

## DAVE AIKENS

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### Principal Optical Scientist/Consultant

A seasoned lens designer and optical engineer combining 35 years of expertise in optics, optical engineering, and optical systems development with extensive understanding of physics and problem solving. A world renowned leader in lens design and optics specifications, especially surface quality, mid-spatial frequency waviness, and forensics. A well rounded engineer with a record of commercial savvy and success, who has designed solar, space, IR, UV, microscopy, reconnaissance, lighting and precision coherent and incoherent optics instruments and systems. A creative, energetic presenter with real-world experience at getting things done, and at solving seemingly intractable physics problems, who brings energy and insight to every task.

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Surface Imperfections • Mid-spatial Frequency Ripple • Standards Compliance  
Optics Education and Training • Lens Design • Imaging and Non-Imaging Systems  
Fourier Domain Analysis • Optics and Optical Technology • Product Development/Launch  
P&L Responsibility • Engineering Management • Organizational Development

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### PROFESSIONAL EXPERIENCE

**President – Savvy Optics Corp.**, Chester, Connecticut. • **2007 - Present**  
(Privately Held Company; 1-10 employees; <\$1M)

*Savvy Optics Corp. was founded by Dave Aikens in 2007 with the mission to facilitate commerce in the optics industry by offering products and services aimed at reducing confusion, conflict, and waste in optical specifications and drawings. From innovative and practical lens design to forensic physics and expert witness work, from assisting with cost reductions through supply selection and specifications management, to educational services, we help our customers move from the design intent to manufacturable optics.*

*Savvy Optics Corp. now offers an array of courses for engineers and optics personnel which is offered on-site or in conjunction with SPIE and OSA conferences. All of the courses are accredited by OEOSC and range in topics from “Understanding Scratch and Dig” and “Specifying Optics” for beginners to more advanced topics which address optics drawings specifications and power spectrum density specifications for surface waviness and roughness.*

*In 2010, Savvy Optics Corp. launched an initiative to take the subjectivity out of scratch and dig measurements by partnering with CCDMetrix to design, develop, and market a software-assisted scratch and dig measurement system. With over forty systems now in the field and five different product configurations to choose from, the SavvyInspector<sup>®</sup> is rapidly becoming the preferred method of validating the surface quality of optics.*

Responsible for all corporate governance, as well as product design, optical system design and engineering. Currently using Zemax but facile with OSLO and Code V as well. Areas of specialization include precision optics for semiconductor and industrial metrology, UV and IR systems, non-imaging systems for solar, architectural and industrial lighting, and optics requiring extremely tight flatness, waviness, roughness, and surface imperfection tolerances.

## DAVE AIKENS

• Page Two •

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**Executive Director – Optics and Electro-Optics Standards Council, Rochester, NY • 2010 – 2015** (Non-profit Corporation)

*OEOSC manages all of the standards activities in the United States associated with fundamental standards for optics. This includes managing the American Standards Committee for Optics (ASC/OP) and the Technical advisory group to ISO TC172 for international optics standards.*

Responsible for all corporate governance, as well as managing correspondence with ANSI and ISO, and editing and publishing all American National Standards for Optics. Oversees all task forces, schedules all meetings, and maintains all standards related communications.

**Director of Engineering - Zygo Corporation, Middlefield, Connecticut. • 2002 - 2007**  
(Public Company; 500-700 employees; \$150M-\$200M, ZIGO)

Responsible for all product development, design, release, and support for metrology products, a \$40-\$80M per year business. Managed a department of 60 engineers and designers and a budget of \$6M-\$10M per year. In addition, managed all business related to custom metrology solutions, a \$10M-\$15M engineering-intensive metrology P&L within the metrology business unit.

Presided over the design and release of virtually every metrology product in Zygo's product portfolio. Released over 20 new systems to the marketplace in five distinct product families, including state of the art SWLI microscopes and Fizeau interferometers, as well as dozens of custom metrology products for semiconductor, aerospace and automotive metrology applications.

Some Zygo product highlights:

**NewView 6300** This flagship product was released in 2004, with great success. We have seen more than 30% CAGR in NewView sales since its introduction, driven by superb quality, best-of-breed performance, and exceptional value through careful CGS management. The sensor head has been used as the basis for both the Z3D and FPM product lines to great success.

**PTI 250** Launched in 2003, this design of a low-cost, small-aperture Fizeau Interferometer filled a critical gap in Zygo's Fizeau product line. Development required extensive partnering with off-shore suppliers and outsourced engineering. Its release and subsequent success in Asia forced our competitor to slash margins and divert RDE spending, relieving the pressure on our core 4" product line.

**VeriFire Asphere** Announced in 2007 after a \$2M, four year development effort, the VeriFire Asphere (VF-A) represents one of the greatest achievements in the world of optical test, allowing direct measurement of aspheric surfaces at TACT times under 5 minutes, allowing for in-cell metrology for aspheric lens manufacturing.

Some other significant successful products are **Z3D-7000, FPM Gen4 and Gen5, NV600, VeriFire MST, GPI XP/D, GPI PE, NewView MPT**, and numerous accessories.

## **DAVE AIKENS**

• Page Three •

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**Engineering Manager, Optics - THERMA-WAVE, INCORPORATED, Milpitas, California • 2000-2002** (Public Company; 200-500 employees; TWAV; Semiconductors industry)

Managed all optical systems design and engineering across all products. Served as engineering manager for the now-flagship Series 7 product family. Led the entire product development effort for Therma-Wave's Optical CD measurement product family, based on both library and RCWA modeling approaches. Worked intimately with optical technologies such as ellipsometry, scatterometry, and reflectometry for the semiconductor manufacturing industry.

**NIF Optical Engineering Manager - Lawrence Livermore National Lab • 1994 - 2000**  
(Government Agency; 9000-10,000 employees; Defense & Space industry)

Served in various roles over the eight years on the NIF project. Managed the optical system design and engineering group for this \$1B, 10 year program to build a 192 beam laser system capable of generating 2 mega-Joules of laser energy for Fusion Research, the largest and most powerful laser system ever constructed. Managed the finishing group, including development of new optical polishing and manufacturing technologies to enable an outsourced production capacity scale up of more than 100x, for the more than 7,000 meter-scale optical components. Personally negotiated more than \$20M of contracts with LLNL suppliers of optics.

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### **PRIOR EXPERIENCE**

**Senior Optical Engineer, KLA Instruments, San Jose, CA • 1991 - 1994**

**President and Founder, Dema Bekz Corporation, Portland, OR • 1989 - 1991**

**Optical Engineer, Lawrence Livermore National Laboratory, Livermore, CA • 1987 - 1989**

**Optical Engineer, Hughes Aircraft Company, El Segundo, CA • 1983 - 1987**

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### **EDUCATION**

**Master of Science in Optical Engineering (1984)**  
**Bachelor of Science in Optical Engineering (1983)**  
**Institute of Optics**  
University of Rochester, Rochester, NY.

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### **PROFESSIONAL AFFILIATIONS**

SPIE Fellow  
Head of American Delegation, ISO TC172/SC1  
Leader, American Standards Council Task Force 4: Optics Drawings  
Corporate Member: SPIE

## DAVE AIKENS

• Page Four •

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### SELECTED TECHNICAL PUBLICATIONS (Reverse Chronological Order)

Aikens, D., "New options for optical quality tolerances," *International Optical Design Conference Proceedings of SPIE Vol. 10590, 105900J* (2017).

Kasunic, K., et al., "Technical and cost advantages of silicon carbide telescopes for small satellite imaging applications," *AIAA/USU Conference on Small Satellites, Proceedings of SPIE Vol. 10402, 104020C* (2017)

Smythe, R., and Aikens, D., "Interferometric measurement of mid-spatial frequency wavefront errors," *Technical Digest, Optical Fabrication and Testing; Process Evaluation (OM3B)*, July 2017.

Youngworth, R., and Aikens, D. "Adopting and using optical standards," *Technical Digest, Optical Fabrication and Testing; Performance Definition and Measurement (OW4B)*, July 2017.

Aikens, D. "International surface imperfection standard" Free 1 hour webinar offered by Photonics Media Corp. <https://www.photonics.com/Webinar.aspx?WID=112>

Aikens, D. "New optics drawings standards" Free 1 hour webinar offered by Photonics Media Corp. <http://www.photonics.com/Webinar.aspx?WID=94>

Youngworth, R., Kiontke, S., and Aikens, D., "Implementing ISO standard-compliant freeform component drawings," *Opt. Eng. Volume 55, Issue 7*, April 2016.

Kiontke, S., Aikens, D., and Youngworth, R., "Freeform capability enabled by ISO 10110," *Optical System Alignment, Tolerancing, and Verification IX*, Proc. SPIE Vol 9582, September, 2015.

Aikens, D., "Making Optics Standards Global," *Optics and Photonics News*, March 2015.

Aikens, D., Youngworth, R., "Optics standards for the global marketplace," *Technical Digest, European Optical Society Annual Meeting, TOM3 Optical System Design and Tolerancing*, September 2014.

Ulrich, W., et al., "Value of ISO standardization in a global optics and photonics industry," *Optics-photonics Design and Fabrication (ODF), 12PL-02* (Optical Society of Japan, OSJ, 2014).

Aikens, D., and Lahner, M., "Solving the wall wash problem with a single lens," *International Optical Design Conference 2014*, Proc. SPIE-OSA Vol 9293, December 2014.

Kiontke, S., Aikens, D., and Youngworth, R., "Description and tolerancing of freeform surfaces in standards," *International Optical Design Conference 2014*, Proc. SPIE-OSA Vol 9293 0T, June 2014.

Youngworth, R., Kiontke, S., and Aikens, D., "Standards: A Key Element of Optical Design, Engineering Productivity, and Time to Market," *International Optical Design Conference 2014*, Proc. SPIE-OSA Vol 9293 17, June 2014.

## DAVE AIKENS

• Page Five •

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Youngworth, R. N., and Aikens, D. M., "Default optical tolerances on drawings," OFB101-30, Technical proceedings at SPIE OptiFab, pending publication, May 2011.

Aikens, D. M., "Meaningful surface roughness and quality tolerances," *International Optical Design Conference*, Proc. SPIE 7652, pp 765217-1 to 765217-7, June 2010.

Aikens, D. M., "The truth about scratch and dig," *OSA Technical Digest, Optical Fabrication and Testing*, June 2010.

Aikens, D. M., "A better aspheric equation," Rochester Regional Photonics Cluster Newsletter, Vol 6, No 2. April 2010.

Nelson, J. DG., Youngworth, R. N., Aikens, D.M., "The cost of tolerancing," *Optical System Alignment, Tolerancing, and Verification III*, Proc. SPIE Vol 7433; August 2009.

Aikens, D. M., "New High Index Glasses," Rochester Regional Photonics Cluster Newsletter, Vol 5, No. 7; September 2009.

Aikens, D. M., "Looking for a peak-to-valley specification that works," Rochester Regional Photonics Cluster Newsletter, Vol 5, No 6; July/August 2009.

Aikens, D. M., De Groote-Nelson, J., Youngworth R. N., "Specification and Control of Mid-Spatial Frequency Wavefront Errors in Optical Systems," *OSA Technical Digest, Optical Fabrication and Testing 2008*, OSA/FIO/LS/META/OF&T, OTuA1; May 2008.

Wang, D. Y., Aikens, David M., and English, R. Edward, Jr., "Design of optical systems with both near-field and far-field system requirements," *Optical Engineering ; VOL. 39 ; ISSUE: 7*, pp. 1788-1795; Jul 2000.

Lawson, J K ; Aikens, D M ; Wang, D Y ; Williams, W H , " , Optical specification -- Their Role in the National Ignition Facility," *OSA Technical Digest, Optical Fabrication and Testing*; Jun 2000.

Aikens, D., Bissinger, H. D., "Overview of small optics for the National Ignition Facility," *Optical Manufacturing and Testing III*, SPIE's 44<sup>th</sup> Annual Meeting, Denver CO, 1999.

Aikens, D M; English, R E ; House, W ; Lawson, J K ; Nichols, M A ; Whistler, W T, "Surface figure and roughness tolerances for NIF optics and the interpretation of the gradient, P-V wavefront and RMS specifications," *Optical Manufacturing and Testing III*, SPIE's 44<sup>th</sup> Annual Meeting, Denver CO, 1999.

Aikens, D M; English, R E ; Wang, D Y, "Implementation of ISO 10110 optics drawing standards for the National Ignition Facility," *Optical Manufacturing and Testing III*, SPIE's 44<sup>th</sup> Annual Meeting, Denver CO, 1999.

Aikens, D. M., "Fusion Research Improves Optics Manufacturing," *Laser Focus World*, October 1998, PP S17-19.

Aikens, D. M., Rich, L., Bajuk, D., Slomba, A., "Developing enabling optics finishing technologies for the National Ignition Facility," *Proc. OSA International Lens Design Conference*; Jan 1998.

## DAVE AIKENS

• Page Six •

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Lawson, J.K., Aikens, D.M., English, R.E. Jr., Wolfe, C.R., "Power spectral density specifications for high-power laser systems," *Specification, Production, and Testing of Optical Components and Systems*, SPIE Proc. Vol. 2775, pp345-356; 1996.

Aikens, D., Roussel, A., Bray, M., "Derivation of preliminary specifications for transmitted wavefront and surface roughness for large optics used in inertial confinement fusion," *Proceedings of the solid state lasers for Applications to Inertial Confinement Fusion Third Annual Conference, Monterey CA*, 1995.

Taylor, J.S., Aikens, D.M., Brown, N.J., "Framework for assessing key variable dependencies in loose-abrasive grinding and polishing," *Proc. ASPE Annual Meeting*; Oct 1995.

Aikens, D., "The origin and evolution of the optics specifications for the National Ignition Facility," *Proc. SPIE Vol. 2536*, pp 2-12; 1995.

Lawson, J.K. ; Wolfe, C.R. ; Manes, K.R. ; Trenholme, J.B. ; Aikens, D.M. ; English, R.E. Jr., "Specification of optical components using the power spectral density function," *Optical Manufacturing and Testing, Proc. SPIE Vol. 2536*; pp. 38-50; 1995.

English, R. Edward Jr., Aikens, D.M., et al, "Implementation of ISO 10110 optics drawing standards for the National Ignition Facility," *Proc. SPIE Annual Meeting*; Jul 1995.

Aikens, D.M., Wolfe, C.R., Lawson, J.K., "The use of PSD functions in specifying optics for the National Ignition Facility," *Optical Fabrication and Testing, Proc. SPIE Vol. 2576*, 1995.

Wolfe, C.R. ; Lawson, J.K. ; Aikens, D.M. ; English, R.E., "Database of wavefront measurements for laser system modeling, optical component development and fabrication process qualification," *Proc. SPIE 2545, Interferometry VII: Applications. 229*, 1995.

Wolfe, C.R. ; Lawson, J.K. ; Aikens, D.M. ; English, R.E., "A database of wavefront measurements for laser system modeling, optical component development and fabrication process qualification," *Proc. OSA Annual Meeting*; Apr, 1995.

Aikens, David M., "Beginning the design of a UV microscope objective," *Proc SPIE 1690, Design of Optical Instruments*, pp. 20-41; 1992.

Aikens, David M., "The design of an IR non-lens," *Proc. SPIE 1485, Reflective and Refractive Optical Materials for Earth and Space Applications*, p83; Sept. 1991.

Aikens, David M., Young, William R., "Airborne infrared and visible sensors used for law enforcement and drug interdiction," *Surveillance Technologies, Proc. SPIE 1479*, pp. 435-444; 1991.

Aikens, D. M., Taylor, J. R., "Causes of damage in multilayer dielectric coatings exposed to high average power visible laser radiation," *Proc. SPIE Boulder damage symposium*; Oct 1987.

**DAVE AIKENS**

• Page Seven •

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**Granted and in-process U. S. Patents  
(reverse chronological order)**

**US Patent No. 9500588 B2, Flow cell modules and liquid sample analyzers and methods including same**, Joseph L. DiCesare, Feng Jin, Timothy P. Neal, David Aikens. Granted Nov 22, 2016.

**US Patent No. 8797528 B2, Flow cell assembly for liquid sample analyzer**, Gregory Hanlon, Timothy Neal, Richard Edwards, Joseph L. DiCesare, David M. Aikens. Granted Aug 5, 2014

**US Patent Application 20130120974, Wall wash lighting fixture**, Gordon L. Swisha, Joseph J. Lomenzo, David M. Aikens

**US Patent No. 8543557B2, Evolution of library data sets**, David M. Aikens, Youxian Wen, Walter Lee Smith. Granted Sept 24, 2013.

**US Patent No. 7154607, Flat spectrum illumination source for optical metrology**, James Lee Hendrix, David Y. Wang, David M. Aikens, Lawrence Rotter, Joel Ng. Granted December 26, 2006.

**US Patent No. 6898596, Evolution of library data sets**, David M. Aikens, Youxian Wen, Walter Lee Smith. Granted May 24, 2005.

**US Patent No. 6879449, Broadband refractive objective for small spot optical metrology**, David M. Aikens, David Y. Wang. Granted April 12, 2005.

**US Patent No. 6862090, Coaxial illumination system**, Jianhui Chen, David M. Aikens. Granted March 1, 2005.

**US Patent No. 6744505, Compact imaging spectrometer**, David Y. Wang, David M. Aikens. Granted June 1, 2004

**US Patent No. 6587282, Broadband refractive objective for small spot optical metrology**, David Y. Wang, David M. Aikens. Granted July 1, 2003.

**US Patent No. 6099389, Fabrication of an optical component**, Michael A. Nichols, David M. Aikens, David W. Camp, Ian M. Thomas, Craig Kiikka, Lynn Sheehan, Mark Kozlowski. Granted August 8, 2000.

**US Patent No. 4916536, Imaging range finder and method**, James R. Kerr, Michael E. Fossey, David M. Aikens, Bruce L. Cannon, John J. McDonald. Granted April 10, 1990.