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Development – constructive or destructive

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***Abstract*— The never ending demand of the so called modern and civilized society for their comfort and prosperity is fulfilled by using the natural resources in various forms. The rapid growth of human population is demanding more and more natural resources and thereby causing fast depletion of our natural resources. Manufacturing of various goods and services for human use results in pollution, waste, emission and generation of toxic substances. Efforts are therefore required to reduce the amount of these undesirable substances. Only the conservation of natural resources and their judicious use can ensure the very survival of our present as well as future generations. Developments have to take place but at the same time it has to be 'Sustainable' so that it can take care of our environmental needs. Innovations in the field of science and technology will definitely help in this direction by ensuring the judicious use of materials for fulfilling our basic needs as well as to improve the overall quality of life. This paper highlights the needs and ways to achieve a proper balance between the environment, economic growth and welfare of the society for a sustainable future.**

***Keywords* —Progress and development, Environment, Energy, Technology, Industrialization, Sustainability, Product Life cycle.**

I. Introduction

As per Alfred Russel Wallace (1892) the word 'progress' may either mean an advancement of material civilization or advancement in mental and moral nature of man. He had mentioned that each generation is benefited from the trials and failures of the preceding generation. As per him the discovery of printing caused very fast pace of progress in our mankind as it helped in facilitating and circulating all new knowledge.

'Progress' never stops! The human population is progressing since the birth of Adam and Eve. But this progress is ultimately dependent on various materials from our mother earth. The manufacturing sectors today are under great pressure to meet the ever increasing demand of various goods and services for meeting the society's demand. These demands are to be met by using various natural resources either in virgin form or after suitable processing.

II. HUMAN PROGRESS AND DEVELOPMENT

There has been a steady development of the human population since the dawn of creation. As per John McCarthy (1995), the human progress in the last few centuries comprised of the followings:

- Increased access to material goods
- Increased life span
- Reduced childhood death
- Increased opportunities for education
- Safe water supply
- Societies that people choose to migrate to
- More individual choice of occupation, lifestyle and avocations
- More opportunity to enjoy both culture and nature
- Cleaner environment
- Increased consideration for the values in nature, e.g. for the preservation of biological diversity
- Increased concern for less advanced people and their cultures
- More and more new goods and services available to more and more people.

III. Role of Science and Technology in Human Progress

Science and Technology has a very important role in the progress of the mankind. The human being is progressing very fast with the advancement of science and technology. As per John McCarthy (1995) humanity has progressed over hundreds of thousands of years, but until about the seventeenth century, progress was rare and slow. As per him the greatest rate of progress for the average person occurred around the end of the 19th century when safe water supplies, telephones, automobiles, electric lighting, and home refrigeration came in short order.

According to Stephen E. Little (1999) Science and Technology development is increasingly driven by the requirements of a globalizing world economy and the advent of information/communication technologies that had supported this globalization process.

IV. Progress vs. Environment

Due to consistent and relentless efforts human being were able to progress continuously. In spite of tremendous progress and development one wonders whether this progress is constructive or destructive in nature. Constructive development signifies development which is 'sustainable'. A

detailed analysis shows that the developments are destructive i.e. not sustainable in many instances. Various human activities for meeting their growing demands and the rapid population explosion have resulted in over-exploitation of natural resources, environmental degradation and various associated problems. Some of these are:

- Global warming and climate change
- Exhaustion of natural resources including fossil fuels
- Soil, water and air pollution.

There is an urgent need to protect our environment from any further degradation. Conservation of natural resources, protection of the environment and reduction of environmental degradation might be possible by some of the following ways:

- Adopting integrated and holistic approach
- Commitment from top decision making body/ government
- Educating the Public and making them aware of their environment.
- Framing various standards, environmental policies, regulations and their strict implementation
- Involvement of citizens, industries, educationists, scientists and the government in making various policy decisions
- Emphasis on Research and development for technological up gradation
- Allocation of budgets for carrying out research and developmental tasks.

V. Industrialization and Sustainability

To meet the ever increasing demand of the market, rapid industrialization is the need of the hour. The society's growing concern for the environment has a great role in pressurizing the manufacturers to comply with the environment friendly practices. Stricter government norms and regulations are also forcing the manufacturers for adopting better, alternate and innovative ways of manufacturing. Under such compulsion the manufacturers are left with no other choice but to improve their practices in order to survive and compete in the market. These trends and practices will ultimately lead towards sustainable growth and development.

According to Bruntland Commission report published in 1987 any development may be termed as 'sustainable' if the needs of the current generation do not impinge on the ability of future generations to meet their needs. The term sustainability contains the idea that humans on this planet should live in such a way, that the needs of the present are satisfied without risking the need for the future. This is possible only through a proper balance between ecological, economic and social dimensions.

A. Technology vs. Sustainable development

There are limited natural resources on our earth. As the human population is growing at an alarming rate there is an ever increasing need for natural resources. These increasing demands can be met through the use of technologies especially innovative technologies and through the judicious use of resources.

Roger C. Herdman (1994) was of the opinion that Technology can affect sustainability in a positive way by reducing throughput and waste and by increasing efficiency and finding alternatives to scarce resources. As per him environmental benefits are not the sole measure of a technology's contribution to SD (Sustainable development) but appropriateness of scale, use of local resources, and equity are important considerations as well.

B. Sustainable consumption and manufacturing

The rapid growth of world population has a great demand for variety of products for human use. These are obtained from scarce natural resources either in the form of virgin materials obtained directly from nature or in the form of finished goods that are manufactured in industries using the virgin materials and by using energy in some form or the other. The consumption level of energy and goods are increasing at an alarming rate and there may be an acute shortage of raw materials in the near future. Moreover the consumption pattern is also changing in the society. Hence there is an urgent need of sustainable consumption for sustainable growth. The manufacturing sectors are required to develop Sustainable manufacturing practices that can promote a good quality of life which will lead towards a sustainable development. Some of these steps might be the followings:

- Adoption of sustainable technologies and practices
- Efficient and effective use of natural resources
- Effort to minimize undesirable environmental effects
- Use of alternate materials for making better products
- Use of clean and efficient technologies
- Use of recycling technologies
- Focus on research and development for developing innovative technologies.

Till recent past many of the industries and their manufacturing practices were causing harm to the environment leading to its gradual degradation in a variety of ways. It is likely that the environment concerned society and the government will not tolerate these malpractices and damages caused by the manufacturers any further. It is also likely that the competition and challenges will continuously increase amongst the manufacturing industries in the future. Therefore only the manufacturers adopting sustainable technologies and sustainable work practices will be able to survive and thrive in the years to come.

It can be said that manufacturing will be truly 'sustainable'

only through the active participation and commitment of the Government, the society and the manufacturing organizations.

VI. SOME RECENT TRENDS FOR CONSTRUCTIVE DEVELOPMENTS

Responsible technocrats, researchers and manufacturers are expected to develop various technologies that will bring a cleaner, healthier, safer and sustainable global environment. The recent trend is to develop alternate materials for manufacturing, focus on innovation, development of micro and nano technologies, product development through recycling, analyzing energy during manufacturing with the aim of reducing it by process optimization or by better product design or by using advanced technologies.

A. *Development of alternate materials and better design*

The recent trend is to look for alternate materials that may require less energy to produce goods and may reduce the generation of scrap, waste, emission, toxic substances. As per Blawert C et al. (2004) recent global trends are driving the automotive industry to manufacture lighter, more environmentally friendly, safer and cheaper cars. Mustafa Kemal Kulekci (2008) stated that, in the past, aluminum and plastic were been used extensively as the preferred material for many automobile parts but in the recent years the use and applications of magnesium in the auto sector are increasing. He also highlighted that recent research and development studies of magnesium and magnesium alloys have focused on weight reduction, energy saving and limiting environmental impact. The leading automakers are concentrating on the reduction of car weight and limiting the amount of exhaust emissions due to legislative compliances and consumer preferences for safer, cleaner vehicles and environment friendly products (Friedrich et al. 2001).

B. Development of new and innovative technologies

The recent trend is to develop newer and innovative technologies that may give birth to the concept of sustainable manufacturing holistically. According to Dr. Hans-Gunter Vieweg (2012) innovation processes are characterized by the convergence of interdisciplinary inputs from the fields of science, technology, geography and many other fields. Nanotechnology, materials technology, information technology and flexible manufacturing are considered as key drivers of innovation. In order to achieve sustainable development, environmental protection constitutes an inherent part of the development process and, therefore, cannot be considered in isolation. Ways to improve the existing designs and processes in order to reduce consumption, wastage and prevent residues from damaging the environment have to be found. As a result, scattered but strong pools of knowledge have been developed in the areas of Lean Manufacturing, Sustainability, Waste Reduction, Energy Efficiency and related issues. However, these pools of knowledge are not synergized and inadequate, or no linkages exist between these diverse knowledge bases. As a result, conflicting interests between different knowledge bases pose a severe hindrance in the development and use of these technologies. A holistic techno-managerial blue print may be required to find the resolution of such conflicts. The development of sustainable products by using multi-disciplinary knowledge inputs will not only ensure a large economic impact but will also fulfill the all-important obligation towards achieving the objectives as envisaged in the definition of sustainable manufacturing.

C. Macro, Micro and Nano manufacturing technologies

In recent years, manufacturing industry has witnessed a rapid increase in demand for macro, micro and nano products and components in many industrial sectors including electronics, optics, medical, biotechnology and automotive sectors. This reflects the current trend of product 'miniaturization'. All 3 platforms i.e. macro, micro and nano must be able to perform multiple functions either singly or in a combination thus allowing function integration (i.e. combination of different functions) and length-scale integration (i.e. mixing of the macro, micro and nano dimensions). This would result in tremendous cost and environment benefits (E. B. Brousseau et al., 2010).

John Allen (2010) highlighted the need for developing versatile miniature machine tools for in situ repair/ maintenance work on large mechanical systems. As per T. Eriksson (2008) a Micro factory is a concept that refers to extreme miniaturization of a manufacturing system. It was pointed out that if the equipment could be miniaturized without compromising the manufacturing capability, it would result in a dramatic reduction of space and energy consumed by a factory. As a consequence the environmental impact would also be reduced.

D. Recycling for Sustainability

Recycling is a concept that many a times help in reducing environmental degradation as the same material is used again and again. The cost of the recycled product is generally much lower as compared to that produced with virgin materials. According to Butler and Hooper (2000) and Fleischmann et al. (2001) the cost of conversion of recycled material into new products is often less than the conversion cost using virgin materials. For example, steel mini-mills that melt scrap iron

do not require the same level of capital investment (coke ovens, iron ore sintering facilities, blast furnaces) as required for the conventional steel mills, thereby greatly reducing capital and operating costs (Crandall, 1996). Similarly, paper mini-mills have lower capital and operating costs than

conventional mills because the separation of cellulose fibers from wood has already been done (Denison and Ruston, 1997). As per Joy M. field et al. (2007) while producing aluminum, steel, paper, and glass a lot of adverse environmental consequences stem from the initial processing of the virgin materials. Consequently, environmental regulations and their associated costs are very high for manufacturers using virgin materials. On the other hand, the use of recycled materials significantly reduces all forms of pollution and therefore, has minimal environmental compliance issues besides substantial cost benefits (Kharbanda and Stallworthy, 1990).

E. Qualitative Analysis of Energy

The demand for energy is rapidly increasing. At the same time the conventional resources of energy are depleting very fast. The efficient use of energy for the industrial and other applications has assumed a great importance. This thought gave birth to the concept of "exergy" (G. Wall et al., 2011) which deals not only with the quantitative aspect of "energy" but also its "qualitative" aspect. This concept focuses on the 'capability' of 'energy' to perform tasks. This can be further explained by understanding the work potential of a particular type of energy. For example 'frictional energy' has very little ability to perform any work. On the other hand some forms of thermal energy have tremendous work potential. Consequently it can be said that different forms of energy posses different work potential. The importance of designing more energy efficient (exergetic aspect) machines and equipments have to be understood at length.

VII. Product Life Cycle and Sustainability

Sustainable products are the products that are fully compatible with nature throughout their entire life-cycle. Various aspects and criteria should be considered while designing a product based on sustainability issues. The various parameter of sustainability for designing a sustainable product is shown in figure 1.1.

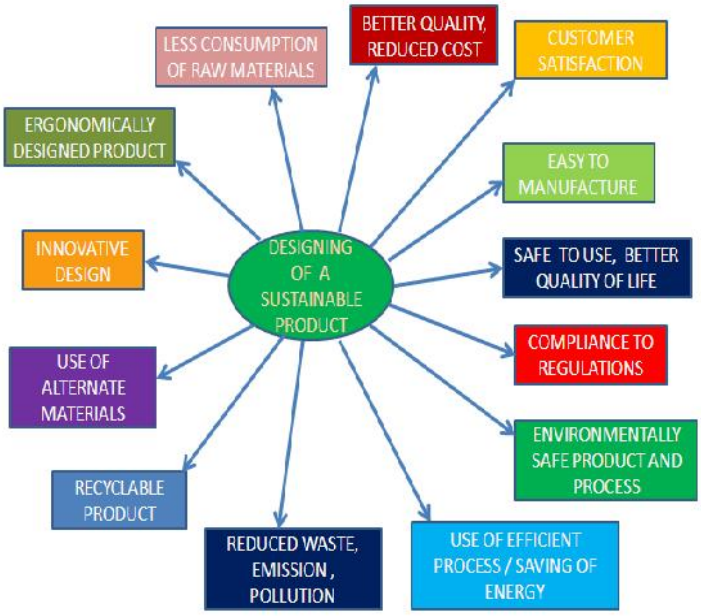

Figure 1.1: Parameters of sustainability

CONCLUSION

Progress and developments are never static but are always dynamic in nature. The rapid developments in last few decades has highlighted the fact that the over exploitation of the natural resources resulted in destructive development by causing much damage to our eco system. It is therefore desirable that the concept of sustainability to be inbuilt in all the aspects of manufacturing including processes, tools, methodologies and techniques. The manufacturers are expected to use renewable energy, develop technologies that are more energy efficient and focus on the reduction and optimization of waste, emission and toxic substances while manufacturing. The development of sustainable manufacturing processes and practices will give rise to true sustainable development.

REFERENCES

[1] Alfred Russel Wallace, "Human Progress: Past and Future," S445:1892, http://people.wku.edu/_charles.smith/wallace/S445.htm
[2] Blawert C, Hort N, Kainer KV (2004), "Automotive applications of magnesium and its alloys," Trans Indian Inst Met, 57(4):397–408.
[3] Butler, J. and P. Hooper (2000), "Factors Determining the Post-Consumer Waste Recycling Burden," Journal of Environmental Planning and Management, 43, 3, 407-432.

[4] Crandall, R.W. (1996),"From Competitiveness to Competition: The Threat of Minimills to Large National Steel Companies," Resources Policy, 22, 1/2, 107-118.
[5] Denison, R.A. and J.F. Ruston (1997), "Recycling is Not Garbage," MIT's Technology Review, 100, 7, 55-60.
[6] Dr. Hans-Gunther Vieweg (2012), "An introduction to Mechanical Engineering: Study on the Competitiveness of the EU Mechanical Engineering Industry," ENTR/06/054.
[7] E. B. Brousseau & S. S. Dimov & D. T. Pham (2010), "Some recent advances in multi-material micro- and nano-manufacturing," Int J Adv Manuf Technol 47:161–180.
[8] Fleischmann, M., P. Beullens, J.M. Bloemhof-Ruwaard, and L.N. Van Wassenhove (2001), "The Impact of Product Recovery on Logistics Network Design," Production and Operations Management, 10, 2, 156-174.
[9] Friedrich H, Schumann S (2001), "Research for a new age of magnesium in the automotive industry," J Mater Process Technol, 117:276–281.
[10] Goran Wall, Tsatsaronis (June 2011), "Life Cycle Exergy Analysis of Wind Power," 2nd Int Exergy Life Cycle Assessment and Sustainability Workshop Symposium, Greece.
[11] John Allen & Dragos Axinte & Paul Roberts & Ralph Anderson (2010), "A review of recent developments in the design of special-purpose machine tools with a view to identification of solutions for portable in situ machining systems," Int J Adv Manuf Technol, 50: 843–857.
[12] John McCarthy (1995), "Progress and its Sustainability," http://www-formal. stanford.edu/jmc/progress
[13] Joy M. Field, Robert P. Sroufe (2007),"The Use of Recycled Materials in Manufacturing: Implications for Supply Chain Management and Operations Strategy," International Journal of Production Research, Volume 45, Numbers 18-19, September 2007, pp. 4439-4463(25).
[14] Kharbanda, O.P. and E.A. Stallworthy (1990), Waste Management, Auburn House, New York.
[15] Mustafa Kemal Kulekci (2008), "Magnesium and its alloys applications in automotive industry," Int J Adv Manuf Technol 39:851–865, DOI 10.1007/s00170-007-1279-2.
[16] Roger C. Herdman (1994), "Perspectives on the Role of Science and Technology in Sustainable Development," OTA-ENV-609.
[17] Stephen E. Little (1999), "Science, Technology and Society in East Asia: Frameworks for the challenges of the Next Century," AI & Soc 13:247-262, © 1999 Springer- Verlag London Limited.
[18] T. Eriksson & H. N. Hansen & A. Gegeckaite (2008), "On the use of industrial robots in microfactories," Int J Adv Manuf Technol, 38:479–486.