



Green Manufacturing for Global Concern and Sustainable Development

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Abstract

Green manufacturing is the Methodology/ Philosophy/Technology/ Concept that is aimed at minimizing wastes and pollution during the Manufacturing of a product through proper Product Design, Process, Material Selection and Product Lifecycle Management design.

Green Manufacturing in this context refers all the manufacturing methods that do not contribute at all, or very little pollutants to environment. Mostly people always consider all aspects of Global warming, GHG emissions, waste disposal, deforestation and the many other similar aspects when talk about GM. So obviously there exists a lot of difficulties in initializing, implementing or maintaining the concepts of GM. Though some aspects are common in GM, their discrimination, role, and direct impact on GHG are not clearly as well as separately analyzed and treated. This paper is a qualitative approach to achieve the real Green Manufacturing

Key words: GM, GHG, Product Design, PLM, 3M Standardization, Waste reduction.

1. Introduction

The term Green Manufacturing embraces all utilities, facilities, plants and industries etc which produce some form of finished goods from some form of raw materials. Instead of treating all facilities under one group treat each sector individually and lay down policies for each type of Manufacturing unit and train them to achieve the real benefits of Green Manufacturing.

Green Manufacturing is not an easy concept or a single module to deal with. It is actually a set of combination of all concepts shown in figure.

Achieving Green Manufacturing is not an unattainable concept to worry about and not a cake-walk either. Devising and implementing proper methodology can fetch not only expected results but save millions of rupees every year toward the journey to Green Manufacturing. [6]

1.1. Tangible/Direct benefits of Green Manufacturing

1. Pollution free environment.
2. Neat and clean environment.
3. Safe working conditions.
4. Reduction of wastes of all kinds.



5. Savings in manufacturing costs.
6. Savings in raw materials costs.
7. It ensures safety.
8. Energy savings.
9. Company's standard is improved and becomes government friendly with legislation.
10. Avoids health hazards of human and other living things.
11. No wastage & hence costs savings.
12. Recycling of all items made possible.

1.2. Intangible/Indirect benefits

1. Morality of the workers is improved.
2. Customer satisfaction and appreciation.
3. Less toxic products and safe working conditions.
4. Improved manufacturing methods.
5. Depletion rate of Natural resources is reduced greatly.
6. Increased productivity.
7. Employer, employees' relationship is improved.
8. Job satisfaction and improvement of skills of workmen.
9. The management may feel proud of their products and services.
10. GM ensures effective life cycle of products there by helps to improve quality of products in future.
11. Future Generation is saved from global warming.

2. The Main Focus areas of GM

President of Pojasek& Associates, an internationally recognized expert on the topic of business sustainability and process improvement, said that a Manufacturing firm to go Green, should focus on wastes. "Carbon comes from four inputs:

1. Energy, 2. water, 3. Materials and 4. Labor.

Pay attention to those inputs and you will reduce your carbon footprint," he said. I can also suggest, two more inputs, Processes and Machines should also be considered (5 and 6) to go green.

The below two graphs show the rate of carbon emission and the relationship ratios of Population, GDP and GHG emission. One could realize the alarming rate which emphasizes the need of Green manufacturing in all walks of life. Anyone can understand, that there exists a very complex relation between GDP, Population and GHG emission. That is why I am telling it the high time to implement GM. Many organizations began to realize the benefits of GM.

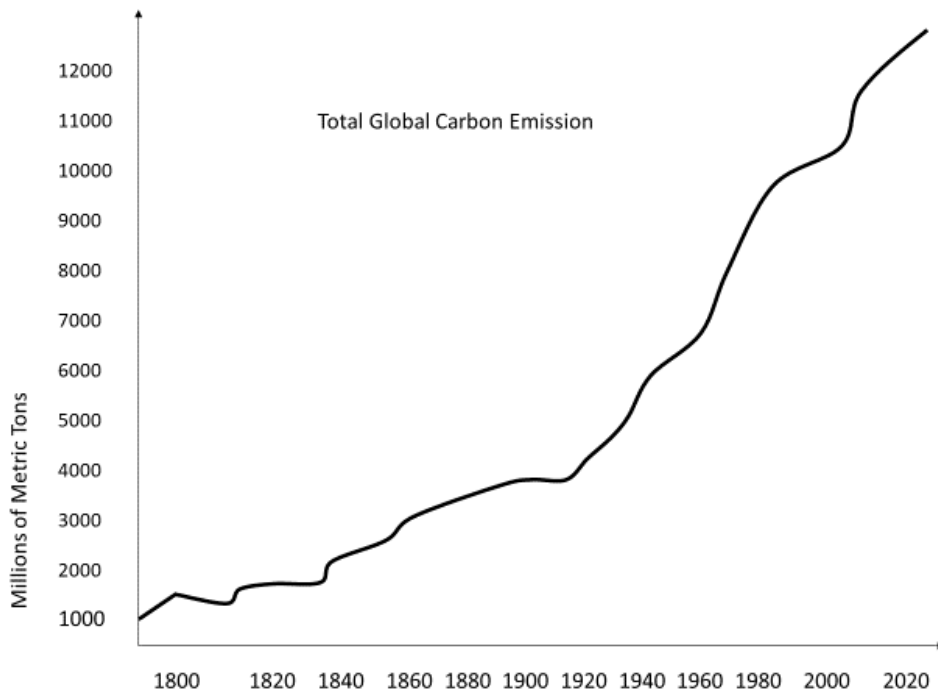


Fig. 1. Total carbon Emission – Globally

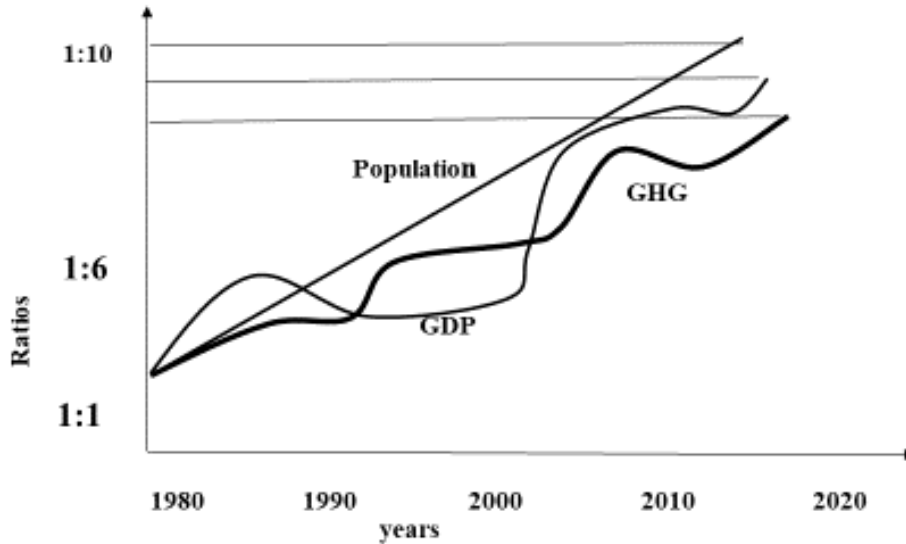


Fig. 2. Typical Relation between GDP, Population and GHG Emission

3. Modules of Green Manufacturing

The very first step towards GM I would say starts from site selection and product design phase. If you take the case of I.C. engines the use of a simple or Solex carburettor is completely replaced by many other fuel injection systems one among the reasons being fuel economy. Not because of the advancement technology it is made possible, but the demand for fuel efficient vehicle is one among the reasons. Thus, many products which are being manufactured in



non-eco-friendly methods and materials can completely be replaced with newer methods and materials to achieve GM. The following are some of the very vital steps to be followed to achieve GM.

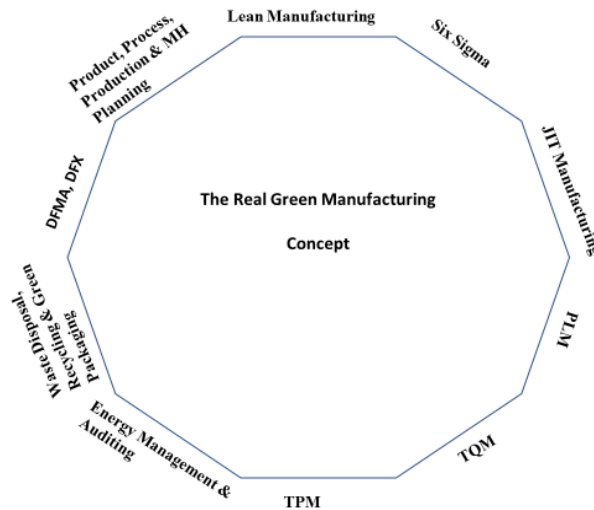


Fig.3. Main Modules of GM

Green manufacturing starts from site selection itself. A suitable site selection for a unit is an important aspect to meet the challenges of induction and processing of raw materials, maintenance and waste disposal. Then the layout, not to be ignored.

Cement, sugarcane, thermal power plants, fertilizer manufacturing, chemical industries, rubber industries, metal casting, textile dyeing units are some examples for which plant location should be of prime importance though all industries to be setup, need to consider this aspect in the point of GM.

4. Basic and prime steps of GM

- Select a Suitable Site & Layout
- Design the Products using KISS principle (Keep It Simply Simple)
- Adopt DFMA and DFE (Design for Environment) principles
- Decide Raw Material and shape keeping GM in mind
- Select Material Handling equipment
- Decide the method of raw material storage (prefer JIT wherever and whenever possible)
- Decide Manufacturing methods for GM (prefer additive manufacturing to subtractive)
- Decide the green lubrication and cooling methods
- Follow 3M Standardization (for non-degradable products)
- Sub contract sub-assemblies only to GM companies



Decide packaging methods

Decide recovery of wastes and recycling methods

Decide waste (if any) disposal methods.

5. The 3M Standardization a path way to GM

I Suggest a new principle of the 3M, Standardization (Proposed by me) for GM. The 3Ms are

1. Mini, 2. Medium, 3. Maximum

When tube lights, width of fridges and so many components have to follow size standardization, why can't the Government, implement the same to other products also plastics and rubber and non-biodegradable items? (Sachet of shampoo and oil, water bottles, etc.). This is not going to affect the sales instead it will increase profit and reduce overhead and other expenses. Intermediate sizes manufacturing should be avoided.





Fig. 4. Numerous sizes of plastic bottles, sachets of oil, shampoo (to be minimized based on 3M principle).

6. A case study on Dry or CO₂ Machining

A little creative thinking can lead to cutting waste in surprising areas. The United States used 2 billion gallons of metalworking fluids to cool and lubricate metals in 2000. They accounted for 12 percent of machining costs.

So, Steve Skerlos, principal investigator at the Environmental and Sustainable Technology Laboratory at the University of Michigan turned to supercritical carbon dioxide as a replacement. [9].

When he separated it from the atmosphere and compressed it to 1,100 psi, it dissolved in oil. "A high-velocity stream of gas delivers a minute amount of oil that provides all the lubricity you need, and the expansion of the gas removes heat right where you generate it. Tools last longer and you can machine faster," Waste disposal disappears as an issue because the process uses only 5 milliliters of oil per hour.

It would take roughly 30 to 160 days of 24-hour machining to use the same amount of fluid a conventional metalworking fluid-cooled machine uses in an hour. Also cutting speed increased with CO₂ machining. [10].

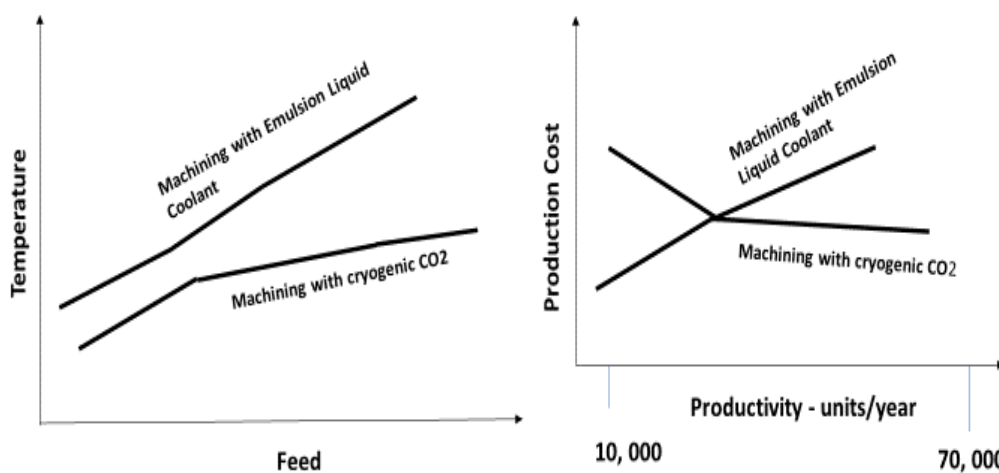


Fig. 5. a) Feed Vs Temperature,

5. b) Productivity vs Production Cost



7. Switchover to GM concepts

I suggest many areas in which GM principle could be implemented. The present scenario and proposed are tabled as below.

Table.1. Present and Proposed scenarios for GM- Comparison.

S. No.	Current Scenario	Proposed concepts to arrive GM
1.	Welded Parts & Gas cutting	FSW/Adhesive/Seam/ Laser Welding & cutting[4]
2.	R.O system for water purification	F.O and Shockwave desalination
3.	Subtractive Manufacturing	Additive Manufacturing whenever possible
4.	PM Electric Drives	RG VVVF Drives
5.	Poor value addition	Eliminate NVAA
6.	End of Pipe control	End of Life cycle Management, SCM [8]
7.	CAD/CAM/CAE	CIM & Statistical Package for social sciences
8.	Poor design with more parts count	3D printing reduces parts count
9.	Hot forging, casting, Machining	Cold forging, abrasive jet/Water jet Machining, EDM
10.	R & D department for product development	R & D SIPOC (Suppliers, input, process, outputs, customers)
11.	Mass Production with non-Green materials	Lean Manufacturing with Green materials [2]
12.	Electro Plating	Autocatalytic Plating
13.	WEEE	RoHS[3]
14.	Lead metal PCBs	Lead free PCBs
15.	Non-futuristic Design	Futuristic design
16.	Machine Room elevators	Machine room-less elevators
17.	Hydraulic drives for even small power application	Use Air muscle
18.	BPI	Green BPI
19.	Products Design for short term use & throw	Design for long term use & recycling
20.	Non-eco-friendly design	Futuristic CDD, 5s, 6 Sigma,



21.	Liquid coolant & Cutting oil Emulsion	Supercritical Carbon dioxide
22.	CRT, Plasma, Displays	LCD, LED displays
23.	Cost cutting Designs	Waste cutting Designs
24.	Use of conventional Energy sources	Use Renewable energy sources[1]
25.	Acid cleaning, Grinding for casting	Blast cleaning and shot peening, [5]

8. Waste Reduction promotes GM

Waste is considered as waste in many companies even today. Most companies do not take seriously the Waste reduction concept. There are many hundreds of different ways the waste can take place. (manufacturing time, rework time, material, energy, scrap, men, fuel, water and many). [3]

It is a sad fact to note that companies are more concerned about increasing production sales and price to achieve profit. They rarely realize the elimination or reduction of wastes of many kinds will fetch profit and save lot of money.

Most of the companies, fail to realize and identify where and when wastes occur during the course of their entire manufacturing activities.

The first waste reduction concept was proposed by Taiichi Ohono father of TPS Toyota Production System.

With the advancement in software and concepts (Andon, Gemba, HeijunkaHosinKanri , PDCA, Plan, Do, Check, Act, over all Eqpt Effectiveness OEE, Muda, Key Performance Indicators- KPIS Poka-Yoke (error proofing) SMED- single minute exchange dies, Root cause analysis) wastes can be eliminated completely, if not, to a very minimum.

Use the Wastes

If at all not possible to eliminate or reduce wastes use the waste usefully. That is, a waste of a machining process, say punching or coining the scrap can be used further to produce tiny parts or recycle. (in textile industries the waste yarns are used to produce waste pockets used for cleaning).

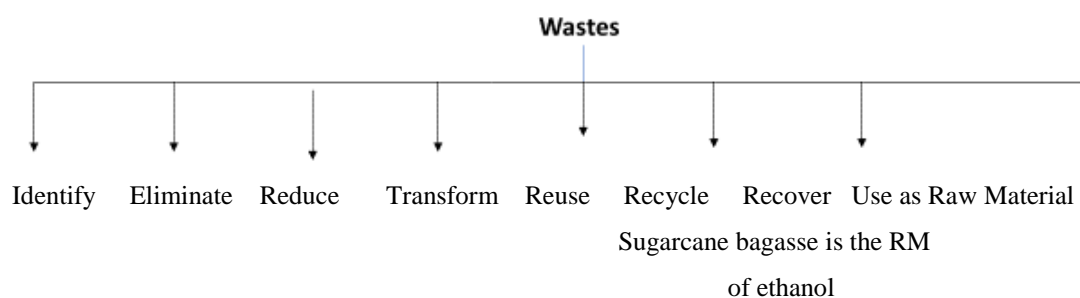


Fig.6. Waste Treatment options

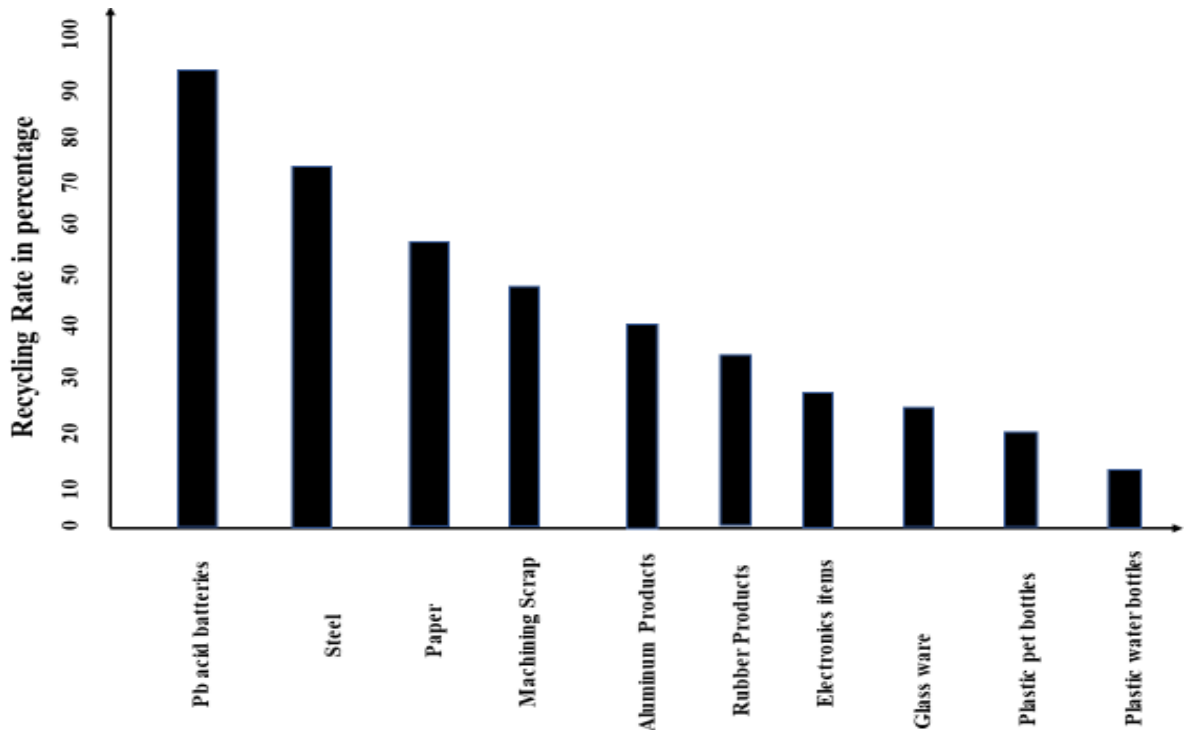


Fig.7. Percentage of Recycling of various materials around the globe.

9. The Role of consumer

Consumers support for GM is also not to be neglected. Of course, it may compel and drive the Manufacturers to go for GM and Green Products. If the customers realize the very need of the GM, they will opt to buy only mostly Green Products in all walks of life, say cars (solar, Electric, carbon fiber body panelled etc), computers, (with LCD/LED VDU) foods (non -plastic containers packed) etc. Even in cinemas people will love to see computer graphics fire accidents in buildings, instead of real fire settings.

Thus, consumers role is not to be ignored and given enough due in achieving the concept of real GM. The only thing is the consumers and customers have to be educated to buy and use mostly green products.

Conclusion

The concept and practice of GM not only protect global environment but also will save lot of money in the long run. Only an integrated approach among producer, and end user of the end products is utmost important in realizing the real benefits of GM.

It is the high time to derive and implement new paradigm, standardization and standards for industrial sectors, cottage industries, service providers, to adhere to GM. The Central and State Governments in collaboration with international and national standardization organizations should make new legislations to encourage GM in all areas of manufacturing.



The seems to be complexity concept of GM can easily be faced with a well-defined planning and implementation of the derived legislations. With the presently available technologies, developing technologies, dissemination of ideas and mutual sharing of knowhows GM could readily and easily be achieved globally.

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