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Nano Engineering for Nano Sustainability

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Abstract: Engineering with higher accuracy and precision is going through an accelerated motion over the last 40 years. There is no unique international definition for Nano engineering. However, this development is driven by customer requirements for much higher function of goods, products and services. On the other hand, the concept of sustainability was not given enough importance and consideration, while engineering was going through a rapid development, until late 90's. In this paper the term Nano sustainability is highlighted because of an effective real threat and danger to us caused by misunderstanding of the relationships between the development of engineering and sustainability at the Nano scale.

Keywords: *- Nano engineering, Nanotechnology, Nano sustainability.*

I. INTRODUCTION

In this paper, we consider the term Nano engineering identical to Nanotechnology which is affecting all sides of our life and continuous existence of our ecological system. Several studies explained societal impact of Nano engineering [1], environmental impact of Nano engineering [2] and health impact of Nano engineering [3].Partial solution for these problems was proposed in some research articles and studies by different scientists and agencies [4] but this will never lead to a sustainable development of our life. In this regard, poverty and hunger still exist in many countries especially in the continents of Africa and Asia. Also millions of people do not receive pure, clean and fresh water such as citizens of Ethiopia and Somalia. The number of illiterate people is in increasing mode in some Arabic and Islamic countries because a lack of education [5]. On top of this, despite the excellent development and research in many fields of medicine child mortality is still high in many geographic places on the earth. In other words, Nano engineering couldn't reduce the large gap between high industrialized and poor countries.

On the other hand, Nanoengineering is affecting badly the flora and fauna. Some sea plants are damaged by the toxic water received as output of factories and plants. Also some animals are killed instantly after drinking poisoned water from rivers. The situation is getting worse for people when pollution level will be high for several months such as in Beijing, China or New Mexico, Mexico where the population of these cities is more than fifteen millions day counting.

Finally, Nano technology presents a real danger and threat to the life of all workers and people dealing with Nano materials or involved in its production processes.

An Integrated Model for Sustainable Nano-Engineering (IMSNE)

Nowadays an integrated system, model or methodology for the design and development of sustainable Nano engineering practices does not exist. Some metrics are developed by different industries and institutions to defend partially their engineering activities. As the impacts of Nano engineering is getting very harmful, affecting our life and the existence of ecological system, a new system for the design of Nano engineering applications becomes an urgent necessary need. This system includes but not limited to environmental, societal and health metrics used as a filter of concepts developed while designing a Nano engineering product or application.

In this research paper figure 1 is representing Detailed Environmental Statement (DES) which guides engineers to develop products and items with very low environmental impact. Future work is needed to develop appropriate, effective and detailed societal and health statements to cover all aspects of sustainable development of Nano engineering.

In designing environmentally conscious products, it is important to consider all the stages of their life cycle, including raw material extraction, processing, transport, component manufacturing, product assembly, distribution, end use, service, and disposal and recycling. Today there has been growing concern about environmental and social problems associated with resource consumption, such as materials and energy and an increased desire to design new products and processes, which have fewer negative environmental impacts. This can be achieved at all the stages of the product life cycle through the following factors, which include but are not limited to:

1. Reduction of energy usage, which includes:
- Non - renewable energy consumption
- Renewable energy consumption
2. Reduction of water usage
3. Reduction of material burden, which includes:
- Toxic and hazardous waste
- Air emissions and greenhouse gases
4. Reduction of material volume, which includes:
- Increasing of recyclable materials
- Reduction of product weight
- Increasing of product's operating life
5. Improving product recovery and reuse, this includes:
- Decreasing disassembly and recovery time
- Increasing use of recycled materials
- Increasing percentage of products recovered and reused
6. Reduction of exposure and risk factors, which includes:
- Noise generation, vibration and offensive odors
- Degradation of Flora and Fauna
- Usage of caustic and/or flammable materials

Figure 1: Detailed Environmental Statement (DES)

In the following a complete system or model for a sustainable Nano-engineering practices is represented in figure 2.

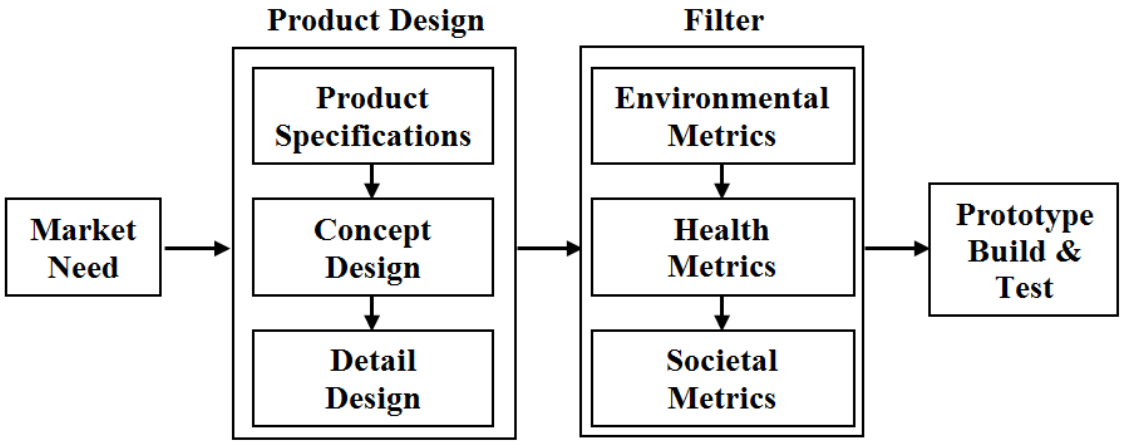

Figure 2: Integrated Model for Sustainable Nano-Engineering

II. CONCLUSION

In summary, the advantages of IMSNE are as follows:

- Environmental, Health and Societal metrics play an important role in reducing the number of product specificationsaccording to their impact. This will drastically reduce the work in product concept development.
- Environmental, Health and Societal metrics enable the designers to prioritize product specifications and, in parallel, to develop the technical characteristics attributed to them.
- Environmental, Health and Societal metrics add new dimensions to the quality of the product by deploying an environmental, health and societal values at the concept level.
- Environmental, Health and Societal metrics are a useful tool to be applied for the introduction of new products, for which a feedback about the product's environmental,health and societal impact does not exist.

- Environmental, Health and Societal metrics allow the designers not only to estimate the total impact of a certain product characteristic but also to identify the main sources of this impact. For example, usage of energy in a product life cycle, water usage or material required for product development and so on**.**
- Environmental, Health and Societal metricshelp the designers to design an environmentally and healthy conscious product. In general, if the product has a bad environmental impact, customer's willingness to pay for the product includes an environmental cost called "hidden cost", e.g. carbon tax. This cost is probably reduced to zero with the use of the filter included in IMSNE.
- IMSNE will guarantee healthy products for all everyone. This will reduce people's and governments consumption on medication.
- IMSNE can be used not only at the conceptual level of product design but also at the component and system levels of product design.

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