

# Simulation Software Tools for CMP Modeling

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**Abstract**— Current research efforts in the area of Chemical Mechanical Planarization have led to the development of various models relating to aspects of the process. The application of these models is unfortunately difficult to realize because of their complex form or necessity for in-depth understanding about subtle process characteristics in order to successfully apply the model. We propose here to develop a suite of software tools to help demonstrate these CMP models. While the software will be aimed to help researchers simulate and characterize the distinctions between various models, it will also provide “educational” value by allowing users without specific CMP domain knowledge, namely students and outside researchers, to interactively simulate process models.

## Introduction

Research on modeling and simulation of the Chemical Mechanical Planarization (CMP) process has become a primary research focus in the Laboratory for Manufacturing Automation (LMA). To date, several models have been developed by the LMA as well as other institutes to try to characterize and predict complicated chemical and mechanical interactions that occur during CMP. These models can vary dramatically from closed-form equations to probability-based predictions to numerical simulations. Every new evolution of these models may bring a subtle enhancement or improvement in the modeling capabilities. Unfortunately, modeling work is often difficult to evaluate, even at a high level, without an in-depth knowledge of process conditions and formulations. We propose to develop software for the evaluation of these CMP models. The major emphasis of the software will be to design and implement interfaces and modules that effectively demonstrate the usage and limitations of each of the models.

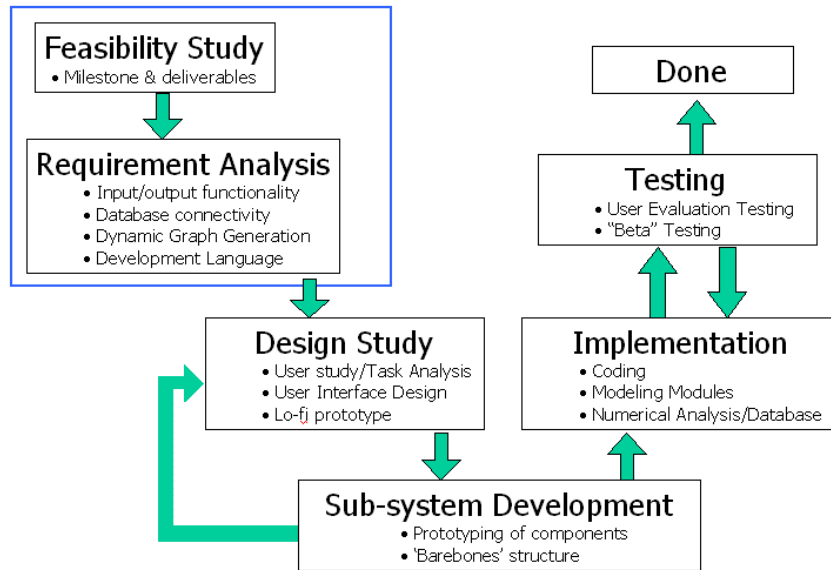
## User-centered Design

The design of the user interface will be a primary focus for the development of the software. It will essentially determine the usability of the software and its ability to successfully communicate the subtlety of each process model. Figure 1 shows the overall development methodology that will be used to facilitate effective software design. A feasibility study and requirement analysis have already been completed. The design study, which is being planned, will be used to understand the habits and needs of the users. A variety of user interface design processes, such as task analysis, low-fi prototyping, user interviews, and surveys, will be used to identify what features and specifications will be necessary for the software to be effective. Furthermore, this information will allow the design of the user interfaces to be critiqued and modified early in the design process.

## Functional Specifications

The functional specifications of the software tools have not yet been finalized. The design approach for this project will be focused on user-centered design, which necessitates flexibility in the development cycle. Initial design planning, however, has brought the attention to these requirements:

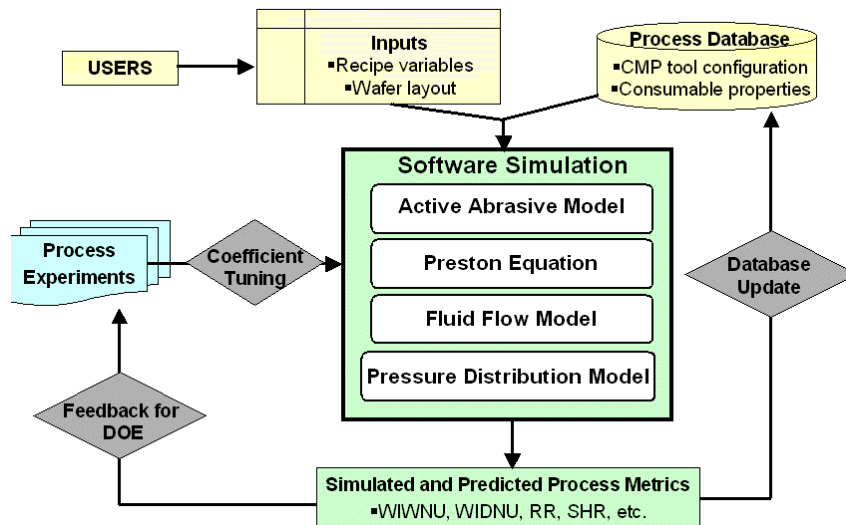
- Users should be able to select any model for simulation
- The user should be able to specify input parameters (such as operating conditions, wafer material, etc.) to the simulation
- Some output from the model should be displayed graphically in terms that can be interpreted by the user
- The software should be usable under at least two different operating “modes”: educational and advanced, which will correspond to the complexity of the simulation procedures
- The software should be able to “save” and “recall” previous simulations
- The process modeling shall be confined to “modules” which must conform to an API (application protocol interface) that will allow the process models to be developed independently from the simulation software
- The software should be available on-line



**Figure 1. Development process and methodology.**

### Process Database Development

The process database will contain information relating to nearly every aspect of the CMP process (Fig. 2). This information may include parameters and properties relating to consumables (slurry, pad, conditioning pad), the polishing tool (eccentricity of polishing head rotation, fluid nozzle location, slurry waste treatment data), etc. The purpose of the database will be to organize this information in a logical and hierarchical format allowing the software to query the database and collect whatever information is needed for the modeling. Sub-tasks in this development plan will include implementation of the process database using Java and Java Servlet languages.



**Figure 2. Schematic diagram of the software architecture.**

### Conclusion

This project is supported in part by the Undergraduate Research Opportunity Program (URO) which enables undergraduates to participate in on-going research projects. Key sub-tasks and deliverables have been defined as part of the project and the functionality of the software will be demonstrated using simple modeling equations, such as the Preston Equation. The development of the other process models will be an on-going process in conjunction with other researchers in the LMA.