

# DWIGHT A. BURFORD, PH.D., P.E.

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## EXECUTIVE SUMMARY

Professional metallurgical engineer with 16 years of experience in aerospace manufacturing research and development, 7 years of experience directing a university research program and facility, including supervising undergraduate students, graduate students, and research staff; and 7 years of experience as a consulting engineer. Experienced in preparing proposals and managing projects for private industry and government agencies, e.g. Federal Aviation Administration (FAA), Department of Defense (DOD), and National Science Foundation (NSF).

## SKILLS SUMMARY

Metals-related processing and fabrication, including friction stir related technologies, machining, fusion welding, forming operations (e.g. stretch, die, etc.), superplastic forming, heat treatment, and new alloy evaluations. Analysis techniques, including metallography, mechanical testing, failure analysis, residual stress analysis, design of experiments (DOE), statistical process control (SPC), finite element analysis (FEA). Computer aided design (CAD) and computer aided manufacturing (CAM). Project management for research and development programs and for production programs. Computer numerical control (CNC) machining and machine tool operation. Expert litigation support.

## PROFESSIONAL EXPERIENCE

### JOINING INNOVATIONS, LLC

**President**, June 2012 to present

- ♦ **Friction Stir Engineering Services:** Includes design and manufacturing of non-consumable, replaceable, interchangeable Stirbits® for friction stir joining and processing, involving CAD, CAM, and CNC. Also includes joint design for engineered structures, failure analysis, process development, and related technical areas.
- ♦ **Metallurgical Consultant:** Engineering support and failure analysis for metals-related processing and fabrication, including machining, welding, forming operations, and heat treatment. Supporting services include metallurgical analyses, DOE, SPC, and FEA.

### NATIONAL INSTITUTE FOR AVIATION RESEARCH (NIAR)

**Senior Research Scientist and Director**, August 2005 to June 2012

- ♦ **Responsibilities:** Directed and developed the Advanced Joining & Processing (AJ&P) Laboratory of the National Institute for Aviation Research (NIAR) at Wichita State University.
- ♦ **Research Emphasis:** Friction Stir Welding – metallurgical evolution, tool development, failure modes, process development for performance specification development, industrialization.
- ♦ **Primary Thrust:** Advanced aerospace materials and joining technologies; research and development funded by industry clients and government funding agencies and programs.

### WICHITA STATE UNIVERSITY (WSU)

**Director, WSU Research Site of the NSF CFSP**, July 2007 to June 2012

- ♦ **Responsibilities:** Directed the WSU Research Site, NSF Center for Friction Stir Processing
  - Developed and coordinated student research program and client projects.
  - Wrote and presented funding proposals and prepare annual reports for NSF I/UCRC grants.
  - Identified and recruited industry members, faculty, and students for research programs.
  - Coordinated WSU Site activities with other CFSP universities and their industry members.

**SPIRIT AEROSYSTEMS, INC.**

**Associate Technical Fellow**, June 17, 2005 to September 1, 2005

- ♦ **Organization:** Manufacturing Research & Development (MR&D), Spirit AeroSystems, Inc.
- ♦ **Note:** Spirit AeroSystems, Inc. was formed through the sale of the Boeing Wichita Division in June 2005 to the Onex Corporation. My duties at Boeing transitioned over to Spirit.

**THE BOEING COMPANY – Wichita Division**

July 1989 to June 2005

**Associate Technical Fellow**, March 1996 to June 2005

- ♦ **Metallurgical Engineering Technical Focal:** Metals-related processing & fabrication, including friction stir welding/joining, machining, stretch forming, residual stress analysis, superplastic forming, anelastic strain abatement, new alloy evaluations, heat treatment, failure analysis.
- ♦ **Project Management:** Internal Application Development (IAD) project – facilitated the lean technology transfer of friction stir welding (FSW) into commercial airframe and tooling applications. Coordinated activities with applicable enterprise-wide organizations.
- ♦ **Key Tools:** DOE and SPC, FEA (MSC MARC), CATIA, Mechanical Test Equipment.

Other positions held at The Boeing Company

- ♦ **Principal Engineer**, December 1995 to March 1996
- ♦ **Advanced Technology Development Analyst 3**, August 1994 to December 1995
- ♦ **Manufacturing Research Analyst**, July 1989 to August 1994

**EDUCATION**

- ♦ **Ph.D., Metallurgical Engineering**, Colorado School of Mines, December 1987
- ♦ **M.S., Metallurgical Engineering**, Colorado School of Mines, December 1984
- ♦ **B.S., Metallurgical Engineering**, Colorado School of Mines, graduated “With High Scholastic Honors,” May 1982; Tau Beta Pi (Fall 1980); American Society for Metals Scholar (1980 & 1981); Outstanding Senior, Department of Metallurgical Engineering (1982)
- ♦ **A.A.S., Manufacturing Engineering Technology**, Colorado State University - Pueblo (formerly the University of Southern Colorado), May 1978

**POSTDOCTORAL STUDIES**

- ♦ **University:** The Ohio State University, Department of Materials Science and Engineering, November 1987 to June 1989
- ♦ **Emphasis:** FEA of sheet metal forming and deformation

**TEACHING EXPERIENCE**

- ♦ Wichita State University, Department of Mechanical Engineering
  - Undergraduate: ME667, “Mechanical Properties of Materials I”
  - Graduate: ME750B, “Advanced Joining Processes - Friction Stir Welding & Processing”
- ♦ Ohio State University, Department of Materials Science & Engineering
  - Undergraduate: “Deformation Processing” (a senior level required course)
  - Graduate: “Plasticity Theory” (Guest Lecturer)

**PROFESSIONAL LICENSE**

- ♦ Professional Engineer (PE), State of Kansas, licensed since February 1993

## PROFESSIONAL AFFILIATIONS

- ◆ American Welding Society (AWS)
- ◆ ASM International
- ◆ SAE International
- ◆ The Minerals, Metals & Materials Society (TMS)

## STANDARDS & SPECIFICATION COMMITTEES

- ◆ International Institute of Welding, C-III-B-WG-B1
- ◆ International Institute of Welding, C-III-B WG-B4
- ◆ SAE Aerospace Metals and Engineering Committee (AMEC)

## PATENTS & PATENT APPLICATIONS

- ◆ D.A. Burford, "End effector for forming swept friction stir spot welds," United States Patent 9,132,504, Sept 15, 2015
- ◆ D.A. Burford, "Controlled Speed Friction Stir Tool Probes having Continuous, Monotonically Decreasing Curved Axial Profiles and Integrated Surface Features," United States Patent Application, filed July 11, 2014
- ◆ D.A. Burford, "Mandrel tool probe for friction stir welding having physically-separate spiraled surfaces," United States Patent 8,579,180, Nov. 12, 2013
- ◆ D.A. Burford, "End effector for forming swept friction stir spot welds," United States Patent 8,444,040, May 21, 2013
- ◆ D.A. Burford, "Friction stir welding tool having a scroll-free concentric region," United States Patent 8,016,179, Sept 13, 2011
- ◆ D.A. Burford, "Friction stir welding tool having a counterflow pin configuration," United States Patent 7,942,306, May 17, 2011
- ◆ D.A. Burford, et al., "System and associated friction stir welding (FSW) assembly, controller and method for performing a friction stir welding operation," United States Patent 7,255,258, Aug 14, 2007 (Also published as CN1597228A, CN100357055C, EP1527843A1, EP1527843B1)
- ◆ R.G. Kendall & D.A. Burford, "Adaptable mandrel for spin forming," United States Patent 6,955,283, Oct 18, 2005 (Also published as CN1593805A, CN100448564C, DE60311807D1, DE60311807T2, EP1512470A1, EP1512470B1)

## AWARDS & RECOGNITIONS

- ◆ Named in the Ad Astra Kansas Initiative, "Science in Kansas, 150 Years and Counting," Top 150 Scientists, 2011
- ◆ Recognized for an invention that resulted in the first royalty-bearing license for WSU, 2011
- ◆ Awarded the 2010 SAE Excellence in Oral Presentation Award
- ◆ Received the "2010 Schwarzkopf Prize for Technology Innovation," for Advancing the Science of Friction Stir Welding, presented by the NSF I/UCRC Directors Association

**PUBLICATIONS & CONFERENCE/COMMITTEE PRESENTATIONS****Refereed Journal Articles & Book**

D.K. Matlock and D.A. Burford, "An Experimental Correlation of Plane Strain Deformation Zone Geometry and Forming Loads," J. Applied Metalworking, Vol. 4, January 1987, pp. 301-05.

D.A. Burford and D.K. Matlock, "A Tensile Model Analysis of Punch Stretch Tests: The Effects of Friction and Strain Hardening on Measurement Sensitivity," Int. J. Mech. Science, Vol. 31, No. 11/12, 1989, pp. 935-48.

D.A. Burford and R.H. Wagoner, "A More Realistic Method for Predicting the Forming Limits of Metal Sheets," in Forming Limit Diagrams: Concepts, Methods, and Applications, R. H. Wagoner, K. S. Chan, and S. P. Keeler, eds., TMS, Warrendale, PA, 1989, pp. 167-182.

D.A. Burford, K. Narasimhan, and R.H. Wagoner, "A Theoretical Sensitivity Analysis for Full-Dome Formability Tests: Parameter Study for  $n$ ,  $m$ ,  $r$ , and  $\mu$ ," Metallurgical Transactions A, Vol. 22A, August 1991, pp. 1775-88.

D. Burford, "Friction Stir Welding of Airframe Structure: From One Delivery System to Another," SAE 2003 Transactions, Journal of Aerospace, Vol. 112, Section 1, pp. 295-300.

D. Burford, B. Tweedy, and C. Widener, "Fatigue Crack Growth in Integrally Stiffened Panels Joined Using Friction Stir Welding and Swept Friction Stir Spot Welding," Journal of ASTM International, Vol. 5, No. 4, Paper ID JAI101568, available online at [www.astm.org](http://www.astm.org).

C. Widener, D. Burford, B. Kumar, J. Talia, and B. Tweedy, "Evaluation of Post-Weld Heat Treatments to Restore the Corrosion Resistance of Friction Stir Welded Aluminum Alloy 7075-T73 vs. 7075-T6," Materials Science Forum, Vol. 539-43, 2007, pp. 3781-88.

C. Widener, D. Burford, and S. Jurak, "Effects of Tool Design and Friction Stir Welding Parameters on Weld Morphology in Aluminum Alloys," Materials Science Forum, Vol. 638-42, 2010, pp. 1261-66.

F. Baratzadeh, C. A. Widener, H. M. Lankarani, D. A. Burford, "Methods to Increase the Fatigue Life of Friction Stir Lap Welds in No-load Transfer Coupons Using a Retractable Pin Tool," Journal of ASTM International, Paper ID JAI103899-11, Published Online 1 May 2012 at [www.astm.org](http://www.astm.org)

H. E. Misak, C. A. Widener, D. A. Burford, and R. Asmatulu, "Fabrication and Characterization of CNT Nanocomposites into 2024-T3 Al Substrates via Friction Stir Welding Process," to be published in Journal of Engineering Materials and Technology, 2014.

**Papers in Conferences with Proceedings**

**D. A. Burford**, D. K. Matlock, and G. Krauss, "Effect of Microstructural Refinement on the Deformation Behavior of Dual-Phase Steels," Proceedings of the 7<sup>th</sup> International Conference on the Strength of Metals and Alloys, Montreal, Canada, August 1985, edited by H. J. McQueen, J.-P. Bailon, J. I. Dickson, J. J. Jonas, & M. G. Akben, pp. 189-94.

**D. A. Burford**, D. K. Matlock, and G. Krauss, "The Limiting Dome Height Punch Test: An Analysis of Sensitivity and Variability," Proceedings of the 15<sup>th</sup> Biennial Congress of the International Deep Drawing Research Group (IDDRG), Controlling Sheet Metal Forming Processes, May 16-18, 1988, Dearborn, Michigan.

**D. A. Burford**, "Friction Stir Welding of Airframe Structure: From One Delivery System to Another," SAE 2003-01-2897, presented at Aerospace Manufacturing Technology Conference & Exposition, Montreal, QC, Canada, September 2003.

**C. Widener**, B. Tweedy, and D. Burford, “*Effect of Fit-up Tolerances on the Strength of Friction Stir Welds*,” Proceedings of the 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Newport, Rhode Island, May 1–4, 2006.

**B. Tweedy**, S. Sellmeyer, A. Jahn, and D. Burford, “*Static Strength Comparison of Riveted versus Friction Stir Welded Stiffened Panels*,” Proceedings of the 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Newport, Rhode Island, May 1–4, 2006.

**C. Widener**, D. Burford, B. Kumar, J. Talia, and B. Tweedy, “*Evaluation of Post-Weld Heat Treatments to Restore the Corrosion Resistance of Friction Stir Welded Aluminum Alloy 7075-T73 vs. 7075-T6*,” THERMEC 2006, Materials Science Forum, Vols. 539-43 (2007), pp. 3781-88, Vancouver, Canada, July 4–8, 2006.

**D. Burford**, C. Widener, and B. Tweedy, “*Advances in Friction Stir Welding for Aerospace Applications (ATIO-12)*,” Proceedings of the 6th AIAA Aviation Technology, Integration and Operations Conference (ATIO), Wichita, Kansas, September 25–27, 2006.

**D. Burford**, B. Tweedy, and C. Widener, “*Influence of Shoulder Configuration and Geometric Features on FSW Track Properties (Paper 36)*,” Symposium Key Note Address, Proceedings of the 6th International Friction Stir Welding Symposium, Saint-Sauveur, Nr Montreal, Canada, October 10–13, 2006.

**B. Tweedy**, C. Widener, and D. Burford, “*Fundamental Properties of Friction Stir Welded Al 7136 Including Effects of Post-Weld Artificial Aging (Paper 37)*,” Proceedings of the 6th International Friction Stir Welding Symposium, Saint-Sauveur, Nr Montreal, Canada, October 10–13, 2006.

**C. Widener**, J. Talia, B. Tweedy, and D. Burford, “*High-Rotational Speed Friction Stir Welding with a Fixed Shoulder (Paper 38)*,” Proceedings of the 6th International Friction Stir Welding Symposium, Saint-Sauveur, Nr Montreal, Canada, October 10–13, 2006.

**B. Tweedy**, C. Widener, and D. Burford, “*The Effect of Surface Treatments on The Faying Surface of Friction Stir Spot Welds*,” Friction Stir Welding and Processing IV, edited by R. Mishra et al., pp. 333-40, Orlando, Florida, May 2007.

**C. Widener**, J. Talia, B. Tweedy, and D. Burford, “*Corrosion in Friction Stir Welded Dissimilar Aluminum Alloy Joints of 2024 and 7075*,” Friction Stir Welding and Processing IV, edited by R. Mishra et al., pp. 449-58, Orlando, Florida, May 2007.

**C. Widener**, J. Talia, B. Tweedy, and D. Burford, “*Investigation to Restore the Exfoliation Resistance of Friction Stir Welded Aluminum Alloy 2024*,” Friction Stir Welding and Processing IV, edited by R. Mishra et al., pp. 459-68, Orlando, Florida, May 2007.

J. Merry, B. Tweedy, C. Widener, and **D. Burford**, “*Static Strength Comparison of Discontinuous Friction Stir Welded Stiffened Panels*,” Proceedings of the 7th AIAA Aviation Technology, Integration and Operations Conference (ATIO), Belfast, Northern Ireland, September 18-20, 2007.

C. Widener, B. Tweedy, and **D. Burford**, “*Path Independence of Allowables Based Friction Stir Butt Welds*,” Proceedings of the 7th AIAA Aviation Technology, Integration and Operations Conference (ATIO), pp. 1702-11, Belfast, Northern Ireland, September 18-20, 2007.

**D. Burford**, B. Tweedy, and C. Widener, “*Fatigue Crack Growth In Integrally Stiffened Panels Joined Using Friction Stir Welding and Friction Stir Spot Welding*,” Proceedings of the 7<sup>th</sup> International ASTM/ESIS Symposium on Fatigue and Fracture, Tampa, Florida, November 14–16, 2007.

- B. Tweedy**, C. Widener, J. Merry, J. Brown, and D. Burford “*Factors Affecting the Properties of Swept Friction Stir Spot Welds*,” Proceedings of the SAE 2008 World Congress, Detroit, Michigan, April, 14–17, 2008.
- B. Tweedy**, C. Widener, S. Jurak, and D. Burford, “*Effects of Weld Tool Design and Welding Parameters on Swept Friction Stir Spot Welding in Thin Gauge Aluminum*,” The 7th International Friction Stir Welding Symposium, Awaji Island, Japan, May 20–22, 2008.
- C. Widener**, B. Tweedy, and D. Burford, “*An Investigation of Tool Design and Welding Parameters on Fatigue Life in FS Welded 2024-T3*,” The 7th International Friction Stir Welding Symposium, Awaji Island, Japan, May 20–22, 2008.
- J. Brown**, D. Burford, B. Tweedy, and C. Widener, “*Evaluation of Swept Friction Stir Spot Welding Through Sealants and Surface Treatments*,” 8th International Conference on Trends in Welding Research Conference, Session 5: Friction Stir Welding, Processing II, Callaway Gardens Resort Pine Mountain, Georgia, June 1–6, 2008.
- J. Gross**, F. Akhtar, B. Tweedy, C. Widener, and D. Burford, “*Development of an End Effector for Friction Stir Spot Welding*,” SAE 2008 Aerospace Manufacturing and Automated Fastening Conference, Paper No. 2008-01-2286, Charleston, South Carolina, September 16–18, 2008.
- C. Widener**, D. Burford, and S. Jurak, “*Effects of Tool Design and Friction Stir Welding Parameters on Weld Morphology in Aluminum Alloys*,” THERMEC 2009, Maritim Hotel, Berlin, Germany, August 25–29, 2009.
- H. Misak**, C. Widener, D. Burford, and R. Asmatulu, “*The Distribution and Flow of Nickel Powder and Carbon Nanotubes Mixed in an Aluminum Matrix via Friction Stir Welding*,” in SAMPE Fall Technical Conference, Wichita, Kansas, 2009.
- T. Lam**, C. Widener, J. Brown, and D. Burford, “*Low Z-force Friction Stir Spot Welds Conventional Tool & Process Development Approach*,” Friction Stir Welding and Processing V, edited by R. Mishra et al., pp. 181–90, ISBN: 978-0-87339-737-7, April 2010.
- D. Burford, C. Widener, **J. Brown**, K. Poston, and G. Moore, “*Evaluation of Swept Friction Stir Spot Welding in 2219-T62*,” Friction Stir Welding and Processing V, edited by R. Mishra et al., pp. 215–23, ISBN: 978-0-87339-737-7, April 2010.
- C. Widener**, T. Lam, and D. Burford, “*Corrosion in 2xxx-T8 Aluminum Alloys*,” Friction Stir Welding and Processing V, edited by R. Mishra et al., pp. 257–64, ISBN: 978-0-87339-737-7, April 2010.
- P. Gimenez-Britos**, C. Widener, and D. Burford, “*Correlation between Ultrasonic Phased Array and Feedback Force Analysis of Friction Stir Welds*,” Friction Stir Welding and Processing V, edited by R. Mishra et al., ISBN: 978-0-87339-737-7, April 2010.
- J. Brown**, D. Burford, C. Widener, W. Horn, G. Talia, and B. Tweedy, “*Corrosion and Fatigue Evaluation of Swept Friction Stir Spot Welding through Sealants and Surface Treatments*,” Friction Stir Welding and Processing V, edited by R. Mishra et al., ISBN: 978-0-87339-737-7, April 2010.
- P. Gimenez-Britos**, C. Widener, E. Boldsai Khan, D. Burford, “*Probability of Detection Analysis of NDT Methods for Friction Stir Welded Panels*,” 8th International Friction Stir Welding Symposium, Maritim Seehotel, Timmendorfen Strand, Germany, May 18–20, 2010.
- D. Burford, P. Gimenez-Britos, E. Boldsai Khan, and **J. Brown**, “*Evaluation of Friction Stir Weld Process and Properties for Aerospace Application: e-NDE for Friction Stir Processes*,” FAA Joint Advanced Materials & Structures (JAMS) Center of Excellence 6th Annual Technical Review Meeting, May 19–20, 2010.

**K. Witthar**, E. Boldsaiikhan, G. Talia, and D. Burford, “*Robotic High Speed Friction Stir Welding*,” 5th International EWI/TWI Seminar on Joining Aerospace Materials, Cincinnati, Ohio, September 20-21, 2010.

A. Handyside, F. Baratzadeh, J. Butler, H. Lankarani, B. Carlson, and **D. Burford**, “*Friction Stir Welded ‘A’ Frame for Dual Function Test Fixture*,” Friction Stir Welding and Processing VI, edited by R. Mishra et al., pp. 159-69, ISBN: 978-1-1180-0201-8, March 2011.

**J. Brown** and D. Burford, “*Friction Stir Fabrication of Spar T-Joints Made from 7075 Aluminum*,” Friction Stir Welding and Processing VI, edited by R. Mishra et al., pp. 213-20, ISBN: 978-1-1180-0201-8, March 2011.

F. Baratzadeh, A. Handyside, E. Boldsaiikhan, H. Lankarani, B. Carlson, and **D. Burford**, “*Micro-structural and Mechanical Properties of Friction Stir Welding Joints of 6082-T6 with 6063-T6*,” Friction Stir Welding and Processing VI, edited by R. Mishra et al., pp. 229-36, ISBN: 978-1-1180-0201-8, March 2011.

**E. Boldsaiikhan**, D. Burford, and P. Gimenez-Britos, “*Effect of Plasticized Material Flow on the Tool Feedback Forces during Friction Stir Welding*,” Friction Stir Welding and Processing VI, edited by R. Mishra et al., pp. 335-43, ISBN: 978-1-1180-0201-8, March 2011.

**J. Brown**, J. Gross, J. Buller, and D. Burford, “*Retractable vs. Fixed Probe Tools in Swept Friction Stir Spot Welding*,” in Friction Stir Welding & Processing VI, San Diego, California, 2011 (presentation only).

K. Witthar, J. Brown, and **D. Burford**, “*Swept FSSW in Aluminum Alloys through Sealants and Surface Treatments*,” Friction Stir Welding and Processing VI, edited by R. Mishra et al., pp. 417-24, ISBN: 978-1-1180-0201-8, March 2011.

**D. Burford**, E. Boldsaiikhan, “*Early Detection of Volumetric Defects Using e-NDE during Friction Stir Welding*,” 9th International Friction Stir Welding Symposium, The Von Braun Center, Huntsville, AL. 15-17 May 2012.

**E. Boldsaiikhan**, D. Burford, “*Generalized e-NDE Algorithm for Friction Stir Welding*,” 9th International Friction Stir Welding Symposium, The Von Braun Center, Huntsville, AL. 15-17 May 2012.

**S. Jurak**, D. Burford, M. McCoy, “*Analysis of Mechanical and Metallurgical Properties of Friction Stir Butt Welded AA2024*,” Friction Stir Welding and Processing VII, edited by R. Mishra et al., pp. 183-194, ISBN: 978-1-11860-578-3, 2013.

**D. Burford**, “*Developing and Deploying FSW&P through Standardization*,” Friction Stir Welding and Processing X, edited by Y. Hovanski et al., Springer International Publishing, eBook ISBN 978-3-030-05752-7, (<https://www.springer.com/us/book/9783030057510>), March 2019.

### Conference Presentations without Proceedings

**J. Merry**, J. Takeshita, B. Tweedy, and D. Burford, “*Comparison of the Effects of Tool Geometry for Friction Stir Welding Thin Sheet Aluminum Alloys for Aerospace Applications*,” 17th AeroMat Conference & Exposition, Seattle, Washington, May 15-18, 2006.

B. Tweedy, C. Widener, **J. Brown**, and D. Burford, “*The Effect of Engineered Materials on the Faying Surface of Friction Stir Spot Lap Welds*,” General Aviation Technology Conference & Exhibition (GATC), Wichita, Kansas, August 29-31, 2006.

B. Tweedy, C. Widener, **J. Merry**, and D. Burford, “*Fundamental Properties of Friction Stir Welded Al 7075 Replacement Alloys*,” General Aviation Technology Conference & Exhibition (GATC), Wichita, Kansas, August 29–31, 2006.

**D. Burford**, “*The National Science Foundation Center for Friction Stir Processing*,” General Aviation Technology Conference & Exhibition (GATC), Wichita, Kansas, August 29–31, 2006.

**D. Burford**, “*Friction Stir Welding and Processing at the National Institute for Aviation Research*,” AWS Welding in Aircraft & Aerospace Conference, Dayton, Ohio, September 19–20, 2006.

**D. Burford**, “*New Materials and Processes for Airframes – Friction Stir Welding (ATIO-5)*,” 6th AIAA Aviation Technology, Integration and Operations Conference (ATIO), Wichita, Kansas, September 25–27, 2006.

**D. Burford**, “*Integral Panels Joined Using Discontinuous Friction Stir Welding, e.g. Spot Welding*,” The 8th Boeing Sponsored Industry-Wide Unitized Structures Technical Interchange Conference, San Antonio, Texas, December 1, 2006.

**J. Merry**, B. Tweedy, C. Widener, and D. Burford, “*Static Strength Comparison of Discontinuous Friction Stir Welded Stiffened Panels*,” TMS 2007 Annual Meeting & Exhibition, Orlando, Florida, February 25–March 1, 2007.

**D. Burford**, “*Qualification of Friction Stir Spot Welds as ‘In Situ’ Mechanical Fasteners: A Preliminary Analysis*,” IIW/GKSS International Seminar, Friction-Based Spot Welding Processes, Geesthacht, Germany, March 29–30, 2007.

**D. Burford**, “*Evaluation of Friction Stir Weld Process and Properties for Aircraft Application*,” The Joint Advanced Materials and Structures Center of Excellence, Atlantic City, New Jersey, July 2007.

**D. Burford**, “*FSW Path Independence and FSW and FSSW ‘In Situ’ Fasteners*,” The 9th Boeing Sponsored Industry-Wide Unitized Structures Technical Interchange Conference, Palm Springs, California, December 3, 2007.

**D. Burford**, B. Tweedy, and C. Widener, “*Development of Design Data for FSW and FSSW*,” The 7th International Friction Stir Welding Symposium, Awaji Island, Japan, May 20–22, 2008.

**D. Burford**, C. Widener, B. Tweedy, “*Path Independence of Friction Stir Welding and Friction Stir Spot Welding Developed as an ‘In Situ’ Integral Fastener System*,” 8th International Conference on Trends in Welding Research Conference Session 5: Friction Stir Welding, Processing II, Callaway Gardens Resort Pine Mountain, Georgia, June 1–6, 2008.

**D. Burford**, “*Standards & Specifications for Friction Stir Technologies*,” AeroMat 2010 Conference & Exposition, Optimizing Performance & Affordability of Aerospace Materials, Bellevue, Washington, June 22, 2010.

**P. Gimenez-Britos**, C. Widener, and D. Burford, “*Stress Corrosion Cracking in Butt Welded 2024-T3 Alloy*,” SAE Aerospace Wichita Aviation Technology Conference (WATC), Wichita, Kansas, August 21, 2008.

**J. Gross**, F. Akhtar, B. Tweedy, C. Widener, and D. Burford, “*Development of an End Effector for Friction Stir Spot Welding*,” SAE 2008 Aerospace Wichita Aviation Technology Conference (WATC), Wichita, Kansas, August 21, 2008.

**J. Brown**, D. Burford, and C. Widener, “*Evaluation of Swept Friction Stir Spot Welding Through Sealants and Surface Treatments*,” SAE 2008 Aerospace Wichita Aviation Technology Conference (WATC), Wichita, Kansas, August 21, 2008 (presentation only).



**T. Lam** and D. Burford, “*Low Z-Force Friction Stir Spot Welding (FSSW) – Conventional Tool & Process Development Approach*,” SAE 2008 Aerospace Wichita Aviation Technology Conference (WATC), Wichita, Kansas, August 21, 2008.

B. Tweedy, C. Widener, **T. Lam**, D.A. Burford, and J. Brown, “*Fatigue of Swept Friction Stir Spot Welds in Thin Sheet 2024-T3 Aluminum*,” in Aerospace Manufacturing and Automated Fastening Conference & Exhibition, Charleston, South Carolina, 2008.

**D. Burford**, “*Friction Stir Welding: Challenges For Aerospace Aluminum*,” AWS/AA Aluminum Welding Conference & Exhibition, Seattle, Washington, September 21-22, 2010.

**D. Burford**, P. Gimenez-Britos, E. Boldsai Khan, and J. Brown, “*Advanced e-NDE for Friction Stir Joining Technologies*,” SAE 2010 Aerospace Manufacturing and Automated Fastening Conference & Exhibition (AMAF): Technology for the Next Generation Aircraft, Wichita, Kansas, September 28-30, 2010.

**D. Burford**, P. Gimenez-Britos, E. Boldsai Khan, and J. Brown, “*Evaluation of Friction Stir Weld Process and Properties for Aerospace Structures: e-NDE for Friction Stir Processes*,” FABTEC 2010, AWS Professional Program (W32), Session 2: Friction Stir Welding, Georgia World Congress Center, Atlanta, Georgia, November 2, 2010.

**D. Burford**, “*Development of Design Data for FSSW Joints*,” 7<sup>th</sup> International EWI/TWI Seminar on Joining Aerospace Materials, Boeing Longacres Customer Center, Renton, Washington, September 16-17, 2014,

#### **Grant Funded Project Reports (2005-2012)**

D. Burford, C. Widener, and B. Tweedy, “*Friction Stir Welding and Related Topics*,” NIAR, WSU, Wichita, Kansas, NIS End-of-Year Progress Report, NIS Project No. 06-006, July 2006.

D. Burford, B. Tweedy, and C. Widener, “*Friction Stir Welding and Related Topics*,” NIAR, WSU, Wichita, Kansas, NIS End-of-Year Progress Report, NIS Project No. 07-006, July 2007.

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