An Arbitrary-Lagrangian-Eulerian Code for Polygonal Mesh: ALE INC(ubator)

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In this work we have developed a 2D unstructured Arbitrary-Lagrangian-Eulerian (ALE) code. This code is devoted to solve computational fluid dynamics (CFD) problems for general polygonal meshes with fixed connectivity. Main components of the method are: (1) a Lagrangian scheme, (2) a Reference Rezone Jacobian Strategy, and (3) a Remapping method. In the Lagrangian scheme each polygon is split into subcells. The compatible Lagrangian hydrodynamics equations are solved during one time step and the mesh is moved according to the fluid velocity (see Refs. 1, 2, 3).

The Reference Rezone Jacobian Strategy improves the quality of the untangled mesh and, at the same time, requires the new mesh to be close to the original untangled grid (from Step 2) and preserves interfaces between materials (see Ref. 4). An Untangling process ensures the validity of the mesh, if the mesh was tangled as a result of the Lagrangian step. The method finds an untangled mesh which is as close as possible to the previous Lagrangian grid (see Refs. 5, 6).

The Remapping method gives the linear and bound preserving remapped hydrodynamics variables on the new mesh (see Refs. 7, 8).

These three steps have been adapted to the subcell description of the scheme and the polygonal meshes. The Untangling and the reference rezone Jacobian processes deal now with general polygonal meshes and preserve the interfaces between materials. The remapping step is performed from a subcell point of view and the accuracy of the remapping stage has been improved with new techniques from [9].

ALE INC. can be used as a purely Lagrangian code (only Step 1 is used), an ALE one (*x* Lagrangian steps are performed then Steps 2, 3 are activated) or as an Eulerian one (Steps 1 and 3 are used and the remapping is done on the same initial grid). Moreover the code can be used in Cartesian or cylindrical coordinates.

Fig. 1 is the simulation of the Guderley problem: a unit disk ($\rho = 1$, $\rho = 0$) at rest is compressed by a cylindrical shock wave. The intial mesh is polygonal (either symmetric or with a false center of convergence, located at (−0.5, 0) as in [1]). Time $t = 0$, $t = 0.6$, $t = 1.0$ are printed showing the cylindrical symmetry preservation with or without an initial symmetric polygonal mesh.

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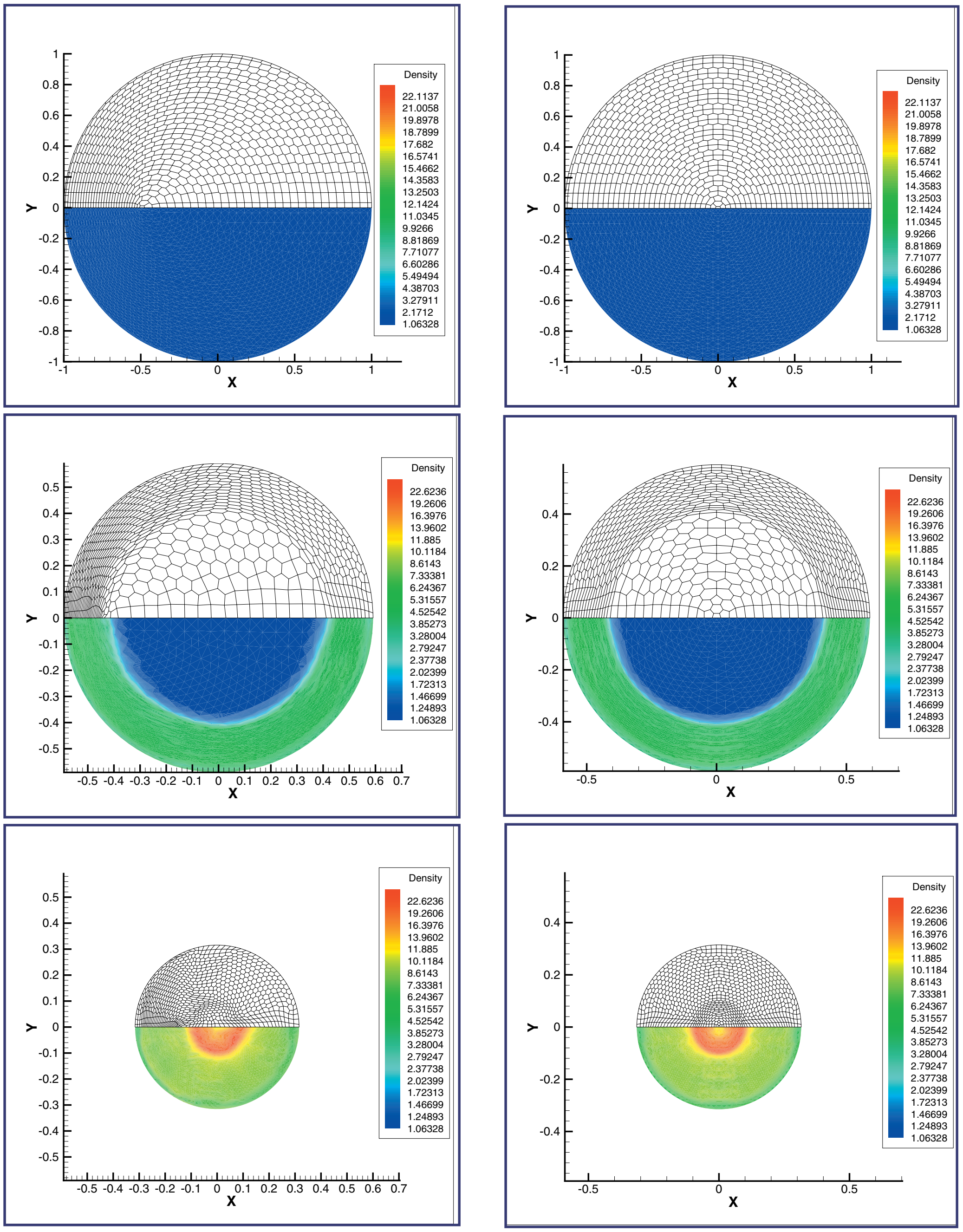

Figure 1—
Guderley problem nonsymmetric (left) and symmetric (right) polygonal mesh—Top: t = 0.0, Middle: t = 0.6, and Bottom: t = 1.0.

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