

## The Role of SEMATECH in Enabling Global TCAD Collaboration

E. M. Buturla, J. Byers, A. Husain, M. Kump, P. Lloyd, R. Manukonda, S. Runnels,  
D. Scharfetter

Technology Computer Aided Design  
SEMATECH  
2706 Montopolis Drive  
Austin, Texas 78741  
TCAD.DEPT@SEMATECH.ORG

### Abstract

SEMATECH is a consortium of United States semiconductor manufacturers conducting precompetitive research and development for semiconductor manufacturing. This paper discusses the efforts of the Technology Computer Aided Design (TCAD) group at SEMATECH to create and foster international cooperation in a number of precompetitive TCAD-related areas. In addition, the paper addresses techniques for information exchange and the need for TCAD standards.

SEMATECH (SEmiconductor MAnufacturing TECHnology) is a consortium of United States semiconductor manufacturers working with government and academia to sponsor and conduct research aimed at assuring leadership in semiconductor manufacturing technology for the U.S. semiconductor industry. SEMATECH develops advanced semiconductor manufacturing methods, materials and equipment, and validates its development in a proving facility that simulates its members' production lines. Recently, SEMATECH has created new thrust areas, namely Design, Test, Packaging, Materials, and TCAD. This new emphasis at SEMATECH has resulted in organizational changes including the creation of a TCAD group responsible for creating a strategy and operation plan that utilizes SEMATECH resources and leverages other available external efforts.

The focus of the SEMATECH TCAD effort is to provide a precompetitive differential advantage in TCAD to the SEMATECH member companies through benchmarking, joint development, and leveraging the efforts of other research and development groups such as the Semiconductor Research Corporation and the National Labs. Transfer of resulting technology to the member companies and commercialization (if appropriate) are also part of the mission. Initially, SEMATECH TCAD efforts were kept within the United States, but recently there has been interest from the SEMATECH member companies' TCAD representatives to expand interactions with other groups. As a first step, TCAD opportunities were discussed at the recent JESSI/SEMATECH meeting in Erlangen in April.

There are a number of TCAD activities that are sufficiently important and yet pre-competitive such that they lend themselves to global cooperation. Some areas of current interest are

- Benchmarking standards
- Compact model standardization
- Interoperability standards
- Experimental impurity profiles

Benchmarks are necessary to understand how well a simulator performs. Metrics such as accuracy of the model prediction compared to experimental data and CPU time and memory requirements can be compared between competing simulators. A good set of benchmarks can indicate to the user the ability of a particular simulator to perform for the operating range of interest. Creating a comprehensive set of benchmarks is a laborious task. It is the opinion of many TCAD practitioners that such a set would be of great value across the industry. SEMATECH recently hosted a workshop to establish a benchmarking methodology as well as to set up a suite of test cases for process, device, lithography and compact model simulators. Our plan is to define the format for test cases and then collect input files, expected results, and an explanation of the test cases. This information will be kept in an easily accessible location on the Internet and contributions to the suites will be coordinated and monitored by SEMATECH. Interactions with some European TCAD providers have occurred and further are expected.

Compact model development is another prevalent but non-standardized effort among TCAD practitioners. Many compact models are currently used in the industry. However, there is no standard model which can be used for exchanging technology information in cases of joint product development and between chip manufacturers and system designers. In addition, many technology developers spend considerable effort creating accurate compact models for their technologies. To reduce the total amount of effort required, SEMATECH has sponsored workshops to study this problem and to generate a strategy for compact model evaluation and standardization. In addition, SEMATECH is supporting the very ambitious goal of creating an industry standard compact model and also is pursuing model interface development. These efforts require significant resources, thus collaboration with European developers are welcomed.

Interoperability standards is a concept that has been of interest to TCAD developers for some time. The ability to easily take some simulation code and easily integrate it with a different simulator is the objective of these standards. There was considerable interest a few years ago in “frameworks” concepts, it was felt there were technical approaches that would allow for “plug-and-play” software. Unfortunately, the implementation was very expensive, so the concept was not generally utilized. As a result, most TCAD developers have developed their own non-standard approaches. SEMATECH has sponsored a joint TCAD Framework integration project involving suppliers and member companies. The evaluation of that effort is currently underway. Some

software developers claim that using object-oriented programming techniques will allow “plug-and-play” capability much more easily than present methods. A recent SEMATECH-sponsored workshop addressed this subject and resulted in a starting point for standards in object-oriented TCAD software.

Another important activity at SEMATECH is the creation and maintenance of a profile database. Numerous 1D impurity profiles are already in existence and others are being generated where gaps exist. Such data is costly and time consuming to create, and a reliable profile database would lead to efficiencies. Interactions between SEMATECH and IMEC for profile exchange in transient enhanced diffusion, polysilicon diffusion and silicidation have been initiated. It is expected that these efforts will result in profile exchanges.

Cooperative efforts between the US and European TCAD communities have been initiated with a number of activities now underway. Such efforts have been enhanced by the ability to communicate electronically and the use of Internet as a vehicle to provide quick and inexpensive information exchange. SEMATECH desires further global cooperative activities. Contributions and suggestions are invited. Please contact us at [TCAD.DEPT@SEMATECH.ORG](mailto:TCAD.DEPT@SEMATECH.ORG).