International Conference on Economic Engineering and Manufacturing Systems
Braşov, 25 – 26 October 2007

CONSIDERATIONS UPON THE DESIGN OF THE MACHINE-TOOLS IN ACCORDANCE WITH THEIR DUTY CYCLE

Ion TUREAC
"Transilvania" University of Braşov, Romania

Abstract. The product design, their fabrication and consumption in compliance with the principles of the market economy have resulted in the current economic development, which may be characterized through reaching a satisfactory level of the well-being and through the utmost deterioration of the environment health.

In order to cast away the possibilities of aggravation of the disequilibrium between the economic rise and the environment quality, there is necessary to reconsider the criteria on whose basis the products have been made and consumed so far and to pass to a new manner of approach.

In this paper there are presented the deficiencies of the current manner of conceiving and designing an important group of products – the one of the machine-tools. According to the paper, there is necessary, in the prospect of the rise in the demand of consumption goods and production means, for these products to be designed so as their impact upon the environment should be eliminated or reduced to the lowest level.

The paper enhances the possibility of our possessing, in the future, machine-tools that should have a less cumbersome influence upon the deterioration of the environment, through taking into consideration their entire duty cycle during the design phase. Under these circumstances, approaching a management of the environment turns into reality in complete compliance with the principles of durable development.

Keywords: duty cycle, machine-tools, sustainable development

1. Prospect of the production of machine-tools

On the basis of the analysis of the level of current economic development, there may be concluded that in its accomplishment the machine-tools have played an overwhelming part. There is also expected that in the future they might significantly contribute to the economic development. In guise of main means of production of other means of production, and also of consumption goods, they have permanently concentrated the attention of the researchers, of the producers and of the consumers, there being aimed at their diversification and perfection, so as their use might be more efficient.

In prospect, in the long and medium term, due to the augmentation of the number of inhabitants on Earth – the prognoses [7] indicate the augmentation of the population until 2050, from approximately 6.5 billions in the present, to more than 14 billions – there is prefigured the rise and the diversification of the consumptions in all fields. Under these circumstances, there will be necessary massive rises in the production of goods, and at the same time there will be necessary the adequate rise of the production means. Therefore, the machine-tools will play in the future a priority part in the production processes and they will contribute to the economic development.

The augmentation of the number of machines will stand for a prerequisite of the satisfaction of the high demand for products in the future, however not for a sufficient condition. There ensues that them, beside the high technical and economic performance that they should possess in order to produce how and how much, likewise ought to have environment performance in order to carry out their functions without contributing significantly to the amplification of the pollution and to the inefficient consumption of the natural resources. Under such an approach, there is possible that the environment performance of the economic organizations should be obtained through summing up the results – in this direction – that each and every product yields.

2. Necessity of designing the machines taking into consideration their duty cycle

The prospect of the fabrication and of the consumption of a very high number of machine-tools compels the research and the design to take into consideration also the influence they will exert

upon the environment. Knowing likewise the impact different variants of machines will produce, there may be operated the option for fabricating and consuming solely those which not only ensure the conditions required by the producer and the consumer, but also possess the aptitudes which make them less harmful to the environment.

In order to obtain and put into practice the new series of machines that should ensure the satisfaction of the necessary of products in the future and at the same time that should ensure the lowest levels of the impact upon the environment, there is necessary to reconsider the current criteria of design and the bases on whom the production settles upon.

As regards the conception and the design of the machines-tools, there has to be noted that they should be made and used so as to comply simultaneously the requirements of three basic factors: the producer, the consumer and the environment. If, as regards the conditions for the satisfaction of the first two factors, there are effected studies and research which have contributed to our obtaining the current results, as regards the conditions imposed by the environment, the accomplishments have not reached so far a satisfactory level, in order to grant us for the future the production means necessary to a durable economic development.

One of the ways through which obtaining machines whose utilization should induce lower impacts upon the environment is facilitated, consists in conceiving and designing them so as not only the stage in which they are exploited should be taken into consideration on a priority level, but also their entire duty cycle. In such an approach, the designers have the possibility to identify all phases of the machine existence in which there may appear environment aspects or impacts upon the environment and they may implement in the projects only the solutions which avoid such situations or reduce them to the minimum.

3. Duty cycle and its importance

The international standards from the series ISO 14040 express the duty cycle through the wholeness of the stages successively gone though and through the correlation to a system-product from the acquisition of the raw materials or from their extraction out of the environment, to the post-use. In paper [3], there is considered the duty cycle of a system-product through summing up the following stages: the conception and the design, the extraction and the taking over out of the environment of the primary materials, the fabrication, the distribution associated to the placement in the using place, the utilization and the elimination out of the circuit as waste material – recyclable or non-recyclable – or the destruction. Among the stages enumerated before, there may be included other sub-stages that may be taken into consideration separately or may be included in those already presented. If the product that has reached the post-use stage is wholly recyclable – a fact which is to be desired – then the cycle closes through the reintegration in the environment in the succession: environment-product-environment. The parts which are reusable are reintegrated in other products, and the products that are non-recyclable reach the environment without being assimilated within.

In figure 1 there is presented the scheme of the duty cycle of a product with features similar to the features of the machine-tools.

According to the papers [1] and [2], the product is the result of the association of three basic components: substance, energy and information. The physical form of the product is determined by the substance and the energy consumed for obtaining it, and the use value is attributed to it through the quantity and the quality of the information implemented in the project according to whom it is being executed. The information is likewise the one which settles the levels of the substance and energy consumptions in each and every one of the stages of the duty cycle.

Every stage of the duty cycle of the products in the group of the machine-tools is marked by the apparition of environmental aspects or by impacts upon this one. The environmental aspects or the impacts are mostly due to the substance and energy consumption, and also to other causes such as: the noise level, the maintenance, the ergonomics, the reintegration capacity etc, and their size may be controlled – ever since the design stage – through the implementation within the projects of technical and technological solutions that should eliminate or diminish them up to the level to which they are not harmful or they do not induce losses. The general categories for the environment impacts which have to be taken into consideration in the framework of the activities of assessment of the duty cycle are: the natural resources, the human health and the ecological consequences.

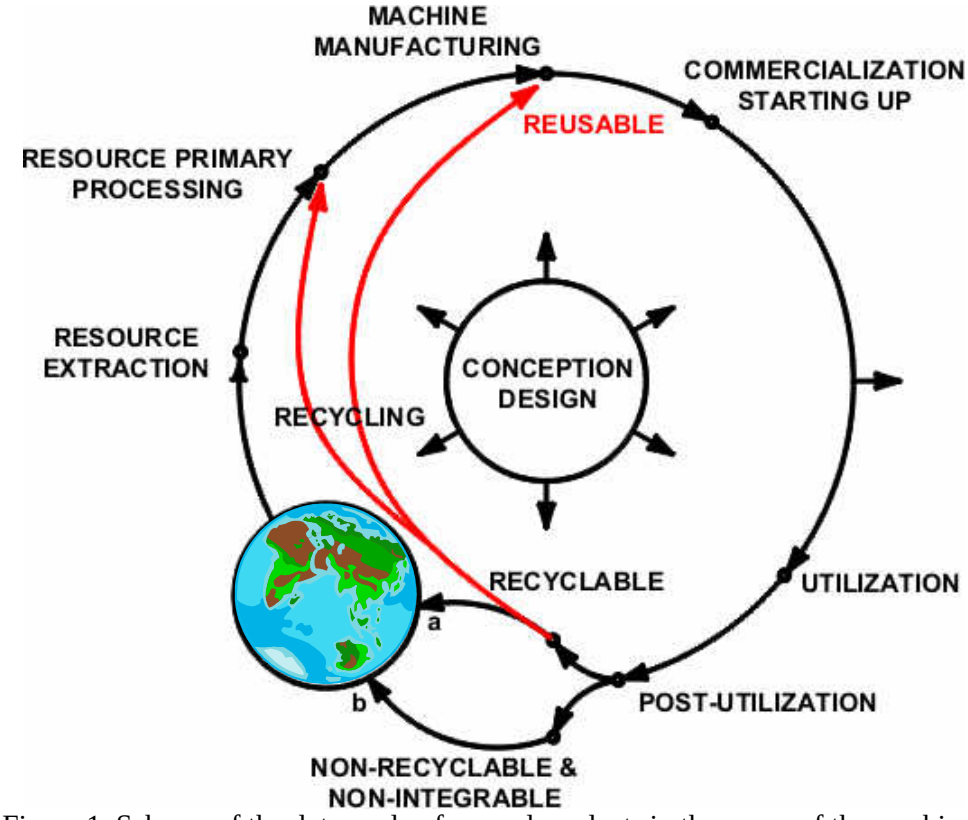

Figure 1. Scheme of the duty cycle of several products in the group of the machines

To their great majority, the effects of the impacts are concentrated in losses which are registered in the directions mentioned above and they cannot be quantified under the monetary aspect through the existing means. The most wasting consequences are in connection with the ecological consequences and they manifest themselves through the deterioration of the environment.

In order to eliminate the possible consequences in the directions mentioned above, there is necessary to leave behind the existing design practice, which allows the execution of the product especially on technical and economic criteria and only after it is put to consumption, to exhibit preoccupations for combating the effects due to the impacts upon the environment. The assessment and the analysis of the product duty cycle enable our taking into consideration the consequences induced by its fabrication and consumptions impacts ever since the conception – design stage and the avoidance of the solutions that lead to the non-economical use of the solutions, to the harm done to human health and to significant ecological consequences.

Knowing in-depth all effects which manifest themselves along the duty cycle of the machine-tools allows the specialists in design, the producers and the consumers to take the best decisions, at least in the following directions:

.- determining the opportunities for the improvement of the environmental aspects generated by the machine-tools in the different stages of their existence;

.- opportunity of the design or of the re-design of certain variants of machine-tools or of their fabrication technologies;

.- selection of the relevant indicators concerning the technical, economic and mostly environmental performance, including the techniques for their measurement;

.- approach of several marketing issues which may include the claims referring to the environment such as those in connection with the eco-etiquette scheme, with the environment declaration, etc.

The approach of the machine design, of their production and consumption in the manner presented above will allow the economic organizations to determine their environment performance in the framework of a motivated environment management, in compliance with the demands which will be imposed in the future. This way, there will be possible to obtain in the future

the great quantities of necessary products without affecting the environment health, in accordance with the requirements of the durable economic development.

4. Conclusions

1.- So that in the prospect, the machine-tools should contribute no more to the aggravation of the current ecological crisis, there is necessary to reconsider the conditions of their design;

2.- One of the conditions for the elimination or for the reduction of the impact of the machine-tools upon the environment is to design them by taking into consideration their entire duty cycle;

3.- Through the assessment and the analysis of the duty cycle, there may be identified the stages in which the machine-tools induce impacts with negative effects upon the consumption of the resources, upon the human health and upon the ecological equilibrium;

4.- The design of the machine-tools in correlation with their duty cycle allows obtaining much improved variants, whose fabrication and consumption has a lower impact upon the environment.

References

1. Bran, P.: *Economica of Value (Economica valorii)*. ASE Press, Bucureşti, Romania, 2002, ISBN 973-594-0841 (in Romanian)
2. Brown, R.L.: *Eco-Economy (Eco-economia)*. "Tehnică" Publishing House, Bucureşti, Romania, 2001 (in Romanian)
3. Drimer, D. et all.: *Ecology. Encyclopaedic Dictionary (Ecologia. Dicţionar enciclopedic)*. "Tehnică" Publishing House, Bucureşti, Romania, 2006 (in Romanian)
4. Gridan, T. et all.: *Global Warming or Glaciation (Încălzire globală sau glaciaţiune)*. "Didactică şi Pedagogică" Publishing House, Bucureşti, Romania, 2006 (in Romanian)
5. Popescu, I. et all.: *Sustainable Development. A Romanian Perpective (Dezvoltarea durabilă. O perspectivă românească)*. "Economică" Publishing House, Bucureşti, Romania, 2006 (in Romanian)
6. Tureac, I. et all.: *Sustainable Development and re-design of Products in Machine Building (Dezvoltarea durabilă şi reconceperea produselor în construcţia de maşini*. "Transilvania" University Press, Brasov, Romania, 2001 ISBN ISBN 9738124-32-8 (in Romanian)
7. Tureac, I. et all.: *Sustainable Development of Products in Machine Building (Dezvoltarea durabilă a produselor în construcţia de maşini*. "Transilvania" University Press, Braşov, Romania, 2006, ISBN 973-635-639-6 (in Romanian)