Jenő Balogh
An Object-Oriented Architecture for Analysis and Design of Steel Structures
Theses of the dissertation

Thesis 1.
To represent the structural model, I conceived and developed a system of classes that are linked together in the Tmodel class. Within the Tmodel class, I created classes for static (linear and nonlinear), vibration, and buckling analyses. To allow for the complete separation of the analysis classes (descendants of the Tanalysis class) from the finite element classes (descendants of the Telements class) and from the structural model class (Tmodel) itself, the objects of the Tmodel class apply the event-driven invocation paradigm through the use of property fields. Such separation based on property-based event-driven invocation was not previously available.

Thesis 2.
To serve as ancestor class for all the finite element classes in the system, I developed an abstract finite element class, the Telement class, that incorporates the general functionality of a finite element. The Telement class implements a multi-stiffness component capability, previously not available in object-oriented finite element formulations. That allowed for the Telement-based finite element classes to significantly simplify the implementation of finite elements that use selective reduced integration schemes. Based on the capabilities brought together within the Telement class, I developed an improved plate finite element, called the "modified Heterosis plate element". Compared to the original Heterosis plate element which fails the constant curvature patch test for a non-parallelogram element shape, the modified Heterosis element passes the patch test for an arbitrary element shape, and exhibits improved performance for meshes of finite elements with extremely distorted geometries.

Thesis 3.
To meet the needs of modern analysis of steel structures based on the assumption of semi-rigid structural connections, I developed a family of link finite element classes for structural connection modeling, not currently available in an object-oriented formulation, based on the TElement class and using the capabilities brought together within the object-oriented architecture developed herein.

Thesis 4.
To provide the analysis capability for future, entirely probabilistic-based, analysis and design approaches, I conceived and developed a new, probabilistic structural model class, the TProbModel class, that applies the Monte-Carlo method. The TProbModel class uses multi-threading to allow for parallel processing and use of the continuous advances in computer technology. Such a probabilistic structural model class was not previously available.

Thesis 5.
To allow for a smooth interfacing between the finite element model and the member design model, I introduced a structural member class, the TSteelMember class. To allow the use of the structural member class in conjunction with various country-specific steel design codes, I developed a member design class, the TSteelMemberDesign class, based on the TSteelMember class. Within this research, I developed descendant classes corresponding to the European (Eurocode 3) and Hungarian (MSZ 15024) steel design codes, of which the first is presented in the

dissertation.