

Remanufacturing is a key circular business strategy that has high potential to extend product lifecycle and reduce waste. Remanufacturing refers to the process of restoring used durable product to “like new” specifications to be used in original intended function by replacing worn or failed parts¹. Remanufacturing is a distinct process in the circular economy and waste reduction strategies and can offer numerous advantages for manufacturers which will be discussed in a two-part series within the Better Buildings, Better Plants - Waste Reduction Network Newsletter. In Part I, the focus is on what constitutes remanufacturing along with generic steps in a remanufacturing operation. Part II will focus on remanufacturing implementation, key benefits, drivers, and barriers for the manufacturers.

Remanufacturing as part of circular economy initiatives should be distinguished from other waste reduction strategies such as – repair, recondition, and reuse strategies. Table 1 details concise definitions of each term with examples. Remanufacturing strategy is more intensive than repairing and reconditioning and does require higher effort as illustrated in Figure 1². It also involves restoring the product to at least the original or better specifications and usually provides a similar warranty certification from the manufacturer.

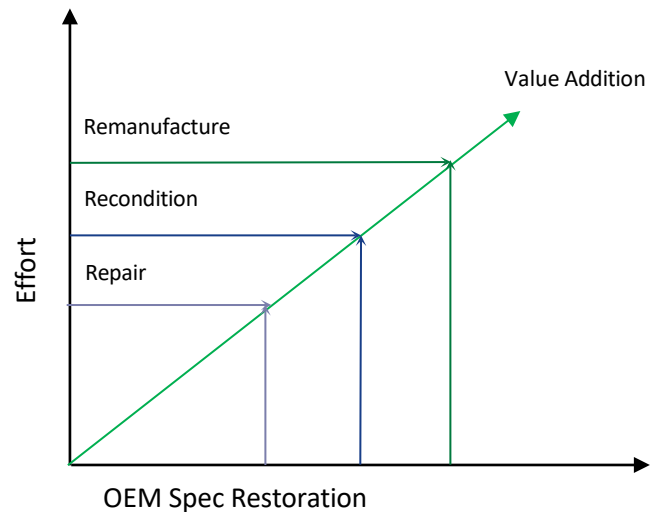


Figure 1: Remanufacturing effort and value addition

Table 1: Distinguishing remanufacturing from other circular economy alternatives

| Strategy | Definition | Example |
|----------------------|--|--|
| Repair | Failed components are restored/replaced to return to original functionality in use phase | Many appliance vendors offer repairing services |
| Recondition | Overhaul/maintenance of the original equipment to regain lost efficiency (usually less than OEM), with less than original warranty | Regular used machine is overhauled by maintenance, aesthetic restoration |
| Remanufacture | Recovering old products to diagnose wear and tear and restore at least OEM functionality, efficiency, and aesthetics with warranty | Remanufacturing of car alternator |
| Refurbish | Replacing defective parts in an assembly to restore functionality | Lightly used / returned laptops are sold at discount after refurbishing by manufacturers |

¹ EPA Archives, “Reuse : Solid Waste in New England.” <https://archive.epa.gov/region1/assistance/web/html/def.html> (accessed Aug. 19, 2023).

² M. Matsumoto. and W. Ijomah Dr., “Remanufacturing,” in Handbook of Sustainable Engineering, J. Kauffman and K.-M. Lee, Eds., Dordrecht: Springer Netherlands, 2013, pp. 389–408. doi: 10.1007/978-1-4020-8939-8_93.

A generic remanufacturing process, as illustrated in Figure 2 involves recovery, fault inspection, reconditioning, and final quality testing. Cleaning and sanitizing components combined with partial repair and replacement of few worn components – as necessary – is provided³. The product is resold with quality and specifications recertified as a new product. It contributes to the circular economy by extending the lifetime of products.

Remanufacturing has been successfully practiced across manufacturing industries such as – furniture, textile products, transportation equipment, electrical equipment, computer equipment, household appliances, etc. Remanufacturing as a strategy is easily adoptable in the case of products that are assembled and use core sub-components that are non-consumable. The remanufacturing process may have a waste stream, but waste produced is significantly lower as compared to manufacturing new product from raw materials. The waste reduction can be as high as 60 to 98% depending on the remanufactured components. This can achieve significant improvement in material efficiency. The material efficiency can produce sizeable impact on the site and life-cycle energy requirements and greenhouse gas emissions. For more information on this topic, review the referenced resources.^{4 5}

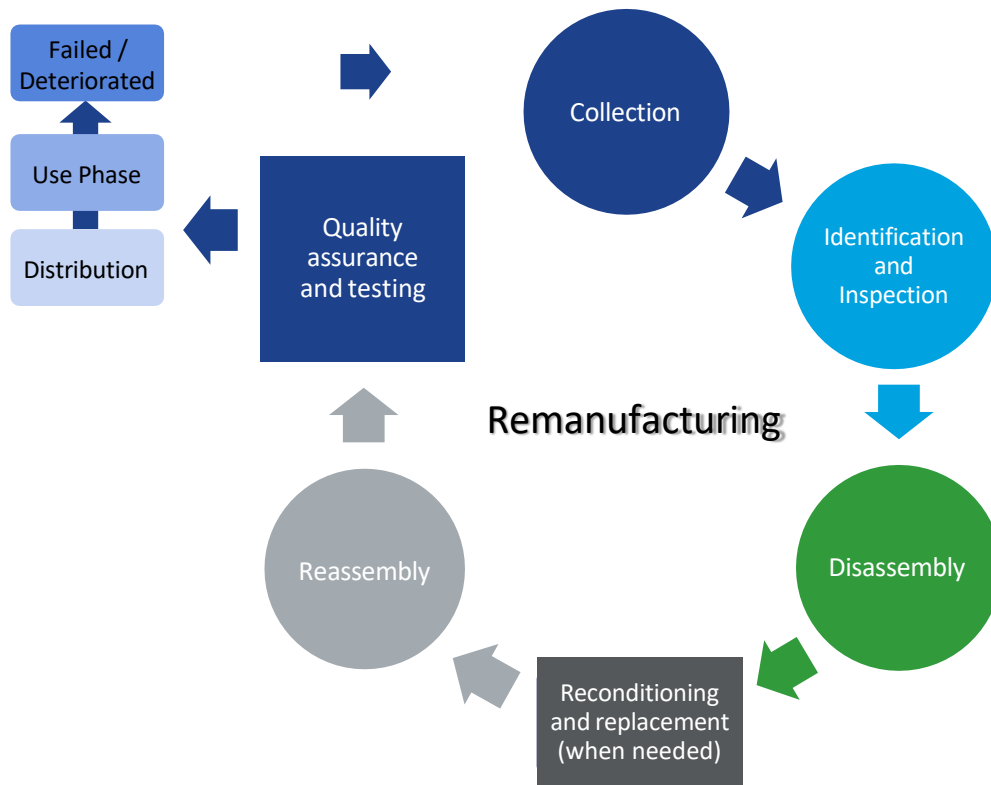


Figure 2: Typical steps involved in a remanufacturing operation.

³ S. A. Chaudhari, S. U. Nimbalkar, B. Lung, M. Gonzalez, B. Hill, and B. Esch, “Key Strategies In Industry For Circular Economy : Analysis Of Remanufacturing And Beneficial Reuse,” in Proceedings of REMADE Circular Economy Tech Summit and Conference, Washington, DC: Wiley Scrivener Publishing, Mar. 2023.

⁴ V. M. Smith and G. A. Keoleian, “The Value of Remanufactured Engines: Life-Cycle Environmental and Economic Perspectives,” *Journal of Industrial Ecology*, vol. 8, no. 1–2, pp. 193–221, Feb. 2008, doi: 10.1162/1088198041269463.

⁵ Golisano Institute for Sustainability (GIS) at Rochester Institute of Technology, “What is Remanufacturing?,” Apr. 2020. <https://www.rit.edu/sustainabilityinstitute/blog/what-remanufacturing> (accessed Aug. 19, 2023).