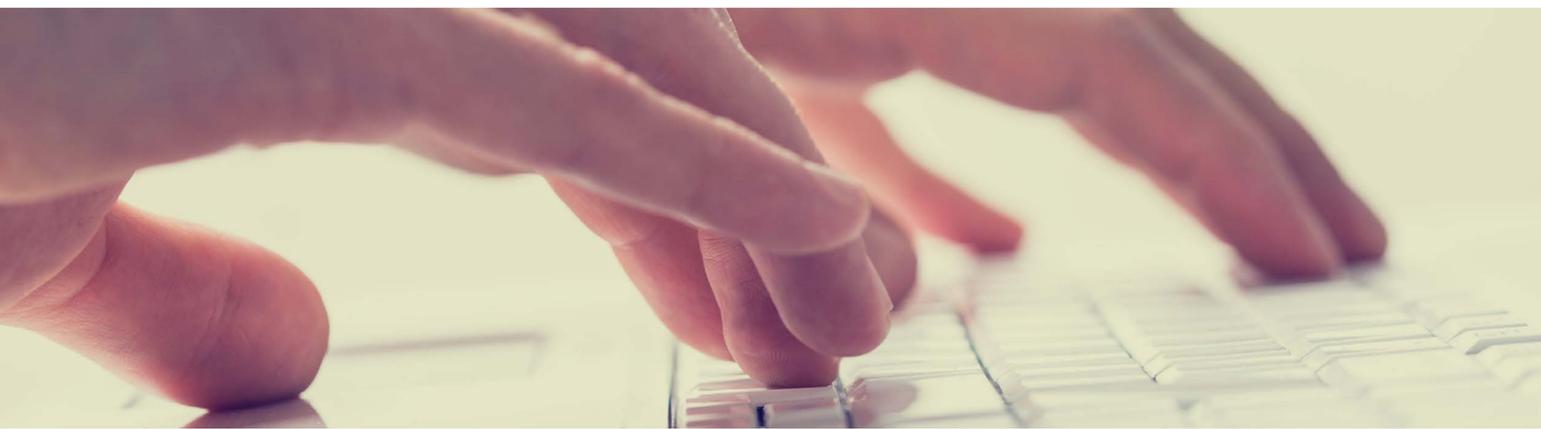


# VFT<sup>®</sup> Virtual Fabrication Technology

MODELING & SIMULATION

Virtual Welding, Fabricate a Superior Product

[www.emc-sq.com](http://www.emc-sq.com)



## What does VFT® provide for the User?

VFT is a computer-based software suite that allows designers to predict potential weld-induced distortion and residual stress states based on a planned fabrication process so that weld design strategies can be implemented to significantly reduce or eliminate these undesirable states prior to fabrication.

## How does a product designer implement VFT®?

The user needs to provide information describing the structure to be welded:

- Structure Geometry
- Weld Type
- Weld Material Properties
- Torch Speed
- Structure Material Properties
- Number of Weld Passes

The solid model developed by the user through standard CAE/CAD packages will have a Finite Element (FE) mesh generated for the simulation. This FE Mesh, along with the properties described above, will be input through the solution process via a graphical user interface (GUI). (Figures A & B illustrate VFT® process flow)

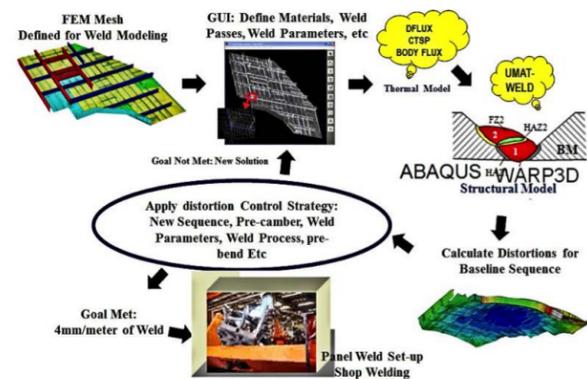


Figure A: VFT computational weld modeling system

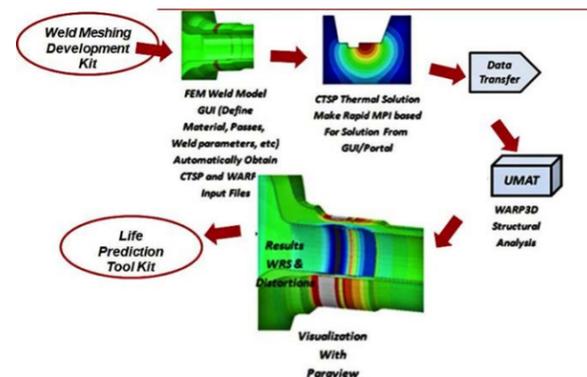


Figure B: VFT/AweSim Plans for SMEs Accessing Portal

## What does the product designer receive from VFT®?

The output from the VFT® analysis includes predicted distortion values (deformations) of the structure and residual stresses due to welding. These results are provided in graphical format (contour and fringe plots) and tabular values at selected locations on the structure. This type of information permits the designer to employ control strategies (e.g. weld sequencing and clamping) to reduce or eliminate distortions and residual stress states induced by welding, which ultimately leads to longer design life for the final product. Furthermore, the weld residual stresses can be used to enhance fatigue and stress corrosion cracking predictions.

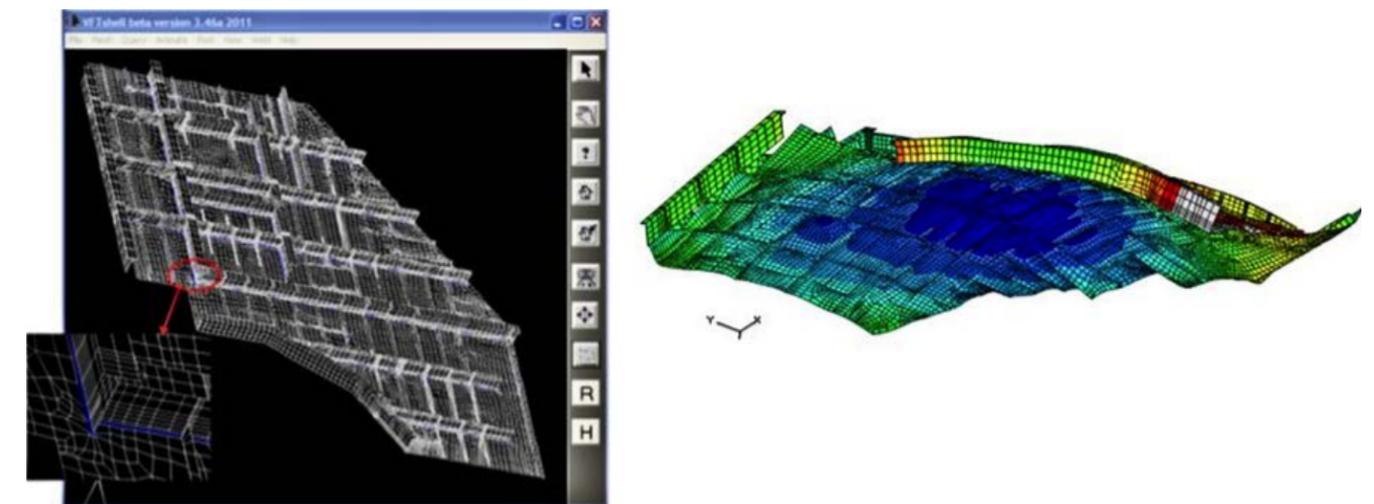
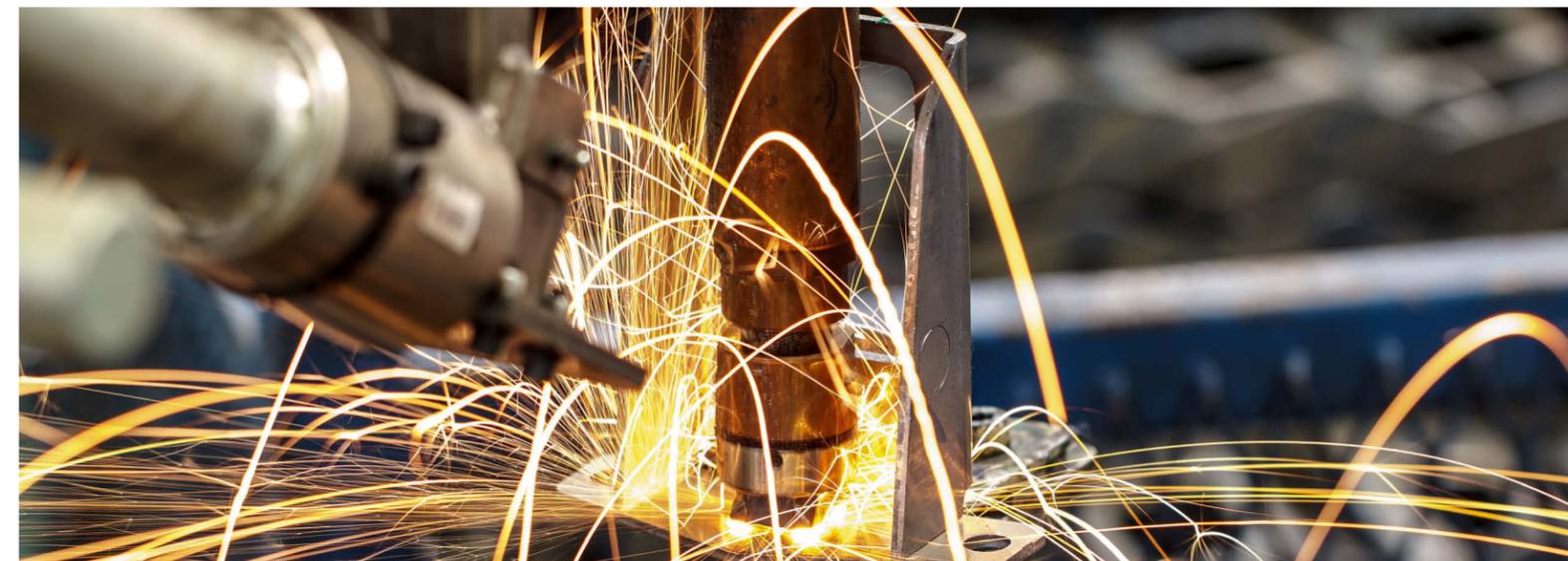


Figure C: Large Panel Structure Model (left), Distortion Due to Welding (right) Prior to Pre-camber Distortion Control Strategy



The main focus of VFT<sup>®</sup> is the use of modeling and simulation methodologies to enhance fabrication processes resulting in improved product performance, better product quality, less maintenance, improved warrantability, and lower cost.

Through a more recent US DOE Small Business Innovative Research (SBIR) program, Engineering Mechanics Corporation of Columbus, (Emc<sup>2</sup>), *has adapted VFT<sup>®</sup> so that small- and medium-size enterprises (SME) can have cost effective access to the tool to improve their products and realize the full benefits of its use.*

Prior to this SBIR effort, VFT<sup>®</sup> had been out of the reach of most SMEs because of the need for high end expensive computational resources and highly trained and experienced staff. Emc<sup>2</sup>'s modifications now provide SMEs with a readily available tool via the high performance computing (HPC) facility at the

Ohio Supercomputer Center (OSC) within the Ohio State University (OSU), which is easy to use and low cost.

At OSC, VFT<sup>®</sup> is found on the AweSim website making it simple for SMEs to seamlessly and securely access all modules of VFT<sup>®</sup>. AweSim is an OSC program to help lower barriers to entry for HPC- based modeling and simulation (M&S) especially for SMEs. It acts as the equivalent HPC version of various 'App Stores' that exist for Smartphone platforms and employ a user-friendly, tailored format for a diverse set of end users at affordable prices. Three main AweSim components have been developed for user access: App Kit for building apps; App Runtime for running apps; and App Store for locating and buying apps (See Figure D). Additionally, a range of training options is offered.

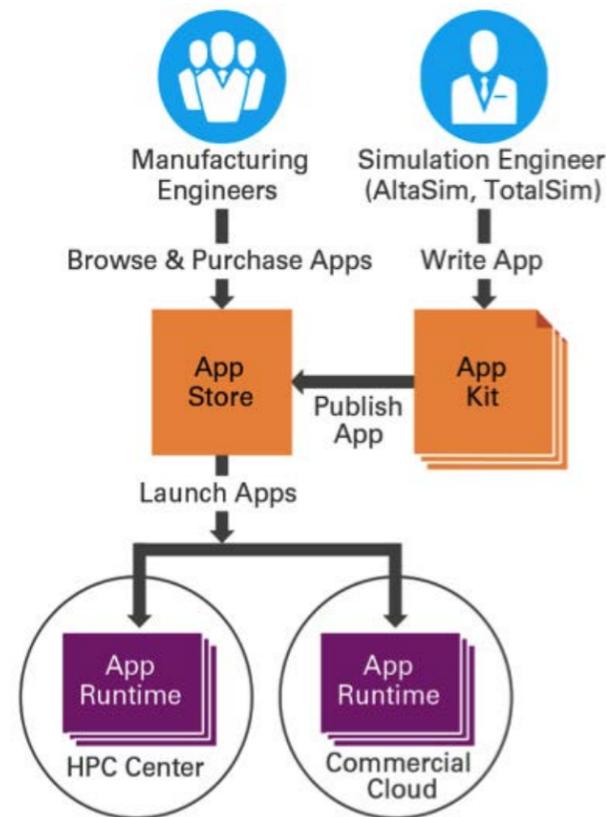
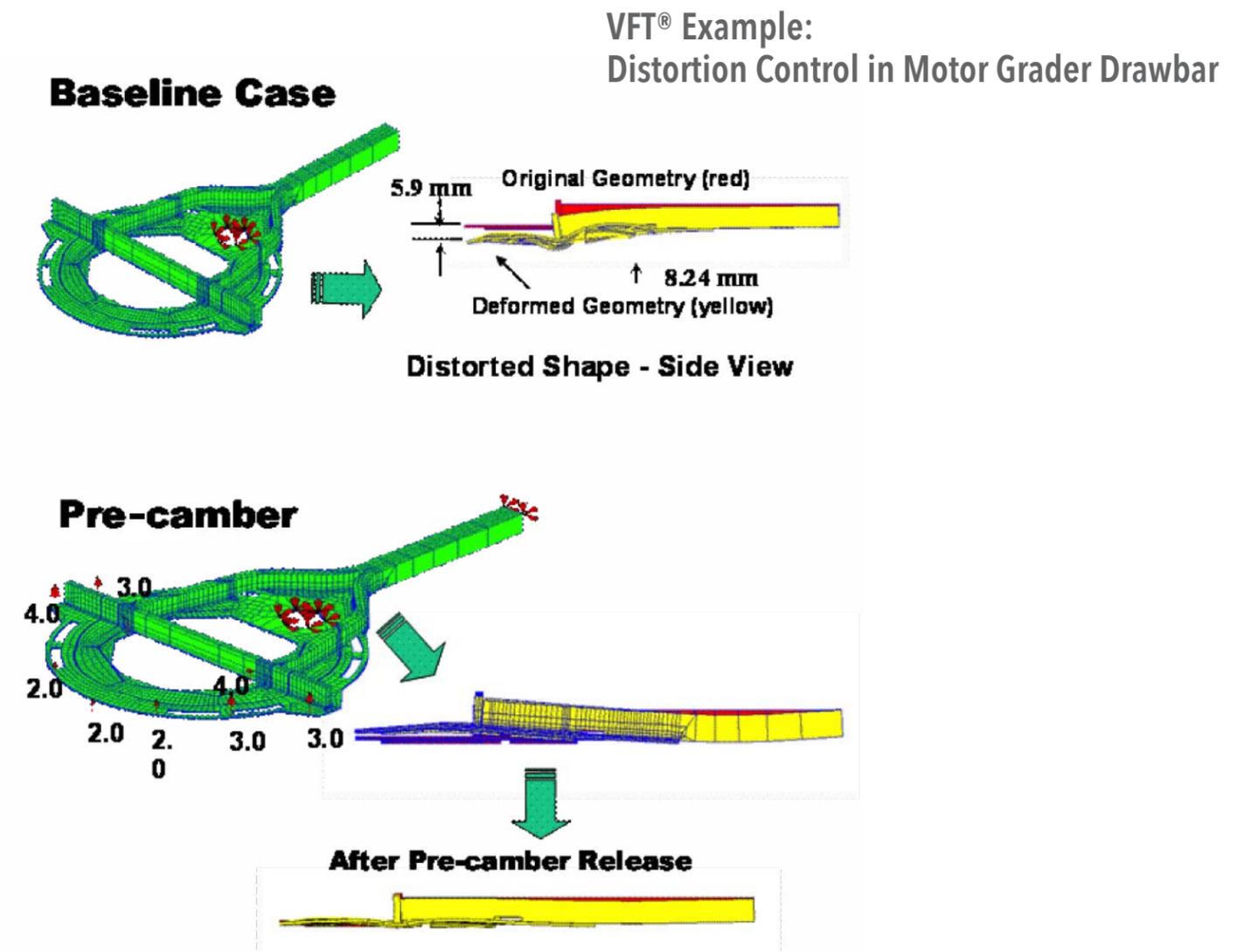


Figure D: App Kit, App Runtime and App Store will support rapid development of inexpensive new apps for end users

## Emc<sup>2</sup>'s VFT<sup>®</sup> Responsibilities

Emc<sup>2</sup> works on a continuing basis to improve VFT<sup>®</sup>. Feedback from code users provides insight for potential code advancements. These suggested enhancements are reviewed on a regular basis and improvements are prioritized and implemented based on time and funding availability. For example, originally the structural part of the weld problem solution was performed solely via a commercial code which has a significant licensing fee per seat. For non-small weld problems, the solution procedure is typically performed using parallel processing, which requires multiple licenses per the parallel solution process. To remedy this situation, a public domain (open source and no fee) solver was implemented as an option for problem solution. Use of the open source solver (WARP3D) has been validated by comparison of results with those obtained using the commercial solver.



## Other Attributes

VFT® is not only useful in reducing/eliminating distortion and residual stress states due to welding processes, but is also used to establish more optimal strategies for weld repairs. For example, in pipe-type structures a defect may only be part way around the circumference, so only a partial repair would be necessary. (Figure E shows examples of repair analyses).

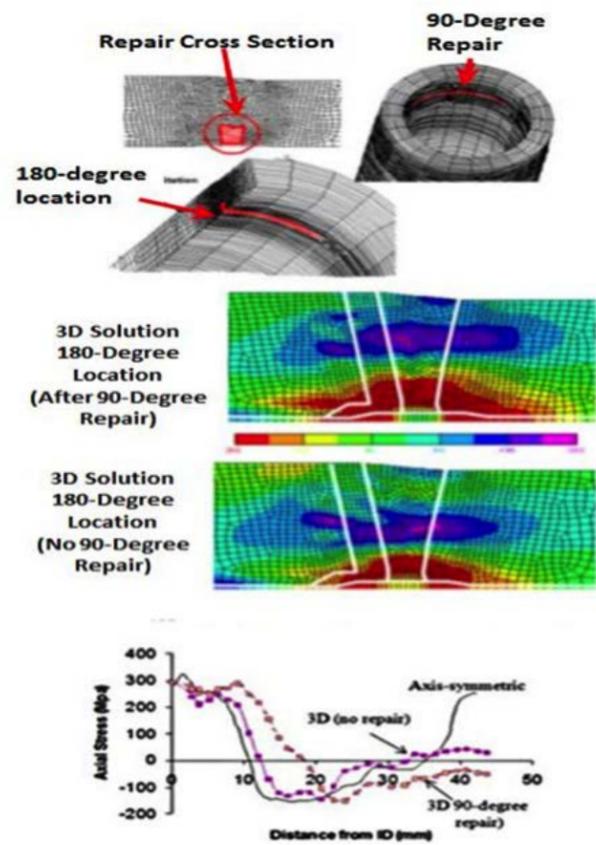


Figure E: 3D Weld Repair

Finally, VFT® is used to analyze and design processes to weld parts together that are of different materials.



## Training and Outreach Activities

Emc<sup>2</sup> and OSC conduct training sessions either physically at OSC or via webinar/podcast as needed for new VFT® users. Staff members from industry organizations attend a presentation to review and understand technical content and determine level of interest in pursuing further training in use of the technology at their workplaces.

Training sessions will be conducted on a regularly scheduled basis depending on results of ongoing outreach activities to enlist SMEs throughout the domestic U.S.



## Company Profile

Founded in 1998 by Dr. Gery Wilkowski, Engineering Mechanics Corporation of Columbus (Emc<sup>2</sup>) is a privately-owned, for-profit, small business that conducts high-tech contract R&D for government clients in the nuclear and defense industries and commercial clients in the aeronautical, aerospace, and oil and gas industries. Originally founded as a high tech company providing unique solutions for pipeline integrity and safety issues using state-of-the art computational engineering analyses and testing for the oil/gas and nuclear power industries, Emc<sup>2</sup> has broadened its scope over the last decade to include innovations and solutions in:

- **Structural integrity of components and systems fabricated from metallic and polymers**
- **Plastic pipe analysis and plastic manufacturing processes**
- **Manufacturing process modeling for welded structures**
- **Probabilistic Mechanics**
- **Risk Analysis**
- **Product Development.**
- **Fluid Mechanics**

Emc<sup>2</sup> is nationally and internationally recognized for developing innovative solutions that replicate "real world" behavior for structural integrity, process modeling, safety assessments and risk analysis of complex engineered systems and structures. Since 1998, Emc<sup>2</sup> has completed over 470 projects for 179 different clients.



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