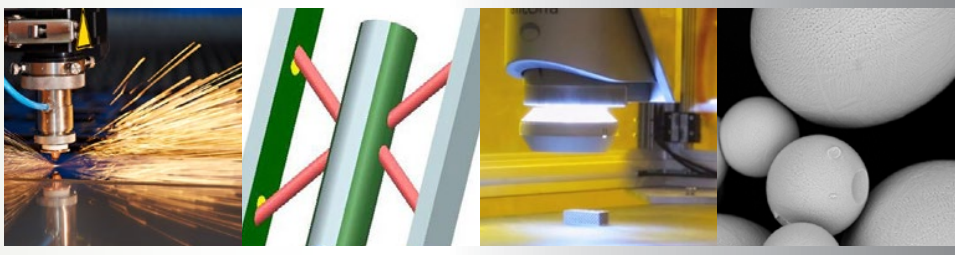
INNOVATING THE FUTURE FOR HEAVY MANUFACTURING INDUSTRIES

THE IMPACT OF ADVANCED MANUFACTURING TECHNOLOGIES

EWI®
We Manufacture Innovation



HEAVY MANUFACTURING NEEDS INNOVATION

In the face of economic challenges, increased global competition, and new regulatory environments, heavy equipment manufacturers must innovate to stay competitive. Focusing on innovation now can help manufacturers create a long-term competitive advantage by positioning their organization to be responsive to new market opportunities, alternative revenue paths, and previously underserved customers.

A successful innovation strategy includes the employment of advanced technologies during product design and manufacturing, investment in R&D for mass customization and remanufacturing, and forging of new relationships with innovation-minded organizations and customers.

Many of the challenges facing heavy equipment manufacturers are universal:

- Increasing customer demand for shorter lead times
- Pressure to reduce the cost and duration of new product development
- Evaluation and prioritization of new innovative technologies

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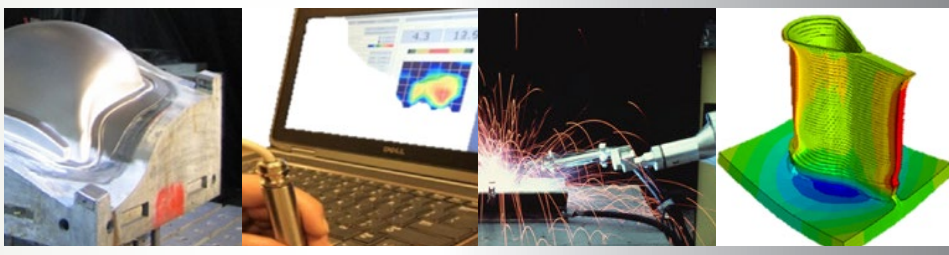
For heavy equipment manufacturers looking to stay competitive well into the future, innovation is the key to success.



TECHNOLOGIES TRANSFORMING MANUFACTURING

Disruptive technologies are the key to meeting customer demands for increased longevity, customization, and performance. These technologies include:

- Simulation and modeling
- Advanced automation
- Additive manufacturing
- Integrated computational materials engineering (ICME)
- Advanced materials and material combinations

To stay competitive, manufacturers must actively invest in R&D across all their manufacturing processes.

- Design methodologies and tools
- Forming processes
- Joining processes
- Process monitoring and control
- Inspection and quality assurance

Of course, every company faces barriers to innovation. Many organizations lack the resources and skilled personnel required to fully embrace and adopt a strategy of innovation. In this case, manufacturers must find the right innovation partner. EWI is a world leader in developing and deploying new, innovative technologies that enable companies to bridge the gap between R&D and manufacturing implementation.

This report provides examples of work across a diverse range of technologies—all in the pursuit of advanced manufacturing innovation.

AUTOMATING REPAIR AND REMANUFACTURING

Economic pressures are increasing the demand for repaired and remanufactured parts and equipment. In many cases, repairing a part may be the most economical option. In other cases, the damaged part may no longer be in production. As customers continue to push service limits and stretch the service lives of heavy equipment, manufacturers are searching for new methods to automate and improve their repair processes.

The challenge:

Automating repair and remanufacturing is difficult as part condition can vary significantly. Nevertheless, customers expect remanufactured parts to cost less and perform equally well.

The solution:

EWI offers a range of services to enable automated repair and remanufacturing, including:

- **Metal additive manufacturing (AM)**
  AM allows for as-needed fabrication of out-of-production parts. EWI's Metal AM solutions enable the fabrication of titanium, nickel, and high-grade stainless-steel parts using laser, electron beam, arc, ultrasonic, thermal/cold spray, and friction stir welding processes.
- **Wear classification**
  One obstacle to automated repair and remanufacturing is the classification of widely varying wear/usage states. EWI's extensive nondestructive evaluation and fitness-for-service expertise supports the creation of automated classification and repair processes.
- **Adaptive welding**
  Adaptive welding can compensate for wear variation to increase overall efficiency without sacrificing quality when repairing or remanufacturing parts. EWI's adaptive welding systems automatically adjust the welding parameters and robot path to compensate for part-to-part variations.
- **Structural Health Monitoring**
  Remote monitoring of structural health can facilitate the timely replacement and repair of damaged parts. Manufacturers can use the collected data to determine when components should be taken out of service, allowing parts with long lead times to be pre-ordered, and enabling maintenance crews to accurately schedule any necessary repairs.

LIGHTER, STRONGER EQUIPMENT

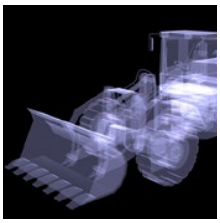
As heavy equipment customers continue to demand increased efficiency and longer service life, manufacturers push to respond with reduced weight, increased power, and lower emissions. The strategic incorporation of lightweight materials into equipment designs can provide a number of significant benefits; however, joining dissimilar materials can prove challenging without sufficient expertise.

The challenge:
Manufacturers are looking to decrease weight while maintaining or extending service limits and service life.

The solution:
A range of processes are available to join dissimilar material combinations.

EWI has extensive experience helping manufacturers develop joining techniques for a wide variety of dissimilar materials. Among the available techniques are arc-based, laser-based, resistance, and solid-state welding processes, as well as brazing and soldering, and adhesive bonding. These processes can be used to:

- Significantly reduce weight
- Create unique multi-material structures
- Tailor-engineer material properties
- Incorporate high-performance materials only where required to reduce cost
- Optimize strength-to-weight ratios
- Enhance corrosion and erosion resistance
- Increase high-temperature strength
- Increase durability



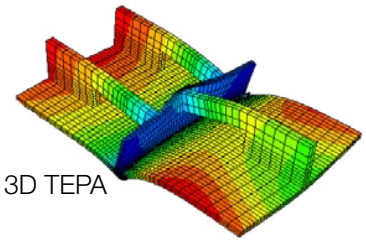
IMPROVED FIRST-TIME QUALITY

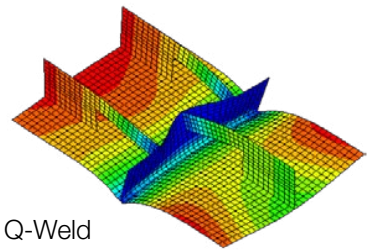
Residual weld stresses often cause distortion in welded components, resulting in:

- Additional fitting and tacking time to join distorted assemblies
- Increased weld time and cost due to poor fit-up
- Poor dimensional control
- Negatively impacted aesthetic appearance of the finished product
- Compromised structural integrity

The challenge:
Manufacturers need methods of efficiently determining the most effective techniques for mitigating and correcting distortion.

The solution:
Prediction software can help manufacturers quickly down-select distortion reduction techniques to improve first-time quality.


3D TEPA


Q-Weld

EWI has developed three finite-element-based distortion-prediction tools:

- WeldFEA: Models welding processes in detail, predicting distortion in small welded structures
- Q-Weld: Predicts distortion for large and complex welded structures
- EWI Weld Predictor: Simulates arc welding procedures for prediction of thermal profile, resulting microstructures, residual stresses, and distortion

In addition, EWI has developed numerous practical processes to control weld distortion including a patented thermal tensioning technique to control buckling of thin steel structural panels.

- By mitigating distortion, an EWI client in the shipbuilding industry reduced its scrap rate from 60% to 0%.
- Cost savings from EWI-developed mitigation techniques are estimated to exceed $21 million over a five-year period, yielding an ROI of more than 10:1.

AUTOMATED PRODUCTION

Manufacturers turn to advanced automation to reduce downtime, improve quality, decrease cycle times, and increase labor productivity.

The challenge:
Varying fit-up tolerances, volumetrically changing weld joints, and complex geometries represent a significant challenge in the automation of many heavy fabrication welds.

The solution:
Adaptive welding can compensate for wear variation to increase overall efficiency without sacrificing quality.

EWI develops custom fully-automated adaptive welding systems. By combining commercially available measurement tools with our algorithms, these systems are able to accommodate joint variations without operator input. After gathering joint measurements, the welding parameters and robot path are adjusted based on a dynamic joint fill plan. For multi-bead welds, this process repeats, allowing continual adjustment based on the updated joint geometry.

NONDESTRUCTIVE TESTING

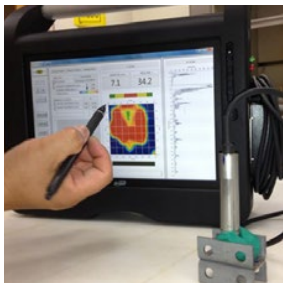
A significant percentage of engineering failures are due to fatigue. Heavy equipment is rarely subjected to constant loads in its lifetime, as factors like varying service and environmental conditions cause loads to fluctuate. These fluctuations can cause cracks to develop in the structure, which can then lead to sudden catastrophic failure. For fabricators of welded equipment that is subjected to cyclic loading, fatigue-life analysis is critical.

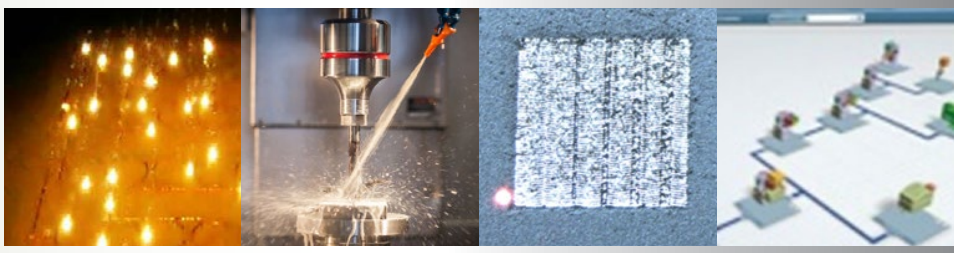
The challenge:
Manufacturers must improve resistance to fatigue failures without reducing performance.

The solution:
Quick, efficient, and accurate nondestructive testing allows manufacturers to assess the structural health of equipment.

One such technology is resonant fatigue testing. EWI designed resonant fatigue testing systems to test the next generation of materials and allow simulation of many years of service in a matter of hours or days. EWI has successfully tested low modulus materials like titanium and aluminum pipe in resonant bending fatigue without the need for expensive modifications to the test equipment or the sample geometry.

Another example is 2D matrix-phased-array ultrasonic testing. EWI used ultrasonic modeling and simulation to design a nondestructive method of examining advanced high-strength steel (AHSS) resistance spot welds. The technology greatly minimizes the difficulty of inspection and increases the reliability of the results.





INNOVATION FOR THE FUTURE

Manufacturers who invest in innovative and disruptive technologies position themselves to stay ahead of the game and remain competitive in the future. The right innovation partner can accelerate this process and ensure the most effective investment of capital resources through well-informed process selection.

EWI has a history of developing and deploying innovative technology solutions to give manufacturers a competitive edge. By providing leading-edge engineering support, applied research, and strategic services, we serve as an extension of our customers' innovation, engineering, and manufacturing teams.

To learn more about your membership benefits, contact Aaron Haines at **614.688.5146** or **ahaines@ewi.org**.

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