

## Vitae of Madhukar Vable

### ADDRESS

Mechanical Engineering-Engineering-Mechanics,  
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### EDUCATION

09/76-05/81 Ph.D., Aerospace Engineering, The University of Michigan, Ann Arbor, Michigan  
08/73-05/76 M. Tech., Aerospace Engineering, Indian Institute of Technology, Kanpur, India  
08/68-05/73 B. Tech., Mechanical Engineering, Indian Institute of Technology, Kanpur, India

### HONORS

Fellow of Wessex Institute of Great Britain, 2002  
Distinguished Faculty Member Award from Michigan Association of Governing Boards of State Universities, 1999.  
Michigan Technological University Distinguished Teacher Award, 1998.  
Member of Academy of Teaching Excellence of Michigan Technological University.  
Most valuable research project award from Michigan Materials and Processing Institute for 1994/95 year.  
Member of Editorial Board of The International Journal of Boundary Element Methods Communications. (1994-2004).

## I. SCHOLARSHIP

### Books

1. *Mechanics of Materials*, 2nd Edition, Expected On-line Publication (2009).
2. *Intermediate Mechanics of Materials*, Oxford University Press, New York, 604 pages, ISBN: 978-0-19-518855-4), (2008)
3. *Solution Manual for Intermediate Mechanics of Materials*, Oxford University Press, New York, 520 pages, ISBN: 978-0-19532926-1, (2008)
4. *Mechanics of Materials*, 1st Edition, Oxford University Press, 774 pages, ISBN: 0-19-513337-4, (2002)
5. *Solution Manual for Mechanics of Materials*, 1st edition, 705 pages, ISBN: 0-19-515844-X, (2002)

### Book Chapters

1. *Resolution of Stress Gradients In Bonded Joints by Boundary Element Method*, Modeling of Adhesive Bonded Joints, Eds: L. Silvia and A. Oechsner Springer, Heidelberg, Germany ISBN: 978-3-540-79055-6, (2008).

### Software Development

Developing a computer program with a graphical user interface that is based on Boundary Element Method. The computer program is a synthesis of my research in Boundary Element Method. The computer program called BEAMUP can be used for solving Poisson's equation, problems in elastostatic, fracture mechanics, and plate bending. The material can be isotropic or anisotropic, homogenous or non-homogenous, and can contain point and line singularities. The mesh can be automatically refined to achieve a user specified accuracy.

For additional details please see my home page.

### Publications

1. "Boundary element analysis of inclusions with corners" *Engineering Analysis with Boundary Elements* v31, pp 762–770,(2007) (With J. Maddi).
2. "Boundary element analysis of bonded joints", *International Journal of Adhesion and Adhesives*, 26, 133-144, (2006), (With J. Maddi).
3. "Integrating fracture mechanics into undergraduate design." *Proceedings of ASEE annual conference*, Nashville, June 12-15, (2005)
4. "Enhancing understanding of concepts in mechanics of materials using design" Paper 1010, *Proceedings of FIE conference*, Boulder, Colorado, Nov. 5-8, (2003)
5. "Intuition, observations, and mathematical generalization in mechanics of materials," paper 150, *Proceedings of ASEE annual conference*, Nashville, June 22-25, (2003).

6. "Tests for multiple materials problems" Boundary Elements XXIV, EDs. C.A. Brebbia, A Tadeu, and V. Popov, pp 731-740, (2002) (With M.E. Fox)
7. "Controlling errors in the process of automating boundary element method analysis" Special Issue of Engineering Analysis with Boundary Elements, v26, pp405-415,(2002) (*INVITED*).
8. "Minimizing the error near discontinuities in boundary element method". Special issue Engineering Analysis with Boundary Elements, v25, pp607-617, (2001) (*INVITED*).
9. "Optimum interpolation functions for boundary element method". Engineering Analysis with Boundary Elements, v24, pp189-200, (2000), (with B.A. Ammons and M.E. Fox).
10. "An efficient numerical model for analyzing mechanically fastened composites" SAMPE Midwest advanced materials and processing conference, pp 270 279, Sept.12-14,(2000)
11. "Strength of Bolted Joints in Composites Under Concentrated Moment", J. Comp. Mat. v34, pp1242-1262, (2000) (with J.T.Grutta, I. Miskioglu, and S. Charoenphan).
12. "Minimizing Some of the Mesh Errors in Boundary Element Method" Boundary Element Technology XIII, Eds. C.S. Chen, C.A. Brebbia, and D.W. Pepper, pp449-458, Computational Mechanics Publications, June 8-10, (1999), (With B.A. Ammons) (*INVITED*)
13. "An hr-method of Mesh Refinement for Boundary Element Method" Int. J. for Numerical Methods in Engineering. v43, 979-996 (1998) (with B.A. Ammons).
14. "A Dynamic Algorithm for Integration in the Boundary Element Method." Int. J. for Numerical Methods in Engineering,v41, 639-650,(1998)(with B.A. Ammons).
15. "Continuity and Collocation effects in the Boundary Element Method." Int. J. for Numerical Methods in Engineering. v 40, 1877-1891 (1997) (with B.A. Ammons)
16. "Boundary Element Analysis of Cracks" Int. J. for Solids and Structures. V 33, No. 13, pp. 1853-1865 (with B.A. Ammons) (1996)
17. "A Study of the Direct and Indirect BEM" Boundary Element XVII Ed. C.A. Brebbia, S. Kims, T.A. Oswald, H. Power, pp. 3-10, Computational Mechanics Publication, Proceedings of the XVII Boundary Element Conference, Madison, Wisconsin, July 17-19, 1995 (With B. Ammons) (*INVITED*)
18. "A Boundary Element Method for Plate Bending Problems" Int. J. for Solids and Structures. V 29, No.3, pp 345-361 (1992) (withY.Zhang).
19. "An Indirect Boundary Element Method for Plate Bending Problems" Boundary Element XIII, Ed. C.A.Brebbia, G.S.Gipson. Computational Mechanics Publications, pp.511-522, (1991) (with Y.Zhang)
20. "Importance and use of Rigid Body Mode in Boundary Element Method", Int. J. for Numerical Methods in Engineering, V 29,pp.453-472 (1990).
21. "Boundary Element Method for Composite Bodies" Advanced Boundary Element Methods, Ed.

B.S. Annigeri and K. Tseng, Springer-Verlag, pp 214-224,(1989) (with Y.Zhang).

22. “Boundary Element Analysis of Mechanically Fastened Composite”, Boundary Element Techniques: Applications in Engineering, Ed. C.A.Brebbia and N.G.Zamani, pp.19-32, (1989). (*INVITED*)

23. “Stress Analysis in Plane Orthotropic Material by the Boundary Element Method”. Int. J. for Solids and Structures, V 24, No 1, pp.1-11 (1988). (with D.L.Sikarskie).

24. “Development of a finite element algorithm for elasto-plastic analysis”, Proceedings 1988 ASME Computers in Engineering, V 3, pp. 575-583 (with J.V.Shah and T.R. Grimm).

25. “Making the boundary element less sensitive to changes or errors in the input data”, Int. J. for Numerical Methods in Engineering. V 24, pp. 533-1540 (1987).

26. “Boundary element method for mixed boundary value plane elastostatic orthotropic problems”. Boundary Elements IX., Ed. C.A.Brebbia, W.L. Wendland and G. Kuhn. Computational Mechanics Publications, V. 2 pp. 209-223,(1987) (with D.L. Sikarskie).

27. “Improving the solution of the boundary element method by changing the conditioning of the matrix in algebraic equations”. Advanced Boundary Element Methods, Ed. T.A. Cruse, Springer-Verlag, pp.443-450, (1987)

28. “An Algorithm Based on the Boundary Element Method for Problems in Engineering Mechanics”, Int. J. for Numerical Methods in Engineering. V 21, pp.1625-1640 (1985).

29. “Software Needs for Vehicle Crash Simulation”, Proceeding of ASME Computers in Engineering Conference and Exhibition - Vol.II, Boston, MA, Aug. 4-8, 1985 (with T.R. Grimm and J. Shah).

30. “Mathematical Model of Aortic Valve Vibration”. J. of Biomechanics, V 17, No. 11, pp. 831-837 (1984) (with D.L.Sikarskie, P.Stein).

31. “A Solution Technique for Indirect Boundary Integral Equations in Planar Elasto-Plastic Problems,” Int. J. of Solids and Structures. V 19, pp. 93-104 (1983) (with D.L.Sikarskie).

32. “Factors that Affect the Frequency of Aortic Valve Vibrations”. Presented at the 3rd International Conference on Mathematical Modeling. University of Southern California, Los Angeles, California (1982) (with D.L.Sikarskie and P.Stein).

33. “An Efficient Algorithm for the Numerical Evaluation of Integral Equations.” Computer and Structures. V 14, pp.29-35 (1981) (with D.L. Sikarskie).

34. “An efficient algorithm for the numerical evaluation of boundary integral equations”, Proceeding of the 3rd International Conference on Boundary Element Method”, Irvine, California, July (1981) (with D.L.Sikarskie). (*INVITED*)

### **Invited Presentations**

1. “Engineering Triumphs and Disasters: A Mechanics of Material Viewpoint”, January 29th, 2009, MEEM seminar.

2. “Recent Developments of BEM Application to Bonded Joints”, 2nd International Conference on Advanced Computational Engineering and Experimenting, Barcelona, Spain, July 14-15, 2008,
3. The following three talks were given at Michigan State University, East Lansing, Industry-University Educational Seminar on the topic of “Current Trends and Advances in Finite Element and Other Engineering Analysis Methods”. July 15-16th, 2000.
  - (a) Introduction to Boundary Element Method in Engineering.
  - (b) Errors In Boundary Element Method.
  - (c) Application of BEM to Fracture Mechanics and Interface Problems
4. “Teaching and Research: Two Components of Scholarship? or Two Vocations of Specialists? Graduate Student Council, Michigan Tech. Univ. Houghton, Feb. 1999
5. “Stress Analysis of Mechanically Fastened Composites by Boundary Element Methods”, Joining of Material, 5th Annual Materials and Mechanics Workshop. Traverse City, September 13-15 (1987).
6. A Mathematical Model of Aortic Valve “Vibrations”, International symposium on current concept on the use of aortic and pulmonary allograft for heart valve substitutes, Berlin, Germany, Sept.7-9 (1987) (with D.L.Sikarskie and P. Stein).

## Reports

1. “Non-linear thermal analysis by BEM”, January 2006, Report submitted to ThermoAnalytic, Inc. Calumet, MI 49913.
2. “Boundary element method for transient heat transfer”, March 2004, Report submitted to ThermoAnalytic, Inc. Calumet, MI 49913.
3. “Program structure for steady state heat transfer problem by BEM”, June 2003, Report submitted to ThermoAnalytic, Inc. Calumet, MI 49913.
4. “BEM for multiple material steady state heat transfer problem.”, March 2003, Report submitted to ThermoAnalytic, Inc. Calumet, MI 49913.
5. “Boundary element method for steady state heat transfer”, Dec. 2002, Report submitted to ThermoAnalytic, Inc. Calumet, MI 49913.
6. “A Special Class of Fastening Problems for Random Fiber Composites” Third Annual Report, Michigan Materials and Processing Institute, June 1998.(with D.L. Sikarskie, J.B. Ligon, I. Miskioglu)
7. “A Special Class of Fastening Problems for Random Fiber Composites” Second Annual Report, Michigan Materials and Processing Institute, January 1997.(with D.L. Sikarskie, J.B. Ligon, I. Miskioglu)
8. “A Special Class of Fastening Problems for Random Fiber Composites” First Annual Report, Michigan Materials and Processing Institute, July 1995.(with D.L. Sikarskie, J.B. Ligon, I. Miskioglu)
9. “Theoretical and experimental investigation of mechanically fastened joints”, Technical Report

August, 2009

TACOM Contract DAAE07-85-C-R037 (1986) (with G.Cloud, D.L.Sikarskie).

10. "Heat Gain and Temperature Variation During a Daily Cycle Inside a 10 Meter Domehus". 1977, A report prepared for Gorsline International, Inc., Mill Valley, California, (with D.L.Sikarskie).

11. "An Algorithm for Evaluating the Boundary Integral Equations in Planar Elasto-Plastic Bodies", Ph.D. Thesis. The University of Michigan, Ann Arbor, Michigan, 1981.

12. "Study of Minimum Weight Design of a Stiffened Cylindrical Shell Using the Finite Element Method".M. Tech Thesis. Indian Institute of Technology, Kanpur.

### **Presentations And Others**

1. "Errors in Boundary Element Methods" Fifth International Conference on Integral methods in Science and Engineering. Houghton, Michigan, August 10-13, 1998

2. "Experimentally Validated Computer Model for a Special Class of Fastening Problems" Proceedings of the SEM Spring Conference on Experimental Mechanics, Bellevue, Washington, June 2-4, 1977, pp 186-187 (with Paul Hildebrand)

3. "A Special Class of Fastening Problems for Random Fiber Composites" Symposium on Polymer Composites Processing, June 25th, 1997, East Lansing, MI

4. "A Special Class of Fastening Problems for Random Fiber Composites" MMPI Technical Committee, June 24th, 1997, Novi, MI

5. "Crack Analysis by the Boundary Element Method" Twenty-fourth Midwestern Mechanics, Conference, Ames Iowa, October 1-4, 1995, (With B. Ammons).

6. Interview published in Boundary Elements Abstracts and Newsletter. V 3, No.3, pp 114-115;(1992)

7. "Boundary Element Method For Plate Bending Problems" Dept. of Material Science and Mechanics, Michigan State University, East Lansing, Oct.20, (1992)

8. "An Indirect Boundary Element Method for Plate Bending Problem", Developments in Mechanics V. 15, Ed. J.B. Ligon, et. al. pp. 529-530. 21st Midwestern Mechanics Conference, Aug. 13-15 (1989) Houghton, (with Y. Zhang).

9. "Analysis and Design of Joints in Composites", Michigan Polymer Consortium Conference, April 28-29, 1989.

10. "Boundary element method for plane elastostatic orthotropic problems", Abstracts, First world Congress on Computational Mechanics (with D.L.Sikarskie). Austin, Texas, Sept. 22-26 (1986).

11. "Theoretical Investigation of Mechanically Fastened Composite," Army Material Testing Lab, Watertown, Massachusetts, U.S.A., April 6th, 1986.

12. "Theoretical Investigation of Mechanically Fastened Composite," Tank Automotive Command, Warren, Michigan, Dec. 17, 1985.

13. “A solution procedure for elasto-plastic boundary integral formulation” Proceeding of the 17th Midwestern Mechanics Conference, Ann Arbor, Michigan, May 68(1981) (with D.L.Sikarskie).

### **Funding**

1. “Partial Funding for Integral Methods in Science and Engineering 98” with B. Bertram, A. Narain, D.L. Sikarskie, and A.A. Struthers. National Science Foundation, April 1, 1998- March 31, 1999, Amount \$10,428.
2. Faculty Development Grant from Michigan Technological University, Jan. 1996, Amount: \$4,250.
3. “A Special Class of Fastening Problems for Random Fiber Composites” with J. Ligon, I. Miskioglu, and D.L. Sikarskie. Sponsors Chrysler Corp., General Motors, and State of Michigan. July 1994 - July 1997, Amount: \$368,089
4. C<sup>2</sup>E<sup>2</sup> Equipment Grant From Michigan Technological University, Nov. 1992, Amount: \$3,000
5. “Theoretical and Experimental Investigation of Mechanically Fastened Composites”, with D.L.Sikarskie and G.Cloud, Tank Automotive Command, Warren, Michigan, 05/85-09/86. Amount \$142,566.

## **II. TEACHING**

### **Undergraduate Courses:**

Static  
Introduction to Dynamics  
Introduction to Mechanics of Materials  
Intermediate Mechanics of Materials  
Introduction to Finite Elements  
Undergraduate Design Projects

### **Graduate Courses:**

Plates  
Finite Element Method in Engineering (developed this course)  
Boundary Element Method in Engineering (developed this course)

### **Graduate Students**

J.V. Shah, M.S. (1987)(Co-advisor T. Grimm)  
Yikang Zhang, Ph.D. (1989)  
John Needham, M.S. (1990)  
Pamela Stanley, M.S. (1991) (Co-Advisor D.L. Sikarskie)

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Yuejun Li, Ph.D. (1991) (Co-advisor L. Lorenzo)  
Bruce Ammons, Ph.D. (1996) (N.S.F. fellow and MTU fellow)  
Jooi Lim, M.S. (1995)  
Paul Hildebrand, M.S. (1996)  
Saiphon Charoenphan, M.S. (1998)  
Michael Fox, M.S. (1999)  
Jai Hind Maddi, Ph.D. (2006)

**Teaching Details:**

Full Load: 9 Credits/Semester  
Average Class Size: 40 Students  
Student Evaluation: 4.4 — 4.8 on 5 (Univ. Avg - 4.0)  
Average Time Spent: 22 Hours/Week

**III SERVICE**

**External**

Treasurer, ASEE mechanics group, 2003-2006.

Member of the Scientific Advisory Committee of International Conference for Boundary Element Technology, BETECH 2003, Detroit, May 19-21, 2003.

Member of the Organizing Committee of the Fifth International Conference on Integral Methods in Science and Engineering, August 10-13, 1998, Houghton, MI.

Chaired three sessions at the Fifth International Conference on Integral Methods in Science and Engineering, August 10-13, 1998, Houghton, MI

Member of the Scientific Advisory Committee of International Conference for Boundary Element Method in Engineering.(1991, 1993, and 1995)

Member of Editorial Board Boundary Element Abstract and Newsletter (1989-1994).

Chairman of session “Fracture Mechanics”, 24th Midwestern Mechanics Conference, Iowa State University, Ames Iowa. Oct. 1-4th, 1995

Chairman of session “Numerical and Computational Aspects” 17th Boundary Element International Conference, Madison, Wisconsin, July 17-19, 1995

Chairman of session “Plates and Shells” 15th Boundary Element International Conference, Worcester, August 10-13, 1993

**Reviewer**

The International Journal for Numerical Methods in Engineering.  
The International Journal for Solids and Structure.

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The International Journal of Analytical and Experimental Modal Analysis.  
Engineering Analysis with Boundary Elements.  
National Science Foundation.  
International Journal of Fracture.  
Numerical Methods for Partial Differential Equations

Co-Editor: Development in Mechanics. V 15 Proceedings of the 21st Mid-Western Conference, Houghton, MI 49931

Book review: "Structural Impact and Crash Worthiness - Vol. I", Edited by G.A.O. Davies in Experimental Techniques, Vol. 9, No. 11, p. 18 (1986).

Panelist in Discussion of Joining of Material, 5th Annual Materials and Mechanics Workshop, Traverse City, Sept. 13-15th (1987).

Co-chairman of Session of Vehicle Crash Simulation, ASME Conference on Computers in Engineering, Boston (1985).

### **Internal**

Member of Academic Quality Improvement Program at Michigan Tech (AQIP), 2008-09

Member MEEM department charter oversight committee (2007-2010)

Senator at Large to MTU senate (2007-2009)

Chair, Academic Policy Committee (2007-2009)

University Committee on Academic Tenure, Promotion, and Reappointment. (2005-2008)

Chair, Liaison Council of MTU-AAUP Chapter (2004-2007)

MEEM department alternate senator to the MTU senate. (2003--2005)

Member MEEM Department Graduate Committee (2003--present)

Member MEEM Department Charter Oversight Committee (2005-present)

Member of MTU Senate Academic Policy Committee (2003--2005)

(a) Appointment, promotion, tenure, dismissal, and leaves of the academic faculty (b) Criteria for positions that are to be accorded academic rank. (c) Academic freedom: rights and responsibilities. (d) Regulations concerning the awarding of honorary degrees.

Member MEEM Department Computer Committee (2003--2004)

Member of College of Engineering Dean Evaluation Committee (2001)

The committee conducted surveys of Faculty, Department Chairs, and Staff in the college of engineering and produced a report on Dean performance that was distributed to the college constituency.

Member MEEM department graduate committee. (2000-2001, 2003--)

(a) To administer, review on a continuing basis, conduct appropriate hearings and recommend changes in graduate program policy, admissions and recruitment.(b) To administer, review on a continuing basis, conduct appropriate hearings and mandate changes needed to improve and upgrade the Ph.D. examination.

Member MEEM department charter oversight committee. (2000-2003)

The committee oversees that department charter policies are followed.

Member oversight committee of first year engineering program. (1998-2000)

The committee oversaw the development of two courses in the first year engineering program.

Member, University Conflict of Interest Committee (1998-2001)

Develop policies and makes recommendations to the Provost regarding conflict of interest cases.

Member of Department Charter Committee (1995-1999)

The two member committee coordinates changes to the department charter that may be initiated by faculty members, department executive committee or by the university administration.

Chair, Department Computer Committee (1997-98)

To conduct continuing review of the Department's computing needs and to make appropriate recommendations to the Department Chair.To oversee the acquisition and disposition of computing facilities.

Chair, Ad, Hoc Committee on merit, work-load, and P & T (1997)

The committee was charged to develop a work-load and merit algorithm that is consistent with the promotion and tenure guidelines.

Solid Mechanics Area Director.(1995-1997)

The Area Director provides leadership in organizing and implementing policies and instructional and research programs, and acts as a link in communication between the Area Faculty and the Department Chair. The Area Directors, in consultation with the Area Faculty, will advise the Chair on matters relating to: Course development; Course offerings; Teaching loads and assignments; Faculty recruitment; Resource allocation and budget recommendation; Department policy.

Member of Department Computer Committee (1996-1998)

To conduct continuing review of the Department's computing needs and to make appropriate recommendations to the Department Chair.To oversee the acquisition and disposition of computing facilities.

Member solid mechanics faculty search committee. (1994-1995)

Senator at Large: University Faculty Senate (1990-1993).

(a) Chair, Institutional Evaluation Committee. (1991-1992)

Developed evaluation processes for all academic administrators from Chairs of department to the President of the university that are used each Spring.

Developed reappointment procedures for Department Chair, Dean's of colleges and Dean's of Schools.

(b) Chair, Ad Hoc committee on departmental governance and search procedures for supervisors. (1991-1992)

Developed a process for changing from Head to Chair form of department governance for the entire university.

Developed search procedures that can be used for selection of department Chairs, college Deans and Directors of institutes.

Member Department Chair Search Committee (1992).

The committee coordinated a national search for Chair of ME-EM department.

Member of University Committee on the Academic Calendar (08/90-05/91).

The Committee gathered detail information, conducted a faculty vote and submitted a proposal to the University board of control to change the calendar from quarter to a semester. The recommendation was not accepted.

Member of University Judiciary Committee (1989-1992).

The committee recommends disciplinary action on student offenses to the Dean of Students.

Member of Senate Calendar Task Force (02/90-08/90).

The task force gathered preliminary information, conducted a straw poll and recommended that the University formally consider changing calendar from quarter to a semester system.

Advisor to Pi Tau Sigma - Mechanical Engineering Honor Society (1985-1990).

Pi Tau Sigma is an honor society of Mechanically Engineering.

Member of ME-EM Faculty Development Committee (1988-1989)

The committee performs two functions: (a) it reviews files of all assistant professors and identifies strength, weakness and course of action that would enhance the chances of tenure and promotion. (b) it functions as a promotion and tenure committee in the department.

Member of Solid Mechanics Graduate Curriculum Committee (1987-1989)

The committee reviewed the graduate course offerings and recommended changes in the solid mechanics program.

Chairman, ME-EM Graduate Recruitment Committee (1986-1988)

Developed a workshop format for recruitment of graduate student that has resulted in improved quality and increased the number of graduate school applicants.

Conducted a faculty survey and developed a set of recommendations for improvement of the graduate program. The recommendations were endorsed and accepted by the department administration and the faculty.

#### **IV. PROFESSIONAL MEMBERSHIP:**

American Society of Mechanical Engineers (ASME)

American Society of Engineering Education (ASEE)

#### **V. CONTINUING EDUCATION:**

Workshops: ADVANCE Recruitment of Women Faculty, 2009

Workshop: NACME Diversity, Nov 17, 1998 Houghton

Workshop: "Federal Funding for High Tech R&D in FY94--- Small Business Innovation Opportunities" Oct. 26 1993, MEERA, Houghton

Workshop: "Total Quality Education", Spring, 1992

Workshop: "Industrial Technology Institute's Workshop On Technology Transfer" February 1992, Houghton

Workshop: "Advisors Workshop", Fall 1987, Houghton.

Workshop: "Hands on Experience Using Geomod", May 1987, Houghton.

Workshop: "Boundary Element Method", July 1986, Houghton.

Workshop: "Thin Wall Structures", Summer 1985, Houghton.

Workshop: "Writing Across the Curriculum", Spring 1985, Houghton.

Workshop: "Winning Grants" - Spring, 1985, Houghton.

#### **VI. WORK EXPERIENCE:**

09/90-present Associate Professor, Engineering Mechanics Michigan Technological University, Houghton, Michigan.

01/03-12/06 Consultant to ThermoAnalytics Inc., Calumet, Michigan

08/92-11/92 Visiting Associate Professor, Material Science and Mechanics Department, Michigan State University East Lansing.

11/84-08/90 Assistant Professor, Engineering Mechanics Michigan Technological University, Houghton, Michigan.

01/83-08/83 Visiting Assistant Professor, Mechanical Engineering Department, University of Bridgeport, Bridgeport, Connecticut.

09/81-08/82 Assistant Professor, Engineering Mechanics Michigan Technological University, Houghton, Michigan.

01/81-08/82 Instructor, Department of Metallurgy, Mechanics and Material Science, Michigan State University, East Lansing, Michigan.

09/76-12/80 Graduate Student, Aerospace Engineering, University of Michigan, Ann Arbor, Michigan.

(1) Lab Instructor. Taught undergraduates their first course in engineering instrumentation.

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- (2) Junior Consultant to Gorsline International Inc. Assisted Dr. D.L. Sikarskie to analyze the heat flow and temperature variation in a prefabricated house.
- (3) Research Assistant to Dr. R.M. Howe. Assisted in the development of a helicopter simulator.

- 01/74-05/76 Research Assistant to Dr. S.S. Rao, Indian Institute of Technology, Kanpur Developed and integrated finite element and an optimization program for determining the minimum weight design of a stiffened cylindrical shell.
- 12/72-01/73 Student Trainee at Metal Box Company - The container manufacturer in India. Determined the cause of failure of solenoid valve used in collection of battery cell bottoms.
- 05/72 -07/72 Student Trainee at Mahendra and Mahendra - The jeep manufacturer in India. Cataloged machine components.