

# RESEARCH BRIEF

2002/007

## SEMPER-II: Digital Building Models for Intranet Collaborative Design Computing

### OBJECTIVES

This research has been conducted under a Memorandum of Understanding among the National University of Singapore, Temasek Polytechnic, Singapore and Carnegie Mellon University, USA on 7 November 1997. It set out the general agreement among the parties to collaborate on the following areas:

- Advanced building performance modelling across multiple domains to support building design and engineering decision making;
- Protocol for performance-based design involving multi-agent collaboration in distributed environments;
- Global information infrastructure to facilitate synchronous and asynchronous design activities through intranet communication;
- Application of SEMPER-II, an active multi-aspect prototype building design and simulation environment, towards intranet collaboration of geographically distributed user groups via the SREN-vBNS network.

This project also represented the first few participants in the high-speed research collaboration between Singapore and USA researchers, facilitated by the SREN-vBNS linkup, which was launched in Washington DC on 7 November 1997 by the signing of the implementation agreement between the National Science Foundation (NSF), USA, and the then National Science and Technology Board (NSTB), Singapore.

Most existing building performance analysis methods and tools do not effectively encourage and facilitate iterative, multi-criteria, and multi-agenda building design development. SEMPER, which was originally developed at Carnegie Mellon University (CMU), is a building design and performance simulation environment that attempts to remedy these shortcomings. It is an active, multi-domain, spaced-based, object-oriented design support tool for integrated building performance computing. However, it has been developed as a "stand-alone" application.

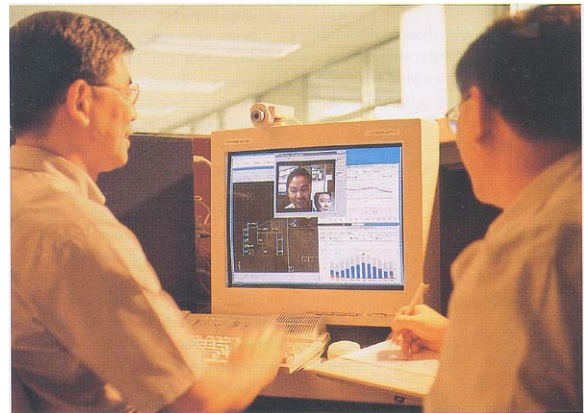


Figure 1. Collaborative design session using SEMPER-II environment.

This project has successfully modified and transformed SEMPER prototype 1 into SEMPER prototype 2 (S2) as an internet-based computational design support environment in order to facilitate geographically distributed design collaboration.

### DELIVERABLES

The project has achieved the following key technical deliverables:

- Implementation of the internet-based communication infrastructure for the various components (e.g., hub and kernel) and applications of S2 using the Common Object Request Broker Architecture (CORBA) technology.
- Development of a link between S2 and a commercial object-based architectural CAD software application (ArchiCAD) to enable the direct transfer of spatial information of the architectural design layout from the CAD model into the S2 environment. This is an essential functionality required to address and overcome a critical barrier in professional practice that has hindered the pervasive use of performance simulation tools in the building industry.

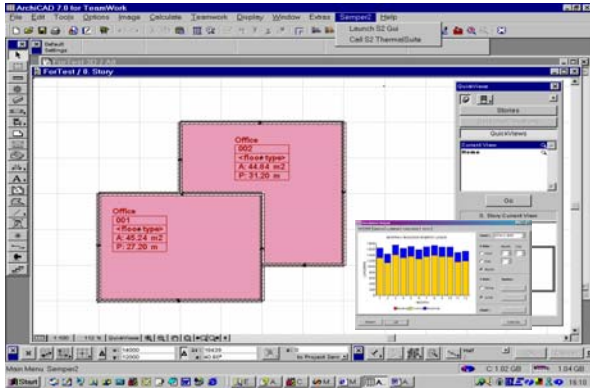


Figure 2. Seamless integration between ArchiCAD and SEMPER-II.

- Implementation of the “Thermal Suite” application, which dynamically links the existing “stand-alone” simulation applications, viz., NODEM (for thermal and energy simulation), BACH (for air flow simulation) and HVAC (for heating, ventilating and air-conditioning system simulation), to provide an integrated and more “realistic” approach to thermal performance analysis of building design.
- Enhancement of the capability of the S2 hub to handle multiple logins and queuing of multiple requests for simulation runs, as well as providing a file management system with versioning function, for the end-user.
- Provision of Singapore weather and material databases for demonstrative case studies in the local context.

Other achievements include the training of students at various academic levels: 2 PhDs, 60 Masters, 44 undergraduates and 69 diplomas. The findings of this project have been disseminated to industry through 2 dedicated public seminars, local and international conferences as well as journal publications.

### NEW DEVELOPMENTS

Information technology continues to evolve in a rapid pace. Even during the progress of this research

project, new IT initiatives are being launched for the building industries in the world. One example is the development of the Industry Foundation Classes (IFC), a part of the standard specifications defined, published and promoted by the International Alliance for Interoperability (IAI), (<http://www.iai.org>), as a basis for information sharing throughout the project life cycle (including facilitating e-procurement of project-related goods and services), and across all disciplines and technical applications in building industries world-wide.

Singapore has adopted this framework in its development of the CORENET system, hosted by the Building and Construction Authority. This necessitates further research to enable building performance simulation tools to capitalize on the shared object model and databases envisaged within the IFC structure.

The S2 research team has in fact embarked on and completed an exploratory research project titled “Mapping of Industry Building Product Model for Detailed Thermal Simulation and Analysis” in collaboration with novaSPRINT. The preliminary results positively indicate that a link can effectively be established between S2 and the IFC compliant systems (e.g., CAD software) to facilitate sharing of model data for performance simulation. This testifies to the true robustness of the original S2 concept and architecture in offering flexibility and adaptability of the simulation environment to continuous evolution of IT in the building industry.

### CONTACT DETAILS

**Associate Professor (Dr) Lam Khee Poh**  
 Department of Building  
 School of Design and Environment  
 National University of Singapore  
 4 Architecture Drive  
 Singapore 117566  
 Tel. (65) 6874 6445  
 Fax. (65) 6775 5502  
 Email: [bdglamkp@nus.edu.sg](mailto:bdglamkp@nus.edu.sg)

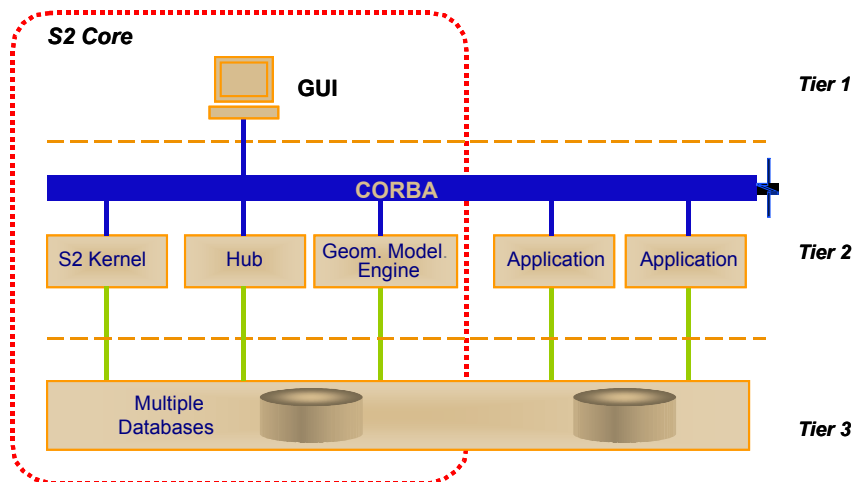


Figure 3. SEMPER-II System Architecture.