ANNALS of Faculty Engineering Hunedoara
International Journal of Engineering
ISSN: 1584 - 2665

FACTORS THAT INFLUENCE ON PRODUCT LIFETIME

[1] Siniša KUZMANOVIĆ, [2] Milan RACKOV

[1,2] University of Novi Sad, Faculty of Technical Sciences, SERBIA

ABSTRACT:
When product lifetime is described, not only in mechanical engineering, it should be known that today many positive law regulations, obligate producers that plan detailed life of every product. It is particularly expressed for responsible products, where producers had to prescribe not only product tracking down, through different phases, but also activities that need to be done over the product to ensure as much as better and longer product life. Their obligation is also that after exploitation period of product, in depend of its material characteristics, to prescribe activities over the product to rationally use the material it is made from, or to prevent environment pollution or to reduce it on smallest measure. The paper analyses technical lifetime, but also economical, ecological and, even, fashion lifetime; because they are also, important, and in certain cases even crucial, for bringing final decision about treating the product.
Key words: product lifetime, personal life of product

1. INTRODUCTION

Accessing different literature [1, 4, 7, 8], it can be concluded that authors have different interpretation of the concept "product life". Because it is needful to explain, in one place, basic terms associated with the product lifetime. When it is discussed about "life" of a product (i.e. machine, in this case), at least six types of life should be distinguished: (1) "life at manufacturer", (2) "life on the market", (3) "life in a storage", (4) "life at user (customer)", (5) "life after exploitation" [8] and, finally, (6) "personal life" of every product (Fig.1).

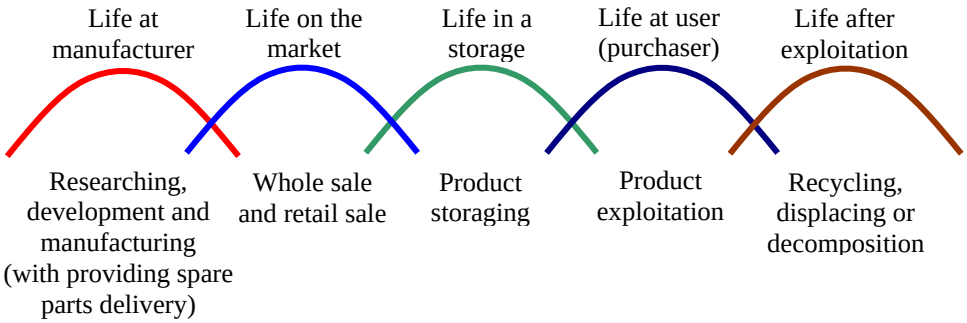

Figure 1. Schematic review of product life phases

2. LIFE AT USER (PURCHASER)

Every product "lives" at the user, too. It has its period of exploitation - "durability of product", which comprises period from the moment of purchasing until it is completely used and/or pulled out from the service (Fig. 2).

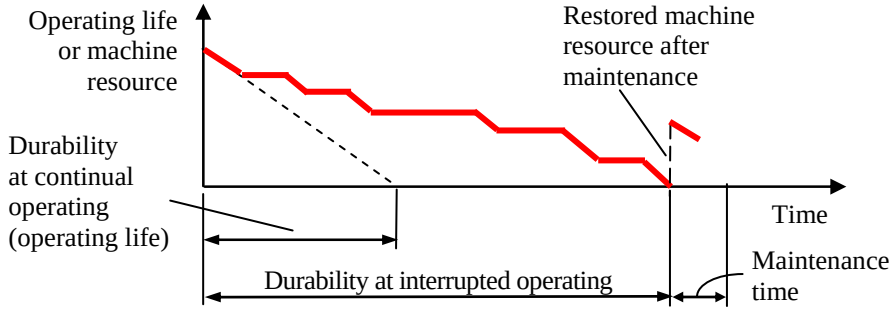

Figure 2. Review of product durability [2]

Operating life of product, usually a machine, defines overall time during that machine can continually operate, at normal conditions and provided exploitation regime, without significant decreasing of its basic operating characteristics and with economic reasonable maintenance price. This period of time is usually called machine resource. Durability (or exploitation life) of machine defines overall time of machine operating with breaks, usually expressed by years, until its all resources are exploited. Durability depends only on projected operating life of machine (available machine resource) and on intensity of its usage. Certainly, more intensive usage and shorter operating life result in reducing of machine durability, and vice versa. When all resources are exploited, machine is being removed or, if it is possible, it is being repaired. Thus, machine resources are restored (partly or even completely) and it can be used again. Of course, repairs can be done only several times, after that new machine should be provided, not only because of its efficiency, but also because it is technically outdated. Dealing with exact definition of product durability, it should distinguish functional, technical, economical, ecological and fashion durability.

3. PERSONAL LIFE OF PRODUCT

Certainly, every product has also its personal life, which begins by the moment when material for product is obtained, then by its manufacturing, storage, sale and exploitation, and finishes by product recycling, or natural disintegration. Personal life of every responsible product is usually recorded in its service book.

4. USUAL POSSIBILITIES AND WAYS OF TRACKING DOWN OF PRODUCT PERSONAL LIFE

Today, many of the positive legal regulations and standards (especially ISO 9000) requires manufacturers to ensure traceability of its products. That means it follows the material from which the product is made, applied technology, machinery and tools, testing and verification are monitored, then, conservation (if it is anticipated that the product conserves), data about applied package, method of packaging and storage, method of repackaging, deconservation, installation, starting to operate and running in, and especially data for exploitation, supervision, service, maintenance and repair (if it is foreseen that the product is repaired), recycling, removal or disposal, if the product is not suitable for recycling. In addition, it is also necessary to track down direct operators (staff, storagers, transporters, installers, service providers, examiners and controllers) and maintain and keep records of all conducted activities.

Traceability is also necessary after the product is sold in order to know who bought them and where to find certain products if some error case or default in production chain is found, to advise all buyers (customers) of product to eliminate that mistake and thus ensuring quality products and preserving the use of reputable companies.

Manufacturers necessarily prescribe the manner of supervision:

- who controls,
- what controls,
- when controlled,
- control measuring,
- nominal values of measured sizes and what are permissible deviations,
- what are the critical values,
- measures to be taken when reaching the critical value,
- ways to repair in case of reaching critical values and
- way of keeping records of all phenomena.

The problem of technical supervision (monitoring) is particularly important today when the technical parameters of products have reached the limits and when consequences of accidents become very specific and sometimes cause real disaster. However, despite the implementation of technical supervision, user of the product must be fully convinced of its reliable operation. Some of its elements may cancel, but the whole system must be capable of working, although it is not always the case, for which they must constantly monitor the state of the system.

Designers are obliged to anticipate the risk that exists when the products are used rationally, as well as the period when the product has to stop to use (Fig.3) in order to avoid the occurrence of major failures, especially accidents and disasters.

The risk of breakdown of complex products, especially in the machinery industry, unfortunately, still exists. Breakdown during machine operates, which can be caused by a number of unpredictable factors could cause catastrophic, critical, major or minor damage, all depending on the severity of

consequences: loss of function, injury to personnel (injury, death), various harmful effects on the environment, etc.

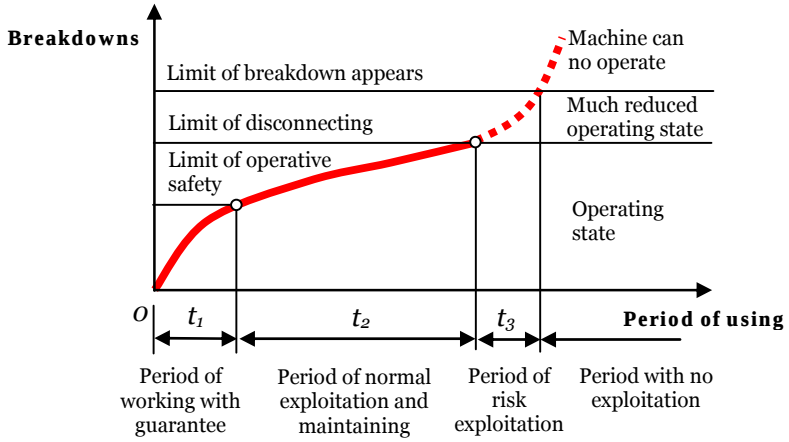

Figure 3. Review of the state machine during operation

When the failure of technical systems appears, it usually comes to the so called "domino effect" in which damage of one element usually causes damage of another element, and so on, which in the end, usually causes severe damage of the whole system (machine).

Technical staff, who uses the machine, often nothing knows about the accidents and disasters. However, they have to be aware of the time that the disaster could happen and that they occasionally occur and they are associated with large financial and sometimes political, social and legal consequences that can not be replaced by any means.

Therefore technical staff must be announced:

- technical leadership must be familiar with their responsibilities,
- engineers has to be announced to the necessity of introducing accidents cases in the documentation,
- highlight the importance of technical experts and knowledge that contribute to increasing reliability and service life of products.

5. DIAGNOSIS AND CONTROL PRINCIPLES

Diagnosis includes all measures that are used for the evaluation of a product. There are destructive (with destruction) and nondestructive (without disjoint and destruction of products) methods of diagnosis. Diagnosis is used for:

- check the correctness,
- checking of working capacity,
- test functionality and
- breakdown research (location, shape and cause).

The technical diagnosis is used to determine:

- working conditions,
- damage degree,
- reliability and effectiveness and
- quality, maintenance and repairs.

State estimation is performed by comparing the fixed value of the observed parameters with the prescribed limits (Fig.4), after which the decision is made whether the product meets the projected target function, and how long will be able to meet, or need to take some actions in to regulation and maintenance.

The basic principle of diagnosis is:

- consecutive and systematic measurements of certain parameters and
- monitoring variations of these parameters and compare with the starting values, where deviations can be determined at a constant, growing and sudden.

Method of diagnosis has to be predicted already in the stage of designing the machine.

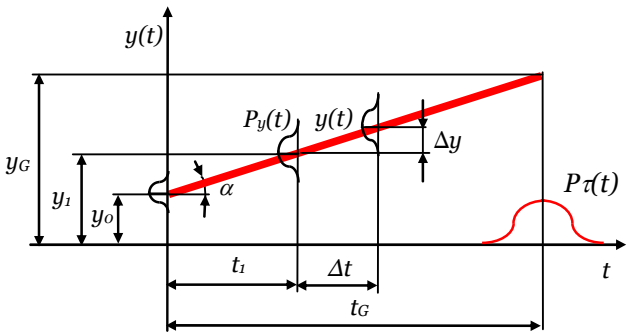

Figure 4. Graphic review of changing of measured parameter in time

t - operating time, t_G - expected operating life, t_1 - testing time, Δt - interval of testing, $P_\tau(t)$ - probability of expected operating life occurrence, y(t) - value of measured parameter, y_o - initial value of measured parameter, y_1 - value of measured parameter after time t_1, Δy - alteration of measured parameter, y_G - boundary value of measured parameter, Py(t) - probability of measured parameter occurrence, α - inclination angle of degression line

Diagnosis can be done in to:
- ❖ normal operating conditions,
- ❖ special operating conditions and
- ❖ stringent operating conditions.

Control methods can be divided into three groups:
- ❖ semi-qualified, for example measuring temperature, pressure, vibration, etc,
- ❖ qualified, the analysis of vibration frequency, constant exploitation registration feature, visual controls, etc,
- ❖ highly skilled, the model analysis, using defectoskopy, magnetography, holography, thermography, frequency analysis, etc.

In general, a simpler method of measurement makes rougher, ie. less accurate, information about the system, and is able only for a short period of time, to indicate the possible breakdowns.

Diagnosis procedures can be:
- ❖ subjective procedures (testing noise, visual and optical testing, penetration, magnetic flow, examination of color, fragrance testing, etc.) and
- ❖ objective procedures (measuring noise, temperature, speed, pressure, flow, torque, power, time, etc.).

Selection of the diagnostic procedure of product damage is necessary to choose when product designing. At the beginning of exploitation the methods of early damage detection are applicated, and then, with increasing damage other methods of diagnosis are used.

During diagnostics some diagnose errors may arise for two reasons:
- ❖ due to errors in determining status and
- ❖ due to errors in the assessment of the situation.

6. CAUSES OF ACCIDENTS

The accidents are often caused by the following errors:

1. Technical errors, caused by:
   - ❖ irregular exploitation, for example, exploitation with a load greater than allowed,
   - ❖ irregular constructions, with the result that critical elements can not transfer the load and
   - ❖ wrong manufacturing, when some components of the product does not match the technical documentation;
2. Organizational errors, caused by the project manager who did not take organizational measures to prevent the occurrence of technical errors from previous paragraph;
3. Lack of qualifications, caused by the responsible person who wasn't well enough trained to avoid the technical and organizational errors.

7. IMPACT OF SERVICE ON THE PERSONAL LIFE OF THE PRODUCT

The service is provided by the manufacturer to the buyer, while the product is still under warranty, and is reflected in the detailed monitoring of the state of products and usually lubricants replacing or tightening the belts or screws, control of the characteristic parameters of flow, capacity, temperature, vibration, noise, etc. Regular and timely service has a very large impact on the proper functioning of the product. Service is usually carried out by the manufacturer or authorized company. Servicers have to pass training and must have adequate instructions for operation, as well as suggestions on what elements should direct the attention of users and maintainers of products. Each product has to be adapted for simple service, that means it has a simple and easy access to parts that need to be serviced in order to shorten the time of service and avoid possible damage when servicing the product. The purchase contracts must be defined the scope, place and manner of implementation of service products. Well-organized service department has an enormous impact on the products placement on the market, so that service network must be organized, personnel trained and special attention must be given to equipment.

8. IMPACT OF MAINTENANCE ON THE PERSONAL LIFE OF PRODUCTS

Maintenance of the product considers activities that user (buyer) implements in order to maintain the product as long as possible in working condition. For this reason, special instruction for the maintenance must be defined to customers, separately for operators and maintainers in order to regular monitor and review and ensure the availability of products (machines). Proper and timely maintenance has a very large impact on the proper operation and long life of each product, and therefore it is paid great attention on the maintenance of the product.

In particular, it differs:

- preventively (before occurrence of damage) and
- corrective (if damage occurs) maintenance.

Preventive maintenance can be periodical maintenance (after a certain period of time specific components are being replaced regardless of their condition, for example replacement of oil in the car) and the maintenance of the state (some of the parameter is followed and when it comes to critical value, such component is being replaced, for example replacement tires in cars).

When corrective maintenance is performed, component is being replaced only after it is registered it is damaged (for example, light bulbs in cars are performed in this way). Preventive maintenance is always applied in those cases where the damage of some components can cause difficult damage of products.

Maintenance method and period are prescribed, but today it is often practiced to make products with a range of maintenance activities reduced to as small a measure. It means that the quality and durability of the product does not depend on the seriousness and responsibility of maintenance services, but that these activities (for example, greasing) are realized automatically, without user intervention. For expensive and complex systems, system performance is monitored through appropriate sensors and computers, which have inputed normal, elevated and critical values of characteristic parameters; so that it is continually supervised the work of system and all deviations are immediately registered and define actions to be taken. If the critical value is reached, operation of the system automatically stops and can not be done its restart until necessary corrective measures are taken. This is, of course, the best way to monitoring the process, because the influence of human factors is reduced to a minimum.

To ensure the easy maintenance of products, manufacturers are required to deliver a list of product parts, as well as assemble drawing of the product, in which the users of products and persons who maintain it can manage and identify the damaged part, determine its label so that, on the basis of it, they could immediately incorporate new part or order from the factory if they do not dispose of it. For some types of products, manufacturers are obliged to deliver some spare parts with the product to the buyer, usually those parts that often breakdown or must often be changed (for example, spare wheel cars, fuses, etc.).

In almost all types of products certain level of hygiene requirements is required, which is in exploitation conditions provided by maintenance service. There is a certain level of cleanliness, the removal of dust and various other materials that may occur in the process of exploitation. Removal of dust is necessary, first of all hygienic (health) reasons, and often for functional reasons. For example, in electric motors, worm gear units and similar products, it is necessary to remove dust in order to conduct the heat (cooling) and thus prevent excessive heating and premature degradation products. To meet this requirement, it is necessary to adapt design of the product for easy cleaning, avoidance of sharp corners which are difficult to remove dust and dirt, etc.

Special group of machines requires hygienic requirements that mean the provision of certain cleaning products that are processed, for example, in the food industry. It is unacceptable that oil from the gear mixers milk dripping in milk, etc. It requires a special approach to product design, usually, additional product ensuring, so to escape leaking oil, etc.

9. INFLUENCE OF REPAIR ON THE PERSONAL LIFE OF THE PRODUCT

Repair of product means major repairing that is made to the product, which is worn by all his resources if it is foreseen to perform repairs on it, or the product had accident damage and it is payable to repair, because it is not worn all his resources. This means there are regular repair and repair after damage.

Today there are two types of products, those that are intended for repair and those that are not. Products that are foreseen for repairs are more expensive and usually have more parts. The main features of these products are that they can be disassembled and then just assembled together again. Every product which will be repaired must have appropriate instructions for repair, in which the labels are given for the components that need repair method of performing the repairs, the value of the characteristic parameters after repairs, and technical features that product should have in the working conditions after repairs. However, it is known that the product after repairing cannot have the same parameters as those it had when it was just new. Quality of repair work and thus the quality of the remaining life of repaired products can be followed. It certainly gives great confidence to the user for more successful and reliable use of the product, as also to insurance companies that need to extend or assume repaired insurance products.

Bringing products to correctly state in warranty period is the task of service and only for major breakdowns, repair service is competent. If the failure occurred during the warranty period due to manufacturer error, then the manufacturer needs to remove a consequence or to replace with a new product, and the warranty period required to be extended. If the failure occurred after the warranty period, then usually maintain customer service locate breakdowns and repair, usually just replace the damaged parts. Identification of damaged parts are usually made based on the assemble drawing of products and a list of spare parts, which the manufacturer is obliged to deliver to each product. Each manufacturer is, under current applicable law, liable to seven years after the sale of products, ensure supply of spare parts.

10. CONCLUSION

Personal life of products is an important feature of every product that is particularly monitored, recorded, analyzed and evaluated. Decision about product treatment is based on the product personal life, depending on which phase of life the product is (quite new, in good condition, or are already old). Personal life of products is monitored during its operation and on the basis of the former personal life a decision about treatment of the product is performed (its service, maintenance, repairs, sales, recycling, or removal). Manufacturer should prescribe the parameters to control the "life" of each product and their characteristic values, while the users are obliged to abide by them. All users are certainly interested that their purchased products operate long and reliable, with acceptable maintenance costs. Because users generally very strictly adhere to all instructions given to them by manufacturers in relation to transport, storage, deconservation, installation, commissioning and starting to operate, service, maintenance, repair, monitoring and removal. Of course, users during monitoring track condition of products and assess their accuracy level.

Of course, features of material from which the product is made, its price and deficiency, significantly affect the behavior of products during the operation, that is on the personal life of the product, as well as treatment with the product after the termination of its operation.

Recycling of products today needs to give very great attention due to limited natural resources and environmental protection, because tomorrow it will already be too late.

REFERENCES

[1.] *KOLLAKOT, R., Diagnostika povreždenij, Mir, Moskva, 1989.*
[2.] *KOTLER, F., Marketing Management, Mate, Zagreb, 2001. (in Croatian)*
[3.] *KUZMANOVIĆ, S., Product Management, University of Novi Sad, Faculty of Technical Sciences, Novi Sad, 2007. (in Serbian)*
[4.] *MILOVANČEVIĆ, M., STEFANOVIĆ-MARINKOVIĆ, J., Power Transmission Condition Monitoring, Machine Design 2010, Faculty of Technical Sciences, Novi Sad, ISSN 1821-1259*
[5.] *OGNJANOVIĆ, M., Machine Design, University of Belgrade, Faculty of Mechanical Engineering, Belgrade, 2000. (in Serbian)*
[6.] *ORLOV, P. I., Osnovi konstruirovanija, Mašinostroenie, Moskva 1977*
[7.] *SREDIĆ, N., ĆOSIĆ, I., Influencing External Factors on Definition of Managing the Strategy at the End-of-Life Products, Proceedings, DEMI 2003., Banjaluka 30. i 31.5.2003.*

ANNALS OF FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL OF ENGINEERING