

Sabbatical Leave Report for Academic Year 2005-6

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In 2005-2006 I spent a sabbatical year at Korea University teaching, writing, consulting in rheology, and learning about international engineering education. In my sabbatical proposal I had three main objectives, and two of these were substantially met: I have learned ways that chemical engineering is taught abroad, and I have made great progress in the writing of my textbook, "An Introduction to Fluid Mechanics." In addition, I have come back with many new ideas about teaching that I am incorporating into my classes immediately. The experience of trying to learn a foreign language and to struggle with unfamiliar material has greatly influenced my understanding of students who are encountering engineering concepts for the first time.

OBJECTIVE 1: Complete a good first draft of my undergraduate fluid mechanics textbook

Beginning with an outline and 285 pages of text and figures, my draft textbook, now titled "An Introduction to Fluid Mechanics," now numbers over 600 pages. The text has changed greatly as a result of the time for reflection and study that I had while in Korea. The outline has changed significantly, and I have decided to deemphasize the transport analogy and focus rather on making the connections between math, chemistry, and physics and fluid mechanics. I am quite excited about the text in its current form and optimistic to complete it very soon.

The text outline and current status at the beginning and end of sabbatical are shown below.

Chapter 1 Why study fluid mechanics (completed) status unchanged
Chapter 2 How Fluids Behave (95% done) Now 100% complete
Chapter 3 Mathematics Review (80% done) status unchanged
Chapter 4 Modeling Fluids (30% done) Now 100% complete
Chapter 5 Fluid Stresses (70% done) Now 100% complete
Chapter 6 Stress-Velocity Relationships (new chapter; 100% complete)
Chapter 6 The Transport Analogy (70% done) moved to appendix
Chapter 7 Microscopic Balance (new chapter; 100% complete)
Chapter 7 8 Internal flows (5 % done) Now 80% complete
Chapter 8 9 External flows (not begun) Now 10% complete
Chapter 9 10 Boundary layers (not begun) Now 10% complete
Chapter 10 11 Advanced topics (not begun) Now 20% complete
Chapter 12 Energy Balances (new chapter; 75% complete)

Chapter 13 Macroscopic Momentum Balance (new chapter; not begun; may be cut)
Chapter 14 Dimensional Analysis (new chapter; not begun; may be cut)
Chapter 15 Unit Operations (new chapter; not begun)
Chapter 16 Plumbing (new chapter; not begun)
Appendix A Table of Nomenclature (20% done) status unchanged
Appendix B Glossary (20 % done) Now 30% complete
Appendix C Mechanical Engineering Balance (100% done) moved to Chapter 12
Appendix D Fluid Properties (not begun) status unchanged
Appendix E Unit Conversions (not begun) status unchanged
Appendix F Mathematics Appendix (20% done) Now 90% complete
Appendix G Derivations (new chapter; 100% complete)

The project is at a very good place currently, although more than 18 months will be needed to complete it, depending on how much can be done during the school year. The changes to the outline are significant and philosophical. I am truly grateful for the time for reflection that I had during sabbatical to make this progress.

OBJECTIVE 2: Learn about bioprocess engineering

I made progress in learning about bioprocess engineering at Korea University. I met and spoke with several faculty about their program, which is well established. I shared with them the information I have on the MTU Bioprocess Engineering minor. Now that I am back at MTU I am working with the CM Curriculum Committee to improve our bioengineering offerings.

OBJECTIVE 3: Learn about chemical engineering pedagogy outside of the U.S.

I was fortunate to attend three conferences in Korea, one a UNESCO meeting on engineering education in the Pacific Rim. This conference was very enlightening, bringing together engineers from all over Asia, Australia, and the Pacific. We heard the challenges of teaching engineering in the region and shared our insights on accreditation, which is well established in the U.S. but just coming to Asia/Pacific. I also attended the Korean Society of Rheology meeting and the International Symposium on Applied Rheology. I have made good contacts with Korean chemical engineers and will invite several to speak at Michigan Tech to share their experiences. I have written two invited articles for Korean publications, sharing my impressions of my Korean experience.

OBJECTIVE 4: Advance rheology writing and teaching projects.

I did not have the opportunity to present my short course on rheology in Korea, but I taught a semester-long version of the course and was inspired to offer my MTU rheology course CM4650 by distance education spring 2007. I hope to market this class around the world. I was able to do some rheological consulting and begin to make ties with researchers in Korea that will benefit me in the years to come.

In addition, I maintained ties with colleagues at MTU and completed several publications.

Kunen, Emily, Jason M. Keith, Peter W. Grant, Julia A. King, and Faith A. Morrison, "Rheology Modeling of Carbon-Filled Liquid Crystal Polymer Composites," *Journal of Applied Polymer Science*, under review, September 2006.

King, Julia A., Jason M. Keith, Ryan C. Smith, and Faith A. Morrison, "Electrical Conductivity and Rheology of Carbon Fiber/Liquid Crystal Polymer Composites," *Polymer Composites*, accepted July 2006, in press.

King, Julia A., Faith A. Morrison, Jason M. Keith, Michael G. Miller, Ryan C. Smith, Mariana Cruz de Jesus, Amanda M. Neuhalfen, and Rodwick L. Barton, "Electrical Conductivity and Rheology of Carbon -Filled Liquid Crystal Polymer Composites," *Journal of Applied Polymer Science*, 101(4), 2680-2688 (2006).

I also made two invited technical presentations in Korea.

Morrison, Faith A., "Engineering Textbook Writing: One Author's Perspective," Pohang University of Science and Technology (Postech), Department of Chemical Engineering, May 8, 2006, invited.

Morrison, Faith A., "Drawing the connections: Engineering Science and Engineering Practice," Korea University, Department of Chemical and Biological Engineering, Fall 2005, invited.