

REMANUFACTURING UPGRADE FOR GREEN MAINTENANCE

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Abstract: With the rapid development of new technologies, products life is shorter and shorter, which leads to more new product manufacturing and more used product retiring, this brings great threat to social sustainable development strategy because of resource shortage and environment pollution. Green maintenance reduce resource consume and waste let during repair process to some extent, but it couldn't change the condition of short life product retiring because of technology renovation. However adopting remanufacture upgrade in green maintenance, the performance or function of product can be upgraded, then realize the additional value restore and products prolong life. This paper describes remanufacturing upgrade's status and significance during green maintenance, and analyzes the related content and cases of remanufacturing upgrade.

Keywords: remanufacturing upgrade; green maintenance; sustainable development

1. Introduction

With the rapid development of technologies in many industries and the enhancement of people's ecological consciousness, more and more products are facing the challenge of retiring from service market before achieving its designed life because of inefficient and obsolete performance and function or poor ecological ability, especially in the electronics and electrical productions, thus an vast waste in resource and energy is causing. Lots of company have realized this important question presently, and make efforts on prolonging the technology life of product. In this condition, remanufacturing upgrade has been chosen as a key method to extend life during product green maintenance.

2. Remanufacturing Upgrade and Green Maintenance

At present, Remanufacturing, which is regarded as an optimum option at the end-of-life product and as a major technological method for supporting sustainable development strategy, has been rapidly expanded in the world, and has made the prominent progresses in economy and ecology^[1]. As an essential content in total life of product, remanufacturing plays a vital role during every stage of product. Remanufacturing process is consisted of restore and upgrade after worn products have been disassembled^[2].

Green maintenance is a modern maintenance mode of synthetically considering resource using efficiency and environment impact, which require realizing the sustainable target of minimum environment negative affect and maximal resource using rate during repair process. The application of remanufacturing upgrade during product green maintenance will possess obvious resource and environment benefit by enhancing product performance to prolong its technology life, which chime in with green maintenance doctrine and is an emphasis part of green

maintenance.

Remanufacturing upgrade in green maintenance mainly refers to apply advanced technologies, new material, new technique, such as surface technologies, electronic information, ecological technologies and so on, and adopt the methods of replacement of module, reconstruction of framework, optimization of performance, then realize to upgrade the quality or function of product, so satisfy customer the higher requirements. In short, remanufacturing upgrade is paid more attention because of improving the performance/functions of products. So it is clear that the performance, function, ecology of products will also be improved by adopting remanufacturing upgrade, and the life of products can be prolonged. Therefore, remanufacturing upgrade in green maintenance process will become crucial to ensure that product could exert all its potential in economic and ecological benefits.

Remanufacturing upgrade is an important part of green maintenance, and has an obvious difference with traditional maintenance. Repair usually means the process of restoring any faults (broken parts etc.) of the product to the required state in order to return the product to working order, but any operations on unbroken parts are excluded, so the quality of repaired products is inferior to original one. However upgraded products may improve whole or part quality or function of original product, and general performance is superior to the original one, even to or over the up-to-date level of product. So it is clear that upgraded products have more competitive in market.

3. Significance and Application of Remanufacturing Upgrade

Using Remanufacturing upgrade frequently in green maintenance of product is accorded with the philosophical idea that product itself develops. Based on traditional idea, product, which is designed and

produced according to the requirement of produce or society under certain situation, is static object, so it just become to performance fall for some reasons such as abrasion, erosion and so on, emerging downgrading application of static product. However, with the development of new technologies, new approaches and new idea (for example ecological consciousness), people come to know the nature more and more, so the people need that product also should tend to be dynamic increasing, finally this leads to a conflict between product static downgrading using and people's dynamic upgrade requirement. At present, in order to solve the product interior conflict, the new model products are produced continually and replace obsolete one, and this situation leads to a phenomena that some new products in their inventory stage have been washed out the market because of technological reason, which brings lots of waste of resources and costs. Regarded as a objective extensive of produced and applied by people, the static situation of product is not fit to the opinion of matter general development, so the Remanufacturing upgrade's development and application in the obsolete product make the upgraded product to be better one in function or performance than old one. Remanufacturing upgrade can effectively solve the intrinsic contradiction of product development, so develop the product from static downgrade using to dynamic upgrade application, then realize the sustainable development of product^[3]. Remanufacturing upgrade is an efficient method to realize sustainable development of product, also is important approach to prolong the life cycle of product, which takes a non-substitutable position in the total life cycle.

Remanufacturing upgrade application in repairing process could cause vast economic and ecological benefits, which would save the added valued (such as energy, resource and material etc.) of product, prolong the technological life of product, and release the ecological pressure of retired product, then satisfy the life need by the more economical and ecological product obtained by and Remanufacturing upgrade is paid more attention because of improving the performance/functions of products. So it is clear that the performance, function, ecology of products will also be improved by adopting remanufacturing upgrade, and the life of products can be prolonged. Therefore, remanufacturing upgrade in green maintenance process will become crucial to ensure that product could exert all its potential in economic and ecological benefits.

Remanufacturing upgrade has been developed widely in the world during green maintenance, and now its primary subjects of applied it are military equipments, test apparatus, electronic machines etc. The upgrade program was initially conceived in the late 1980s when Defense budgets of United States were large. The application of Remanufacturing upgrade in America military equipments has primarily

enhanced the performance of obsolete equipments and extended its service life. For example, the B-52H bomber was designed from 1948, and produced from 1961 to 1962, but they have been technically upgraded two times in 1980 and in 1996, so their complete function have been enhanced apparently by that. It is evaluated in 1997 that there is still an average life of 13,000 fly hours, and retired time is expected to be in 2030^[4].

Remanufacturing upgrade has been widely researched in china. Professor Luo Yun took upgrade repair as a basis method except restoring repair and in advanced repair, and then believed that it would play a critical role in 21st century^[5]. Today, upgrade program has been developed in many fields, such as testing instrument, electronic equipment etc. For example, atomic absorption spectrum instrument (AASI) regarded as major instrument of element analysis is broadly used in china, and play an important role. AASIs, which were imported in early time, are old and have a high rate of failure in data disposal because of long time service. So they could not meet the requirements of data analysis and testing at present, but the cost of purchasing new one is expensive. Jiangsu Province Cooperation and Maintenance Center for Large-Scale Instrument upgraded an AASI, which was made by Japan and imported in 1979. The main method of upgrade was to replace the data disposing and recording part by advanced computer control technology, so the upgraded instrument has been improved in analysis precise, analysis speed and automatic level. This kind remanufacturing upgrade method can be used to all kinds of AASI that were made in the early 80's of 20th^[6].

4. Remanufacturing Upgrade Methods

4.1 Contents of Remanufacturing Upgrade

The objects of being upgraded are obsolete products with a stable framework, and the activity of upgrade will face more restriction, so upgrade needs more advanced technologies. Generally speaking, REMANUFACTURING UPGRADE are described to upgrade the performance or function by adopting new material, new technologies and new processing, and the contents of REMANUFACTURING UPGRADE are as follows:

- Enhanced restore method which characterizes to repair the failed part by advanced surface engineering technologies, mainly used to improve the surface or mechanics performance so that the life of product is extended.

- Module replacement method which characterizes to replace the old module by latest one, mainly used to add special function or improve reliability and ecologicability so that the application of product is optimized.

- Reform improve method which characterizes to add new module by reforming part makeup of product, mainly used to add new function, correct the

failure of product and promote reliability so that the product can suit the new service situation.

Generally speaking, the original product manufacturers own the information of original product and latest product, therefore they have a special advantage in upgrade program and should designed the remanufacturing upgrade process of obsolete product, and indicate some repair units which have necessary situation to finish it following the designed processing. In upgrade movement, there are two ways, one is to upgrade one product in one time, another is to upgrade bath products in one time, It is clear that batch products upgrade movement will have higher economy and reliability of product.

4.2 Process

When the failed and obsolete products have been taken back to the factory or maintain position, it will undergo the following process of upgrade (figure 1).

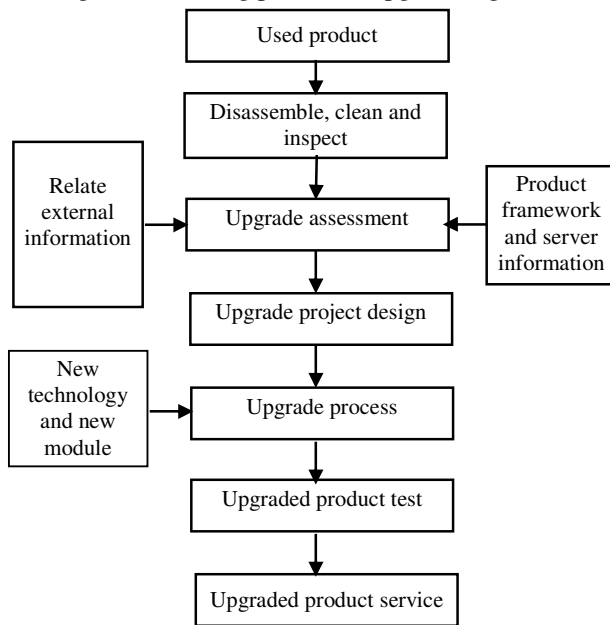


Fig.1 Used product remanufacturing upgrade process

- Necessarily disassembling, then diagnosing and failure analysis,
- On the basis of information of new technologies, new product, service situation and failure model, assessing the upgradeability of product, determining whether the product could be upgraded,
- Identifying the detail plan of upgrade process,
- Executing the upgrade procedure, which involve disassembly, cleaning, replacement/refurbishment/reconstruction, assembly, and so on,
- Testing of upgraded product, then packing the upgraded product
- Distributing the upgraded product, and returning it to market for service.

Upgrading repair, which improves the performance and function of product, is more difficult than restoring one, which restores the function of product, and sometimes even is more difficult than the

manufacture because its processing object is a fixable product. Therefore, remanufacturing upgrade in the repairing process, which is a important method in advanced maintenance, has gigantic profit, at same time, also face more challenges.

4.3 Influence Factors

Remanufacturing upgrade activity in repairing processing regarded as an important part of product total life interacts with other stage, especially in design stage. If the upgradeability is considered in design stage, the product will be well to be upgraded in repairing process. Although have not formed quantitative design standards, lots of qualitative standards have been built for upgradeability in product design, such as making the framework, materials and product standards of product more easily to upgrade, adopting modularization, standardization, open and easily disassembling product makeup, and so on^[7].

5. Cases Study of Remanufacturing Upgrade

The National Key Laboratory for Remanufacturing upgraded 4 lathes (C620,CA6140, longer CA6140, C630) in 2002. These 4 lathes were manufactured in 70s of 20th, and their failure modes mainly included abrasion, scratch, fatigue fracture, colliding damage etc. That they just were restored to original status needs lots of cost, and repaired lathes have a limited use. However remanufacturing upgrade could enhance prominently the automatic degree and machining precision. Under the same using effect, the cost of upgrade lathe just is 1/3-1/5 cost of purchasing the similar type new numerical control one. Remanufacturing upgrade process in repairing process is as follows:

- Adopting surface engineering technologies (such as nano-complex-brushing technology, micro-pulse repair technology) to restore the damage and abrasion of lathes, and restore the geometrical form and dimension precision.
- Replacing the high precise transmission component (such as ball bearing leading screw) and adopting the nano-decreasing friction technology, so the movement precision could reach to 0.005mm per pulse in X direction and 0.01mm per pulse in Z direction.
- Fixing micro-computer numerically controlled equipment and relative servo system to replace original electric controlled system so that machining program could be stored by the numerically controlled lathes, enhancing the controllable ability and controlled precision, realizing the automatic or half automatic manipulation of machining and manufacturing.

Table 1 shows the comparison of precise inspection report of CA6140 lathe between original one and upgraded one.

Table 1: Upgraded CA6140 lathe precise inspection report^[8]

Testing items	Permitted error	Before upgrade error	After upgrade error
Equal degree of principal axis line to movement of smooth board	a=0.02/300 b=0.015/300	a=0.22 b=0.15	a=0.02 b=0.015
Parallel degree of the movement of smooth plank to tail final extend direction	a=0.03/300 b=0.03/300	a=0.01 b=0.015	a=0.01 b=0.015
The supported plate's jumpiness of principal axis shoulder	0.02	0.015	0.005
Radial circinal jumpiness of principal axis neck	0.01	0.02	0.005
Radial circinal jumpiness of principal axis cone-shaped hole axis line	a=0.01 b=0.02/300	a=0.05 b=0.3	a=0.01 b=0.02
Linear degree of smooth board movement in vertical plane	0.04	0.42	0.04

6. Summary

Remanufacturing upgrade plays an important role in product total life, and is improved by the intrinsic developing impetus of product. In short, that remanufacturing upgrade is adopted in the green repairing processing can obviously enhance the reliability and ecologicability, and acquire the maximal benefit of economy and ecology. However, because remanufacturing upgrade is a field of advanced technologies, a lot of unknown contents and technologies need to be explored in the future.

References

- [1] Steinhilper, R. Remanufacturing: The Ultimate Form of Recycling. Fraunhofer IRB Verlag, 1998,
- [2]. Yao Jukun, Liang Zhijie, Cui Peizhi. Study on Remanufacturing Upgrade. New Technology & New Process. 2004(3):17-19
- [3]. Yao Jukun, Xiang Yonghua, Zhu Sheng. Contents and Philosophic Significance of Remanufacturing. Zhongguo Ziyuan Zhonghe Liyong. 2003(8):7-9
- [4]. Jia Fengshan, Zhao Hengzhi. Revelation of Prolonging "B-52" Bomber performance of USA army. PLA Newspaper. Dec. 10th, 2002, 6th edition
- [5]. Luo Yun. The Maintenance of Facing the 21st Century. Chinese Ship maintenance. 1999(6):38-40.
- [6]. Zhou Xizeng, Xia Chunyang. Upgrade Reform of Atomic Absorption Spectrum Instrument, Chinese Journal of Spectroscopy Laboratory. 2001, 18(3):407-409
- [7]. Bert Bras, Mark W. McIntosh. Product, Process, and Organizational Design for Remanufacture – an Overview of Research. Robotics and Computer Integrated Manufacturing, 1999 (15):167-178
- [8]. Yao Ju-kun, Shi Xiao-jun.. Study for Used Mechanic-electric Equipment Information Remanufacturing Upgrade. Machinery. 2007(4):1-4

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