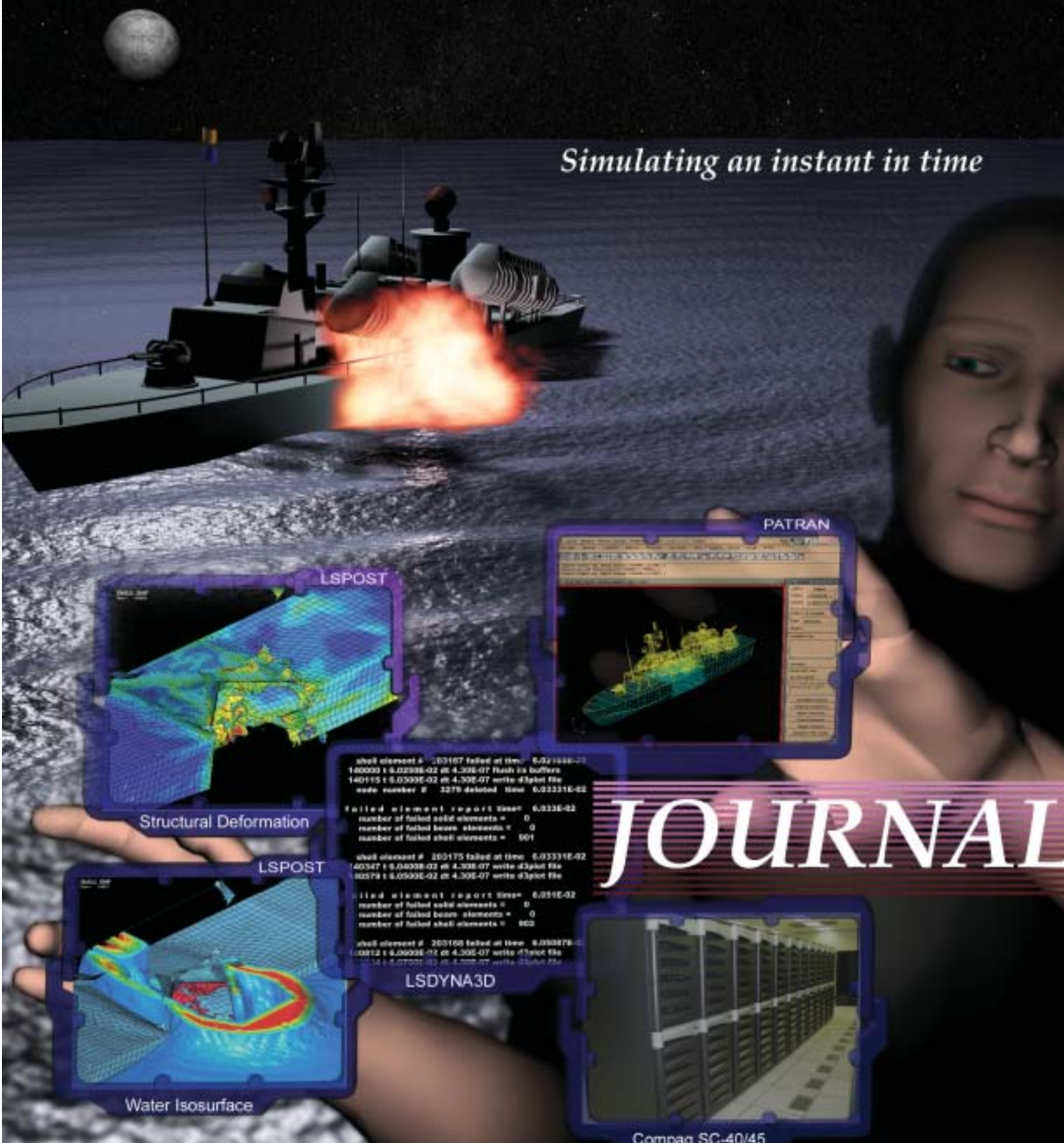


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Simulating an instant in time

PATRAN

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Structural Deformation

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Water Isosurface

LSDYNA3D

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Compaq SC-40/45

Feature

Simulating an Instant in Time

By Ronald L. Hinrichsen



ship are modeled in the Lagrangian domain. This domain is typical of CSM analysis methods where the mesh is allowed to deform and move. The Eulerian and Lagrangian domains are loosely coupled together and information (such as position, pressure, etc.) is exchanged at the interfaces of the two domains.

Figure 1 shows two views of the model meshes, which were used for this simulation. The white mesh is the Lagrangian domain, which consisted of shell elements, while the blue mesh is the Eulerian domain, which consisted of brick elements.

The ASC MSRC provides modeling and simulation (M&S) support to a number of organizations interested in weapon system survivability. This support ranges from providing mentoring and training services for engineers and researchers in the survivability community, to actually performing M&S work on specific weapon and threat systems.

In order to accurately predict how a structure will react to a threat, state of the art software is needed which captures the physics of the encounter. Generally, this means that a coupled Computational Structural Mechanics (CSM)/Computational Fluid Dynamics (CFD) technique must be used. There are CSM/CFD software packages currently used, which capture the necessary physics to simulate these events. In this article, we highlight the capabilities of the LSDYNA3D® code in simulating the detonation of a high explosive charge in close proximity to a surface ship.

In simulating the instant in time when the explosion takes place, the water, explosive charge and air are modeled in a multi-material Eulerian domain. This domain is typical of CFD analysis methods where the mesh is fixed in space and the materials are allowed to flow through the mesh. The structural members of the shell elements, while the blue mesh is the Eulerian

One of the capabilities that was effectively used in this simulation was the assignment of the multi-materials to the Eulerian domain. The feature that was used is called *INITIAL_VOLUME_FRACTURE_GEOMETRY. With this feature, the interfaces between water, air, and explosive were defined by specifying air above a given coordinate plane, air within the ship's hull,

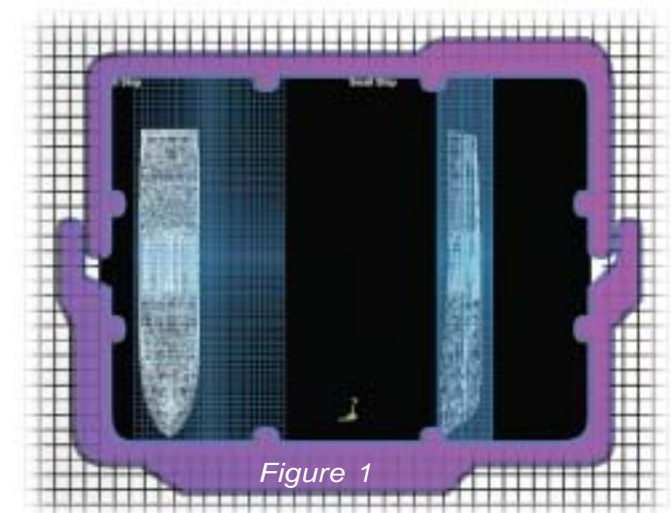


Figure 1

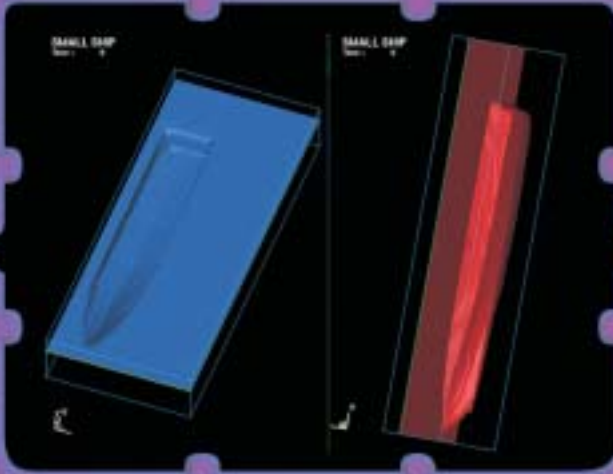


Figure 2

explosive in a sphere located near the ship's hull, and water everywhere else. Figure 2 shows isosurfaces in two views of the Eulerian domain. Everything above the blue isosurface is air. The material is shown in red and below is water and the spherical explosive charge.

At the beginning of the simulation, the spherical explosive was detonated. The high-pressure pulse quickly impacted on the ship's hull, and the hull material failed progressively due to the exceedance of the allowable plastic strain limit.

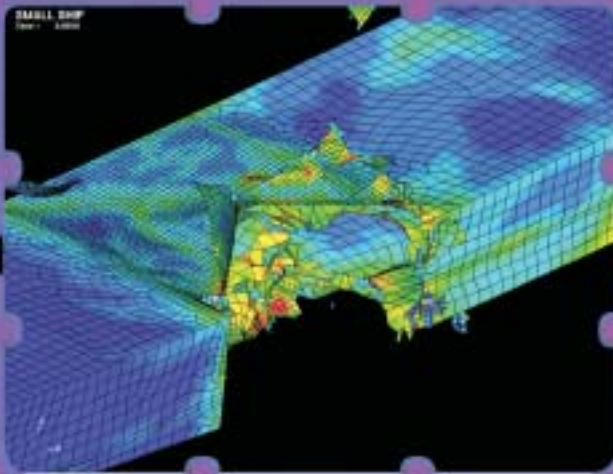


Figure 3

Figure 3 shows a close-up of the ship's hull with color stress contours superimposed on the model. Figure 4 shows a close-up of the water isosurface showing the water entering the ship through the breach in the hull and overflowing the hull surface as the event occurs.

The simulation of this instant in time (actually 81 milliseconds) was performed using four processors on the Compaq SC-40/45 computers at the ASC MSRC. It required 543 hours of CPU time and ran to completion in 191 wall-clock hours.

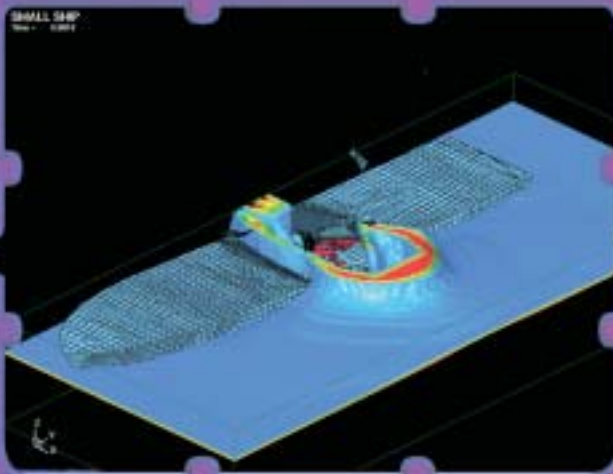


Figure 4

M&S of these types of events is valuable in predicting event-outcomes in advance as well as assisting in test planning. If you are interested in this type of M&S, contact Dr. Ronald L. Hinrichsen at hinrichsen@rhamm.com.