WINDprove

Mike Zuteck – President

PROFESSIONAL EXPERIENCE

Mr. Zuteck has pursued rotor research and design as an independent consultant in the field of wind energy since 1977. He proposed to Sandia the concept of a sweep twist blade design, provided the initial study analysis of engineering feasibility, was the lead designer for the effort to reduce this design to practice, helped guide build by Knight & Carver, and verification atmospheric and fatigue testing. He also provided key design guidance and analysis for the Sandia 9m research blades including the CX-100, TX-100, and flatback BSDS blades fabricated by TPI Composites, and also supported subsequent testing of these blades. He supplied the initial structural design concept and analysis for a variable diameter extensible blade. These projects are all within this decade.

Also within this decade Mr. Zuteck provided field failure examination and analysis of blade problems including surface cracking, structural cracking, web debonding, lightning, tower strike, spar/shell debonding, root bond failure, and even bullet hole spar damage. This work covers a wide range of modern blade types and sizes, and provides background on the difficulties encountered with current blades. This work lead to expert deposition testimony in one case, and outside wind, to litigation support for a helicopter crash.

Earlier in his career, Mr. Zuteck had key technical responsibility for rotor system design in many projects which include: two NASA research rotor systems, many commercial rotor designs with thousands of blades produced, the DOE/NASA/GE 400' diameter multi-megawatt Mod-5A design study, and the Westinghouse 142' dia., 600 kW turbines. He served as structural consultant on the SERI advanced airfoil composite blades, and was co-recipient of the 1990 American Wind Energy Association Technical Achievement Award for that work. He is the originator of the airfoil tower concept that received study both here and abroad. He provided blade designs for both the AOC and AWT NREL supported wind turbines, led the design of an innovative flap control retro-fit for the Westinghouse turbine, and was a contributor on the ERS and NPS blade designs.

He has worked with both US Department of Energy and National Academy of Sciences panels that set energy research directions in the aerodynamics and materials areas. He provided lead consulting on a two year SBIR sponsored materials research program to advance the strength and fatigue data for wood/epoxy wind turbine materials, and has also supported the Montana State research program for fiberglass blade composites.

Mr. Zuteck contributed input at an FAA meeting to help define certification requirements for powered lift vertical takeoff aircraft. He has worked with a helicopter blade company on innovative blade design, and solving problems with existing blade designs. He did the detailed structural design and aerodynamic concept for a state of the art aerobatic wing, and key tradeoff and optimization, and some detailed design, for the Formula 40 trimaran Adrenalin, which was successful in professional European circuit racing. He designed the Tornado catamaran that took the Silver medal in the 1976 Olympic games.

Mr. Zuteck also has ten years experience in aerospace. He served as part of the Apollo lunar landing team, and received the astronaut's special Snoopy award for his unique landing radar predictions during the pioneering landings in mountainous lunar terrain. He created the attitude dependent on-orbit aerodynamic drag model for the space shuttle, and also authored the automatic data-editing technique which pre-processed drop-out prone tracking data used by the Manned Spacecraft Center.

EDUCATION

M.S. Physics, University of Illinois, 1972

B.S. Physics, Massachusetts Institute of Technology, 1967

SELECTED PUBLICATIONS

S. Larwood, M. Zuteck, "Swept Wind Turbine Blade Aeroelastic Modeling for Loads and Dynamic Behavior", Windpower 2006, http://flight.engr.ucdavis.edu/~smlarwood/documents/Larwood_Windpower_2006.pdf

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D. Griffin, M. Zuteck, et al, "Development of Prototype Carbon-Fiberglass Wind Turbine Blades: Conventional and Twist-Coupled Designs." *2004 ASME Wind Energy Symposium*, *Reno, NV*, *5-8 January 2004*. American Society of Mechanical Engineers; pp. 1-12. http://www.aiaa.org/content.cfm?pageid=406&gTable=Paper&gID=13763

M, Zuteck, "Adaptive Blade Concept Assessment: Curved Planform Induced Twist Investigation", SAND2002-2996, October 2002, http://sandia.gov/wind/topical.htm#ADAPTIVE

M. Zuteck, "Hawaii Zuteck Rotor Project Compilation of Reports", NREL/SR-500-26086, November 1998, http://nsdl.org/resource/2200/20061005024309501T

D. Spera, J. Esgar, M. Gougeon, M. Zuteck, "Structural Properties of Laminated Douglas Fir/Epoxy Composite Material", NASA Reference Publication 1236, DOE/NASA/20320-76, May 1990 (hardback book)

T. Stroebel, C. Dechow, M. Zuteck, "Design of an Advanced Wood Composite Rotor and Development of Wood Composite Blade Technology", DEO/NASA/0260-1, NASA CR-174713, December 1984

Kevin Jackson, Ph.D. – Principal Engineer

PROFESSIONAL EXPERIENCE

Kevin Jackson began his wind energy career during graduate study at the University of California in 1982. In 1985, he began to provide engineering consulting services to California's emerging commercial wind power industry. Dr. Jackson has served as Principal Investigator on several successful DOE funded wind energy research and development efforts. Most recently he managed the STAR blade development project, which in 2008 was selected by the U.S. Department of Energy Wind and Hydropower Technologies office as one of the "Top 10 Program Accomplishments". Over the years, Dr. Jackson has managed a variety of commercial wind turbine repair, retrofit, and performance enhancement projects. He has been responsible for blade geometry definition and structural design, drive train component analysis, yaw system design, and tower structural analysis.

Dr. Jackson has worked extensively with field test data sets gathered from operational turbines. In the past, he was a key participant in field testing of Micon 65 and 108, Enertech 40 and 60, Kenetech USW 56-100, Mitsubishi 250, Wind Eagle 300, NedWind 500, and Zond 750 wind turbines. Interpretation of massive field test data sets has been a major focus of effort, and Dr. Jackson developed computational tools to speed processing and enhance analysis. This work included development of methodologies for evaluating fatigue damage rates and estimating the lifetime of wind turbine equipment. He has developed methods for scaling design loads from existing test data for use in the analysis of similar turbines for which no test data are available. He has also developed analysis tools for wind turbine performance assessment using site SCADA data. This software has been used to calculate power curves, expected energy, and expected revenue for large wind plants.

Dr. Jackson has worked extensively in support of owners and wind site landowners on issues related to the safety, reliability, quality, and performance. In this work he has often conducted engineering investigations, tests, and analyses leading to the preparation of technical reports and recommendations. On several assignments Dr. Jackson has been asked to render expert opinions and provide oral testimony relating to the mechanical engineering aspects of wind turbines and commercial power generation facilities. Projects in this area have included evaluation of warranty issues, review of turbine energy production, failure analyses, and other aspects of wind technology assessment. Engineering projects have included a wide range of machinery, including the USW 56-100, Mitsubishi 250 and 600, Vestas V47, V80, V82, V90, and V100, NEG Micon 750, and 900, Zond 750, Bonus 1.3, GE 1.5 and 2.5, Siemens 2.3, Gamesa 2.0, REpower 2.0, and other megawatt-scale wind turbines.

EDUCATION

Ph.D. Mechanical Engineering, University of California at Davis, 1989.

M.S. Mechanical Engineering, University of California at Davis, 1984.

B.S. Mechanical/Aeronautical Engineering, University of California at Davis, 1982.

SELECTED PUBLICATIONS

K. Jackson, M. Zuteck, C.P. van Dam, “Sweep-Twist Adaptive Rotor Blade: Final Project Report”, Knight & Carver Wind Group, SAND2009-8037, January 2010.

K. Jackson, C.P. van Dam, and D. Yen Nakafuji, "Wind Turbine Generator Trends for Site Specific Tailoring," Wind Energy, 2005.

K. Jackson, M. Zuteck, C.P. van Dam, K.J. Standish, and D. Berry, "Innovative Design Approaches for Large Wind Turbines," Wind Energy, Vol. 8, No. 2, 2005, pp. 141-171.

K. Jackson, "Scaling Wind Turbine Fatigue Design Loads", Proceedings of the 1994 ASME Conference, New Orleans, January 1994.

K. Jackson, "Deriving Fatigue Design Loads From Field Test Data", Proceedings of the Windpower '92 Conference and Exposition, Seattle, October 1992.

D. W. Bernadett and K. Jackson, "Teetering Three-Bladed Rotors Through the Use of Multi-Axial Suspension", Proceedings of the Windpower '92 Conference and Exposition, Seattle, October 1992.

K. Jackson, "Load Estimation Methods for Advanced Wind Turbines", Proceedings of the Windpower '89 Conference and Exposition, San Francisco, September 1989.

K. Jackson, "Mechanical Design and Load Estimation Methods for Advanced Wind Turbines", Doctoral Dissertation, Department of Mechanical Engineering, University of California at Davis, June 1989.

K. Jackson, "Dynamic Response of Active Yaw Drives", Proceedings of the Windpower '88 Conference and Exposition, Honolulu, September 1988.

K. Jackson and P.G. Migliore, "Design of Wind Turbine Blades Employing Advanced Airfoils", Proceedings of the Windpower '87 Conference and Exposition, San Francisco, October 1987.

WINDprove

Richard Santos, Ph.D. – Principal Engineer

PROFESSIONAL EXPERIENCE

Richard Santos has a broad range of international experience in design and control of wind turbines, including a strong background in dynamics and control systems for utility-scale variable-speed machines. He has provided key expertise for certification of wind turbines, resulting in over twenty certification design reviews including blades, hub, mainshaft, bearings, brakes, bedplate, generator housing and tower. He holds B.S. and M.S. degrees in aerospace/mechanical engineering from Syracuse University and a Ph.D. degree in aerospace engineering sciences from the University of Colorado with a focus on damage mitigating control of wind turbines.

Dr. Santos was a research and test engineer at the National Renewable Energy Laboratory for many years and has frequently supported NREL projects. He later spent three years as a wind turbine engineer in Spain, working for an original equipment manufacturer during development of new 80 m and 100 m diameter multi-megawatt machines. In that role, he worked on all phases of the design from aeroelastic simulation, to structural analysis is, to mechanical loads testing all the way through IEC type approval. This experience has provided Dr. Santos with the requisite Spanish language skills to support wind energy projects throughout Europe and the Americas.

Dr. Santos remains active in wind turbine mechanical loads field testing, in addition to supporting manufacturers and wind park owners with analysis and engineering services. He has performed nearly twenty IEC certification-level mechanical load field tests on turbines ranging from 2 kW to 3000 kW. He has also been the convener of the IEC Maintenance Team 13 responsible for writing the IEC Technical Standard, "Wind Turbine Generator Systems, Part 13: Measurement of Mechanical Loads" that was approved as an International Standard in 2015.

His work has included both written and oral expert testimony for international arbitrations and patent cases relating to wind turbine mechanical failures and control systems.

EDUCATION

Ph.D.	Aerospace Engineering Sciences, University of Colorado at Boulder, 2007.
M.S.	Aerospace /Mechanical Engineering, Syracuse University, 1990.
B.S.	Aerospace /Mechanical Engineering, Syracuse University, 1987.

SELECTED PUBLICATIONS

Santos, R., Development and Simulations of Tower Damping System for ECO74 Wind Turbine using MSC/ADAMS, June 2007.

Santos, R., *Dynamic Interaction of Global Wind Turbine Dynamics with Structural Subcomponents*, AWEA Conference Paper, 2007.

Rossetti, M., Gudyol, M, Santos, R., *Dynamic Tuning of Aeroelastic Wind Turbine Models,* EWEA Poster Paper, 2007.

Santos, R., INF-3199 *Summary of ARTEMIS System Identification Software,* January 2007.

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