David Alber
Curriculum Vitæ

National Renewable Energy Laboratory
1617 Cole Boulevard, Mail Stop: 1608
Golden, CO 80401

david_alber@nrel.gov
http://www.davidalber.net/
Tel: +1.303.275.4018

Education

2000–2007 **University of Illinois at Urbana-Champaign**
Ph.D. in Computer Science, May 2007, Dissertation title: *Efficient Setup Phase Algorithms for Parallel Algebraic Multigrid*
Advisors: Luke Olson and Paul Saylor
M.S. in Computer Science, May 2004, Thesis title: *Computational Local Fourier Mode Analysis in the Multigrid Solution of Coupled Systems*

1995–1999 **University of Iowa**
B.S. in Biological Science and Computer Science, December 1999

Research Interests

Iterative linear solvers, algorithmic efficiency, scalability, combinatorial scientific computing, computational biology. Interested in applications to aerospace, biology, and medicine.

Employment

2007–current Postdoctoral Researcher, National Renewable Energy Laboratory
Postdoctoral position in Materials and Computational Science Center. Primary responsibilities to SciDAC-sponsored project titled "Green Energy: Advancing Bio-hydrogen".

Summer 2004 Summer Intern, Lawrence Livermore National Laboratory
Worked with Jim Jones and Barry Lee on multigrid algorithms to solve Maxwell's equations (continuation from previous summer).

Summer 2003 Summer Intern, Lawrence Livermore National Laboratory
Worked with Jim Jones and Barry Lee on designing a multigrid algorithm to solve the definite Maxwell's equations discretized using edge elements. Also considered techniques to solve the indefinite problem using multigrid.

Summer 2002 Summer Intern, Lawrence Livermore National Laboratory
With Jim Jones and Barry Lee, worked to classify systems of PDEs and the performance characteristics of multigrid on them. Software was developed to enable computational local Fourier analysis.

1998–2000 Software Engineer, University of Iowa College of Business
Developed a real-time trading market for the College of Business. The Iowa Electronic Markets are real-money financial markets that allow twenty-four hour trading to an audience of several thousand users.

1994–1998 Laboratory Technician, University of Iowa College of Medicine
Conducted experiments (Southern blots, PCR, gel runs, darkroom work, analysis) and maintained the lab (prepared chemical solutions, gels, computer work, cleaning, autoclaving).

Research Experience

- *High-Performance Systems Biology*
  Several naturally occurring organisms are known to produce hydrogen through a variety of mechanisms. In the green alga *Chlamydomonas reinhardtii* hydrogen is produced as a byproduct of photosynthesis. The goal of this project is to (a) build a complete model of the metabolism of *C. reinhardtii*

and encode the model in the Systems Biology Markup Language (SBML) and (b) to produce high-performance software to support scientific discovery. The thrust of my involvement in this research is the development of support tools for the modeling effort and engineering a suite of high-performance software for model translation, model integration, function and derivative evaluation, and optimization. Discussion and results are available in [P3, P4, P6].

- *Improvements for Parallel Coarse Grid Selection Algorithms*
  Parallel coarse-grid selection algorithms are graph algorithms seeking to satisfy heuristics based on algebraic smooth error. Each node in the graph is assigned a weight, and coarse-grid points are selected based on finding nodes with the largest weights. This research focused on streamlining the search and weight update properties of these algorithms to produce a more optimal algorithm [P5].

- *Parallel Compatible Relaxation*
  Implemented and tested the performance of parallel compatible relaxation algorithms for algebraic multigrid. Discussion and results appear in [P2].

- *Improving Operator Complexities for Parallel Algebraic Multigrid*
  Studied parallel coarse-grid selection algorithms, especially Cleary-Luby-Jones-Plassmann (CLJP). Modifications were made to the original algorithm which improved the coarsening properties. The new method retains many of the attractive properties of CLJP while being more competitive with other algorithms. The results of this project appear in [P1]. Application and extension of this idea to the Parallel Modified Independent Set (PMIS) algorithm is discussed and tested in [P2].

- *Multigrid for Electromagnetics*
  Worked on implementing an unstructured multigrid solver for problems arising from the definite form of Maxwell's equations for electromagnetics. Traditionally solving these problems using multigrid yields poor performance. The goal was to create a solver with better performance and scalability than previous solvers.

- *Scalability Testing for Radiation Transport Software*
  Conducted scalability tests for Paul Saylor and Dennis Smolarski using radiation transport software written for a supernova modeling project. The tests were run on Seaborg, the NERSC IBM SP RS/6000.

- *Local Fourier Analysis for Systems of PDEs*
  Implemented a software package which conducts local Fourier analysis on scalar and system PDEs. This package produces smoothing and two-grid rates for the problem with a variety of smoothers and other options. The output includes informative plots of the smoothing rates for different Fourier modes.

- *Contributions to the Computational Modeling of Protein Tertiary Structure*
  Under the guidance of Professor Alberto Segre (University of Iowa, College of Business), I implemented software to add to the functionality of PEX – a software package developed by Segre *et al.* to predict the tertiary structure of proteins from their amino acid sequence. Specifically, my tasks included implementing and testing clustering algorithms for protein backbone angles (Ramachandran plots), building an API that launches a viewer and loads the current best protein solution for viewing, and creating several libraries of amino acid sidechain angles to be incorporated into the folding engine in future versions of PEX.

- *Electron Microscopy Investigation of* Echinostoma caproni
  Assisted Professor George Cain (University of Iowa, Department of Biological Sciences) in his study of the parasite *E. caproni*. In the investigation I learned electron microscopy techniques including preparation, sectioning, and staining of samples. The samples were prepared and viewed using both scanning electron microscopy (SEM) and transmission electron microscopy (TEM).

Publications

[P1] D. M. Alber. Modifying CLJP to select grid hierarchies with lower operator complexities and better performance. *Numer. Linear Algebra Appl.*, **13**:87–104, 2006.

[P2] D. M. Alber and L. N. Olson. Parallel coarse grid selection. *Numer. Linear Algebra Appl.*, **14**:611–643, 2007.

[P3] C. Chang, D. Alber, P. Graf, K. Kim, and M. Seibert. Addressing unknown constants and metabolic network behaviors through petascale computing: understanding H_2 production in green algae. *J. Phys.: Conf. Ser.*, **78** 012011, 2007.

[P4] C. H. Chang, P. Graf, D. M. Alber, K. Kim, G. Murray, M. Posewitz, and M. Seibert. Photons, photosynthesis, and high-performance computing: challenges, progress, and promise of modeling metabolism in green algae. *J. Phys.: Conf. Ser.*, **125** 012048, 2008.

[P5] D. M. Alber and L. N. Olson. Bucket-sorted independent sets for algebraic multigrid. In preparation.

[P6] D. M. Alber, P. Graf, C. H. Chang, K. Kim, and M. Seibert. High-performance systems biology toolkit. In preparation.

Conference Talks

[C1] Analysis and Performance of Multigrid for Systems of PDEs. With Jim E. Jones. *Eleventh Copper Mountain Conference on Multigrid Methods*, Copper Mountain, CO, USA, March 2003.

[C2] Modifying CLJP Coarse Grid Selection to Attain Lower Complexities. *Twelfth Copper Mountain Conference on Multigrid Methods*, Copper Mountain, CO, USA, April 2005.

[C3] Parallel Coarse Grid Selection Strategies. With Luke Olson. *Ninth Copper Mountain Conference on Iterative Methods*, Copper Mountain, CO, USA, April 2006.

[C4] Parallel AMG Setup Phase Algorithms. With Luke Olson. *SIAM Conference on Computational Science and Engineering*, Costa Mesa, CA, USA, February 2007.

[C5] Bucket Sorted Independent Sets. With Luke Olson. *Thirteenth Copper Mountain Conference on Multigrid Methods*, Copper Mountain, CO, USA, March 2007.

Teaching Experience

Summer 2005 TA for CS 450 (Introduction to Numerical Analysis) for Hanna VanderZee.

Spring 2001 TA for CS 257 (Numerical Methods) for Professor Jean Ponce.

Fall 2000 TA for CS 231 (Computer Architecture I) for Professor Josep Torrellas – awarded *Outstanding Teaching Assistant Award* for work in this course.

Grants and Awards

- SIAM Conference on Computational Science & Engineering Travel Grant, Spring 2007.
- SIAM Combinatorial Scientific Computing Workshop Travel Grant, Spring 2007.
- Outstanding Teaching Assistant Award, Department of Computer Science, University of Illinois at Urbana-Champaign, Fall 2000.

Service

- Referee for *International Journal of High Performance Computing Applications*.
- Founder and President of SIAM student chapter at University of Illinois at Urbana-Champaign.

References

- Christopher Chang (`christopher_chang@nrel.gov`), Technical Supervisor, Materials and Computational Science Center, National Renewable Energy Laboratory.

- Luke Olson (lukeo@uiuc.edu), Advisor, Department of Computer Science, University of Illinois at Urbana-Champaign.
- Paul Saylor (saylor@cs.uiuc.edu), Advisor, Department of Computer Science, University of Illinois at Urbana-Champaign.
- Details and additional references available upon request.

Golden, Colorado, December 8, 2008