PhoenixDfR™ guiding designers to make more informed decisions about remanufacturability

Brian Hilton, Scott Nichols, Frank Zelinger, Michael Thurston, Golisano Institute for Sustainability, Rochester Institute of Technology
Corresponding Author: Brian Hilton, Brian.Hilton@rit.edu; 585-475-5379
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In an era marked by unsustainable consumption and waste, the traditional linear economy—where products are created, used, and then discarded—exemplifies resource inefficiency. The urgency to transition to a circular economy has never been more critical. Remanufacturing, a vital component of this new paradigm, offers a sustainable solution by restoring discarded products to their original performance. However, the potential of remanufacturing is often constrained by initial product designs that hinder the efficiency of remanufacturing processes.

Design for Remanufacturing (DfRem) has long been recognized as a solution. Our team utilized Failure Modes and Effects Analysis (FMEA) to identify potential design features that inhibit remanufacturing. FMEA helps identify issues that reduce product life, cause failures, or make products difficult or uneconomical to remanufacture. These failure modes were collected through direct observations, expert discussions, industry surveys, and comprehensive literature reviews.

The FMEA method prioritizes failure mode risks based on severity, occurrence, and detectability, allowing designers to address critical issues early in the design process. The Risk Priority Number (RPN) derived from these factors helps prioritize failure modes, focusing on those posing the greatest risk. By addressing these failure modes, organizations can enhance product quality and reliability from the design phase onward.

Reliability-Centered Maintenance (RCM) extends FMEA insights into a broader maintenance framework. While FMEA identifies and prioritizes failure modes, RCM focuses on preserving system functionality over time. It uses detailed failure mode data to develop targeted maintenance strategies. By examining the functions of a part, potential failures, and their consequences, RCM determines the most effective maintenance tasks. This process was expanded to not only look at maintenance strategies, but also include restoration and repair strategies for remanufacturing.

The results of the DfRem FMEA and RCM analysis were integrated into a software tool called PhoenixDfR™. This tool employs hierarchical logic inspired by RCM to link design rule mitigations to specific failure modes and calculate the benefits of implementing these rules. PhoenixDfR™ also provides a high-level assessment of the economic and environmental impacts of design choices, identifies features that hinder or facilitate remanufacturing, and integrates with leading CAD packages for rapid adoption. By calculating a Reman Index, PhoenixDfR™ guides designers in making informed decisions about remanufacturability.

Embracing this holistic and forward-thinking approach brings us closer to a future where products are not just designed to be discarded but designed to endure, sustain value, conserve resources, and embody the principles of the circular economy.