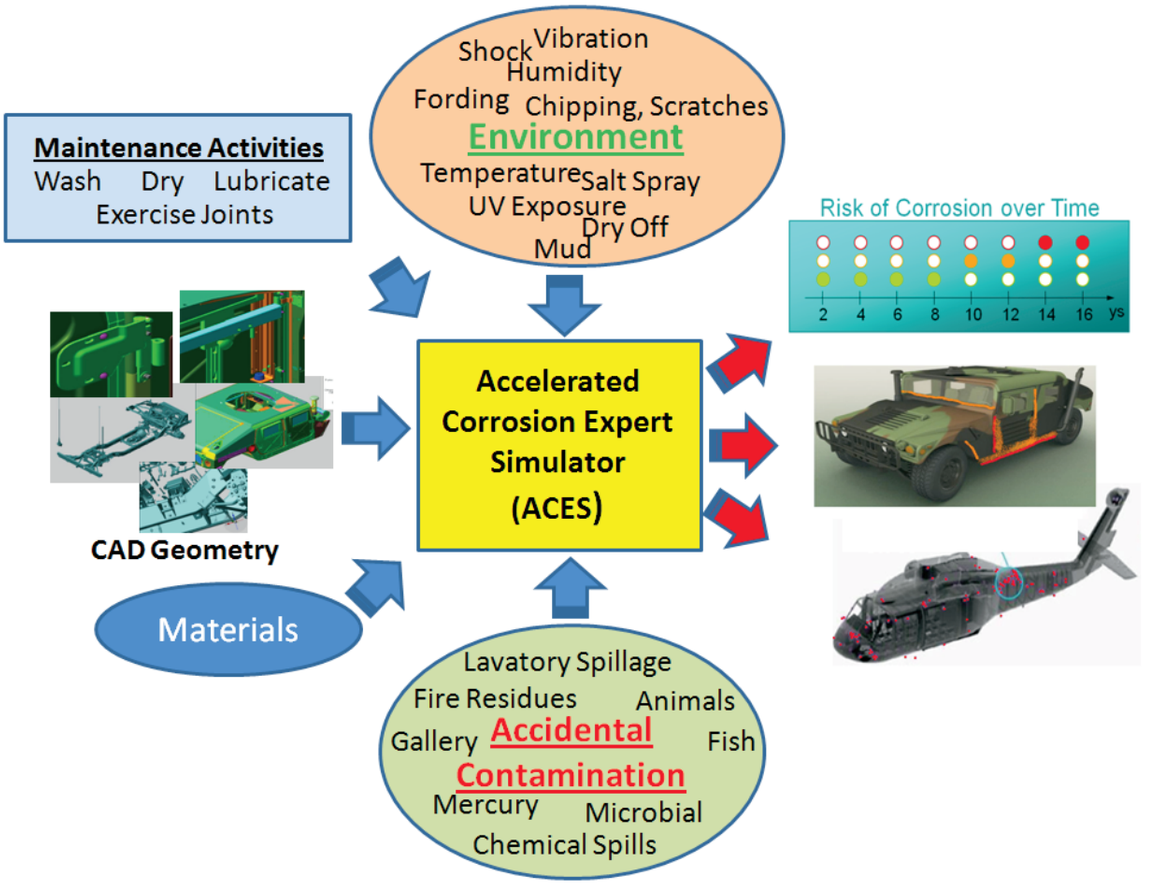
# ACES: Accelerated Corrosion Expert Simulator




The Navy and Army have combined resources to develop a Simulation and Modeling tool for predicting the deterioration of assets such as aircraft and wheeled vehicles due to corrosion. NAVAIR and RDECOM TARDEC are sponsoring the development of ACES for two different application domains. The development under Army sponsorship simulates General (Uniform), Galvanic and Crevice corrosion, which are the primary sources of corrosion on wheeled vehicles. The NAVAIR effort concentrates on modeling Pitting, Exfoliation and Stress Corrosion Cracking which are the leading corrosion problems in aircraft. The result of the combined effort is a prediction tool that addresses the six most dominant forms of corrosion found in most applications.

ACES utilizes imported 3D geometry models of the vehicle. If the models contain missing geometric detail, ACES will report the discrepancy to the user. The future version of the ACES tool includes a robust Knowledge Acquisition Facility that incorporates learning algorithms for semi-automatic updating of the models as new experimental or field data is obtained which fill voids in the corrosion knowledge base by automatically adding information based on its relative importance as determined from corrosion tests and observed hot-spots. The ACES system uses

simulation and prediction algorithms for the breakdown of various coating applications, poultice entrapment areas and the mechanism for corrosion in crevices, etc.

The general concept is that 3-D CAD/CAE geometry, material, coating and auxiliary data, maintenance and operational profiles and environmental data are all provided as input to a combined physics-based, statistical and heuristically reasoning engine running on a GPU[1] parallel processing system to perform time dependent simulation as to the deterioration of the geometry due to coating deterioration and corrosion over time.

The output from the simulator is a relative risk of corrosion over time which is color coded either as a progressive time line for a particular part, component or zone of the vehicle, or as a colorized degradation displayed on the 3-D geometry

The 3-D CAD/CAE geometry is imported into ACES using STEP[2] format along with detail on part materials, coatings and auxiliary data such as the assembly sequence, all of which are typically excluded from the STEP file. An integrity check is then performed on the geometry and supporting data to insure that all the necessary information is present and that there is no missing or inconsistent data, such as non-manifold geometry. It then either adds/modifies the files to accommodate the discrepancy if possible or reports the problem back to the end-user for resolution.

The Geometry Analyzer then uses a separate Rule-Based Production System to determine some geometry related facts such as the anode to cathode area ratio, presence of crevices, poultice entrapment and water collection/ improper drainage areas. Predefined environment, operation and maintenance profiles are available to describe the exposure and usage of the vehicle over time. Alternatively the user can specify custom profiles to use as input to the analysis engine. The assembled working memory containing a global database of “Facts” or evidence such as the environmental and operating profile provided by the user and input geometry is combined with entries from the long-term Knowledge Base of rules, solution methods, corrosion models themselves, relationships as input to the Reasoning Engine.

The Reasoning Module contains an assembly of both physics-based and AI solution engines. AI solution engines include Rule-based production system “Expert Systems”, Bayesian Network Engine, Markov Chaining, Neural Networks, Recursive Methods time-series analysis, Genetic Algorithm methods, Recursive Search Techniques, etc., which can be applied to different models needed to describe the corrosion process.

The ACES output is a detailed report of the deterioration of the vehicle over time as a graphical display of the corrosion of individual assemblies, components, parts or the vehicle as a whole. The ACES Explanation Facility provides accompanying output reports to the user that explains the logic and reasoning used in the prediction.

---

[1] Graphical Processing Unit

[2] "Standard for the Exchange of Product model data".