# A Model Base for Software Engineering

Sholom Cohen

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213-3890
Tel: (412) 268-2572 (voice) -5758 (fax)
Email: sgc@sei.cmu.edu

**Abstract**

This paper reports on the activities of the Application of Software Models (ASM) Project at the Software Engineering Institute (SEI). The ASM project combines two previous efforts at the SEI in domain and architecture modeling. Our position is that a core competance in software modeling is essential for successful reuse. The ASM project is developing methods, training, and an organizational pattern of operations for supporting the development of this core competance within other organizations.

**Keywords:** Strategic planning, architecture, domain analysis/engineering

**Workshop Goals:** Learning; networking; understanding industry needs; explaining our position

**Working Groups:** domain analysis/engineering; reuse process models

Sponsored by the U.S. Department of Defense

# 1 Background

Sholom Cohen is a member of the technical staff of the Software Engineering Institute (SEI). Mr. Cohen is currently project leader of SEI's Application of Software Models project. This project combines both the Domain Analysis and Software Architecture Engineering projects. As project leader, Mr. Cohen has co-authored two major technical reports on domain analysis methods and an annotated bibliography of domain analysis. He is also the author of a study on the implications of software reuse for the Ada 9X project. Besides domain analysis, Mr. Cohen's research activities include the development of life cycle methods for software reuse, concentrating on designing for reuse and on reuse-based implementation.

# 2 Position

For systematic software reuse, organizations must invest in evolving a core competence in software modeling. This core competence involves modeling the common capabilities of software applications within a product family, and developing a generic design founded on a software/hardware architectural model. As an organization enriches its software assets with models, the process for developing or evolving software applications will become more an engineering change activity of mapping from needs to software solutions than a synthesis activity of building from scratch.

## 2.1 Application of Software Models Project

The Application of Software Models project is developing the technology, engineering process, organization structure and transition planning involved in building and applying a core competence in software modeling. The activities of this project are based on our experience in a number of key supporting techiques:

- domain modeling
- software architecture
- composition of systems via the application of models
- design for and with reuse

The application of these techniques leads to the systematic creation and application of models which form a codified technology base of engineering knowledge. Software engineers use this technology base to support:

- analysis of customers' needs
- synthesis of solutions based on recognized commonalities or on variations from previous solutions
- reuse and reengineering of legacy software

This approach to modeling is a component of the Model-Based Software Engineering approach being promoted by the project. The MBSE approach establishes a framework for relating several types of models:

- Abstract models give us basic modeling concepts. They address questions such as: What is a domain model, what is an architecture, and what are the structures for reusable components?
- Concrete models apply the abstract models by adding domain information. They include the domain model of a particular class of applications, a generic design, a collection of components, an application generator. For a specific domain, the concrete models constitute a domain-specific software architecture, as has been defined by the DSSA program.
- Instances are the applications built upon the concrete models.

The creation of abstract models is chiefly a research and development activity. The SEI has produced abstract models such as those which form the Feature-Oriented Domain Analysis (FODA) method, the Object Connection Update model, and the Object Connection Architecture model. The project also uses abstract models created by other organizations such as the CAMP object architecture. MBSE includes a process for creating concrete models: domain engineering, and a process for using concrete models in the construction of applications: application engineering.

### 2.2 Project Activities

Through collaboration with sponsors, the project has used abstract models as a basis for creating concrete models through domain engineering and is applying these models in the creation of applications. These sponsors include:

- Army Communications and Electronics Command (CECOM) - creation of a domain model of Army movement control, a tactical decision aid supporting command and control.
- National Institute of Standards and Technology - applying the FODA method for developing a model of network management systems software.
- Joint Modeling and Simulation System (JMASS) - applying OCU model for design of friendly and threat models.
- Ballistic Missile Defense Office - using abstract models as a means of evaluating the BMDO Information Architecture and its ability to support system defintion of Battle Management Command Control and Communications (BM/C3) applications.
- Navy - creating concrete models to support the development of weapon system trainers.
- MICOM - creating concrete models to support development of electro-optical fire control systems. This work is being done with our Texas Instruments resident affiliate.

The project also seeks to work directly with industry to support their ability to establish a core competence in software modeling. We have several contacts in the early stages of transition.

### 2.3 Details of CECOM effort

Since 1989, the project has been working with CECOM to develop models for a domain-specific software architecture. The domain of interest for this work has been movement control, which is a command and control tactical decision aid that deals with the movement of soldiers and materiel on the battlefield. The work was initiated under Lt. Gen. Peter Kind and has continued under the sponsorship of the Software Engineering Directorate with Dennis Turner as our key point of contact.

The project has created the following products for CECOM:

- a domain modeling method called Feature-Oriented Domain Analysis (FODA)
- a domain model of movement control using FODA models as the abstract modeling concepts
- a generic design that encompasses the domain of movement control using the Object Connection Architecture as the abstract model
- a working prototype that illustrates the use of a domain specific software architecture for creating an application
- a technical report on using an abstract architecture model to map the domain model to a generic design model (in-progress). Taken together, these models consitute a domain-specific software architecture for movement control

The project is currently extending the DSSA for movement control to include a geographical information system, time-space deconflication, and simulation. The working prototype built from the dssa will also be reengineered to operate on the Army common hardware/software using the ATCCS reference architecture and common applications support software.

The project is also working with several groups building command and control systems that will incorporate the movement control dssa. These include the Strategic-Theater Army Command and Control System (STACCS) currently under development by CSC, Army Tactical Command and Control System (ATCCS) under development at CECOM, and Department of Army Movement Management System - Redesign (DAMMS-R) a product of the Army Combined Arms Support Command.

## 3 Project Products

The project is currently developing a set of support services, training and documentation for organizations wishing to develop a software modeling compentence. We currently have in place:

- an overview briefing describing the evolution to MBSE
- an overview briefing on abstract and concrete models to support design
- a multi-day tutorial/workshop on domain analysis
- technical reports covering the FODA method, a sample domain model, tool support for domain analysis, evolving to MBSE (in-progress), and mapping the domain model to a generic design (in-progress).

## 4 Biography

Prior to joining the staff of the SEI, **Sholom Cohen** was a member of the software engineering technology branch of the McDonnell Douglas Astronautics Company. In that position, he was a key developer of the Common Ada Missile Packages components and tools.

On a lighter note, Mr. Cohen is the author of a children's book, *Yitzy and the G.O.L.E.M.* (HaChai Publications, 1992), a book about a pre-teen computer hacker, and is currently working on a second book in the same *Yitz Berg from Pittsburgh* series.

Mr. Cohen received his BS from the Massachusetts Institute of Technology, an MA in Library and Information Science from the University of Michigan, and an MS from Columbia University (New York).

The SEI, located in Pittsburgh, Pennsylvania, is a federally funded research and development center operated by Carnegie Mellon University under contract to the U.S. Department of Defense. The objective of the SEI is to provide leadership in software engineering and in the tran sition of new software engineering technology into practice.