated (FEA) eight different medical grade plastic injection molded parts and clamps produced in quantity for various tracked surgical tool systems. Full FDA approved sterilization, packaging, labeling along with obtaining FDA approvals. InnerOptic technology, Inc.

High EMI computer enclosures. Full series of commercial designs for extremely high EMI environments. Modified Faraday cage design. One even used inside Los Alamos's super collider core. Matrix Corp.

Green Energy wind farm. Lead engineer for consortium to install Boeing-designed large windmills for power generation near Manteo, NC. Technically feasible but abandoned due to environmental / no tower (height) ordinances at the time.

Outdoor Computer System. Lead Mechanical Engineer for design of utility pole-mounted video on demand cable TV system. Fully IP66 rated (sealed, water tight). Computer, hard drives, power supplies all inside custom cast aluminum enclosure with integral fins. Needed to power up and operate from -40° - 50°C. Separate cold weather startup circuitry. Needed to stay cool in summer, full sunlight, covered in bird droppings. Also in charge of environmental testing. ICTV Corporation.

Custom Industrial robot. Lead mechanical engineer for custom hydraulic robot installed into automotive assembly line. 3 axis plus end-effector. 100% custom design. Rugged, industrial design with 24 hour round the clock operation. Hydraulic with electronic positioning feedback. GKN.

## **Business Development Activities:**

**InnerOptic Technology Inc.** Co-founder. Exclusively licensed 4 patents from UNC-Chapel Hill for development of 3D endoscopic and 3D medical visualization system. Pulled in and signed contracts for ~\$2.5M in both private and public investment including SBIRs. Built devices, performed trials on humans, received FDA clearance for medical device Fall 2009. Negotiated and completed sublicensing of technology to other companies.

**Duval Research Inc.** Founder. Design & contract engineering company for projector and rugged electronic packaging. Expert Witness patents, optical-mechanical. 2 employees. 1998-

**KWEST, Inc.** Co-founder. Designed, built, sold and installed custom robot(s) for assembly line use; my emphasis on mechanical side of system. Installed in US automotive supplied assembly line. 1984-1985.

## **Patents:**

"Methods and Systems for Real-time Structured Light Depth Extraction and Endoscope Using Structured Light Depth Extraction"; US Patent # 6,503,195; Kurtis Keller, Jeremy Ackerman, Michael Rosenthal, Henry Fuchs & Andrei State.

"Methods and systems for laser based real-time structured light depth extraction"; US Patent # 7,385,708; Kurtis Keller, Jeremy Ackerman.

“Methods, Systems, and Computer Program Products for Full Spectrum Projection”; US Patent Application #20090009723; Kurtis Keller; Lea Vicci.

“System and method of providing real-time dynamic imagery of a medical procedure site using multiple modalities”; US Patent Application #20080030578; Sharif Razzaque, Andreio State, Kurtis Keller, Caroline Green.

“Apparatus, system and method for optically analyzing a substrate”; US Patent Application #20060184040; Kurtis Keller, Caroline Green.

“Methods and systems for laser based real-time structured light depth extraction”; US Patent Application #20050219552; Kurtis Keller, Sharif Razzaque.

“Methods and systems for dynamic virtual convergence and head mountable display”; US Patent Application # 20040238732; Andrei State, Kurtis Keller.

### **Publications:**

“Single-imager, Stereo Endoscope”; Kurtis Keller & Andrei State. SPIE Medical Imaging 2011, 2011.

“Head Mounted Displays for Medical Use”; Kurtis Keller, Andrei State, and Henry Fuchs; Invited Paper; Journal of Display Technology, IEEE and OSA, Vol. 4 Number 4, 2008

“Thin-foil magnetic force system for high-numerical-aperture microscopy ”; Fisher, J. K., L. Vicci, J. Cribb, K. Keller, B. G. Wilde, T. O’Brien, K. Desai, R. M. Taylor II, R. Superfine; Review of Scientific Instruments; 2006.

“Simulation-Based Design and Rapid Prototyping of a Parallax-Free, Orthoscopic Video See-Through Head-Mounted Display”; Andrei State, Kurtis P. Keller and Henry Fuchs; *Proc. International Symposium on Mixed and Augmented Reality (ISMAR) 2005* (Vienna, Austria, Oct 5-8, 2005

“Towards Tumor Detection through Optical Tomography in a 3D Depth Extraction Endoscope”; Kurtis Keller, Adam Wax, Caroline Green, Andrei State, and Henry Fuchs; MMVR, January, 2005.

“3D Force Microscope: a nanometric optical tracking and magnetic manipulation system for the biomedical sciences”; Fisher, J. K., L. Vicci, J. R. Cummings, K. Keller, B. G. Wilde, T. O’Brien, K. Desai, C. Weigle, G. Bishop, R. M. Taylor II, R. Superfine; Review of Scientific Instruments; October 2004.

“Severe Environment Conduction-cooled Boards with Daughter Cards - Design Methods and Analysis”; ASME InterPack 2003, Kurtis Keller.

“Monticello Through the Window”; 4th Symposium on Virtual Reality, Archaeology and Cultural Heritage 2003, Nathaniel Williams, Chad Hantak, Kom-Lim Low, John Thomas, Kurtis Keller, Lars Nyland, David Luebke and Anselmo Lastra.

“Mixed Reality HMD Design”; VR2002, Andrei State & Kurtis Keller.

“Surface Reconstruction of Abdominal organs using Laparoscopic Structured Light for Augmented Reality Applications”; Jeremy Ackerman, Kurtis Keller, Henry Fuchs; Electronic Imaging 2002 – Photonics West.

“Switched Pattern Laser Projection for Real-time Depth Extraction and Visualization through Endoscopes”; Kurtis Keller, Jeremy Ackerman, and Henry Fuchs; 2002, International Symposium on Optical Science and Technology SPIE's 47th annual meeting.

“Augmented Reality Guidance for Needle Biopsies: A Randomized, Controlled Trial in Phantoms”; MICCAI 2001”, Rosenthal, M. R., State, A., Lee, J., Hirota, G., Ackerman, J., Keller, K., Pisano, E., Jiroutek, M., Muller, K., & Fuchs, H.

- “High-Performance Wide-Area Optical Tracking: The HiBall Tracking System”; Welch, Greg, Gary Bishop, Leandra Vicci, Stephen Brumback, Kurtis Keller, and D'nardo Colucci; 2001 Presence: Teleoperators and Virtual Environments 10(1): 1-21.
- “Real-time Structured Light Depth Extraction”; Kurtis Keller and Jeremy Ackerman; Photonics West – Electronic Imaging, 2000.
- “The HiBall Tracker: High-Performance Wide-Area Tracking for Virtual and Augmented Environments”; Greg Welch, Leandra Vicci, Stephen Brumback, Kurtis Keller, and D'nardo Colucci; VRST99, 1999.
- “Real-time Anatomical 3D depth Extraction”; Jeremy Ackerman and Kurtis Keller, MMVR, 2001.
- “Augmented Reality Visualization for Laparoscopic Surgery”; Fuchs, Henry, Mark A. Livingston, Ramesh Raskar, D'nardo Colucci, Kurtis Keller, Andrei State, Jessica R. Crawford, Paul Rademacher, Samuel H. Drake, and Anthony A. Meyer; MICCAI '98, 1998.
- “Perception in HMDs, what really makes them all so terrible?”; Kurtis Keller and D'nardo Colucci; Lead conference paper; SPIE Aerosense '98, 1998.
- “Cast 3D Heatsink Design Advantages”; Kurtis Keller; IEEE ITherm '98, 1998. Transactions on Components and Packaging Technologies, IEEE press, 2000.
- "Augmented Reality Assistance for Needle Biopsies: From Early Prototypes to a Controlled User Study"; IMPSE, Andrei State, Michael Rosenthal, Joohee Lee, Gentaro Hirota, Jeremy Ackerman, Kurtis Keller, Etta D Pisano and Henry Fuchs.
- “Efficiency and Cost Tradeoffs Between Aluminum and Zinc Die Cast Heatsinks”; Kurtis Keller; InterPack (International Electronic Packaging conf.), Invited talk, 1997.
- “Video See-through HMD for Surgery Assisted by Augmented Reality”; D. Colucci, G. Hirota, K. Keller, A. State, S. Drake, R. Fish; SPIE - EI'97, 1997.
- “Low Cost, High Performance, High Volume Heatsinks”; Kurtis Keller, 1998 IEMT-Europe Symposium, Berlin, 1998.
- “Commercial Packaging Solutions for a Research Oriented Graphics Supercomputer,” Kurtis Keller and John Poulton; InterPack 1995.
- “Video See-through Design for Merging of Real and Virtual Environments”; Emily K. Edwards, Jannick P. Rolland and Kurtis Keller; VRAIS conference, 1993.

### **Reviewer & Panel Activities:**

WSCG 2001, 2002, 2003, 2005, 2007, 2008, 2009 International Conferences on Computer Graphics, Visualization and Computer Vision. 2009 planning and directors committee.

ISMAR 2008, 2009 reviewer, International Symposium on Mixed and Augmented Reality

NIH grant reviewer, 2008 onward

NSF grant reviewer, 2005 onward

Biotech Forum, Expert Panelist Medical Imaging. 2006, Biotech Center RTP.

Maine Business Development 2002

### **Design Tools / Software:**

Mechanical Design and Mounting –Solid Works, ProEngineer - Wildfire, ACAD.

Optical design – ZEMAX and custom software.

Thermal Simulation – ALGOR, ProEngineer Wildfire Thermal, custom software.

Circuit Board layout and design – PADS, Cadence, ACAD add-on.

Mechanical Prototyping – Full metal-working machine shop qualified (24 years experience) including Bridgeport mills, CNC tool changer mills, lathes, sheet metal fabrication and welding.