ENGINEERING DYNAMICS CORPORATION

Name EDSMAC4 (**E**ngineering **D**ynamics **S**imulation **M**odel of **A**utomobile **C**ollisions)

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Description *EDSMAC4* is an *HVE*-compatible simulation analysis of vehicle collisions. Any number of vehicles, trailers, and/or barriers may be included. Based on the SMAC model originally developed by Calspan for NHTSA, *EDSMAC4* includes numerous extensions developed by EDC. The user enters the initial position and velocity for each vehicle in the study. The user may also enter driver controls (steering, throttle and brakes). Using this information, *EDSMAC4* calculates tire, collision and inter-vehicle connection forces at user-specified time intervals. The simulation then calculates the resulting vehicle positions, velocities, accelerations and damage profiles for each timestep. The results may be displayed numerically in a spreadsheet format or visually in 3-D viewers.

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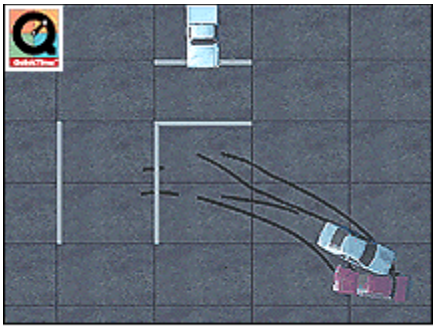

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Researchers may use *EDSMAC4* to predict and visualize how crashes occur. Typically, the user is interested in vehicle initial velocity, velocity change (delta-V, a measure of crash severity) and collision damage. By using *HVE's* 3-D viewers and attaching the "camera" to the driver's position in any vehicle, avoidability studies are inherent to the analysis. *EDSMAC4* also produces a collision pulse that may be loaded directly into any *HVE*-compatible occupant simulation model.

EDSMAC4 has been validated using the RICSAC staged collisions, a set of 12 well-instrumented staged collisions.

EDSMAC4 employs a 2-D, 3 degree of freedom collision model for each vehicle or barrier object. Simultaneous collisions between any number of objects are allowed (examples include a multi-vehicle freeway pile-up, pinning a vehicle between a striking vehicle and a tree, etc.). The original SMAC collision model has also been extended significantly, and now includes A and B stiffnesses for each side, as well as direct support for barrier collisions. *EDSMAC4* also provides a robust model for collisions involving articulated vehicles towing any number of trailers, with or without dollys.

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Tire vs 3-D terrain interaction is modeled transparently to the user, and extends the original SMAC model by calculating quasi-static longitudinal and lateral load transfers, as well as roll, pitch and Z based on the local terrain. This powerful technology, developed by EDC, allows researchers to easily study crashes on irregular surfaces, such as hills, ditches and road crowns. At each timestep, the *EDSMAC4* tire model queries the environment to use the current elevation, surface normal and friction beneath each tire. The trajectory model has also been extended to allow the user to simulate vehicles with tandem axles and dual tires. Tire blow-outs and wheel displacements can also be simulated.

Input Vehicle

- Selectable from *HVE's* built-in databases, according to Type *(Passenger Car, Pickup, Sport-utility, Van, Truck, Trailer, Dolly, Fixed or Moving Barrier),* Make, Model, Year, Body Style
- Tires selectable from *HVE's* built-in databases, according to Type *(Passenger Car, Light Truck, Heavy Truck, Mobile Home),* Manufacturer, Model and Size
- Several Database Sources *(Generic, EDC, User and others),* for both vehicles and tires
- All data are user-editable
- Complete vehicle model specification published in SAE 950308

Environment

- 3-D Terrain Model (from DXF file or several other sources) with user-definable friction zones for tire-road interaction
- Local Gravitational Constant

Event

- 3-D drag-and-drop positioning of vehicles in the environment
- Open-loop driver control tables (steering, braking and throttle)
- Tire Blow-out Parameters (blow-out time and duration, tire stiffness and rolling resistance multipliers)
- Wheel Displacement (Δx, Δy, time, duration)
- Accelerometers (x, y location for up to 5 devices)
- Simulation Controls (integration timesteps, maximum simulation time, output time interval and termination conditions)

Output Variable Output

- Vehicle Kinematics (position, velocity, acceleration vs time)
- Vehicle Kinetics (total forces and moments vs time from tires, collision and inter-vehicle connections)
- Damage Profile Data (force, crush vs time for each damage point)
- Accelerometer Data (velocity, acceleration vs time for each device)
- Tire Data (contact patch coordinates, forces, slip angle, skid status vs time)
- Wheel Data (coordinates, steer and camber angle vs time)
- Collision Pulse (acceleration vs time history for occupant simulation)
- Connection Data (articulation angles, forces)

Trajectory Simulation

- 3-D visualization of vehicle motion and damage profile at user-specified time intervals
- 3-D Damage Profile Viewer

Reports

- Accident History (initial, impact, separation and rest positions and velocities)
- Damage Data (profile, CDC, PDOF, delta-V, peak acceleration)
- Driver Controls (steering, braking and throttle)
- Simulation Controls (numerical integration parameters)
- Vehicle Data (dimensions, inertias, stiffnesses, restitution, inter-vehicle connection and tire properties)
- Messages (event-related diagnostics)