QUARTERLY R&D STATUS REPORT - June, 1989

Reporting Period 4

ARPA Order Number:	6419
Program Code Number:	8E20
Contractor:	Cornell University
Contract Number:	N0014-88-K-0591
Contract Amount:	$2,931,739
Effective Date of Contract:	July 1, 1988
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Using Computer Design and Simulation to Improve Manufacturing Productivity

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Description of Progress

1. Object-Oriented Programming

The most significant development in the past three months has been our group's commitment to develop a uniform platform for specifying geometric objects and operations. The necessity for such a framework became obvious as the number of people in the project grew, and we needed to unify our research and avoid duplication of code. The platform, written in CLOS (Common Lisp Object System), will facilitate the use of various parallel architectures, and will allow programming at higher levels of abstraction, interchangeability of packages written at different institutions, and better documentation.

The platform will include a geometric modeler, an algebra package, a utilities package (to include basic data structures and finite sets), a graphics package, and a finite element mesh generation package. Initial efforts will be focused on the geometric modeler and the algebra package. The finite element mesh generation package is an application that is built on top of these two packages. The utilities package will contain the basic data structures and other tools necessary for programming, and will be developed as needed. The graphics package will provide a simple but uniform graphics interface for the different machines that run our software, namely SUN 3's, 4's and SparcStations, Symbolics, and DecStations.

For our geometric modeler, we have developed a subsystem that stores desired adjacency information and will automatically generate CLOS classes to maintain that information. We are now using this system to implement an algorithm that constructs a delaunay triangulation and uses it to generate a finite element mesh.

The algebra package uses semantically rich languages to express numerical algorithms that will run on different architectures. With this tool, one can build general purpose equation solvers/integrators that can easily be customized to different systems, and that provide simplified methods for constructing simulators in various domains.

It has become clear that a uniform platform would be invaluable if extended to many institutions across the country. For example, in order for one institution to use a modeler created at another institution, there must be a compatibility of editors, finite element code packages, uniform graphics, etc. We hope to provide such a mechanism.

2. Expanding the Simulation System

Until recently, our simulation efforts have been restricted to rigid body dynamics. We are now investigating broader simulation domains. In particular, we are studying injection molding and various finite-element analysis applications.

We are also interested in developing tools that allow engineers to move easily from object representations to simulations. Simulation systems covering various domains are often fairly similar. It may be possible to provide tools for automatically constructing simulators from object representations and other information provided by the engineer.

3. Solid Modeler Robustness

One of our graduate students is expanding our previous work in solid modeler robustness, in which we were able to demonstrate that all conversions of numeric data to logical data for the problem of intersecting convex polyhedra can be made logically independent. He is writing a modular program that can be inserted in solid modelers to prevent crashes caused by making incorrect choices about numeric data. His program contains a list of rules and constraints which promote consistency in approximate numeric data and exact symbolic data.

4. Parallel, Distributed Control of Complex Systems

We are continuing to study control by investigating human walking with our simulator. Stable walking has been achieved in the plane, and we are now performing experiments of walking on a variable, randomly generated terrain. In order to achieve lateral stability, we have added another degree of freedom at the hip.

Change in Key Personnel

No change.

List of Technical Reports

1. An Architecture for General Purpose Physical System Simulation - Integrating Geometry, Dynamics, and Control, Tech Report 89-987, April 1989. J. Cremer.
2. Quaranteed-Quality Triangular Meshes, Tech Report #89-983, April 1989. L.P. Chew.
3. On Planar Point Matching Under Affine Transformation, Tech Report #89-986, April 1989. J. Hopcroft & D. Huttenlocher.
4. An Efficiently Computable Metric for Comparing Polygonal Shapes, Tech Report #89-1007, May 1989. P. Chew & K. Kedem (with E.M. Arkin, D.P. Huttenlocher, J.S.B. Mitchell).

Fiscal Status

Amount currently provided on contract:	$1,129,000
Expenditures and commitments to date:	$810,000
Funds required to complete work:	No additional funds - FY89