NORTHWEST CONSORTIUM FOR MULTISCALE MATHEMATICS AND APPLICATIONS
Project Summary

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Traditional mathematical education of engineers is focused on practical, one-scale models of engineering problems. As the industrial focus shifted from traditional engineering problems first to micro-scale problems, and, recently to nanotechnology, the inadequacy of the traditional modeling and analysis tools has been brought to light. On the other hand, the fine scale models (atomistic, dislocations, networks) are often computationally prohibitive when applied to real configurations. The accurate and efficient solution of such problems requires the application of new methods of multiscale modeling and simulation. Because the current applied mathematics content of graduate education is mostly based on traditional methods, the researchers in engineering and applied sciences are often unaware of mathematical advances that make multiscale analysis of relevant problems possible.

We propose to bring the full weight of multiscale mathematics into engineering and scientific research and graduate education, by pursuing:

(A) Comprehensive, long-term measures concentrated at the School of Mechanical and Materials Engineering (MME) and the Department of Mathematics, Washington State University (WSU):

* Graduate curriculum reform in the MME/WSU,

* Development of the graduate course in Multiscale Modeling of Materials, and,

* Seminar series on Multiscale Mathematics, Computing and Engineering.

Owing to its multidisciplinary nature and organizational structure, the MME/WSU is particularly well suited for the graduate curriculum reform. Moreover, while focusing on the thorough educational reform at WSU, we expect to impact the wider community in the Northwest and nationally, by demonstrating a successful educational reform in an engineering department.

(B) Broad impact regional and national educational activities:

* Four-week summer school in multiscale mathematics taught by international experts in the field,

* Development of two textbooks to deliver the content of the summer school to home universities during the academic year, and,

* Development of web-based educational software library with learning tools and digitized video lectures from the summer program and seminar series.

(C) Research program focused on critical multiscale problems in thermo-mechanics of materials, specifically: homogenization, network-continuum models, and, coarse-graining of dislocation mechanics. The rationale for our selection of critical problems is based on: the mathematical breadth of the problems (e.g., Network-continuum), their applicability in engineering (e.g., Coarse graining of dislocation mechanics), their educational value (e.g., Homogenization), current state of the art and opportunity for major advances (all problems), and, the expertise of the investigators.