RELIABILITY OF MESH GENERATION SOFTWARE

A. H. ElSheikh[a] , **S. Smith**[b] and **S. E. Chidiac**[c]

[a]PhD Candidate, Department of Civil Engineering
McMaster University, Hamilton, Ontario L8S 4L7, Canada
elsheiam@mcmaster.ca

[b]Assistant Professor, Department of Computing and Software
McMaster University, Hamilton, Ontario L8S 4K1, Canada
smiths@mcmaster.ca

[c]Associate Professor, Department of Civil Engineering
McMaster University, Hamilton, Ontario L8S 4L7, Canada
chidiac@mcmaster.ca

Development of unstructured mesh generation algorithms have achieved many advances during the past decade. Past attempts [2,3] to improve the design of general-purpose mesh generators adopted object oriented programming to overcome design complexities. These previous attempts do not have a detailed software design specification, only a partial and informal description of the desired behaviour is provided via various code comments.
This way of development is an error prone process and poses hardships on both the maintenance and extension of the software, thus limiting its lifetime. To solve these problems, a design approach using stepwise refinement of design specifications with the aid of formal methods is proposed. The main concepts of information hiding and separation of concerns are suggested, which result in a better design that will ease the inspection, maintenance and extension of the software. Using formal methods for analyzing the software requirements as well as for writing design specifications will increase software reliability.

Formal methods describe and analyze systems using a collection of notations and techniques based on a strong mathematical basis [1]. These methods reduce the risk incurred by not finding an error in a system before developing it. Formal specification techniques provide a precise description of the desired properties of the system and thus eliminate undesired behavior. Formal methods place an emphasis on early detection of the main design errors, like uninitialized terms, type mismatch, missing operations, missing constraints and unhandled exception cases.

This paper presents an attempt to transfer the technology of formal methods to scientific computation researchers through a formal design specification of an unstructured mesh generator. Concepts of modular design and stepwise refinement will be applied. A template for Module Interface Specification and Module Internal Design will be developed to show a consistent and simple approach to the required formalism. General ideas will be presented on how to implement these concepts using conventional programming languages, which do not directly support the proposed approach.

References

[1] D. A. Peled, "Software Reliability Methods," *Text in Computer Science, Springer-Verlag*, 2001.
[2] M. Beall and M. Shephard,"An object oriented framework for reliable numerical simulations," *Engineering With Computers*,v. 15, p. 61-72,1999.
[3] G. Berti,"Generic Software Components for Scientific Computing,"
PhD Dissertation, TU Cottbus, 2000.