

An Exploration of Designing E-Remanufacturing Course

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1. INTRODUCTION

Nowadays, it would be difficult to find an industry sector in which the management of environmental sustainability is not of significant relevance. Remanufacturing, as a viable solution to achieve the goal of sustainable development, is therefore receiving more and more attention in industry circles and academic community as well around the world. However, it is unfortunate that engineering and cognate areas of education in many countries (e.g., South Africa) have, to some extent, ignored these vital issues. So it is essential that all facets of engineering education should take action on remanufacturing and its related environmental sustainability concerns.

Apart from the broader societal changes, technical advances have also been an important driving force for engineering education reform programs. Therefore, the new computational and simulation tool, i.e., NetLogo (Wilensky, 2009) will be invited to the present this course as part of practical work. We hope that an approach of learning-by-doing would be achieved and we are certain that, once engaged in using this approach, they will enjoy its benefits.

The remainder of this article is organized as follows. Subsequent to the introduction in Section 1, the background of remanufacturing is briefed in Section 2. Then, a description of our research motivations are outlined in Section 3 which is followed a detailed e-remanufacturing course design given in Section 4. Next, the role of NetLogo in our course and an assignment example is discussed in Section 5 and 6 respectively. Meanwhile, the future research directions in the context of offshore remanufacturing are also provided in Section 7. Finally, the conclusion drawn in Section 8 closes this article.

2. BACKGROUND

Remanufacturing is an attractive business option involving value recovery and the reuse of used products. In the process of remanufacturing, the used products (returns) are collected from the disposer market and then they are transported to the remanufacturing plant where they are disassembled to the level of parts and components. The parts/components are thoroughly inspected, defective and worn out parts are repaired or replaced by new ones and then they are reassembled to build up the remanufactured product, which is supposed to be “as-good-as-new.” Technological upgrading of some parts or modules is also possible during the remanufacturing process. A wide range of products are being remanufactured world-wide such as automotive parts, tires, machine tools, photocopiers, cellular phones and computers.

Currently there is no single standard definition of remanufacturing existing in the literature and we have listed some of them as follows:

Definition 1: “Remanufacturing is an industrial process whereby used products referred to as cores are restored to useful life. During this process, the core passes through a number of remanufacturing operations, e.g. inspection, disassembly, component reprocessing, reassembly, and testing to ensure it meets the desired product standards. This could sometimes mean that the cores need to be upgraded and modernized according to the customer requirements (Östlin, Sundin, & Björkman, 2008).”

Definition 2: “Remanufacturing is an end-of-life strategy that reduces the use of raw materials and saves energy while preserving the value added during

the design and manufacturing processes (Zwolinski, Lopez-Ontiveros, & Brissaud, 2006)."

Definition 3: "Remanufacturing can be seen then as an advantageous product recovery option. Not only is it the case, as it is with other options e.g. recycling, that less waste must be landfilled and less virgin material consumed in manufacturing but also the value added in the manufacturing of the components is also "recovered." It also saves the energy needed to transform and sort the material in recycling products (Langella, 2007)."

Definition 4: "Remanufacturing is the ultimate form of recycling. It conserves not only the raw material content but also much of the value added during the processes required to manufacture new products (Giuntini & Gaudette, 2003)."

Definition 5: "Remanufacturing is particularly well suited for end-of-life products that include components characterized by long technology cycles and low technological obsolescence, and when ex ante uncertainty regarding usage intensity results in "over-engineering for certain user groups in order to meet the needs of other user groups" (Toffel, 2004)."

3. MOTIVATION FOR COURSE DEVELOPMENT

Remanufacturing, as an environmentally benign alternative, is experiencing a rapid development during the past decades. An overview of remanufacturing industry is given below on a world-wide scale. There are many reasons for us to develop this course. Here we have briefly classified them into the following aspects.

3.1. The Industry Practice of Remanufacturing

At a global level, there are various companies engaged in remanufacturing activities. The following examples will enable you to have a rapid overview of worldwide remanufacturing markets.

- **Xerox:** Xerox (Ahn, 2009; Berko-Boateng, Azar, Jong, & Yander, 1993; Guide, Jayaraman, Srivastava, & Benton, 2000; Kerr, 1999; Majumder, 2001; Majumder & Groenevelt, 2001), one of the world's leading manufacturing of office equipment offered products and services for printing, publishing, copying, storing and sharing documents. Business started off with Xerox renting its products to customers. However, business soon moved on to leasing the products, particularly, in order to maintain competitive advantage in the market place, Xerox provided services contracts to repair or remanufacturing consumables.
- **Volvo Group:** The Volvo group (Mähl & Östlin, 2006; Sandvall & Stelin, 2006) is the global manufacturer of trucks, buses, construction equipment, marine and industrial engines. In 1850, the Flen plant started to manufacture harvest machines and nearly 100 years later, in 1960, the production was replaced by the remanufacturing of automotive and marine engines.

3.2. Academic Practice of Remanufacturing

- **Journal of Remanufacturing:** From the summer 2010, a new periodical, Journal of Remanufacturing will begin to be published by Springer-Verlag. The journal focuses on establishing an intellectual foundation and direction for the longer-term development of remanufacturing research, remanufacturing knowledge via holistic, interdisciplinary research that fuses academic and industrial expertise.
- **ReMaTecNews (ReMaTecNews, 2013):** As the only international news magazine dedicated to automotive and heavy duty remanufacturing worldwide, the ReMaTecNews is an independent channel for news, views and developments within the remanufacturing industry.

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