



## **Professor Paul A. Lagace**

See:

<http://web.mit.edu/aeroastro/people/lagace.html>

[http://esd.mit.edu/Faculty\\_Pages/lagace/lagace.htm](http://esd.mit.edu/Faculty_Pages/lagace/lagace.htm)

<http://aeroastro.mit.edu/faculty-research/faculty-list/paul-lagace>

<http://web.mit.edu/aeroastro/people/pal/bio.html>

<http://www.worldcat.org/identities/lccn-n88-268588>

<http://www.journalogy.net/Author/22237623/paul-a-lagace>

<http://www.sagepub.com/editorDetails.nav?contribId=525679>

Professor of Aeronautics and Astronautics  
Professor of Engineering Systems  
MacVicar Faculty Fellow  
Department of Aeronautics and Astronautics  
Massachusetts Institute of Technology

### **Education:**

S.B., 1978, Massachusetts Institute of Technology

S.M., 1979, Massachusetts Institute of Technology

Ph.D., 1982, Massachusetts Institute of Technology

**Specialization and Research Interests:**

Composite Materials and their Structures, Fracture, Longevity, and Damage Tolerance, Manufacturing, Generic Systems Applications, Engineering Systems

**Teaching Interests:**

Aerospace Structures, Solid Mechanics, Composite Materials and Structure, Design for Longevity, Systems Engineering, Manufacturing and Production Issues, Systems Thinking

**Positions Held at MIT:**

Co-Director, Leaders for Manufacturing/System Design and Management Programs, 1998 - 2003; Associate Director, Engineering Systems Division, 1999 - 2001; Director, Technology Lab for Advanced Composites, 1986 - present; Assistant Professor, 1982 -1986; Associate Professor, 1986 -1994; Department Executive Officer, 1990 -1991; Acting Department Head, Summer 1991; Professor 1994 – present

**Honors and Awards:**

Hertz Fellow, 1978 -82; Sigma XI; Tau Beta Pi; Sigma Gamma Tau; Department Undergraduate Teaching Award 1988 -89; Baker Teaching Award 1990; Fellow, American Institute of Aeronautics and Astronautics; von Karman Award, Israel Society of Aeronautics and Astronautics, 1995; MacVicar Faculty Fellow, 1995 - present; Department Undergraduate Teaching Award, 1989; Department Advising Award, 1995 and 1998; 1997 L.P. Coombs Award of the Institute of Engineering, Australia; ASTM Stinchcomb Award, 2000; ICCM World Fellow of Composites; Fellow, American Society for Composites; ASTM International Award of Merit, 2007; Fellow, American Society for Testing and Materials International

**Society Memberships:**

American Institute of Aeronautics and Astronautics; Society for the Advancement of Materials and Process Engineering; American Society for Testing and Materials American Society for Composites, Founding Member; American Society for Engineering Education

**Comments:**

In the early 1990s, Professor Lagace, a long-time Boston Red Sox fan, supervised an Experimental Lab project in the Department's Wind Tunnel to prove to Red Sox management that when the 600 Club edifice was built behind home plate in 1988-89, it affected the flight of balls hit, leading to a reduction in home runs. (The Club has since been redesigned and renamed the ".406 Club.")

**More on Research Interests:**

Research in the areas of fracture, longevity, damage resistance and damage tolerance of composite materials and their structures, as well as issues in the application of these materials to aerospace, marine and automotive structures. The research has an experimental orientation, but development of analytical tools is also pursued particularly with the objective of developing efficient analytical methodologies that are useful in performing parametric studies early in the design process. Specific areas addressed include: interlaminar stresses, resultant delamination, and methods to suppress such; the sensitivity of composite materials to notches; impact, damage resistance, and residual strength; progressive failure of laminates in a gradient stress field; **buckling and postbuckling of composite structures**; behavior of composite sandwich structures; composite fuselage technology. Research has been conducted on systems of both thermosetting and thermoplastic matrices.

Fracture, Damage Tolerance and Longevity: Experimental and analytical work to identify and understand the basic mechanisms which cause damage and eventual failure in composite structures. Ultimate goal of the work is to develop models to predict the failure of composite structures under the myriad events and circumstances to which they are subjected. Issues include basic fracture, failure in the presence of damage (damage tolerance) and cyclic loading (longevity). Experimental work ranges from coupon level specimens to built-up structures such as simulated pressurized aircraft fuselages. Models and analysis techniques are developed based on the factors identified through the experimentation.

Interlaminar Stresses and Delaminations: Experimental and analytical work on both aspects of the delamination issue: the calculation of the interlaminar stress fields as well as the understanding and prediction of the delamination process which occurs in composite structures due to geometric discontinuities (free edges, ply dropoffs, etc.) and gradient stress fields, in general. Analysis techniques are developed to predict the interlaminar stresses and experimental work is conducted to consider the initiation and growth of delamination as well as its interaction with other damage modes and its role in the final failure of composite configurations. Both strength of materials and strain energy release rate approaches continue to be explored and utilized in predicting the various aspects of delamination.

Impact Behavior: Experimental and analytical work on the overall issue of impact including both the aspects of damage resistance and damage tolerance. The ultimate goal is to be able to predict the effect any impact will have on the performance of a composite structure. Experimental work on specimens ranging from coupon level to built-up structure is conducted to identify the key mechanisms that are involved in the impact response and the subsequent damage tolerance. These factors are then properly modeled by appropriate techniques in a continuing effort to develop a unified methodology to predict the overall behavior.

Also pursuing research in: Manufacturing issues in composite structures and aerospace structures, in general, including fabrication, assembly, maintenance, and cost aspects. Work particularly focuses on relationship of engineering design to production and maintenance costs.

In later years, Lagace broadened his areas of engagement to include overall views of engineering systems, with particular emphasis on effects of technology.

Dr. Lagacé has taught courses in the areas of mechanics of materials and structures, with special emphasis on composite materials and their structures, and has developed courses dealing with manufacturing with composite materials and advanced topics in composite materials and structures. With James Mar, he developed the video course series "Composite Materials." More recently he developed a course on "Systems Thinking" and a freshman course on the "Essentials of Engineering".

Dr. Lagacé has received departmental and Institute awards for excellence in undergraduate teaching, and is a MacVicar Faculty Fellow. He is a member of several societies including being a fellow of the ASTM, a fellow of the AIAA, a fellow of the ASC, and an ICCM World Fellow of Composites. He has served for six years as the president of the International Committee on Composite Materials, and has received various awards. He also serves as a consultant to industry and as a participant on various governmental committees.

### **Publications up to 1996:**

H.T. Budiman and P.A. Lagace, "Nondimensional Parameters for Geometric Nonlinear Effects in Pressurized Cylinders with Axial Cracks", to appear in Journal of Applied Mechanics,.

P.A. Lagace and S.M. Priest, "Damage Tolerance of Pressurized Graphite/Epoxy Cylinders Under Uniaxial and Biaxial Loading", to appear in Composite Materials: Fatigue and Fracture (6th Symposium), ASTM STP 1xxx, ASTM, Philadelphia, 1996.

Brian L. Wardle and Paul A. Lagace, "On the Use of Dent Depth as an Impact Damage Metric for Thin Composite Structures", to appear in the Proceedings of the American Society for Composites 11th Technical Conference, Atlanta, GA, October, 1996.

Haryanto T. Budiman, Kerry F. Henault, and Paul A. Lagace, "Effects of Axial and Hoop Stiffeners on the Damage Propagation in Pressurized Composite Cylinders", Proceedings of the 37th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Salt Lake City, UT, April, 1996.

Brian L. Wardle and Paul A. Lagace, "Importance of Instability in the Impact Response of Composite Shells", Proceedings of the 37th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Salt Lake City, UT, April, 1996, pp. 1363-1373.

S.M. Spearing, P.A. Lagace, and H.L.N. McManus, "On the Role of Lengthscale in the Prediction of Failure of Composite Structures: Assessment and Needs", Proceedings of The Tenth International Conference on Composite Materials, Whistler, Canada, August, 1995, pp. IV-49 - IV-56.

C.U. Ranniger, P.A. Lagace, and M.J. Graves, "Damage Tolerance and Arrest Characteristics of Pressurized Graphite/Epoxy Tape Cylinders", Composite Materials: Fatigue and Fracture--Fifth Volume, ASTM STP 1230, ASTM, Philadelphia, 1995, pp. 407-426.

P.A. Lagace and E. Wolf, "Impact Damage Resistance of Several Laminated Material Systems", AIAA Journal, Vol. 33, No. 6, June, 1995, pp. 1106-1113.

P.A. Lagace, K.F. Ryan, and M.J. Graves, "Effect of Damage on the Impact Response of Composite Laminates", AIAA Journal, Vol. 32, No. 6, June, 1994, pp. 1328-1330.

N.V. Bhat and P.A. Lagace, "An Analytical Method for the Evaluation of Interlaminar Stresses due to Material Discontinuities", Journal of Composite Materials, Vol. 28, No. 3, 1994, pp. 190-210.

P.H.W. Tsang and P.A. Lagace, "Failure Mechanisms of Impact-Damaged Sandwich Panels Under Uniaxial Compression", Proceedings of the 35th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Hilton Head, SC, April, 1994, pp. 745-754.

P.A. Lagace and J.E. Williamson, "Contribution of the Core and Facesheet to the Impact Damage Resistance of Composite Sandwich Panels", Proceedings of the Tenth DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, April, 1994, pp. II-53 - II-74

J. E. Williamson and P.A. Lagace, "Response Mechanisms in the Impact of Graphite/Epoxy Honeycomb Sandwich Panels", Proceedings of the American Society for Composites Eighth Technical Conference, Cleveland, Ohio, October, 1993, pp. 287-297.

P.A. Lagace and K.J. Bonello, "Damage Accumulation in Graphite/Epoxy Laminates Due to Cyclic Gradient Stress Fields", Composites: Design, Manufacture and Application, Proceedings of the Eighth International Conference on Composite Materials, Honolulu, Hawaii, July, 1991, pp. 38-A-1 - 38-A-15 and Journal of Reinforced Plastics and Composites, Vol. 12, No. 10, October, 1993, pp. 1111-1135.

K.J. Saeger and P.A. Lagace, "Effect of Localized Bending at Through-Flaws in Pressurized Composite Cylinders" Proceedings of the AIAA/ASME/ASCE/AHS/ASC 31st Structures, Structural Dynamics and Materials Conference, Long Beach, California, AIAA Paper No. 90-0920, April, 1990, pp. 966-972 and Journal of Aerospace Engineering, Vol. 6, No. 4, October, 1993, pp. 381-393.

P.A. Lagace, "Understanding Impact of Composite Structures: Issues and Needs", Proceedings of the Second Canadian International Composites Conference and Exhibition, Ottawa, September, 1993, pp. 33-37.

P.A. Lagace, R. L. Mong, and C. Wyland Kuhlmann, "Suppression of Delamination in a Gradient Stress Field in Graphite/Epoxy Laminates", Proceedings of the Ninth International Conference on Composite Materials (ICCM/9), Vol. VI, Madrid, July, 1993, pp. 705-713.

C.U. Ranninger, P.A. Lagace, and M.J. Graves, "Damage Tolerance and Arrest Characteristics of Pressurized Graphite/Epoxy Tape Cylinders", presented at the ASTM Fifth Symposium on Composite Materials: Fatigue and Fracture, TELAC Report 93-4, May, 1993.

P.A. Lagace, J.E. Williamson, P.H.W. Tsang, E. Wolf, and S.A. Thomas, "A Preliminary Proposition for a Test Method to Measure (Impact) Damage Resistance", Journal of Reinforced Plastics and Composites, Vol. 12, No. 5, May, 1993, pp. 584-601.

H. Matsushashi, M.J. Graves, J. Dugundji, and P.A. Lagace, "Effect of Membrane Stiffening in Transient Impact Analysis of Composite Laminated Plates", Proceedings of the AIAA/ASME/ASCE/AHS/ASC 34th Structures, Structural Dynamics and Materials Conference, La Jolla, California, April, 1993, pp. 2668-2678.

P. A. Lagace and E. Wolf, "Impact Damage Resistance of Several Laminated Material Systems", Proceedings of the AIAA/ASME/ASCE/AHS/ASC 34th Structures, Structural Dynamics and Materials Conference, La Jolla, California, April, 1993, pp. 1863-1872.

P.A. Lagace and N.V. Bhat, "On the Prediction of Delamination Initiation", Advanced Composites '93 (Proceedings of the International Conference on Advanced Composites), Wollongong, Australia, February, 1993, pp. 335-341.

P.A. Lagace, N.V. Bhat, and A. Gundogdu, "Response of Notched Graphite/Epoxy and Graphite/PEEK Systems", Composite Materials: Fatigue and Fracture, Fourth Volume, ASTM STP 1156, ASTM, 1993, pp. 55-71.

A.J. Sawicki, M.J. Graves, and P.A. Lagace, "Failure of Graphite/Epoxy Panels with Stiffening Strips", Composite Materials: Fatigue and Fracture, Fourth Volume, ASTM STP 1156, ASTM, 1993, pp. 5-34.

P.A. Lagace, J.E. Williamson, P.H.W. Tsang, E. Wolf, and S.A. Thomas, "The Use of Force as a (Impact) Damage Resistance Parameter", Proceedings of the American Society for Composites Seventh Technical Conference, State College, Pennsylvania, October, 1992, pp. 991-1000.

P.A. Lagace and N.V. Bhat, "Efficient Use of Film Adhesive Interlayers to Suppress Delamination", Composite Materials: Testing and Design (Tenth Volume), ASTM STP 1120, ASTM, 1992, pp. 384-396.

T.A. Guy and P.A. Lagace, "Compressive Residual Strength of Graphite/Epoxy Laminates After Impact", Proceedings of the 9th DOD/NASA/FAA Conference on Fibrous Composites in Structural Design, Lake Tahoe, Nevada, DOT/FAA/CT-92-25, 1992, pp. 253-274.

D.S. Cairns and P.A. Lagace, "A Consistent Engineering Methodology for the Treatment of Impact in Composite Materials", Proceedings of the ASC 5th Technical Conference, East Lansing, Michigan, June, 1990, pp. 589-599 and Journal of Reinforced Plastics and Composites, Vol. 11, April, 1992, pp. 395-412.

P.A. Lagace, M. Beaumont, J.C. Brewer, and C.F. Varnerin, "TELAC Manufacturing Course Class Notes", Edition 3, TELAC Report 88-4b, September, 1991.

P.A. Lagace, K.F. Ryan, and M.J. Graves, "Effect of Damage on the Impact Response of Composite Laminates", Proceedings of the AIAA/ASME/ASCE/AHS/ASC 32nd Structures, Structural Dynamics and Materials Conference, Baltimore, Maryland, April, 1991, pp. 1137-1143.

M.J. Graves and P.A. Lagace, "Composite Fuselage Technology--Summary of Year 1 Results for NASA Grant NAG-1-991", October, 1990.

P.A. Lagace and J.A. Sultana, "Effects of Residual Manufacturing Stresses on the Fracture of Graphite/Epoxy Laminates", presented at the 22nd International SAMPE Technical Conference, Boston, Massachusetts, November, 1990.

J.C. Brewer and P.A. Lagace, "Failure of Graphite/Epoxy Induced by Delamination", presented at the 22nd International SAMPE Technical Conference, Boston, Massachusetts, November, 1990.

P.A. Lagace, "On Delamination Failures in Composite Laminates", Proceedings of the Indo-U.S. Workshop on Composites for Aerospace Applications, Bangalore, India, July, 1990, pp. 318-336.

P.A. Lagace and K.J. Saeger, "Methodology for Prediction of Delamination Initiation at Holes in Composite Laminates", Proceedings of the AIAA/ASME/ASCE/AHS/ASC 31st Structures, Structural Dynamics and Materials Conference, Long Beach, California, AIAA Paper No. 90-1019, April, 1990, pp. 1183-1190.

P.A. Lagace, W. Tsang, and J.E. Williamson, "Damage Resistance and Damage Tolerance of AMOCO ERLX-1983 3K-70 PW Sandwich Panels", Report for Boeing Helicopters for Period 6/1/89 to 12/31/89, January, 1990.

D.S. Cairns and P.A. Lagace, "Residual Tensile Strength of Graphite/Epoxy and Kevlar/Epoxy Laminates with Impact Damage", *Composite Materials: Testing and Design (Ninth Volume)*, ASTM STP 1059, ASTM, 1990, pp. 48-63.

P.A. Lagace, "The Potential for Composite Materials in Marine Structures", *Automation in the Design and Manufacture of Large Marine Systems*, Proceedings of the MIT Sea Grant College Program Lecture and Seminar Series, 1990, pp. 259-273.

P.J. Minguet, J. Dugundji, and P.A. Lagace, "Postbuckling Behavior of Laminated Plates Using a Direct Energy-Minimization Technique", *AIAA Journal*, Vol. 27, December, 1989, pp. 1785-1792.

P.A. Lagace and M.J. Kraft, "Impact Response of Graphite/Epoxy Fabric Structures", Proceedings of the Eighth DoD/NASA/FAA Conference on Fibrous Composites in Structural Design, NASA CP-3087 (Part 2), November, 1989, pp. 669-571.

D.S. Cairns and P.A. Lagace, "Transient Response of Graphite/Epoxy and Kevlar/Epoxy Laminates Subjected to Impact", presented at AIAA/ASME/ASCE/AHS 29th SDM Conference, Williamsburg, Virginia, AIAA Paper No. 88-2328, April, 1988 and *AIAA Journal*, Vol. 27, November, 1989, pp. 1590-1596.

P.A. Lagace and C.E. Wolfe, "Damage Accumulation in a Gradient Stress Field in Graphite/Epoxy Laminates", Proceedings of the American Society for Composites Fourth Technical Conference, Blacksburg, Virginia, October, 1989, pp. 925-934.

M.T. DiNardo and P.A. Lagace, "Buckling and Postbuckling of Laminated Composite Plates with Ply Dropoffs", Proceedings of the AIAA/ASME/ASCE/AHS 28th Structures, Structural Dynamics and Materials Conference, April, 1987, pp. 156-164 and *AIAA Journal*, Vol. 27, October, 1989, pp. 1392-1398.

A.J. Vizzini and P.A. Lagace, "An Elastic Foundation Model to Predict the Growth of Delaminations", Proceedings of the AIAA/ASME/ASCE/AHS 28th Structures, Structural Dynamics and Materials Conference, April, 1987, pp. 776-782 and *Journal of Composites Technology and Research*, Vol. 11, Fall, 1989, pp. 81-86.

M.L. Bernard and P.A. Lagace, "Impact Resistance of Composite Sandwich Plates", Proceedings of the 2nd Technical Conference, American Society for Composites, September, 1987, pp. 167-176 and *Journal of Reinforced Plastics and Composites*, Vol. 8, September, 1989, pp. 432-445.

P.A. Lagace and K.J. Saeger, "Approaches for Preliminary Design Assessment of Delamination Potential in Composite Laminates", Proceedings of the 1st USSR-US Symposium on Mechanics of Composite Materials, Riga, Latvian SSR, May, 1989, (published 1992), pp. 302-310.

*Composite Materials, Fatigue and Fracture, Second Symposium*, STP 1012, P.A. Lagace, editor, ASTM, Philadelphia, 1989.

K.J. Saeger and P.A. Lagace, "Fracture of Pressurized Composite Cylinders with a High Strain-to-Failure Matrix System", *Composite Materials: Fatigue and Fracture, Second Volume*, ASTM STP 1012, ASTM, 1989, pp. 326-337.

P.A. Lagace and D.B. Weems, "A Through-the-Thickness Strength Specimen for Composites", Test Methods and Design Allowables for Fibrous Composites, 2nd Volume, ASTM STP 1003, ASTM, 1989, pp. 197-207.

J.C. Brewer and P.A. Lagace, "Quadratic Stress Criterion for Initiation of Delamination", Journal of Composite Materials, Vol. 22, December, 1988, pp. 1141-1155.

D.W. Jensen and P.A. Lagace, "Influence of Mechanical Couplings on the Buckling and Postbuckling Behavior of Anisotropic Plates", Proceedings of the AIAA/ASME/ASCE/AHS 27th Structures, Structural Dynamics and Materials Conference, San Antonio, Texas, May, 1986, pp. 132-141 and AIAA Journal, Vol. 26, October, 1988, pp. 1269-1277.

S.M. Causbie and P.A. Lagace, "Buckling and Final Failure of Graphite/PEEK Stiffener Sections", Proceedings of the AIAA/ASME/ASCE/AHS 27th Structures, Structural Dynamics and Materials Conference, San Antonio, Texas, May, 1986, pp. 280-287 and AIAA Journal, Vol. 26, September, 1988, pp. 1100-1106.

P.A. Lagace and R.K. Cannon, "Effects of Ply Dropoffs on the Tensile Behavior of Graphite/Epoxy Laminates", Proceedings of the 4th Japan-U.S. Conference on Composite Materials, Washington, D.C., June, 1988, pp. 242-252.

P.A. Lagace, "Fracture and Longevity of Composite Structures", Final Report for Period 15 June 1986 - 14 June 1987 (Air Force Office of Scientific Research), TELAC 88-14, June, 1988.

P.A. Lagace, J.C. Brewer, and C.F. Varnerin, TELAC Manufacturing Course Class Notes, Edition 0-3, TELAC 88-4, May, 1988.

P. Minguet, J. Dugundji, and P.A. Lagace, "Buckling and Failure of Sandwich Plates with Graphite/Epoxy Faces and Various Cores", Journal of Aircraft, Vol. 25, April, 1988, pp. 372-379.

P.A. Lagace and A.J. Vizzini, "The Sandwich Column as a Compressive Characterization Specimen for Thin Laminates", Composite Materials: Testing and Design (8th Conference), ASTM STP 972, ASTM, 1988, pp. 143-160.

P.A. Lagace, "Fracture and Longevity of Composite Structures", Report for Period 15 June 1985 - 14 June 1986 for Grant No. AFOSR-85-0206, February, 1988.

A.J. Vizzini and P.A. Lagace, "The Buckling of a Delaminated Sublaminar on an Elastic Foundation", Journal of Composite Materials, Vol. 21, December, 1987, pp. 1106-1117.

P.A. Lagace, J.C. Brewer, and C. Kassapoglou, "The Effect of Thickness on Interlaminar Stresses and Delamination", Journal of Composites Technology & Research, Vol. 9, No. 3, Fall, 1987, pp. 81-87.

D.S. Cairns and P.A. Lagace, "Thick Composite Plates Subjected to Lateral Loading", Journal of Applied Mechanics, Vol. 54, September, 1987, pp. 611-616.

P.A. Lagace and J.C. Brewer, "Studies of Delamination Growth and Final Failure under Tensile Loading", presented at Sixth International Conference on Composite Materials, London, England, July, 1987.



C. Wang, T.H.H. Pian, J. Dugundji, and P.A. Lagace, "Analytical and Experimental Studies on the Buckling of Laminated Thin-Walled Structures", Proceedings of the AIAA/ASME/ASCE/AHS 28th Structures, Structural Dynamics and Materials Conference, April, 1987, pp. 135-140.

P.A. Lagace and D.S. Cairns, "Tensile Response of Laminates to Implanted Delaminations", Advanced Materials Technology '87, (Proceedings of the 32nd National SAMPE Symposium/Exhibition, Anaheim, California) SAMPE, April, 1987, pp. 720-729.

C. Kassapoglou and P.A. Lagace, "Closed Form Solutions for the Interlaminar Stress Field in Angle-Ply and Cross-Ply Laminates", Journal of Composite Materials, Vol. 21, April, 1987, pp. 292-308.

J. Dugundji, P.A. Lagace, and J.W. Mar, "Postbuckling, Damage Tolerance and Manufacturing Techniques for Advanced Composite Materials", Final Report for Period 1 June 1983 to 30 June 1986 (AFWAL Contract No. F33615-83-K-5016), AFWAL-TR-87-4006, 1987.

P.A. Lagace and K.J. Saeger, "Damage Tolerance Characteristics of Pressurized Graphite/Epoxy Cylinders", Proceedings of the Sixth International Symposium on Offshore Mechanics and Arctic Engineering, ASME, March, 1987, pp. 31-37.

C. Kassapoglou and P.A. Lagace, "An Efficient Method for the Calculation of Interlaminar Stresses in Composite Materials", Journal of Applied Mechanics, Vol. 53, December, 1986, pp. 744-750.

P.A. Lagace, "Delamination in Composites: Is Toughness the Key?", Material Sciences for the Future, (Proceedings of the 31st National SAMPE Symposium/Exhibition, Las Vegas, Nevada), April, 1986, pp. 738-749 and SAMPE Journal, Vol. 22, November/December, 1986, pp. 53-60.

P.A. Lagace and K.J. Saeger, "Response of Impacted Graphite/Epoxy Panels to Cyclic Shear Loading", Final Report for Period 6/86-9/86 (Boeing Vertol), TELAC 86-22, October, 1986.

P.A. Lagace, D.B. Weems, and J.C. Brewer, "Suppression of Delamination via an Interply Adhesive Layer", Composites '86: Recent Advances in Japan and the United States, June, 1986, pp. 323-330.

P.A. Lagace, C. Kassapoglou, and J.C. Brewer, "An Efficient Method for the Calculation of Interlaminar Stresses in Composite Laminates Due to Thermal and Mechanical Effects", Proceedings of International Symposium on Composite Materials and Structures, Beijing, China, June, 1986, pp. 777-783.

P.A. Lagace, D.W. Jensen, and D.C. Finch, "Buckling of Unsymmetric Composite Laminates", Composite Structures, Vol. 5, 1986, pp. 101-123.

P.A. Lagace and S.C. Nolet, "The Effect of Ply Thickness on Longitudinal Splitting and Delamination in Graphite/Epoxy under Compressive Cyclic Load", Composite Materials: Fatigue and Fracture, ASTM STP 907, ASTM, 1986, pp. 335-360.

P.A. Lagace, "Notch Sensitivity of Graphite/Epoxy Fabric Laminates", presented at Composite Materials and Engineering, An International Symposium, Newark, Delaware, September, 1984, and Composites Science and Technology, Vol. 26, No. 2, 1986, pp. 95-117.

P.A. Lagace, "Notch Sensitivity and Stacking Sequence", Composite Materials: Testing and Design (Seventh Conference), ASTM STP 893, 1986, pp. 161-176.

A.J. Vizzini and P.A. Lagace, "The Role of Ply Buckling in the Compressive Failure of Graphite/Epoxy Tubes", Proceedings of the AIAA/ASME/ASCE/AHS 25th Structures, Structural Dynamics and Materials Conference, Palm Springs, California, May 1984, pp. 342-350 and AIAA Journal, Vol. 23, November, 1985, pp. 1791-1797.

P.A. Lagace, "Nonlinear Stress-Strain Behavior of Graphite/Epoxy Laminates", Proceedings of the AIAA/ASME/ASCE/AHS 25th Structures, Structural Dynamics and Materials Conference, Palm Springs, California, May 1984, pp. 63-73 and AIAA Journal, Vol. 23, October, 1985, pp. 1583-1589.

J.C. Brewer, C. Kassapoglou, and P.A. Lagace, "An Efficient Method for the Calculation of Interlaminar Stresses due to Thermal Stresses in Composite Materials", TELAC Report 85-16, August, 1985.

P.A. Lagace, "Postmortem Determination of Delamination Failures", Proceedings of the International Conference: Postmortem Failure Analysis Techniques for Fiber Reinforced Composites, July, 1985, pp. 7-1 - 7-19.

P.A. Lagace and C. Kassapoglou, "An Efficient Method for the Calculation of Interlaminar Stresses in Composite Materials: Part 1 - The Force Balance Method", TELAC Report 85-4, March, 1985.

P.A. Lagace and M.W. Allen, "Evaluation of the Alternative Manufacturing Methods for Bonding Graphite/Epoxy Composites", Advanced Technology in Materials and Processes (Proceedings of the 30th National SAMPE Symposium/Exhibition, Anaheim, California), March, 1985, pp. 427-442.

M.J. Graves and P.A. Lagace, "Damage Tolerance of Composite Cylinders", SAE Paper No. 830766 presented at SAE 1983 Business Aircraft Meeting and Exposition, Wichita, Kansas, 1983, and Composite Structures, Vol. 4, No. 1, 1985, pp. 75-91.

P.A. Lagace, J.W. Mar, and J. Dugundji, "Fracture, Fatigue (Longevity), Dynamics and Aeroelasticity of Composite Structures", Final report for period January 1983 - March 1984 (Air Force Office of Scientific Research), TELAC 84-21, December, 1984.

P.A. Lagace, "The Behavior of Highly Loaded Structural Components", Annual Report for Period September 1982 - August 1983, (Boeing Military Airplane Company), TELAC 83-19, November, 1983.

P.A. Lagace, "Delamination Fracture under Tensile Loading", Proceedings of the Sixth Conference on Fibrous Composites in Structural Design, AMMRC-MS-83-2, Army Materials and Mechanics Research Center, November, 1983, pp. IX 53-70.

P.A. Lagace and S.C. Levin, "Fracture Toughness", Final Report for Period June 1983 - August 1983 (Beech Aircraft Company), TELAC 83-18, October, 1983.

P.A. Lagace, J.W. Mar, and J. Dugundji, "Fracture, Longevity (Fatigue), Dynamics, and Aeroelasticity of Composite Structures", Final report for period January 1982 - December 1982 (Air Force Office of Scientific Research), TELAC 83-11, June, 1983.

P.A. Lagace, "The Behavior of Highly Loaded Structural Components", Report for Period April 1982 - August 1982 (Boeing Military Airplane Company), TELAC 82-20, December, 1982.

J.W. Mar and P.A. Lagace, "Design Technology of Advanced Composites", Final Report for Period August 1977 - May 1982 (Air Force Materials Laboratory), AFWAL-TR-82-4178 and TELAC 82-19, November, 1982.

P.A. Lagace, "Static Tensile Fracture of Graphite/Epoxy, Ph.D. Thesis, M.I.T., TELAC 82-4, April, 1982.

P.A. Lagace and J.C. Brewer, TELAC Manufacturing Course Class Notes, Edition 0-2, TELAC 81-14, September, 1981.

J.W. Mar and P.A. Lagace, "Tensile Fracture of Graphite/Epoxy Laminates with Holes", Advances in Composite Materials, Proceedings of the 3rd International Conference on Composite Materials, Paris, France, 1980, pp. 130-145.

P.A. Lagace, "The Application of Linear Elastic Fracture Mechanics to Continuous Fiber Advanced Composite Materials: A Literature Review", TELAC 79-14, December, 1979.

P.A. Lagace, "Static Tensile Behavior of Cross-Plied Graphite/Epoxy Laminates with Holes", S.M. Thesis, M.I.T., TELAC 79-8, September, 1979.