Foreword

The Asian Productivity Organization (APO) has been conducting various activities related to the environment over the past 10 years to increase environmental awareness and promote policy, technology, and knowledge on the protection and improvement of the environment among its member countries. Inspired by the developments during 1992 such as the Earth Summit in Rio and Agenda 21, the APO launched its Special Program for the Environment in 1994 under a special grant from the Japanese government.

In an endeavor to find practical and attractive approaches for industries to deal with both productivity and environmental protection for sustainable development, the APO has decided to tackle the issue with the concept of Green Productivity (GP). In concrete terms, GP aims at improving environment in the process of increasing productivity, thus giving a competitive edge to businesses in the age of globalization.

To substantiate the GP concept, the APO has adopted a multi-dimensional micro-to-macro approach to promote GP practices. It focuses on the enterprise level through the applications of productivity and management tools (such as TQM, 5S, TPM etc.) that go in tandem with waste and emission prevention, energy conservation, pollution control, and environmental management systems. Initially taking off in the industrial sector, GP is now being increasingly applied to agriculture, service industry, and even communities. GP is thus evolving as a drive with comprehensive strategies for sustainable socio-economic development.

To operationalize GP at practical levels, the APO has developed a six-step, 13-task methodology following Deming's plan-do-check-act (PDCA) cycle. This methodology has been successfully applied in the past few years throughout the APO region in various GP demonstration programs and has been found to be very effective and productive. While the PDCA framework provides the basic skeleton of GP implementation, the distinctive part of GP methodology is its ever-expanding set of tools and techniques to complement the PDCA framework. This methodology has been thus field-tested and is being disseminated through various training programs in APO member countries.

I am very pleased to present this GP Trainer's Resource Manual, which is the culmination of the efforts of many GP experts from the region over the past few years. This manual has so far been used in many of the APO’s multi-country workshops and by the national productivity organizations (NPOs) in their in-country GP programs. By publishing this manual, the APO hopes that the NPOs in APO member countries as well as other national and international agencies can learn more about GP and possibly adopt GP principles and methodology in their training and capacity-building activities.

I would like to record my sincere appreciation to all the GP experts who have contributed to this manual.

Takashi Tajima
Secretary-General

August, 2002

APO and Green Productivity

Contents	Page No.

The Asian Productivity Organization (APO)

→ Intergovernmental regional organization with HQ in Tokyo, Japan
→ Established by convention in 1961

OBJECTIVES

Propagating productivity consciousness in Asia & Pacific Region by performing the roles of:

- think-tank
- catalyst
- regional adviser
- institution builder
- clearing house of information for productivity

Ppromoting and disseminating:

- modern productivity skills
- techniques
- experiences in agriculture, industry, and service sectors

The Asian Productivity Organization (APO) is an intergovernmental, regional organization with headquarters in Tokyo, Japan.

It was established by Convention in 1961 by several Asian countries to hasten their economic development.

The objective of the APO is to increase productivity, and consequently, accelerate economic development in Asia and the Pacific Region through mutual cooperation.

The APO seeks to realize its objective by

Propagating productivity consciousness;

Performing the roles of think-tank, catalyst, regional adviser, institution builder, and clearing house of information for productivity;

Promoting and disseminating modern productivity skills, techniques and experiences in agriculture, industry, and service sectors;

Promoting the Green Productivity (GP) concept and practices among the member countries.

APO Member Countries

- APO is a non-political, non-profit making and non-discriminatory body
- APO has 18 Member Countries

Bangladesh
Republic of China
Fiji
Hong Kong
India

Indonesia
Iran
Japan
Republic of Korea
Malaysia
Mongolia

Nepal
Pakistan
Philippines
Singapore
Sri Lanka
Thailand
Vietnam

- Membership is open to all governments which are ESCAP members

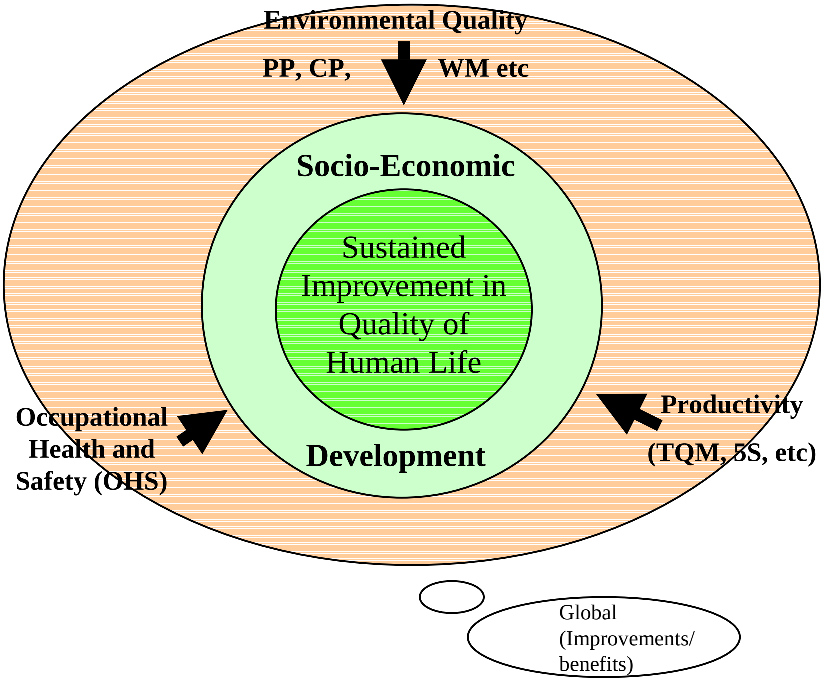
The APO is non-political, non-profit making, and non-discriminatory.

APO membership is open to all governments in Asia and the Pacific region that are members of the UN Economic and Social Commission for Asia and the Pacific (ESCAP).

Governments outside Asia and the Pacific region may become Associate Members.

Special Program for the Environment (SPE)

The Environment Department was established through a special grant from the Japanese government to promote Green Productivity (GP) and other Environmental Projects.



Environment Department Mission

To create paradigm shift amongst the stakeholders for productivity enhancement that is in harmony with the environment, leading to (international) competitive advantage for a sustained improvement in the quality of life

In response to the recommendations of Earth Summit of 1992 that economic development and environmental protection would be the two key strategies for sustainable development, the APO commissioned a basic two-year study on productivity and the environment in 1993.

Based on the research findings, the APO in 1994 created the Office for the Environment, which is now known as Department of Environment, with SPE leading its future direction and activities.

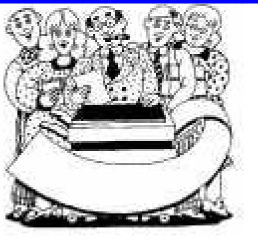
As outlined in the mission statement, the environment department, through its programs and activities, attempts to affect a paradigm shift in society by addressing Productivity, Occupational and Health (OSH) and environmental aspects. In this way, it aims to enhance (international) competitiveness, leading to more profits due to the inherent productivity element; to improve the occupational and environmental health and safety of the workforce, in particular, and society in general; and catalyze a more equitable (both social and gender) value system. It is also expected that such a development strategy at the macro level will ultimately contribute to the alleviation of global problems such as climate change and depletion of the ozone layer.

Thus, this multi-faceted, holistic approach attempts to cover all aspects that are crucial for the overall socio-economic development of a sustained improvement in the quality of human life.

APO World Conference on Green Productivity, 1996

MANILA DECLARATION ON GREEN PRODUCTIVITY

The declaration was signed on 6 December 1996 in Manila, Philippines at the APO World Conference on Green Productivity.



The Conference declared:

Environmental Protection should be promoted without sacrificing Productivity.

For the movement of Green Productivity to be successful, it was recognized that all efforts would have to be pooled by calling for mutual cooperation at transnational and global levels.

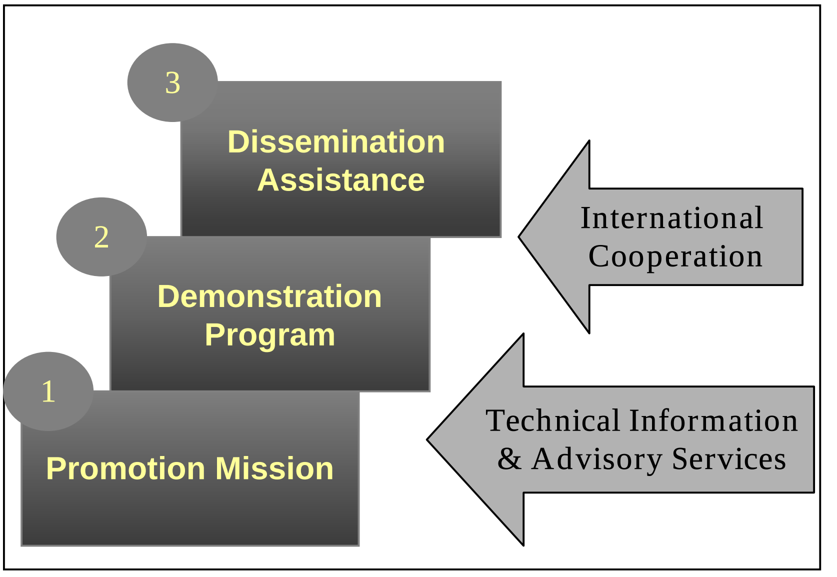
At the APO World Conference on Green Productivity in Manila in December 1996, the "Manila Declaration on Green Productivity" was issued and endorsed by the conference delegates.

THE MANILA DECLARATION ON GP

"All stakeholders (should) promote awareness and mutual cooperation in Green Productivity by:

- actively participating in networking of complimentary activities
- exchanging ideas and experiences
- disseminating information and
- encouraging the involvement of everyone in the GP Movement as the strategy for better quality of life for all."

APO GP Programs



The various activities and projects implemented under APO's Green Productivity Program include:

Green Productivity Promotion Mission to assist member countries to identify the main problem areas and the opportunities for GP implementation.

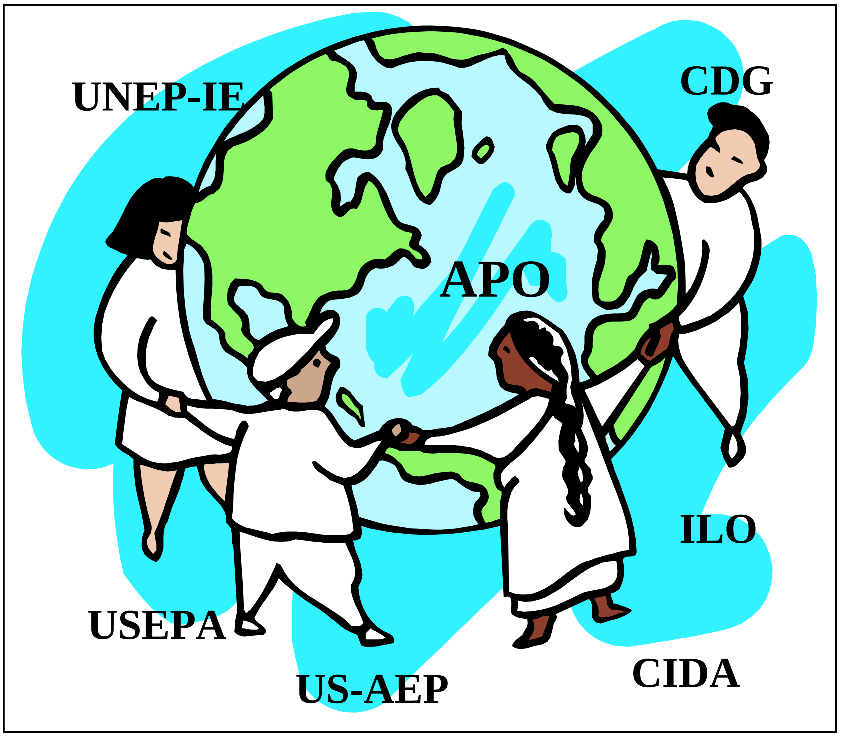
Green Productivity Demonstration Program aims at (i) substantiating that environmental protection and productivity improvement can be profitably harmonized, especially in small and medium businesses, and (ii) promoting the establishment of environment-friendly factories, communities and farms in APO member countries.

Green Productivity Dissemination Assistance aims at providing assistance to NPOs which have already implemented GPDPs to further promote the establishment of environment-friendly factories and farms by encouraging other factories and farms to follow suit.

Green Productivity Technical Expert Services Scheme through which the APO sends experts to member countries which have requested the Green Productivity Promotion missions.

International Cooperation builds on these activities by linking with other international and national organizations outside the APO region which have similar objectives and goals.

International Cooperation



To achieve greater impact and maximize use of its financial resources for the SPE, collaboration with like-minded international organizations and events is regarded as important.

APO collaborations include:

• APO/UNEP IE Collaboration, signed in 1997, for cooperation in the areas of CP/GP.

• APO/CDG collaboration to promote GP amongst SMEs.

• APRCP in Thailand in 1997 and in Brisbane in 1999.

• Collaboration with US-AEP at the Workshop on Green Industry Network in Bangkok, July 1998. APO participated as a sponsor by sending experts to the workshop.

• Collaboration with USEPA, Commonwealth Secretariat, and ILO in Energy, Supply Chain and Occupational, Environmental Health & Safety, starting in 2000.

CHAPTER 1

Sustainable Development & Green Productivity

S.No.	Contents	Page No.

Objective of the Lecture

The objective of this lecture is to provide background to the evolution of the concept of Green Productivity (GP) from productivity practices. The lecture begins with background on the existing state of the environment and development, and builds towards the need for a strategy that can move the Asian region towards sustainable development. The lecture is aimed at both small and medium-sized enterprises (SMEs), as well as policymakers.

By examining trends in present environmental management strategies and practices, the lecture describes the need for the emergence of Green Productivity (GP).

The lecture also presents the driving forces behind GP and the benefits that GP provides to business, the environment and society at large.

It is also the aim of this lecture to show that GP is not just a one-dimensional strategy addressing only specific sectors, such as industry. GP is a multi-dimensional, holistic strategy that aims at improving overall quality of life while leading development in a sustainable direction.

Lecture Specific Instruction to the Resource Persons

This lecture aims to provide background to the evolution of Green Productivity as a concept.

The duration of this lecture is 60 minutes, with 40 minutes reserved for the presentation and 20 minutes for discussion. Bearing in mind that the lecture aims to convince the participants of the need for GP, the suggested allotment of time for the various topics to be covered is as follows:

1. Economic and Environmental Trends 5 minutes
2. Global Environmental Concerns 15 minutes
3. Response to Environmental Concerns 5 minutes
4. Environmental Management Trends 15 minutes

The last 20 minutes must be reserved for discussion, so that the participants can clarify the issues that concern them.

The lecture must be in a narrative form, tracing the history of GP.

In section 1.1 and 1.2 of this lecture, the resource persons may wish to use some location-specific information to illustrate the need for GP in the area where it is being promoted. The resource person may use his or her discretion in selecting the viewgraphs provided for this lecture if additional ones on local issues are to be added. Care should be taken to maintain the correct time allotment for the section.

Section 1.4 is the heart of the presentation and is to be used to convince the participants of the need for GP.

1.1 Economic & Environmental Trends

1.1.1 Economic Activity & Environment

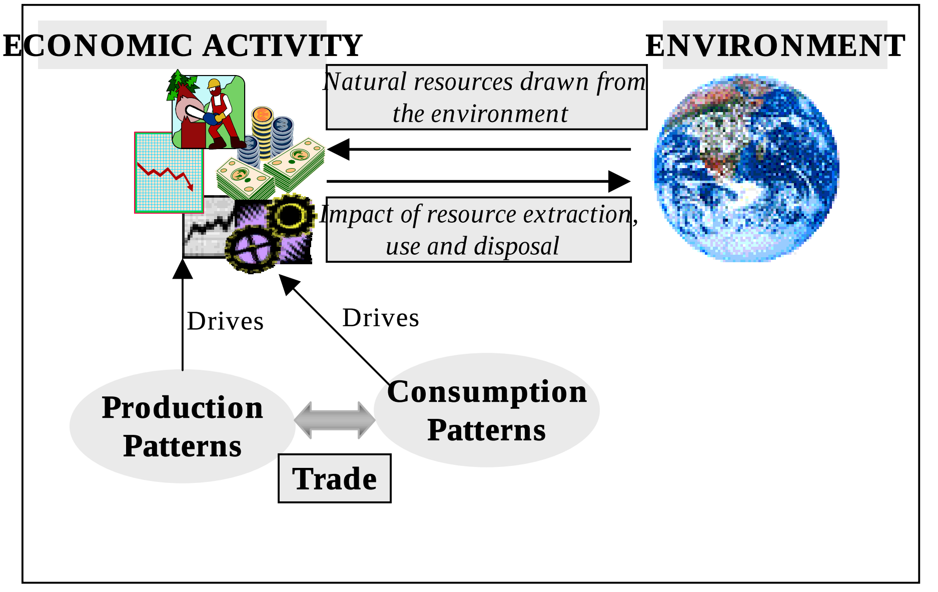
“Environment and development are not separate challenges; they are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base; the environment cannot be protected when growth leaves out of account the costs of environmental destruction. They are linked in a complex system of cause and effect.”

Our Common Future, The World Commission on Environment and Development, 1987

The bottom line here is:

The rate at which resources are extracted/ impacted must be slower that the rate at which they are replenished by natural processes. This is the core or the essence of sustainable development.

Economic Activity and Environment



Any form of economic activity, be it agriculture, industry or, more recently, the services sector, involves use of natural resources.

These resources could be water, energy, mineral or biological. Essential human needs can be met only through goods and services provided by the utilization of these resources.

The process of harnessing these resources to provide useful goods and services, however, also results in degradation of the environment.

Resource consumption in the world is increasing rapidly, driven by population growth and rising wealth. Technological change and urbanization also fuel consumption, by creating new patterns of human needs and aspirations.

Modern *consumption patterns* and the corresponding *production patterns* involved in the satisfying of human needs are leading to high fossil fuel and mineral resource use and excessive water consumption, leading to polluting emissions, volumes of waste and degradation of natural systems.

It is now universally recognized that production and consumption patterns have become unsustainable. This has led to severe, and in many cases, irreversible deterioration of the environment.

To protect the environment, long-term structural change in economic activity is required. It has to be made more responsible and resource utilization needs to be made more efficient.

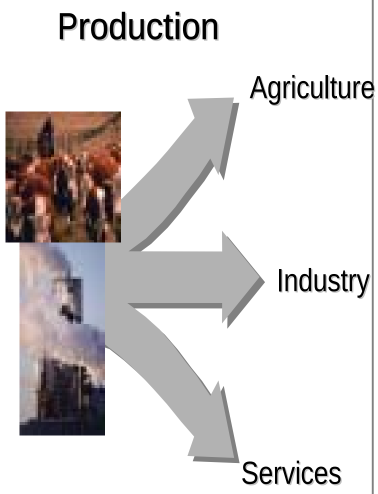
Production and consumption patterns are indeed skewed by trade and competition in international trade.

Before we can develop sustainable approaches and strategies, we need to examine the present situation .

1.1 Economic & Environmental Trends

1.1.2 Production Patterns

Production Patterns



Some facts about Asian economic growth

- Average annual growth between 1990 to 1996, for East Asia and the Pacific, has been 14.5%.
- Industry in East Asia has increased its share of total output from 32% to 45% and in South Asia from 21% to 28% between 1965 to 1996.
- In South Asia the value added (as a % of GDP) by agriculture has fallen from 38% in 1980 to 28% in 1996 while industrial output has increased from 25% to 28% in the same period.
- Exports of services from developing countries grew at an average annual rate of 12% in the 1990s, twice as fast as those from industrial regions.

Production activities that provide essential goods and services for consumption include industry, agriculture and services.

Industry is central to the economies of modern societies and an indispensable vehicle of growth. It is essential that developing countries widen their development base and meet growing needs.

Industry has an impact on the natural resource base throughout the entire cycle, from raw material exploration and extraction to product use and disposal. These impacts may be positive, enhancing the quality of a resource or extending its uses. They may also be negative as a result of pollution and depletion/degradation of resources, both during the manufacture of goods and services as well as during their use and disposal.

In Asia, intensive growth is resulting in heavier pollution loads, both in the short- and medium term. Pollution intensive, resource-based industries such as metal products, chemicals, machinery and equipment are growing very fast in Asia's developing countries. This has resulted in extensive environmental degradation and depletion of natural resources.

Compounding the problems of industrial development, recent changes in agriculture—a mainstay of economic development in a number of Asian countries – is also leading to natural resource degradation. New hybrid varieties of seeds are being used for high-yield crops, resulting in increased use of agro-chemicals in the form of pesticides and fertilizers.

The growth of the services sector in East Asia and the Pacific was three times the world average in the 1990s. In fact, exports of services from developing countries grew at an average annual rate of 12% in the 1990s, twice as fast as industrial regions.

Increasing awareness and growing public concern about the negative impacts of agriculture, industry and services on natural resources is forcing a rethinking of the strategy for growth and economic development.

Industry, however, still has the greatest impact on production and consumption patterns.

Reference Look Up

1. World Development Indicators, The World Bank, 1998

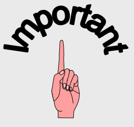
2. Cylke O, Asia,The Environment and the Future of Development in: *An Asian Clean Revolution* - US-AEP (Background Papers, July 1998)

Important

Pollution is a form of a waste and a symptom of inefficiency in industrial production

1.1 Economic & Environmental Trends

1.1.3 Consumption Patterns

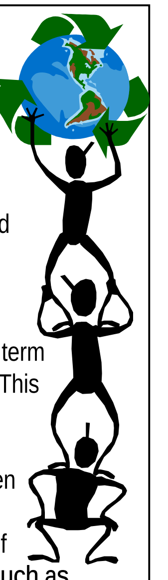


A knowledgeable consumer drives producers to be more responsible. Accountability and communication will thus play a major role in driving development towards a sustainable path. This is where the role of responsible NGOs and pressure groups is critical.

1. Report of the workshop on Consumption in a Sustainable World held in Kabelvag, Norway, Ministry of Environment, Norway, June 1998.

2. Robins N., Roberts., S. *Changing Consumption and Production Patterns, Unlocking Trade Opportunities*, IIED, UK, 1997.

Consumption Pattern



Consumers boycotts of products based on environmentally and socially damaging practices include e.g., use of tropical timber, textiles produced under unsafe / exploitative social conditions, metal finishing done with toxic metals. Boycotts against products of oil companies causing damage to eco-sensitive areas and indigenous people have also been intensive.

Important trends are emerging among consumers in North America, Europe and Japan. Over 80% of Americans are concerned about the environmental and social consequences of a materialistic society.

The Government of Japan launched the ECO ASIA initiative, to draw up a long term perspective for sustainable development for the Asia-Pacific region upto 2025. This found a common Asia-Pacific "eco-consciousness."

Green consumer movement has waned since the late 1980s in Europe. Between 1992-1995 willingness to buy eco-friendly products has fallen from 69-58% in Britain and 75-50% in Germany. Main reason is confusion due to proliferation of labels and false claims. **Active demand still exists however in some areas such as organic produce, fair trade coffee, tea and bananas, organic cotton.**

Green consumerism began in Europe. It reached its peak in the 1980s, and was particularly strong in Germany.

Prominent consumer boycotts include that of Shell Oil in protest at environmental and social degradation in Nigeria; and an eight-year boycott against Mitsubishi Motor Sales of America and Mitsubishi Electric America for the use of tropical timber in paper, packaging and products.

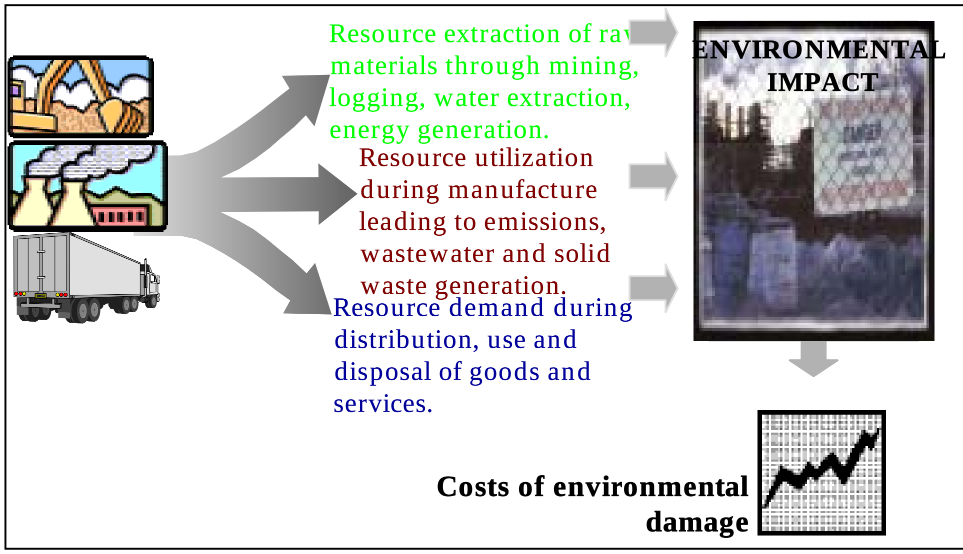
Studies undertaken as early as 1985 showed that demand by consumers for eco-friendly products was 37.6%, a two-fold increase over 1977 figures. Consumers are also beginning to favor manufacturers who take responsibility for disposal of products such as fridges, computers, batteries and cars.

Recent Eurobarometer surveys report that as a result of a proliferation of labels and false claims of eco-friendliness, there is *a decline in the willingness of consumers to pay a premium for eco-friendly goods and services unless categorically proven.*

Japan's rapid transition to consumer affluence makes it a role model for emerging economies in Asia that are shifting to sustainable consumption. Responding to this, the ECO ASIA initiative was launched by the Japanese government to draw up a long-term perspective for sustainable development in the Asia-Pacific region up to 2025. The stress here is on values and traditional frugal Asian lifestyles, which are being threatened by mass consumption. Nevertheless, surveys have shown that patterns of consumption in the region are generally more energy efficient, with more equitable and less excessive consumption than in Europe and America.

Green consumerism is thus forcing producers to recognize "environment" as a competitive advantage and it is also indicating that producers must ensure that their claims are verifiable and authentic.

Industry and Environmental Degradation



Industry impacts the environment at every stage of the life cycle of goods and services produced. These effects begin at the stage of raw material exploration and extraction, continue in the transformation into products, and end in the use and disposal of products by consumers.

Obtaining raw materials through mining and other extractive processes leads to degradation of soil, vegetation, and contamination of air and water bodies.

Manufacturing processes result in air emissions, wastewater and solid waste generation, leading to pollution of air, water, land and associated biota.

Distribution of goods and services demands resources, including energy and packaging material, resulting in secondary environmental impacts.

Finally, the use and disposal of products by consumers again results in pollution of air, water and land.

In the 1950s and early 1960s, negative impacts of industrial activity were perceived to be local, but with the increasing expansion of industry and the globalization of trade, the footprint of environmental problems has crossed national and regional boundaries.

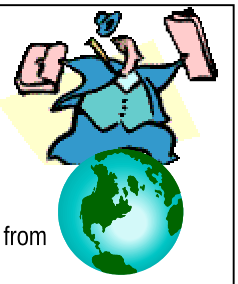
All this environmental damage is happening at a large cost, even in simple economic terms. The costs of environmental degradation in Asian countries such as India are above 5% of annual GDP, and for China may be as high as 10%.

The World Bank estimated in 1992 that East Asian countries would spend up to US$20 billion a year during the 1990s to clean up environmental damage brought about by rapid industrialization and population growth

REFERENCE Look Up

Ramankutty, R., Brandon, C. Asia and the Pacific, Asia Region Technical Department's Environment and Natural Resource Division (ASTEN), World Bank, 1999. http://www-esd.worldbank.org/envmat/vol2f96/ asiapac.htm

Trade and Environment



Trade is becoming increasingly globalized as well as liberalized.

International trade liberalization has been crucial for the success of Asian economies. Trade expansion has led to rapid growth in export-oriented industries, urbanization, construction boom.

Patterns of international trade have changed markedly. Focus of trade from the Asian region has been primarily on resource-intensive and labor intensive goods to the North.

Such growth has had wide ranging benefits, improved living standards, provided technological capabilities and financial resources. However, this outward-looking export based growth has in the aggregate generated new and increased environmental pressures.

From an economic perspective, both trade liberalization and environmental protection are inherently important. There is a need is to ***combine both these aspects to promote sustainable economic development.***

Trade has made nations economically and ecologically more interdependent. In the 1980s, value of trade in manufactured goods grew at a faster rate than that in primary products, with a growing number of developing countries emerging as major exporters of such goods. Industrialized market economies became more dependent on fuel and mineral imports from developing countries.

Developing countries had to use non-renewable raw materials to earn foreign exchange. The dilemma was how to break foreign exchange constraints on growth while also minimizing damage to the environmental resource base supporting this growth. Today, a number of developing countries have diversified into manufactured exports. Trade liberalization has led to Indonesia, Thailand, and Malaysia achieving remarkable growth rates in exports, manufacturing output, and aggregate income. Most striking are the high growth rates achieved in China, by far the largest East Asian developing country.

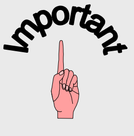
Outward-looking strategies, especially in the Asian region, have dramatically reduced poverty and raised living standards for a large fraction of the world's population.

The flip side is that this trade-led growth has not been supported by corresponding policy changes. As a result, there has been extensive degradation of the environment and natural resources.

Conditions for export success are changing as producers face rising environmental expectations in key export markets due to tightening of regulations, new corporate practices and changes in consumer values and lifestyles.

The export-led growth has also provided Asia with the financial resources, technological capabilities, and institutions with which environmental problems can be managed. By raising living standards and strengthening communications, it has also created social and political conditions in which people demand environmental improvements. The crucial issue, however, is to establish supportive policies and promote strategies that ensure sustainability of trade and the environment.

Over 6.5% of OECD consumption was met by imports from developing countries in 1996 although this is expected to increase to 14% over the next decade. The implications of this trend for developing country exporters could be profound.



The challenge for developing countries is to open up new trade opportunities by stimulating trade in sustainable goods and services. As much as one-third of the value of manufactured exports is in the sectors where environmental requirements are emerging.

Our Common Future, The World Commission on Environment and Development, 1987.

1.1 Economic & Environmental Trends

1.1.6 International Trade & Developing Countries

Vaughan Scott, *Trade and Environment: Perspectives of Developing Countries* UNEP, Environment and Trade

Trade and Developing Countries

One of the most important events in international trade is the completion of negotiations of the Uruguay Round in 1993.

Implications for developing countries are strong given that:
(I) gains of US$ 230 billion per annum are likely to accrue to world economy. Of this less than 30% gains will accrue to the South i.e., the developing countries;
(II) possible economic losses to developing countries importing food because of decreases in allowable European and North American agricultural subsidies.
(III) Multifibre Agreement will be phased out in 2004 thus removing quotas on exports of textiles and clothing which would be favorable for a number of developing countries.

Trade restrictions, protectionist barriers, non - tariff trade barriers such as ecolabels have environmental and economic implications for developing countries and sustainable trade .

In this context, the need to strengthen policy compatibility between trade liberalization and environmental protection has never been more crucial particularly for developing countries. This alone will ensure their survival in international trade. Role of WTO will be crucial in integrating trade and its environmental implications and in promoting and simulating trade in sustainable goods and services

The completion of the negotiations of the Uruguay Round of December 1993 is having far reaching implications on international trade for both developed and developing countries.

The Uruguay Round has set the course for further liberalization of trade and is widely regarded as reinforcing a transparent, predictable, multilateral trading system, benefiting developed and developing countries alike.

The implications of these negotiations need to be assessed in the face of issues influencing international trade, such as policy distortions in importing countries. Ihese range from protectionist barriers (especially for agricultural and textile imports) to bureaucratic regulations which effectively discriminate against foreign producers.

Market access is a subject of much dispute for developing countries. In particular, they are seeking to clarify rules governing exports of agricultural, tropical, wood and fishery products, as well as textiles and electronics.

The central issue is to find a workable balance between the sovereign right of countries to exploit their own environmental resources for economic gain, and the necessity of increased international cooperation to tackle mounting problems of resource and ecological degradation.

It is not surprising, therefore, that an important challenge identified at the Earth Summit in 1992 was to ensure that trade and environment are “mutually supportive."

Having looked at the interdependent relationship between economic activity and the environment, there is a need at this point to trace the changing perceptions of environmental issues to society.

Importance of SMEs

- **A SME enterprise employ less than 100 people and has capital less than US $ 1,00,000**
- **SMEs makeup 90% of number of enterprises in Asia**
- **Account for more than 50% of the Total Industrial Sector output in India and China and 10 to 25% in most other Asian countries**
- **Provide employment to about 50% workforce**
- **Contribute 50% of GDP**
- **Provide about 35% exports**

PROS	CONS
Important Source of Employment for low wage earners	Pose difficult pollution abatement problems
Flexible, React quickly to needs and demand	Specific pollution per unit of product greater than large scale units
Talent for innovation	Limited technical and Financial resources at their disposal

The importance and dynamism of SMEs is one of the distinguishing features of the industrial sector in Asia. They are an important source of employment for low income earners, and by helping to alleviate poverty, serve an important political, as well as economic, function.

SMEs are flexible, react quickly to needs and demands, and show talent for innovation. Also, in India and parts of China that are undergoing fundamental industrial sector reforms, SMEs are the most dynamic industrial sub-sector.

SMEs account for more than 50% of the total industrial sector output in China and India, and for 10%- 25% in most other Asian countries.

They make up over 90% of the number of enterprises in Asia; employ over half the workforce; contribute about half the GDP; and provide about 35% of exports.

Most of the SMEs in the region employ less than 100 people, with capital of less than US$1 million.

SMEs in Asia play a crucial role in the production-consumption cycle. Their presence and contribution is becoming increasingly significant in the trade-environment and supply chain linkages.

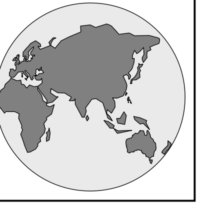
SMEs pose difficult pollution abatement problems. They are not the major polluters in most sub-sectors, but they often pollute more per unit of output than large firms operating in the same sector.

They have limited resources at their disposal (both technical and financial) and often find themselves unable to afford the changes necessary to meet environmental regulations and product controls.

Environmental Issues from 1960s

1970s - Industrial production was rapidly rising with a 7% annual growth in manufacturing. Negative environmental impacts of this boom were perceived as localized problems of air, water and land pollution.

1980s - Increasing global population; consumption patterns became more resource demanding; environmental problems transcended local and regional boundaries; recognition of regional and global impacts of development; acid rain, global warming, ozone layer depletion being recognized as serious issues; trade increased with dependence of developed economies for non-renewable resources on developing economies.



1990s - Sustainable development, environmental and social soundness began to be recognized as issues of governance. Role of environment and development in international trade have become issues of international polity and diplomacy. Emergence of a New Order with sustainable development as the need of the hour.

The late 1960s and early 1970s witnessed the public recognition of environmental issues in the West. However, environmental problems such as toxic waste contamination, air pollution and water pollution were perceived as local problems.

In the 1980s, the fallout of industrial growth began to be reflected in transnational, regional-level problems. Examples include acid rain in Canada originating from industrial emissions in the US; forest destruction in Germany; and acidification of water bodies in Scandinavia.

Developed countries began to increasingly depend on developing countries for renewable resources (fuel and mineral). This trade boosted growth of developing economies but led to degradation of natural resources. Hence, the impact of environmental degradation began crossing local and regional boundaries on the back of trade.

Increased industrialization and energy consumption led to regional problems in the developing economies. Global warming and ozone layer depletion became issues of international concern.

Trade was liberalized and globalized, leading to a greater recognition that environmental degradation does not respect boundaries.

The 1990s saw the emergence of all these issues at international gatherings, and sustainable development has necessarily become the need of the hour. Environmental issues which were being discussed at technical seminars and debates have now become diplomatic issues and an integral part of international trade.

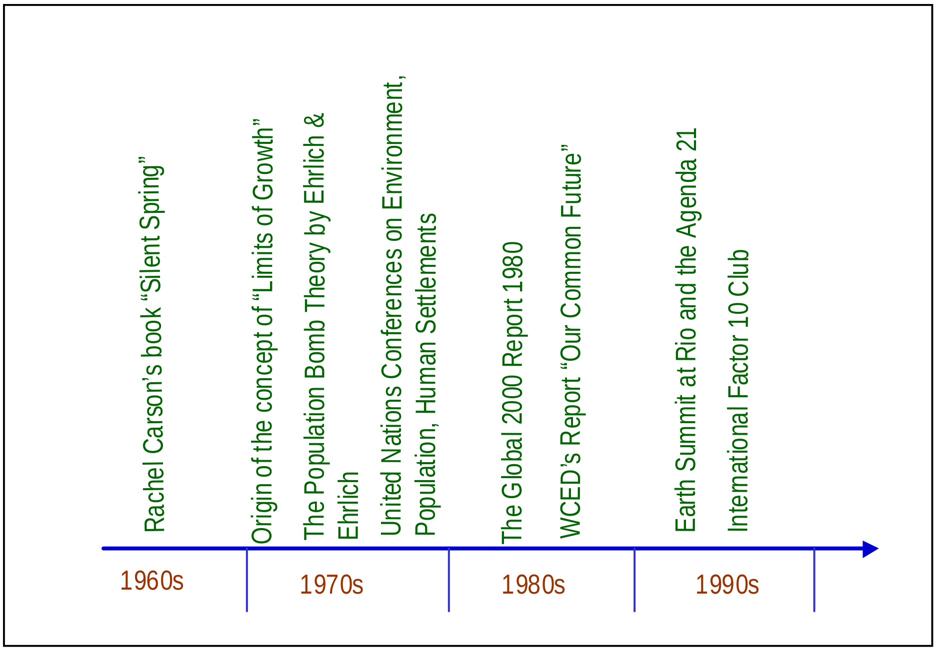
The need to make production and consumption patterns sustainable has therefore become a political and diplomatic issue influencing business and environment.

1.2 Global Environmental Concerns

1.2.2 Landmark Milestones

Agenda 21, United Nations Conference on Environment and Development, 1992

Landmark Milestones



The environmental trends discussed earlier can be mapped to certain landmark activities which show that there has been a recognition of non-sustainability of development over the years starting from the 1960s. This occurred intermittently in the 1960s and 1970s but today the need for sustainable development has become the agenda for the new millenium.

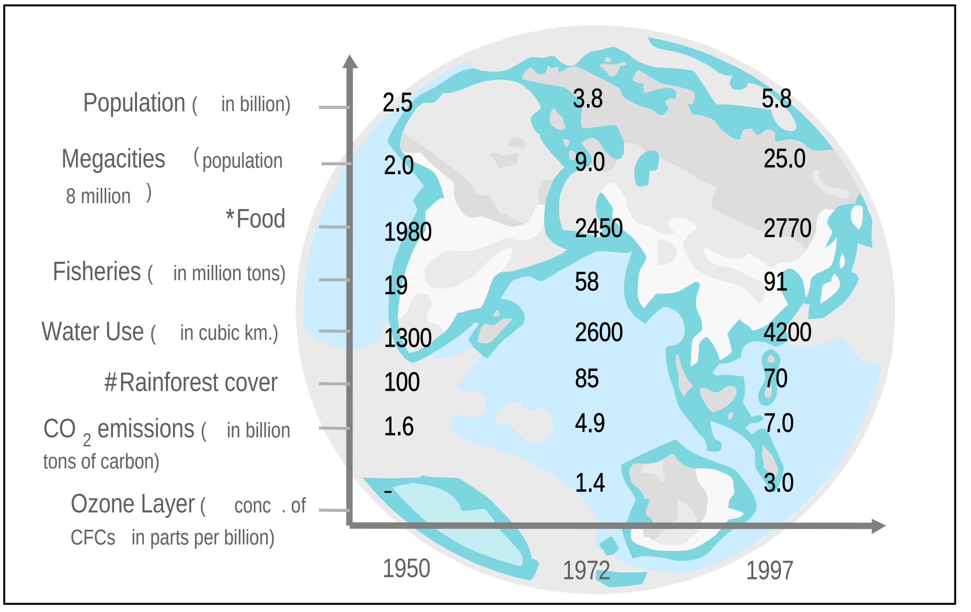
Some of the activities that eventually led to an increase in the public's awareness of the non-sustainability of development are:

- Rachel Carson's book *Silent Spring* that explicitly addressed the dangers of using pesticides.
- The creation of the concept of "limits of growth" that addresses issues of population vis-à-vis the finiteness of resources and pollution caused by overexploitation of these resources.
- The *Population Bomb Theory* by Ehrlich & Ehrlich that addresses the links between population and environment.
- The *Global 2000 Report 1980* which presented the global state of environment.
- The World Council of Environment and Development's (WCED) 1987 report called *Our Common Future*, which for the first time provided a formal definition for sustainable development.
- Warning on environmental degradation and non-sustainability sounded by 1,670 scientists and 107 Noble Laureates on environmental degradation and non-sustainability of current development trends in 1992.
- Formation of the International Factor 10 Club.

1.2 Global Environmental Concerns

1.2.3 Global Scenario

Global Environmental Issues



World Resource Institute
http://www.wri.org

Environmental treaties and conventions have brought to light the issues which have to be confronted and managed. Some of the critical issues are examined in this section at the global level, and in greater detail at the regional (Asia) level. The various global environmental issues of concern are:

Loss of crops and grazing land due to erosion, desertification, conversion of land to non-farm uses etc., currently totaling about 20 million hectares a year.

Depletion of the world's tropical forests, leading to loss of resources, soil erosion, flooding, and loss of biodiversity - currently at a rate of 10 million hectares a year.

Extinction of species, primarily from the global loss of habitat, and the associated loss of genetic diversity. Over 1000 plants and animal species are becoming extinct every year.

“The bottom line is that the human species is living more off the planet’s capital and less off its interest. This is bad business.”

Changing Course
Stephan Schmidheiny with BCSD, MIT Press, England, 1992

Rapid population growth.

Shortage of fresh water resources due to overexploitation of surface and groundwater resources.

Over-fishing, habitat destruction, and pollution in the marine environment. Twenty- five of the world's most valuable fisheries are already seriously depleted due to over-fishing.

Threats to human health from mismanagement of pesticides and hazardous substances, and from water-borne pathogens.

Climate change related to greenhouse gases in the atmosphere.

Ozone layer depletion due to indiscriminate use of chlorofluorocarbons. The active chlorine atoms strip the ozone layer preventing filtering of the sun's ultraviolet rays.

Regional Scenario

- Pollution
- Environmental Degradation
- Resource Depletion
- Biodiversity

To develop a strategy for sustainable development in the Asian region it is necessary to take stock of the environmental issues facing the region.

Environmental issues in the region can be categorized as follows:

- pollution
- environmental degradation
- resource depletion
- biodiversity

Uncontrolled industrial development and growth has led to extensive pollution of air, land and water (surface, groundwater and coastal waters).

This pollution has resulted in degradation of the environment and natural resources. Land degradation has led to loss of arable land, increasing aridity and desertification. Degradation and overexploitation of water resources has led to water scarcity.

Overexploitation of natural resources for fuels and minerals has resulted in depletion of resources. An export-led development that catered to the resource needs of the developed countries has led to excessive depletion of mineral and fossil fuel resources in large parts of the region.

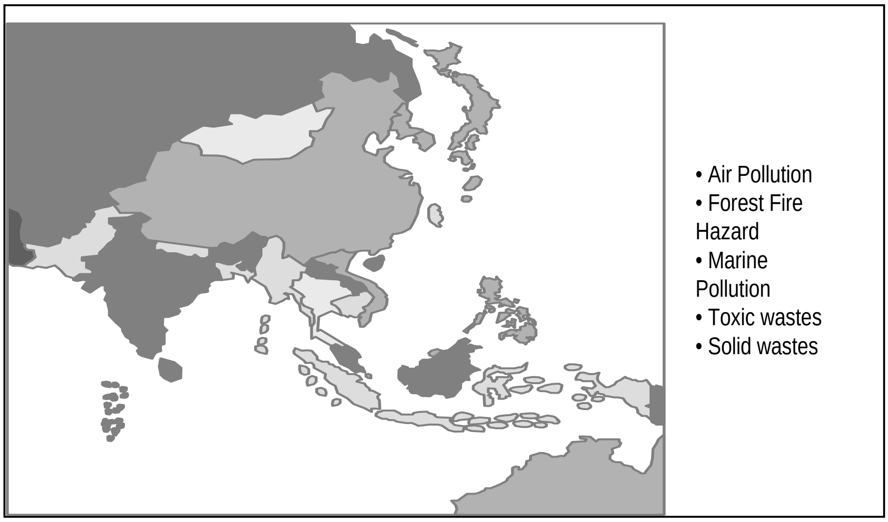
Degradation and resource depletion has manifested itself in the form of species loss, resulting in loss of genetic diversity in terrestrial, aquatic and marine ecosystems.

Each of these aspects is dealt with in greater detail in the following parts of this section.

1.2 Global Environmental Concerns

1.2.5 Regional Scenario - Pollution

Regional Scenario - Pollution



A world bank and ADB sponsored study in 1995 showed that the areas with critical loads up to 320 milligrams per square meter per year (that is, area that are most susceptible to acid deposition) are located in South China, the areas south-east of Thailand, Cambodia and southern Vietnam

Development in the Asian region has been characterized by urbanization and industrialization which have had deleterious impacts, leading to high pollution loads and social stress.

Air pollution, particularly transboundary, is a problem that has accompanied economic growth and high energy consumption. The effects of coal burning tend to spread over a large area, resulting in acid deposition.

The problem of acidification has also started to emerge in parts of Asia and the Pacific region.

Urban air pollution is a serious problem in many major cities of the region. Significant health threats also arise from indoor air pollution resulting from the use of low-quality solid fuels, such as coal, wood, crop residues, and dung for cooking and heating in lower-income urban households and in rural areas throughout the region.

Fly ash generated from the mining of coal is also a significant problem in the region, particularly in India, where the effects are as serious as those caused by acid rain elsewhere.

Slash-and-bum agriculture and the clearing and burning of forests for oil palm plantations leads to haze problems that extend beyond national boundaries, as occurred in the Indonesian forest fires of 1997.

It must be noted that these fires were not a "natural disaster," nor were they the result of agricultural practices. They were essentially the result of an economic policy based upon the overexploitation of natural resources. Most of the fires were deliberately set by plantation companies to clear the land and the ensuing haze caused widespread health problems, and disrupted air, sea and road traffic. It also had a widespread regional impact, affecting Malaysia, Thailand, Brunei, Singapore and even the Philippines and Australia.

1.2 Global Environmental Concerns

1.2.5 Regional Scenario - Pollution

Coastal and marine pollution in the Asian region arises mainly from direct discharge from rivers, surface runoff, drainage from port areas, domestic and industrial effluents, and various contaminants from ships. About 70 % of the waste effluent discharged into the Pacific Ocean has no prior treatment and more than 40% of marine pollution in the region is derived from land-based activities through riverine discharge. The main problems are heavy metal and pesticide contamination; algal blooms due to nutrient build-up caused by industrial effluent and dumping of solid waste into the sea.

Aquaculture has resulted in loss of coastal habitats, including a substantial loss of mangrove forests in South-East Asia. This has had a negative impact on commercial fisheries, particularly in Thailand and the Philippines.

Important

Oil pollution is severe in the Straits of Malacca along the west coast of India (Total deposits of up to 1,000 tons of tar per year)

Toxic wastes contributed by industries and agriculture are predominantly pesticides and heavy metals. Extremely difficult to degrade, they accumulate in the food chain.

Extensive and reliable data on the generation of toxic and hazardous wastes in the region are not available. The 1995 estimates indicate that about 100 million tons are produced annually, with as much as 90% generated in China and India. About 60-65% of these wastes end up in landfills; 5-10% are dumped in the oceans; and only about 25% are either incinerated or undergo physico-chemical treatment.

However, there is growing awareness in the region, especially in Japan, China, and India, of waste detoxification.

Reference Look Up

Implementation of Agenda 21: Review of the progress made since the UN Conference on Environment and Development,, New York, United Nations Department for Policy Coordination and Sustainable Development, Division for Sustainable Development April,1997.

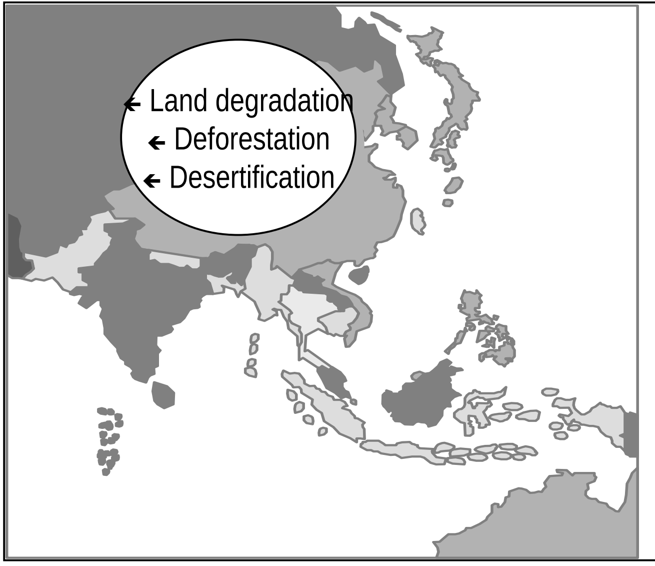
About 700 million tons of solid waste and 1,900 million tons of industrial waste are generated each year in Asia and the Pacific. Among the various sub-regions, East Asia generates the largest share of municipal solid waste.

The key issues regarding solid waste management are the environmental health implications. These are due to the improper storage of rubbish prior to collection and poor standards of disposal. It is estimated that 30-50% of municipal solid waste is uncollected. The disposal of domestic and industrial waste is given relatively low priority in many countries, with only around 70% of the waste in urban municipal areas being collected and only some 5% of this being treated.

Solid waste disposal is a particular problem in the small island states such as Fiji, Maldives, and Western Samoa due to their limited land area. Disposal areas have been used for land reclamation in some of these countries, resulting in contamination and pollution of surrounding coastal areas.

1.2.6 Regional Scenario - Environmental Degradation

Regional Scenario - Environmental Degradation



- Only 15% of the total land area is considered arable.
- South-East Asia has the highest absolute deforestation rates.
- 35% of productive land in Asia is now desertified.

Important

The contribution of human activities to land degradation in the region has been estimated as: 37% by removal of vegetation cover, 33% overgrazing by livestock, 25% unsustainable agricultural practices, 5% overexploitation through construction of infrastructure.

Important

The countries experiencing the fastest deforestation are Bangladesh, Pakistan, Philippines and Thailand.

Reference Look Up

Source: Global Assessment of Human Induced Soil Degradation

The Asia and Pacific region occupies 23% of the world's total land area and has 58% of the world's population.

In most developing countries in the region, soils suffer from varying degrees of erosion and degradation mainly due to rapid rates of deforestation, poor irrigation and drainage practices, inadequate soil conservation, steep slopes, and overgrazing.

Of the world's 1.9 billion hectares affected by soil degradation, the largest area (850 million hectares) is in Asia and the Pacific, accounting for about 24% of the land in the region.

In 1996, studies by United Nations Environment Program, World Resources Institute, United Nations Development Program and the World Bank showed that 13% of arable land in the region is considered to be severely degraded, 41% moderately degraded, and 46% lightly degraded

Only 10-30% of natural habitats are left in many countries in the region and 24% of the land in Asia-Pacific is affected by soil degradation. Only 15% of the total land area is considered arable. More than 50% of the world's irrigated land affected by water logging and salinization is located in Asia and the Pacific. Increased dependence on intensive agriculture and irrigation may exacerbate the situation. This is a serious concern, especially since irrigated lands are expected to increase significantly in the near future.

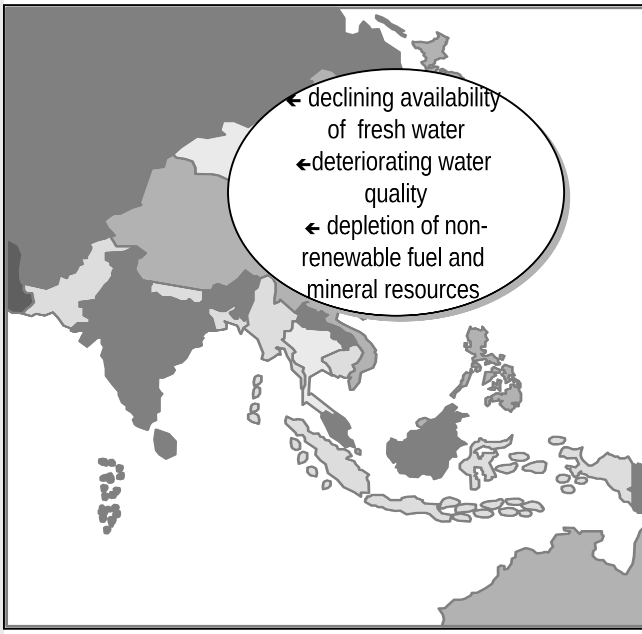
A total of 35% of productive land in Asia is now desertified. The region has the largest population in the world affected by the process. The countries suffering most from desertification are China, Afghanistan, Mongolia, Pakistan, and India.

Due to industrialization, agricultural expansion, and forestry product trade, deforestation remains one of the major environmental issues in the region. Deforestation in the region increased from 2 million hectares per year during 1976-81 to 3.9 million hectares per year in 1981-90. At the current rate of harvesting, the remaining timber reserves in Asia may not last for more than 40 years

1.2 Global Environmental Concerns

1.2.7 Regional Scenario - Resource Depletion

Regional Scenario - Resource Depletion



Water scarcity: Fresh-water availability of below 1,000 cubic metres per capita per year indicates water scarcity.
India is projected to fall into the water-stress category before 2025.

Fossil fuel and energy demand:
The region accounted for about 41% of world coal consumption in 1993.

Important

A Survey by UNEP and the International Lake Environment Committee in 1994 showed that 54% of the lakes in the Southern East Asia suffer from eutrophication problems.

Resources facing serious threats of depletion include water, non-renewable fossil fuels and minerals.

The region is comparatively well endowed with water resources. Only a part of the renewable water resources can be extracted and used, due to the high variability of stream flow between low water and flood seasons, the inaccessibility of some watercourses, and the lack of storage sites on many catchments.

High rates of urbanization and industrialization are pushing up domestic and industrial demand for water. This demand will continue to rise in the region in parallel with population growth.

Afghanistan and Iran suffer from chronic water shortages due to aridity, while parts of China and India experience the same problem primarily due to high population density.

Agriculture accounts for 60-90% of the annual water withdrawal in most countries of the region, with the highest proportion in Afghanistan (99%).

Water pollution in countries in Asia and the Pacific is caused mainly by domestic sewage, industrial effluents, and runoff from activities such as agriculture and mining.

The problem of pathogenic pollution is quite severe in South Asia, South-East Asia, the Pacific Islands, and China. The main source is domestic sewage that is discharged untreated into watercourses.

1.2.7 Regional Scenario - Resource Depletion

South Asia and China are most severely affected by organic matter pollution, the main source of which is effluent from the pulp and paper, and food industries.

Discharge of mine tailings and development of industrial areas with direct discharge of pollutants into neighboring river systems has resulted in hot spots of heavy metal pollution throughout the region.

Overexploitation of groundwater has led to saline water ingress in Thailand, and parts of India. Further loss of groundwater has been due to extensive contamination by industrial pollution. In countries like Bangladesh, salinity and sedimentation are occurring largely as a result of upstream water withdrawal.

Fresh-water availability below 1,000 cubic meters per capita per year indicates water scarcity.

India is among the countries projected to fall into the water-stress category before 2025. Its situation is well illustrated by the case of Rajasthan, which is home to 8% of India's population but claims only 1 per cent of the country's total water resources.

One of the important implications of economic growth in Asia and the Pacific over the last three decades has been the increased demand for energy and, therefore, for fossil fuel.

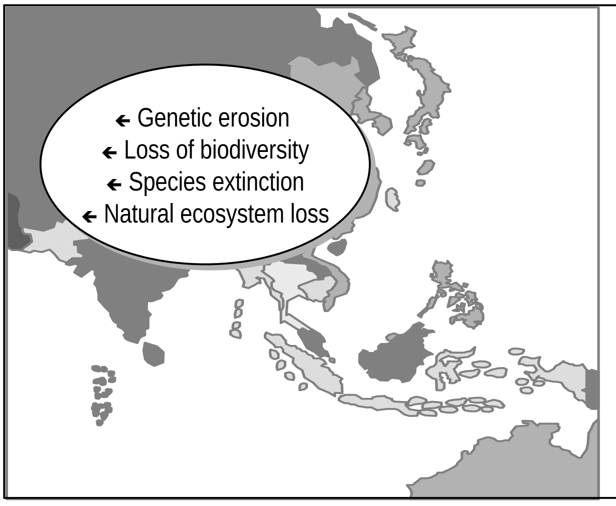
The region, excluding Japan, Australia, and New Zealand, accounted for 21% of the world's primary commercial energy demand in 1992 as compared with 51% for members of the OECD and 28% for the rest of the world.

The growth in energy demand for the whole region was 3.6% per year between 1990 and 1992, compared with average world growth of 0.1%.

The region accounted for 41% of world coal consumption in 1993.

Mineral and non-renewable fuel resources continue to occupy a prominent position in exports and are one of the main sources of foreign exchange.

Regional Scenario - Biodiversity



Only 10-30% of natural habitats are left in many countries in the region.

Important

The underlying causes of loss of biodiversity in the region include:

- International trade, particularly in timber, (which results in forest habitat losses)
- Population growth (leading to accelerated rates of land use change)
- Poverty (in conjunction with demand leading to unsustainable consumptive use of "common access resources")
- The introduction of non-native species (leading to destruction of predatory/prey equilibrium)
- Improper use of agro-chemicals (leading to loss of aquatic species)

Important

With only 10-30% of natural habitats left in many countries, any further decrease could have much more serious consequences for biodiversity than the initial stage, when 50% of the original habitat was lost.

The rainforests of South-East Asia contain some 10% of the world's flora. The region as a whole accounts for two-thirds of the world's flora.

Almost all the nations in the region (with the exception of Singapore and Brunei Darussalam) depend heavily on direct harvesting from nature. The flora and fauna of the region are more threatened now than ever before.

The drive for increased agricultural production has resulted in the loss of genetic diversity. Land under rice cultivation rose between 1960 and 1970 by only 25% but production rose by 77% due to the replacement of traditional varieties with higher-yielding, semi-dwarf varieties. By 2005, India is expected to produce 75% of its rice from just 10 varieties, compared with the 30,000 varieties traditionally cultivated. In Indonesia, 1,500 varieties of rice disappeared during the period 1975-90.

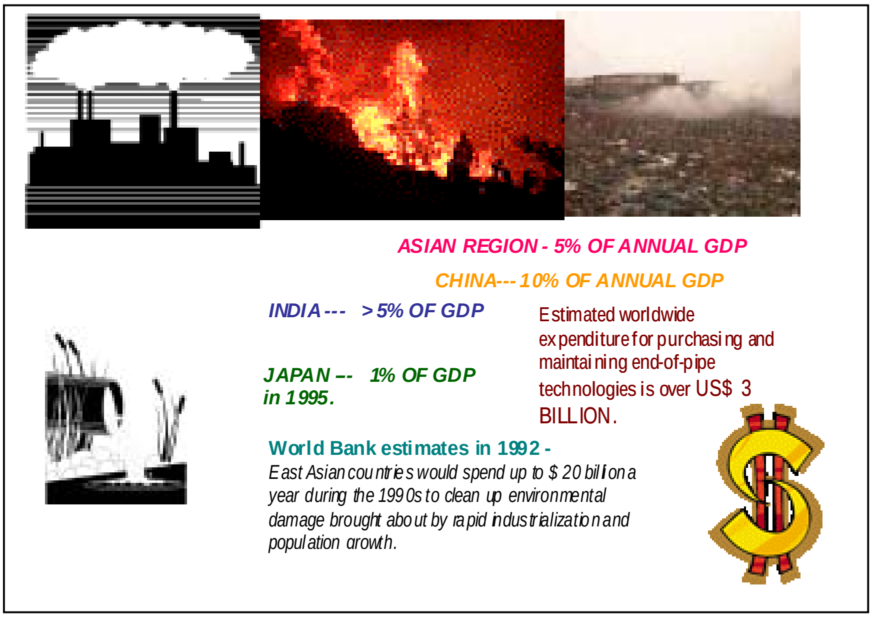
Terrestrial biodiversity loss in various ecosystems has been identified as a major concern, but losses have still to be quantified. Overall habitat losses have been most acute in the Indian sub-continent, China, Vietnam, and Thailand.

The Indo-West Pacific is the center of shallow-water marine biodiversity. Coastal habitat loss and degradation, combined with increased sediment, nutrient, and pollutant discharge into coastal areas, are a major cause of concern, particularly in the insular countries of the region.

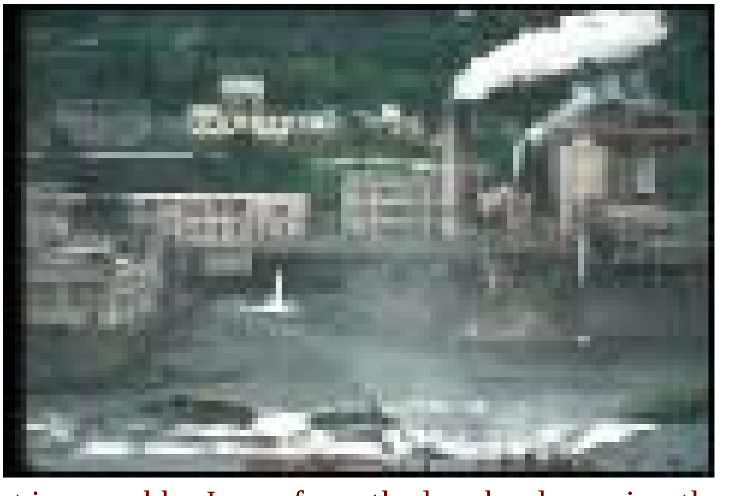
Loss of keystone species, extensive deforestation and habitat loss, increased trafficking in animals and animal body parts, large-scale conversion of land for agriculture, and the construction of large dams has also contributed to loss of biodiversity.

Given this regional scenario, it is clear that never before has there been such an urgent need to develop a strategy that will steer Asian economies in a sustainable direction.

Cost of Environmental Damage



4.5 Trillion Yen in Environmental Damage



Cost incurred by Japan from the loss by damaging the environment in 1995 was calculated as 4.5 trillion yen in real terms which was about 1% of GDP.

Ramankutty, R., Brandon, C. *Asia and the Pacific*, Asia Region Technical Department's Environment and Natural Resource Division (ASTEN), World Bank, 1999. http://www-esd.worldbank.org/envmat/voL1f96/ asiapac.htm

Asia's emphasis on rapid economic growth without equal attention to the environment has resulted in widespread environmental damage.

The resulting costs are large even in simple economic terms. The costs of environmental degradation in Asian countries such as India are above 5% of annual GDP, and for China may be as high as 10%.

The World Bank estimated in 1992 that East Asian countries would spend up to US$ 20 billion a year during the 1990s to clean up environmental damage brought about by rapid industrialization and population growth.

1.3 Response to Environmental Concerns

1.3.1 Public Concern

Public Concern

Societal demand for a cleaner environment and a better “quality of life” is increasing.

Public concern is being expressed as:

- protests / law suits
- consumer boycotts of products
- willingness to pay a premium for eco-friendly products

Incidences	Cause	Result
Love Canal Episode, USA	Toxic Waste Poisioning	PUBLIC PROTEST
Minamata	Mercury Poisioning	
Bhopal gas Tragedy	MIC Gas release	
Bangladesh Wells	Arsenic Poisioning of the Ground water	
Rivers like Ganges, Yamuna, Yangtze, Irrawady etc.	Industrial wastewater & domestic sewage discharge	

Public concern about environmental damage today stems largely from the costs it imposes in terms of health and deteriorating quality of life.

In industrialized countries, public concern over environmentally unsound practices began in the 1960s. In the US, incidents such as the poisoning of Love Canal with toxic wastes triggered a public outcry. Mercury poisoning in Minamata, the Bhopal Gas tragedy in India and the more recent Arsenic poisoning of well waters in Bangladesh attracted widespread attention.

There is also growing public concern over the progressive pollution of Asian rivers such as the Ganges, Yamuna, Yangtze and Irrawady from industrial wastewater and domestic sewage discharge.

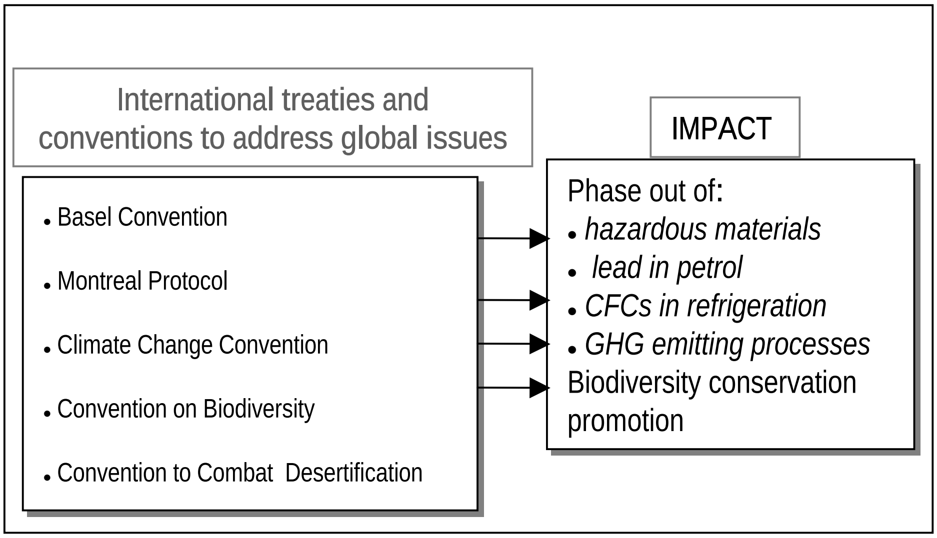
Recently, public activism in Asia against the unsound environment practices of industry has increased. Thousands of non-complying industries in India, for instance, have been forced to close down either through public interest litigation or through judicial intervention based on public concern.

Protests are focusing on:

- Demands for better health and living conditions targeted primarily against industrial degradation of air, land and water
- Loss of habitation due to acquisition of resources for industrial and other developmental activity.
- Globalization of environmental standards and social ethics in industrial production, consumption and trade.

Public concern is expressed not only through protests but also as green consumerism. On the one hand, this takes the form of consumer boycotts. On the other, it shows as a willingness to pay a premium for eco-friendly products.

Environmental Treaties and Conventions



Recognizing the global implications of environmental degradation, the international community responded through treaties and conventions. They recognized that the impact of unsustainable development has moved from local to regional to global levels. Impacts no longer recognize boundaries. Some of the landmark conventions are listed below:

Management of hazardous wastes and their transboundary movements are regulated by the Basel Convention on Transboundary Movement of Hazardous Wastes (and their handling) 1989.

Montreal Protocol regulates the manufacture, use and disposal of ozone depleting substances.

Climate Change Convention regulates the emission of green house gases (GHGs) that have contributed to global warming.

Convention on Biodiversity is aimed at conserving the species diversity of biological organisms.

Convention to Combat Desertification is aimed at preventing further desertification and increased aridity by promoting sustainable land management practices.

These conventions have resulted in the phasing out of CFCs in refrigerants and hazardous materials such as PCBs, lead and asbestos. They have also promoted the use of renewable sources of energy.

Trade is also reflecting environmental issues as it becomes more globalized. The WTO is including environmental conditions in its rules.

It is clear that production, consumption and associated trade are strongly interlinked and are driving environment to be an integral part of business strategy. National and international policies are being forced to view environment as a crucial aspect of any agenda for development.

United Nations Environment Programmes web site

http://www.unep.org

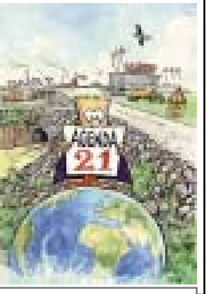
1.3 Response to Environmental Concerns

1.3.3 Sustainable Development and Agenda 21

Sustainable Development and Agenda 21

Sustainable Development

"development that meets the needs of the present generation without compromising the ability of the future generations to meet their needs." ....Our Common Future, 1987.



Agenda 21, is a 300 page plan for achieving sustainable development in the 21st century. It was adopted in the first international Earth Summit, at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, on 14 June 1992

The growing global environmental crisis has led to a consensus response in the move towards sustainable development.

The United Nations Conference on Environment and Development (UNCED) in Rio De Janeiro, 1992, resulted in an Action Plan towards sustainable development.

Agenda 21 represents international consensus, following two years of research, drafting and intensive negotiations at the four meetings of the UNCED Preparatory Committee, on actions necessary to move the world towards the goal of sustainable development.

It is a comprehensive document covering all the issues referred to UNCED by the UN General Assembly in its Resolution 44/228 of 1989.

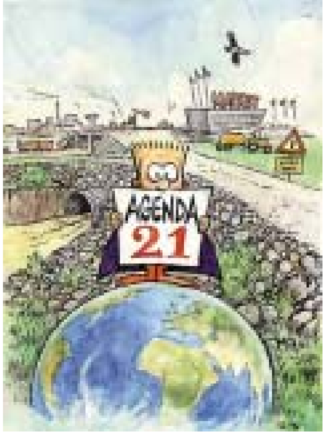
The conference accepted the definition of sustainable development presented by the World Council of Environment and Development in its book *Our Common Future*, 1987.

Agenda 21 deals with all issues of environment and development, including issues of socio-economic development; inequality in the use of resources between nations and within nations; intergeneration equity; population and the carrying capacity of the earth; and the need for cooperation between nations.

The last few years have seen a number of national, regional and global initiatives towards the challenges of sustainable development, as outlined in Agenda 21.

Response to Agenda 21

- Countries set up their own Local Agenda 21 plans.
- Formation of the World Business Council of Sustainable Development (WBCSD), 1992
- Formation of Malaysian Business Council of Sustainable Development, 1992
- WBCSD's Declaration for sustainable development stressed on eco-efficiency in production - *More for Less*



Implementation of Agenda 21 required its translation into country-level plans that would recognize local issues and give priority to addressing them.

The Asia Pacific National Councils for Sustainable Development was formed to help countries set up their own National Councils as well as to coordinate activities in the region. This council is part of the United Nations Council for Sustainable Development.

Corporate responses to Agenda 21 to steer industrial development in a sustainable direction included formation of the World Business Council of Sustainable Development (WBCSD) in 1992. The declaration of the WBCSD was signed by about 50 business leaders from both developed and developing countries.

The WBCSD is a coalition of 120 international companies united by a shared commitment to the environment and to the principles of economic growth and sustainable development. Its members are drawn from 33 countries and more than 20 major industrial sectors. The WBCSD also benefits from a thriving global network of 9 national and regional business councils and 4 partner organizations.

The Malaysian Business Council of Sustainable Development (MBCSD), was created in 1992 to join this global network. Similarly, Indonesia has joined the network with its Indonesian Business Council of Sustainable Development (IBCSD).

The WBCSD provides a powerful and unified business voice on sustainable development issues. It plays an important role in developing closer cooperation between business, governments and others, and in encouraging high standards of environmental management in business itself.

The term "eco-efficiency" in production was coined by the WBCSD in its declaration. It was first introduced as a concept in 1992 in *Changing Course*, the council's report to the Rio 'Earth Summit'.

1.3 Response to Environmental Concerns

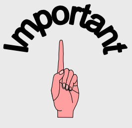
1.3.5 Industry Initiatives

Corporate Response

Corporate responses to Agenda 21 have been in the form of a number of voluntary initiatives. These include agreements, programs, standards and codes of conduct.

Predominant among them are:

- Responsible Care
- Environmental Stewardship
- Corporate Environmental Policy and Reporting
- Certification such as ISO 14000, SA 8000



Responsive Care is a voluntary initiative for developing and implementing guidelines, activities, recommendations and voluntary self restrictions for environmental protection. It is centered on a set of fundamental guiding principles and six codes of management practices.

Voluntary initiatives refer to *industry action that goes beyond applicable environmental laws and regulations.*

A voluntary initiative may nevertheless be (1) legally binding (in the case of a signed contract), (2) mandatory (if it becomes a condition for membership in an industry association, e.g., in a country where Responsible Care is being implemented), (3) compulsory (if it becomes a de facto marketing requirement, e.g., ISO 14000), (4) used to encourage compliance with existing laws.

Responsible Care is the worldwide chemical industry program for continuous improvement of safety, health and environmental performance. It was started in Canada in 1984, was adopted in the U.S. in late 1988, and in Western Europe and Australia in 1989/90. Today, Responsible Care is being implemented in 40 countries. In the Asia-Pacific region it is being implemented in Australia, New Zealand, Philippines, Hong Kong, Malaysia, Singapore, Taiwan, Japan and India.

Environmental Stewardship addresses proper use and disposal of products in the market. **Marine Stewardship** for the food processing sector addresses responsible fish harvesting practices, and **Forest Stewardship** for the pulp and paper sector promotes sustainable forest.

A landmark stewardship initiative is **Extended Product Responsibility (EPR).** Important features of EPR include structuring production processes so that one industry's waste can be used by another, and designing products that avoid the use of hazardous materials so that they can easily be remanufactured or the materials in them recovered.

EPR had its origins in Western Europe where policy makers have focused primarily on the last stage of the product cycle, particularly the take-back of used materials. In Germany, the concept has been applied to a packaging ordinance, whereby consumers, retailers and packaging manufacturers share in this responsibility, with the financial burden for waste management falling on the retailers and packaging manufacturers.

1.3.5 Industry Initiatives

Corporate Environmental Policy (CEP) is a commitment of a business to environmental excellence as a part of corporate mission and vision. CEP accepts the guiding principles of precautionary approach, polluter pays and accountability. It enables the adoption of practical measures, ensures transparency, and must include environment in corporate training schemes.

CEP is a requirement of most voluntary initiatives, codes of conduct and international voluntary standards, such as Responsible Care and ISO 14000.

http://www.iso.ch for information on the ISO standards

Closely linked to Corporate Environmental Policy is **Corporate Environmental Reporting (CER),** a voluntary disclosure of environmental performance by companies. CER serves as a vehicle for greater accountability to stakeholders and as a catalyst for internal change by acting as a benchmarking tool. It also serves as a catalyst for the evolution of internal management systems, improvement of performance, and the emergence of new forms of accountability.

While all these are voluntary initiatives which an organization may choose to adopt depending on its business priorities, **ISO 14000** certification for environmental management systems has become almost an essential requirement in international business.

http://www.cepaa.org for information on the SA 8000 standards

ISO 14000 is a set of voluntary standards designed to help enterprises run environmental management systems. Under development by the International Standards Organization (ISO) since 1991, these standards define the key elements of a management system that will help an organization address the environmental issues it faces. The management system includes: (1) setting of goals and priorities (2) assignment of responsibility for accomplishing them (3) measuring and reporting on results and (4) external verification of results.

The standards do not set performance values but provide a way of systematically setting and managing performance commitments.

As the world moves towards sustainable development, the bottom line is not just economic and environmental performance, but also social performance. Consumers are demanding environmentally and socially sound business practices.

Important: ISO 14000 and SA 8000 have been shown to influence trade and the supply chain, especially between developed and developing countries.

In answer to this demand, the **Social Accountability (SA) 8000** standards have been established by the Council of Economic Priorities. The council's accreditation agency, CEPAA, provides certification.

SA8000 provides transparent, measurable, verifiable standards for certifying the performance of companies in nine areas: child labor; forced labor; health & safety; freedom of association; discrimination; disciplinary practices; working hours; compensation and management of the implementation and review of SA 8000 compliance.

Eco-efficiency, Factor 4 and 10

- Eco-efficiency emphasizes economics, in addition to environmental improvement.
- It is concerned with resource productivity, that is, maximizing the value added per unit of resource input.
- The Wuppertal Institute in Germany coined the term Factor 4 to show that it is possible to quadruple resource productivity given the present state of technology.
- Rising levels of consumption and a doubling of the world's population over the next 40-50 years would require a factor 4 increase in food production, a factor 6 increase in energy use and at least a factor 8 growth in income.
- The Factor 10 Club, an international body of senior government, non-government, industry, and academic leaders believes that within one generation, nations can achieve a ten-fold increase in the efficiency with which they use resources.

As a corporate strategy, eco-efficiency stresses economics, in addition to environmental improvement. Its focus is not merely reducing material use and waste, but also with resource productivity, i.e., maximizing the value added per unit of resource input.

The WBCSD believes that by applying the principles of eco-efficiency, increased value for customers can be created through the sustainable use of resources.

Factor Four: Doubling Wealth, Halving Resource Use, by Ernst von Weizsacker, Amory B Lovins and L Hunter Lovins, Wuppertal Institute for Climate, Environment and Energy, Germany, 1998.

Efficiency in resource productivity is also reflected in the term **Factor 4.** This term was coined by the Wuppertal Institute for Climate, Environment and Energy, when it chronicled 50 examples of quadrupling resource productivity. Most of the examples exist today as widely available technologies. They include energy efficient homes, office buildings, kitchen appliances, lighting, farming systems, and motors and are all off-the-shelf, competitively priced technologies. Others are well-reasoned, technical possibilities, poised for implementation.

Factor 4 has been surpassed by a **Factor 10 Club** of business executives and scientists (mostly in Europe) which is researching and promoting 90% reductions in resource use.

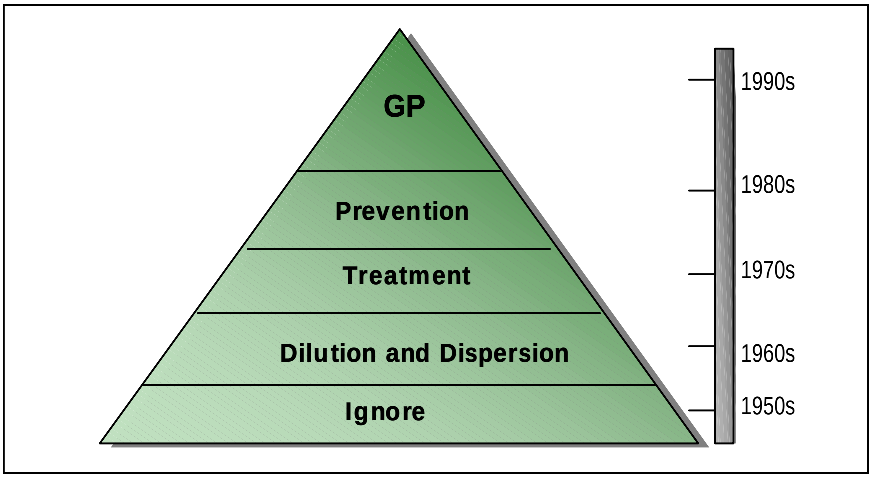
The Factor 10 Club is an international body of senior government, non-government, industry, and academic leaders working out of Germany's Wuppertal Institute since 1994. The Club believes that *within one generation, nations can achieve a ten-fold increase in the efficiency with which they use energy, natural resources and other materials*. Such a goal is within the reach of technology and, with appropriate policy and institutional changes, could be brought within the reach of economics and politics.

A leap in energy and resource productivity of this magnitude would strengthen the basis for sustainable social, economic and environmental progress.

1.4 Environmental Management Trends

1.4.1 From Environmental Protection to Eco-Sustainability

Environmental Management Trends



In the 1950s one common response to environmental pollution problems was to ignore them. This was possible when the problems were relatively small and the awareness of the health and environmental impacts was not high.

In the 1960s, a common approach to pollution was to **dilute and disperse** concentration of the pollutants, for example by constructing tall smokestacks and extending pipelines into the sea to dilute water pollutants.

It was soon realized that this approach did not solve the problem. Many pollutants have been found to be toxic even at small concentrations. Some chemicals retain their toxicity for a very long period, accumulate in soil and water, and eventually find their way into the food chain.

When the environment's assimilative capacity for pollutants was exceeded, there were efforts to establish environmental standards to regulate the discharge of toxic substances.

In the 1970s, **treatment** systems were introduced to ensure the discharge from industries and other enterprises met stipulated environmental quality standards.

Installation of treatment systems was termed the "end-of-pipe" approach.

contd…

1.4 Environmental Management Trends

1.4.1 From Environmental Protection to Eco-sustainability

As the discharge standards became more stringent, the cost of end-of-pipe treatment of wastes became more expensive and affected the economic viability of some industries. In some industrial countries, treatment costs reached as high as 2% of gross national product by the late 1970s.

Despite the high costs, the end-of-pipe approach was found to be inadequate. In fact, some industries relocated to countries that did not have stringent environmental standards. It became evident that end-of-pipe treatment did not eliminate the pollutants, but merely transferred them from one environment to another.

Industry then began exploring technological options to reduce pollution at source, i.e., **pollution prevention** through practices such as Cleaner Production.

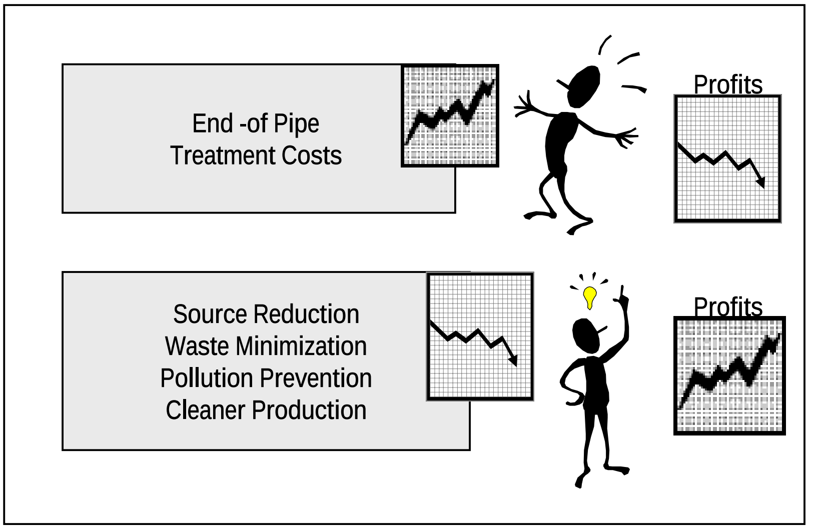
REFERENCE Look Up

World Commission on Environment and Development, *Our Common Future*, Oxford University Press, Oxford, p.210-211, 1987.

The 1990s has seen the need to ensure pollution prevention through efficient resource utilization. Concepts of sustainable development and green productivity, eco-design, product life-cycle and eco-sustainability are emerging as interface areas with the concept of pollution prevention and cleaner production.

End-of-pipe is, however, increasingly being used and will need to be used as a means of handling the residual waste generated after source reduction.

Pollution Prevention and Source Reduction



The focus on end-of-pipe treatment in the late 70s and early 80s led to prohibitively high costs of treatment. This led businesses to re-examine their manufacturing practices.

Governments, international organizations and associations began to work on developing policies and initiatives to tackle these mounting costs.

While businesses moved from a position of clean-up to one of avoiding pollution and waste, programs to support waste minimization, cleaner production and source reduction emerged.

Cleaner Production (CP) is the continuous application of an integrated preventive environmental strategy applied to processes, products and services. It embodies the more efficient use of natural resources and thereby minimizes waste and pollution as well as risks to human health and safety.

CP starts from *issues of environmental efficiency, which have positive, economic benefits*. It encompasses products, manufacturing processes and services. The Cleaner Production Program was launched by the LTNEP Industry and Environment Office in 1989.

Unlike waste minimization, pollution prevention or source reduction methods that are restricted to reducing the amount of waste produced by the manufacturing process, the scope of CP extends across production processes, to product and services. A life-cycle perspective is thus included in its definition.

Pollution prevention and CP were promoted extensively through programs both in the developed and developing countries by UNEP, UNIDO, USEPA and national governments.

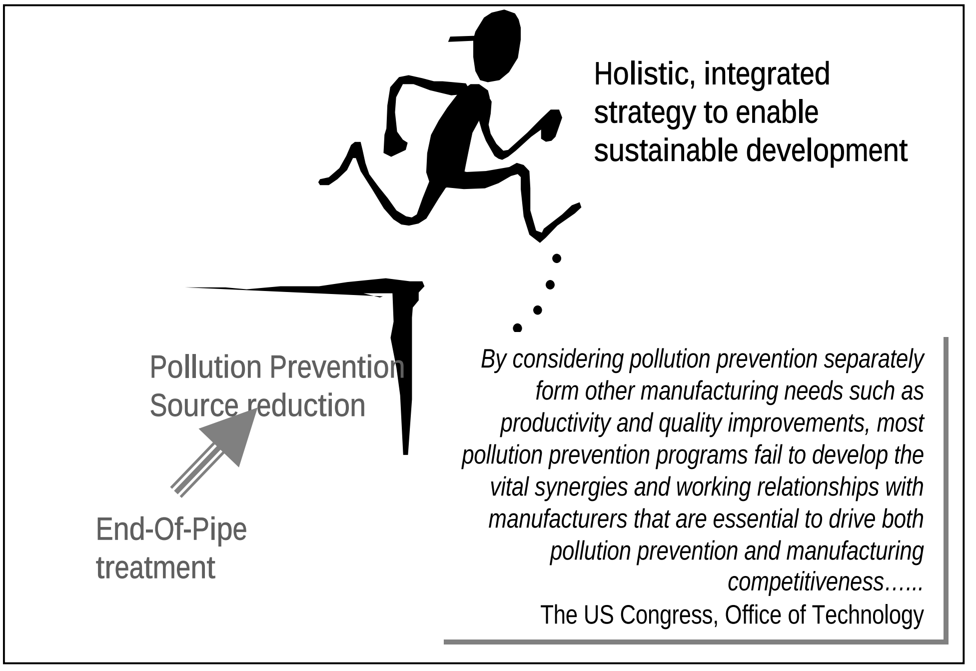
1.4 Environmental Management Trends

1.4.3 Beyond Pollution Prevention

"When scrap, harmful substances, or energy forms are discharged into the environment as pollution, they are a sign that resources have been used incompletely, inefficiently or ineffectively …………. But although pollution prevention is an important step in the right direction, ultimately companies must learn to frame environmental improvement in terms of resource productivity

U.S. Congress, Office of Technology Assessment, Industry, Technology and the Environment: *Competitive Challenges and Business Opportunities*, OTA-ITE-586. Washington, DC: US Government Printing Office, January 1994.

Beyond Pollution Prevention



Compared to conventional end-of-pipe treatment alone, pollution prevention is usually more cost-effective, often resulting in reduced energy and material usage and lower treatment costs. It can produce significant benefits such as reduced environmental impacts from lower energy and material usage.

As prevention and source reduction of pollution began to be actively adopted it was realized that, in contrast to end-of-pipe only treatment, these methods reduce the conflict between environmental protection and industrial competitiveness.

However, for development to be sustainable, both environmental protection and profitability need to be addressed simultaneously. Businesses will have to go beyond pollution prevention.

The US Congress, Office of Technology, in its report *Industry, Technology and the Environment -- Competitive Challenges and Business Opportunities*, recognized that for a program to be effective it must synergies and integrate pollution prevention with the manufacturing needs of an industry. This is captured in the following statement extracted from the report:

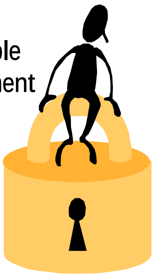
"By considering pollution prevention separately form other manufacturing needs such as productivity and quality improvements, most pollution prevention programs fail to develop the vital synergies and working relationships with manufacturers that are essential to drive both pollution prevention and manufacturing competitiveness."

The wisdom in considering pollution prevention in tandem with manufacturing needs also arises from the fact that, in principle, there are a lot of similarities between pollution prevention and improvement of manufacturing efficiency.

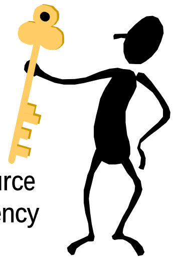
In both cases, production process is examined in greater detail and the focus is on continually improving the process to improve quality, productivity and reduce pollution.

Resource Efficiency and Sustainability

Sustainable Development



Resource efficiency is one of the key issues in sustainable development.



Resource Efficiency

Sustainability thus emerges as a crucial component of any successful paradigm to guide development in the new Millennium.

Requires a new emphasis on the nature and size of inputs to development, especially energy, resource, chemical and other material input.

Related terms and concepts that are emerging include:

- Eco-efficiency
- Eco-sustainability
- Eco-design
- Product Life-Cycle
- Green Productivity

The 1990s have seen the emergence of the belief that there is a need to go beyond pollution prevention if development is to be made sustainable.

Businesses, governments and international agencies are increasingly recognizing that sustainable development requires influencing both consumption and production patterns.

The past decade has witnessed a transition from compartmentalized approaches to profitability and environmental protection towards a more integrated approach of resource efficiency. This cannot be achieved by technological change alone; goals, assumptions and the very philosophy of business has to change.

This trend is, however, still at a nascent stage in developing countries, where increasing population and uncontrolled industrial growth are putting enormous pressure on natural resources.

Concepts that have emerged supporting this transition towards a more sustainable pattern of development are:

Eco-efficiency: Efficiency in resource utilization to produce the same level of goods/services was introduced with the concept of "eco-efficiency" by the World Business Council of Sustainable Development in 1992. This reflected the issue of sustainability of resource utilization in manufacturing.

"Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth's estimated carrying capacity."

Eco-sustainability: The principle of eco-sustainability, like eco-efficiency, recognizes the finiteness of natural resources and the need to utilize them efficiently.

The core concepts of the principle of eco-sustainability are:

• No adverse long term effects on ecosystems.
• Rate of use of natural resources is less than the rate of renewal of the resources.
• Growth is within the carrying capacity of the environment.

Eco-design: This is a design process in which environmental attributes are treated as a design objective rather than a constraint. The environmental attributes are added to the regular design objectives. One of the most well-known eco-design programs is the Design for Environment (DfE). It seeks to incorporate environmental objectives with no or minimum loss of product performance, useful life or functionality.

Differences occur as to which environmental attributes and general goals should be included, leading to differences in terminology such as "Sustainable Product Development," "Life Cycle Design," "Green Product Design" etc.

DfE guidelines vary between different countries, however , the focus here is on eco-friendly product design.

The Dutch Manual for Environment Oriented Product Development probably contains the most detailed elaboration of the environmental objectives for product development. A distinction is made between:

- Design for alternative need fulfillment.
- Design for product lifetime extension.
- Design for minimal materials use and selection of most environmentally compatible materials.
- Design for closure of materials cycles.
- Design for energy conservation.
- Design for cleaner production.
- Design for efficient distribution and logistics.

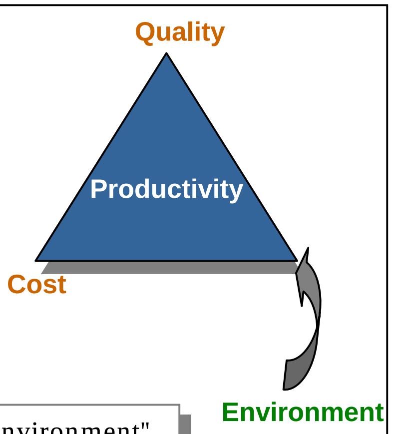
Product Life-Cycle: The entire life-cycle of the product from extraction, through manufacturing to product use and disposal is considered in evaluating the environmental burden of a product. This approach originated in Europe and is considered the most holistic approach to eco-friendly product development.

1.4 Environmental Management Trends

1.4.5 Productivity Practices

Productivity Practices

- Traditional focus of productivity was ensuring cost effectiveness through cost reduction.
- The quality drive and customer satisfaction was the next focus
- Programs to improve productivity by influencing the internal organization of an industry emerged. The most popular have been Kaizen, TQM, TPM etc.



The next step required integration of "Environment" into these productivity improvement programs.

Traditionally, productivity improvement focused on cost effectiveness through cost reduction. Therefore, to improve profitability or organizational effectiveness, the approach used was cost reduction.

With the advent of “the quality” drive, productivity had to be measured by comparing the benefits accrued from a quality program (output) with the resources used within the programs (inputs).

In an attempt to improve productivity by influencing the internal organization of an industry, a number of programs emerged. The most popular have been TQM; Total Productive Maintenance (TPM), which addresses equipment maintenance; 5S, which ensures structured and systematic housekeeping in an enterprise; and Kaizen, which is a philosophy committed to continual improvement.

Important

The total quality movement may be one vehicle through which environmental issues can be integrated into business as a whole.

To some extent, productivity practices such as preventive maintenance and good housekeeping reduce the environmental burden. However, for total environment management, it is necessary to integrate these productivity improvement programs. The need for a viable strategy that integrates “environment” into productivity improvement for industry, agriculture and services has never been higher, particularly in Asia.

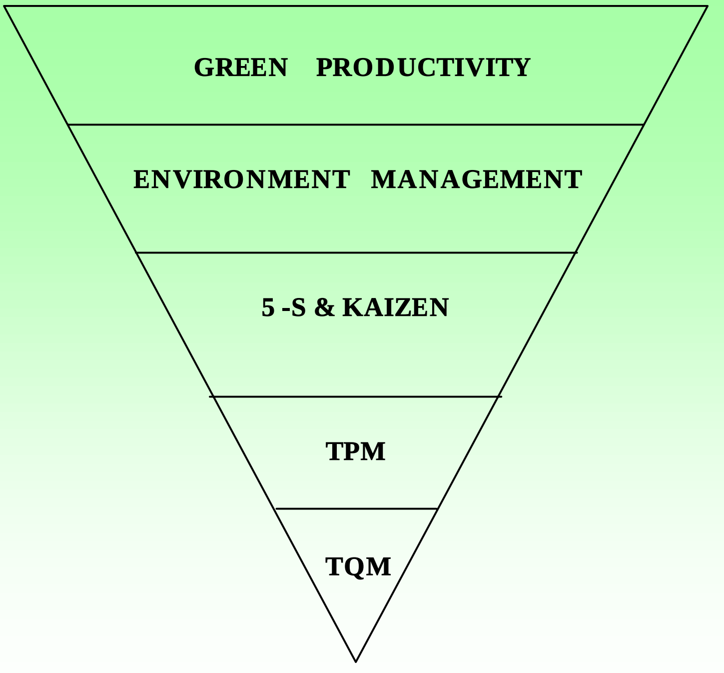
On the one hand, there are pressures (1) to achieve rapid industrial growth (from a limited resource base) while ensuring that there is no further deterioration of natural resources; (2) from the international marketplace to include the environment as a strategic business factor; (3) from increasing public awareness and concern for the environment and (4) from improving environmental regulation and enforcement.

Reference — Look Up

Costing the Earth, Frances Cairncross

On the other hand, there is the impact from the recent East Asia economic crisis. In stabilizing the economy following the crisis, there has been a need for tight fiscal discipline.

At such a time, public spending on environmental protection and the administration of regulatory agencies could be affected. Moreover, enterprises have limited financial resources and, if they have to compete in the international market, their business strategies have to be turned around. This process should be used as an opportunity by industry, agriculture and the services sectors, as well as policy makers, to steer the Asian economy towards sustainable development.



Evolution of Green Productivity

Given this situation, it makes it all the more critical for development in Asia to be guided in a sustainable manner.

It is clear that there are close links between productivity and sustainable development. It is internationally recognised that enhancing productivity will not be possible without protecting the environment. The ultimate objective of productivity improvement is to achieve a better quality of life for everyone.

Productivity improvement also creates national wealth, which enables the society to invest more in environmental protection and rehabilitation measures. On the contrary, degraded environment means a direct threat to the quality of life, and, therefore, poses a challenge to productivity.

Productivity, in a broad sense, is a measure of how efficiently and effectively resources are used as inputs to produce products and services needed by society.

Productivity improvement means improvement in **QCDMS**:

Q= Quality
Higher quality that meets or exceeds customer requirements.
C= Cost
Lower Cost.
D= Delivery
Timely delivery as desired by the customer.
M= Morale
Boosting morale of all concerned.
S= Safety
Improving the safety of every aspect of the product and process.

1.4 Environmental Management Trends

1.4.5 Productivity Practices

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S= Safety
Thinking and improving safety of each and every aspect of the product and process

Outputs are divided into two groups: desired outputs and undesired outputs. Undesired outputs are often called "waste". The productivity of a system is determined by its desired outputs, which are usually regarded as final products. The primary aim of productivity improvement is to increase the ratio of desired outputs to total outputs.

The elimination of waste in all forms, therefore, means productivity improvement. This will reduce the cost and improve the quality of the final product.

By improving the ratio of desired outputs to total outputs (waste minimization) and enhancing quality in accordance with consumer demands (quality management system), total productivity is raised.

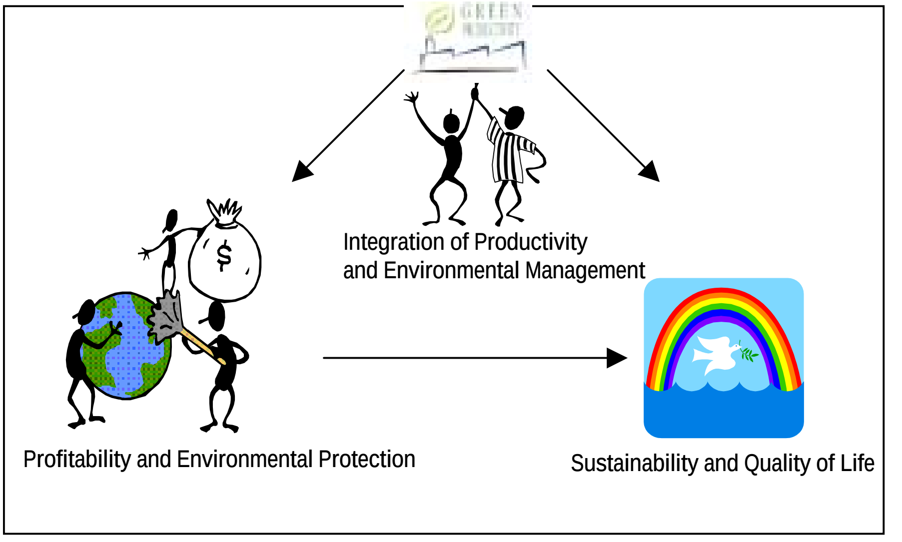
The most important input factors are labor, capital, materials, energy and environmental protection costs.

Current trends have shown that environmental issues, especially those relating to trade and industry, will become more important to the economies of countries in the near future. With this intensifying concern for the environment, manufacturers can not survive unless they meet environmental standards. The very survival of many of them is under threat because they continue to generate pollutants that they have to clean up (end-of-pipe). This approach increases costs and makes them less competitive. It is also very unpopular in the communities in which the companies operate. Successful enterprises adopt a prevention approach through green products, cleaner production processes and low waste technologies. Reducing consumption of energy and materials through technological innovation, design changes, and better housekeeping and maintenance, improves the quality of the products, reduces the level of pollutants and effluents discharged into the environment and reduces costs as well.

In GP practices, the main objective is to identify ways to prevent pollution or waste at its source (increasing output and improving quality), as well as reduce the level of resource inputs through rationalization and optimization (decreasing input). The productivity improvement results of adopting GP practices are lower cost of production, decreased waste disposal and end-of-pipe costs.

This shows that adopting GP practices and techniques does not require a new set of skills to be learned; rather, it is the application of productivity and management tools to a new set of priorities.

From Productivity To Green Productivity



The need to fundamentally change the approach to business by moving towards resource efficiency and taking a holistic life-cycle view of products was recognized in the 1990s.

The need to ensure ecological and economic efficiency as the basis of future strategies in business was found to be essential if development was to be sustainable.

Resource efficiency not only leads to protection of natural resources, but also results in improved productivity. These productivity gains are possible through improved product/service design, manufacturing processes and procedures; increased capital investment in more efficient technology; improved labor performance; increased levels of labor participation; and more effective research and development.

These measures will also improve environmental performance, as shown earlier. Therefore, if development is to be sustainable, there is a need to move beyond pollution prevention and ensure that both productivity improvement and environmental protection are achieved simultaneously.

Important

GP and eco-efficiency share a common vision. GP, however, looks at environment and productivity in an integrated manner to form the foundation of sustainability, considering the harmony needed between production as well as consumption.

Recognition of this integrated approach is reflected in the concept of **Green Productivity.**

Green Productivity (GP) is a *strategy* of integrating environmental and social considerations with business and other activities. It was conceived and developed by the APO in 1994.

The goal of GP is to attain a higher level of productivity to serve the needs of society, and to protect and enhance the quality of environment – both locally and globally.

GP leads to gains in profitability through improvements in productivity and environmental performance.

Learnings from the Lecture

At the end of this lecture, participants should be aware of the global and regional environmental concerns and the various strategies/approaches that have evolved in an attempt to manage them.

The lecture should also have made the participants aware of productivity practices and how the focus has shifted from mere cost reduction to quality, and finally, to recognition of the need to integrate productivity improvements with environmental protection.

Given this background, participants should at the end of the lecture be convinced of the need for an integrated strategy such as GP, particularly in moving the Asian economy in a sustainable direction.

After listening to lecture, participants should have answers for the following questions:

1. What is sustainable development?
2. What have been the global developments in environmental management?
3. Why was there a need for developing a program like GP?
4. What is unique about GP that is not found in other programs aimed at environmental protection or productivity improvement?
5. What is the basic strategy of GP?
6. What are the benefits of GP and who are the beneficiaries?
7. Why focus on SMEs in GP?
8. How important is GP in addressing unsustainable production and consumption?

The next lecture will explain the concepts, practices and principles of GP.

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CHAPTER 2

Concept of Green Productivity

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Objective of the Lecture

The objective of this lecture is to understand the principles and concepts of productivity and how they are integrated into Green Productivity.

In addition, the lecture aims to present the formal definition of GP, its underlying principles and characteristics. Against this background, the lecture then goes on to present how an organization can put the GP strategy into operation.

GP principles have been drawn from both ecological and productivity domains, and this lecture intends to show that environmental protection and productivity improvement have been truly integrated in this approach. The key aspect is a sustainable, multi-sectoral approach focusing on SMEs and community.

Having delineated the underlying principles, the lecture presents GP's focus on all the stages of an organization's activities, i.e., *input, throughput and output.*

The GP framework is explained in showing how the concepts of GP are applied.

The lecture concludes with a presentation of the manifold benefits of GP.

2.1 Productivity Concept and Principles

2.1.1 Productivity Concepts

What is Productivity (Technical Concept) ?

Defining productivity is not an easy task when a precise answer is needed. The term productivity is a broad concept which involves two major aspects. Conventionally, productivity has been defined as the relationship between *output* and *input*. It is normally expressed in terms of the *ratio between output and input* as shown in the view graph. Output represents the product of an operation, or result of special interest. The input refers to the resources consumed in the production or delivery of output.

Sometimes called the *technical* or *production* concept of productivity, it is a very useful measurement tool. It measures one's ability to efficiently utilize available resources to produce desired output and, thus, reflects the changes in productivity. However, this may pose problems if input and output are viewed in quantitative terms only, neglecting the qualitative aspect. Efforts to raise productivity may result in an increase in output with deteriorating quality. In some cases, it may even result in labor-management conflict due to a reduction in labor force in an effort to increase labor productivity. To overcome this problem, the concept of productivity as a broad social concept has been introduced.

What is Productivity (Social Concepts) ?

Productivity should not be viewed merely as a narrow technical concept. It is also a social concept. It can be briefly stated as follows:

Productivity is, above all, an attitude of mind. It seeks to continually improve what already exists. It is based on the belief that one can do things better today than yesterday and better tomorrow than today.

On August 26, 1958, a similar statement was released in Paris by the secretariat of the Productivity Agency Organization, under the title of "The Concept of Productivity and the Aims of the National Centers."

Based on the above concept of productivity, it should be emphasized that to make tomorrow better than today is an innate wish of everyone. Hence, productivity can be a common objective of everybody. It aims to achieve a better quality of life for all.

What is Productivity (Economic Concept) ?

Productivity may also refer to one's ability to create more value for customers. For many business organizations, the economic goal and basis for existence is value creation. Economic gains for all (both the employees, management, government and other stakeholders) is measured in terms of value added, which may come from increases in inputs or improvements in productivity. In most cases, increases in value added are attained through expansion in capital and labor. However, a productivity driven growth model reflects resource efficiency and output superiority in the market since it drives the creation of more value to customers. Hence, a long-term sustainable growth in the economy cannot depend on expansion strategy alone.

What is productivity?

As an integrated concept

$$\text{PRODUCTIVITY} = \frac{\text{Output} \times \text{Satisfaction}}{\text{Input} \times \text{Sacrifices}}$$

- as objective → Social concept
- as a means → Technical concept

What is Productivity (Management Concept)?

From the management perspective, productivity has been equated with efficiency and effectiveness. As illustrated above, efficiency and effectiveness are both management concerns to ensure that desired products and services are done in the right manner all the time. This concept of productivity provides a working definition to manage and improve productivity at micro or organization levels.

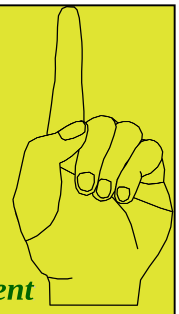
What is Productivity (Integrated Concept) ?

As an integrated concept, productivity can be viewed in two ways: as an objective and as a means. Productivity as an objective is explained by the the social concept of productivity. As a means, productivity pertains to the technical, economic and management concepts of productivity.

Experience has shown that companies and economies as a whole face competition from other countries offering similar or even better products and services. A better option as a long-term strategy, would be to strive for a productivity-driven economic growth involving the expansion of labor and capital inputs and the qualitative improvements of these inputs. Among these, the qualitative aspects of capital and workforce improvement would be of greater concern.

Productivity Principles

Three Guiding Principles of Productivity Movement



- Principle of Increase in Employment
  - Improved productivity ***increases employment***
- Principle of Labor-Management Cooperation
  - In improving productivity, ***labor and management must cooperate*** in discussing the measures
- Principle of Fair Distribution
  - The ***fruits*** of productivity improvement must be ***distributed fairly*** among ***key stakeholders***

The Three Guiding Principles of the Productivity Movement

After understanding what productivity is all about, one must also understand certain principles as guides to ensure success in pushing the productivity movement. These principles are called the "Three Guiding Principles of the Productivity Movement." These are explained as follows:

1. **Principle of Increase in Employment**. In the long run, improvement in productivity will increase employment. However, during transition or before the results of improved productivity are realized, the government and the people must cooperate to generate suitable measures to transfer surplus labor to areas where needed and thus prevent possible unemployment.
2. **Principle of Labor-Management Cooperation.** In developing concrete measures to increase productivity, labor and management, conforming to the conditions existing in the respective enterprises, must cooperate in discussing, studying and deliberating such measures.
3. **Principle of Fair Distribution.** The fruits of productivity improvement must be distributed fairly among management, labor and the consumers.

2.1 Productivity Concept and Principles

2.1.3 Multi-factor Productivity

Important

Productivity can be defined quantitatively in different ways. It could be:

(i) factor productivity e.g., labor productivity that measures output per worker; (ii) multifactor productivity - a broader measure of efficiency, it relates output to the combined inputs of labor, capital, and intermediate purchases (materials, energy, and purchased services). Either way, productivity is an essential indicator of technological and organizational efficiency.

Important

The Asian Productivity Organization (APO), recognizing the strength of multi-factor productivity advocates the Total Factor Productivity approach wherein labor, capital, resources and miscellaneous items such as management, entrepreneurship and technology are measured. In fact the APO has developed guidelines for use of this concept.

Source: Vrat, P., Sardana, G.D., Sahay, B.S., Productivity Management - A Systems Approach, Narosa Publishers, New Delhi, 1998.

Multi-Factor Productivity

MULTI - FACTOR PRODUCTIVITY AND GP

Raw materials productivity = Output (*value or unit or value added*) / Raw material used

Labour productivity = Output / number of employees (number of hours worked)

Variables for quantification of GP that can be factored in are: water, energy, materials (chemicals, auxiliaries, packaging etc.), technology, capital.

Having looked at the various components in the GP framework that steer production and consumption towards sustainable practices, it is very important to be able to measure these efforts to enable continuous improvement. The GP framework proposes to draw from the productivity domain in this context.

Productivity = Output/Input = Value of goods or services/Cost of resources consumed.

There are a number of different inputs associated with any output from an industrial or commercial organization, e.g., labor, capital and materials. However, it can also include energy, water and other industrial sector specific factors such as dyes and other chemicals for the textile manufacturing sector, metal salts, acids and complexing agents for metal finishing operations etc.

Multifactor productivity (MFP) measures are useful for many purposes such as analyzing changes in overall efficiency and total costs. However, factor productivity measures such as labor productivity still provide insights into industry efficiency and are useful for analyzing unit labor costs. Some industries suffer from data inadequacies that prevent the development of MFP measures.

With the increasingly important role that environmental costs and resource efficiency are playing in businesses, MFP appears to be a more appropriate measure. Benefits to an enterprise, due to conservation of resources, improvement of health and safety in the working environment, etc., are more readily reflected in MFP measurement than in factor productivity. Therefore, it is an integral part of the GP framework.

In the context of GP, improvements in MFP can be reflected in terms of less utilization of resources such as water, using as much renewable energy as possible, and employing eco-friendly chemicals in processes. Apart from greater efficiency in utilization of resources, the element of increased safety, reduced toxicity and overall reduced environmental burden is also integrated into the measurement of GP.

2.2 Ecological Concept

Ecological Principles Guiding GP

1. SUSTAINABLE USE OF NATURAL RESOURCES
2. PROTECTION OF ECOLOGICAL BALANCE
3. PROTECT PLANT AND ANIMAL SPECIES AND THEIR ENVIRONMENT

The ecological principles that guide GP are to ensure that there will be ecological sustainability in our development activities. The three principles are as follows:

1. **Sustainable Use of Natural Resources**

This means that to be sustainable, we cannot use up our natural resources faster than they can be renewed or regenerated. For non-renewable resources, we cannot use them at a rate faster then we can find substitutes for.

GP aims at the efficient use of our natural resources. The increased efficiency will result in the conservation of our natural resources and lead to its sustainable use.

2. **Protection of Ecological Balance**

This means that we cannot pollute our environment to the extent that it would be beyond the capacity of the environment to treat these wastes. Pollution would disrupt the various ecological processes that provide us with clean air and water, as well as contaminate the food chain that provides us with our food.

GP, with its objectives of preventing and reducing pollution, would protect the ecological processes that are so essential in maintaining the ecological balance of our environment.

3. **Protect Plant and Animal Species**

Plants and animals, besides being of value in themselves, are essential for our long-term survival as they continue to help maintain the ecological balance of our environment. They are also the basis of our food and other products. The genetic composition of these plants and animals are the genetic resources for the improvement of our food crops, sources of medicine and other useful products.

GP, in the more efficient use of the environment and resources and the reduction of pollution, would contribute to the survival of these species.

2.3 Relationship Between Productivity & Environment

Relationship Between Productivity & Environment

The concept of green productivity is drawn from the integration of two important developmental strategies:

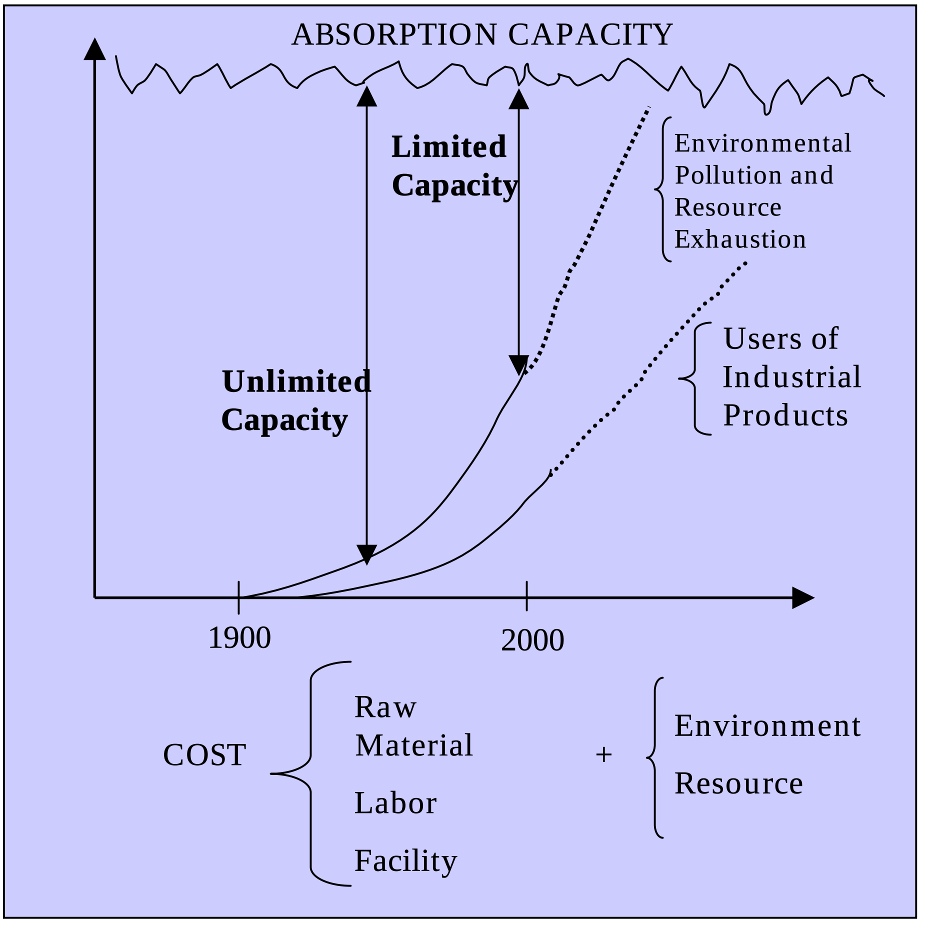
- productivity improvement; and
- environmental protection.

Productivity provides the framework for continuous improvement.

Environmental Protection provides the foundation for sustainable development.

Sustainability is the vision or driving force for GP.

Resource Efficiency & Productivity



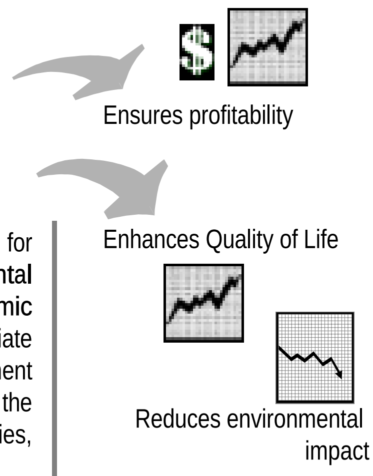
The total amount of resources in the world are fixed. With the growing population, higher living standards and increasing demand of goods, the use of natural resources is also increasing. Human beings are relentlessly exploiting these resources without giving nature the time to replenish them. Often the stable raw material is converted to its basic element, which is discarded after use.

Efficiency of a process is defined as the ratio of the output to the input. In this process, some resources are utilized to make the output happen and some of the resources are wasted. This wasted resource amounts to an equivalent amount of pollution being generated and also a lower productivity. The amount of resources utilized is directly proportional to the productivity. The efficiency of resource utilization depends upon many factors, from the type and quality of raw materials used to the technology used. This ultimately has a direct bearing on the productivity. As the technology becomes older, the productivity decreases. In order to maintain an optimum productivity, an effective system should be evolved for efficient resource utilization.

2.4 GP Concept

2.4.1 Definition of GP

GP Ensures Profitability and Enhances Quality of Life



Green Productivity (GP) is a **strategy** for enhancing **productivity and environmental performance** for overall **socio-economic development**. It is the application of appropriate productivity and environmental management tools, techniques, technologies to reduce the environmental impact of organization's activities, goods and services.

In its formal definition, GP uses three key terms / phrases (i) strategy, (ii) productivity and environmental performance (iii) socio-economic development.

An attractive feature of GP is that it is a *strategy* that leads to gains in **profitability** through improvements in productivity and environmental performance. Excessive use of resources or generation of pollution is indicative of low productivity as well as poor environmental performance. In many ways, these are manufacturing defects that need to be consistently set right. To improve the situation, GP pursues a strategy based on technical and managerial interventions. It is a process of continuous improvement.

Through resource efficiency, it works towards retaining the natural resource "capital," thereby ensuring a form of savings for the environment, too.

The first step in this process is to identify ways to prevent pollution or waste at its source, as well as reduce the level of resource inputs by the process of rationalization and optimization. Possibilities of reuse, recovery and recycling are examined to salvage the wastes generated.

Next, opportunities for substituting toxic or hazardous substances are explored to reduce the life-cycle impact of the product. At this stage, the product itself is examined, including packaging, in the framework of design for environment.

Finally, the waste in its residual forms are treated adequately by suitable end-of-pipe options to meet the regulatory requirements both from the perspectives of the workspace and the receiving environment. In order to ensure a continuous improvement in productivity, as well as in the level of environmental protection, a systematic approach and methodology has been developed for GP.

2.4 GP Concept

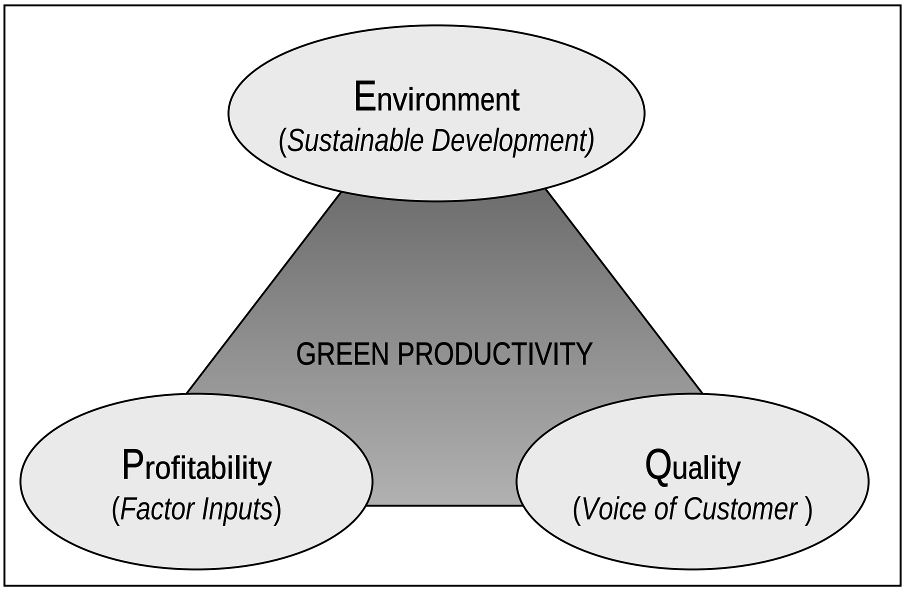
2.4.1 Definition of GP

GP attempts to answer society's needs, therefore, by increasing productivity through environmentally sound manufacturing practices and businesses, thereby catering to customer requirements for more environmentally sound products, while ensuring a healthy and safe environment.

This process, however, is iterative and the GP strategy can achieve this by constantly addressing not just the supply side, but also demand side management. In this way, society’s needs can be steered in a sustainable direction.

2.4.2 Triple focus of GP

Triple Focus of GP



GP aims to ensure environmental protection while making business profitable. This is necessary if development is to be sustainable. Neither environmental protection nor development can happen at the cost of the other.

GP recognizes that environment and development are two sides of the same coin. Extending this recognition, the concept of GP shows that for any development strategy to be sustainable it needs to have a focus on Quality, Profitability and Environment - called the Triple focus of GP.

Quality is dictated by the voice of the customer for both goods and services. GP works at ensuring quality by promoting the use of newer and safer materials, increasing processing and production efficiency and improving working conditions.

The intent of GP is thus to provide the consumer with more performance and value with the use of less resources, including energy, and the creation of less waste.

Essentially, the practice of GP results in using material resources and energy more efficiently and sustainably – "doing more with less".

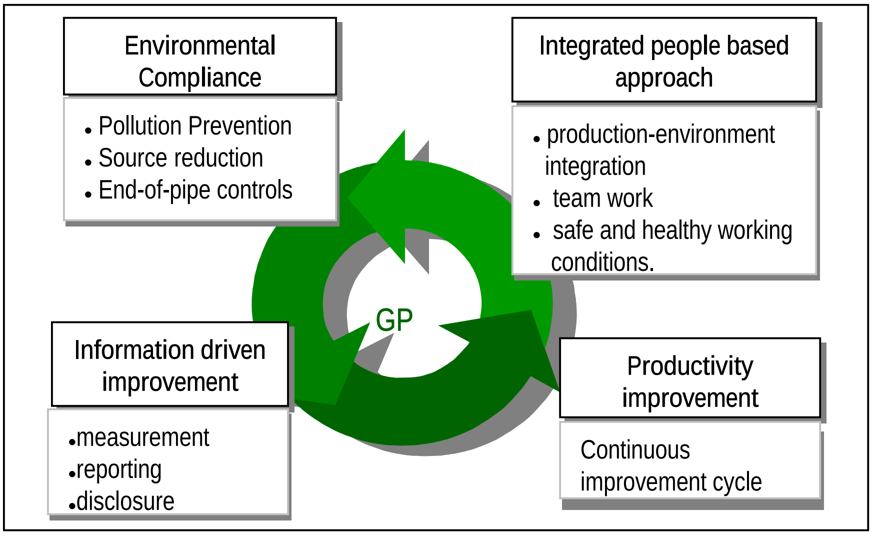
This makes sense both for the *environment* and for business. Natural resources are conserved, thereby reducing environmental degradation. Reducing the amount of material and energy used to make or supply goods and services can directly cut the cost of doing business, thereby ensuring *profitability*. The savings may come from lower production and waste management costs or may take the form of avoiding the cost of potential environmental liabilities.

GP thus works towards attaining higher level of productivity for serving the needs of society and to protect and enhance the quality of environment – both locally and globally – by focussing on **Q-E-P**.

The central principle is that substances should not be produced faster than they can be reintegrated into cycles of nature……
Tachi Kiuchi, Managing Director
Mitsubishi Electric

2.4.3 Distinguishing Characteristics of GP

Distinguishing Characteristics of GP



GP is characterized by four distinguishing characteristics:

Environmental Compliance: The heart of GP is environmental protection, the first step for which is compliance. It is today one of the most challenging tasks facing industry, and can be achieved through the practice of GP by pollution prevention and source reduction. Residues will require to be managed using end-of-pipe treatment measures. While achieving environmental compliance, it is the unique characteristic of GP that productivity will also improve. These practices may lead to a situation *beyond compliance* with the ultimate aim of ensuring *quality of life.*

Productivity Improvement: The other side of the GP coin is productivity improvement. The *kaizen* approach of continuous improvement forms the basis. This has to accompany environmental protection. The concept of continuous improvement achieved by adopting the tenets of the PDCA (Plan, Do, Check and Act) cycle is aimed at ensuring not only the productivity improvement sought in classical productivity programs, but also environmental improvement. This is a dynamic and iterative process.

Integrated People-based Approach: One of the strengths of GP is its worker involvement and team-based approach. This extends to improved working environment, worker health and safety, non-discrimination and related social welfare issues. It is methodology based and involves multi-stakeholder participation. This enables a step-by-step approach, systematic generation of options and solutions, and contribution by all members in an organization to the GP process. The people involvement also ensures transparency and accountability.

Information-driven Improvement: Documentation and reporting are the strengths of GP drawn from systems such as QMS and EMS. The adage *What gets measured gets done* is one of the driving forces of GP. Performance of an organization after establishing a GP program would be continuously measured and evaluated using a set of defined GP performance indicators.

2.4.3 Distinguishing Characteristics of GP

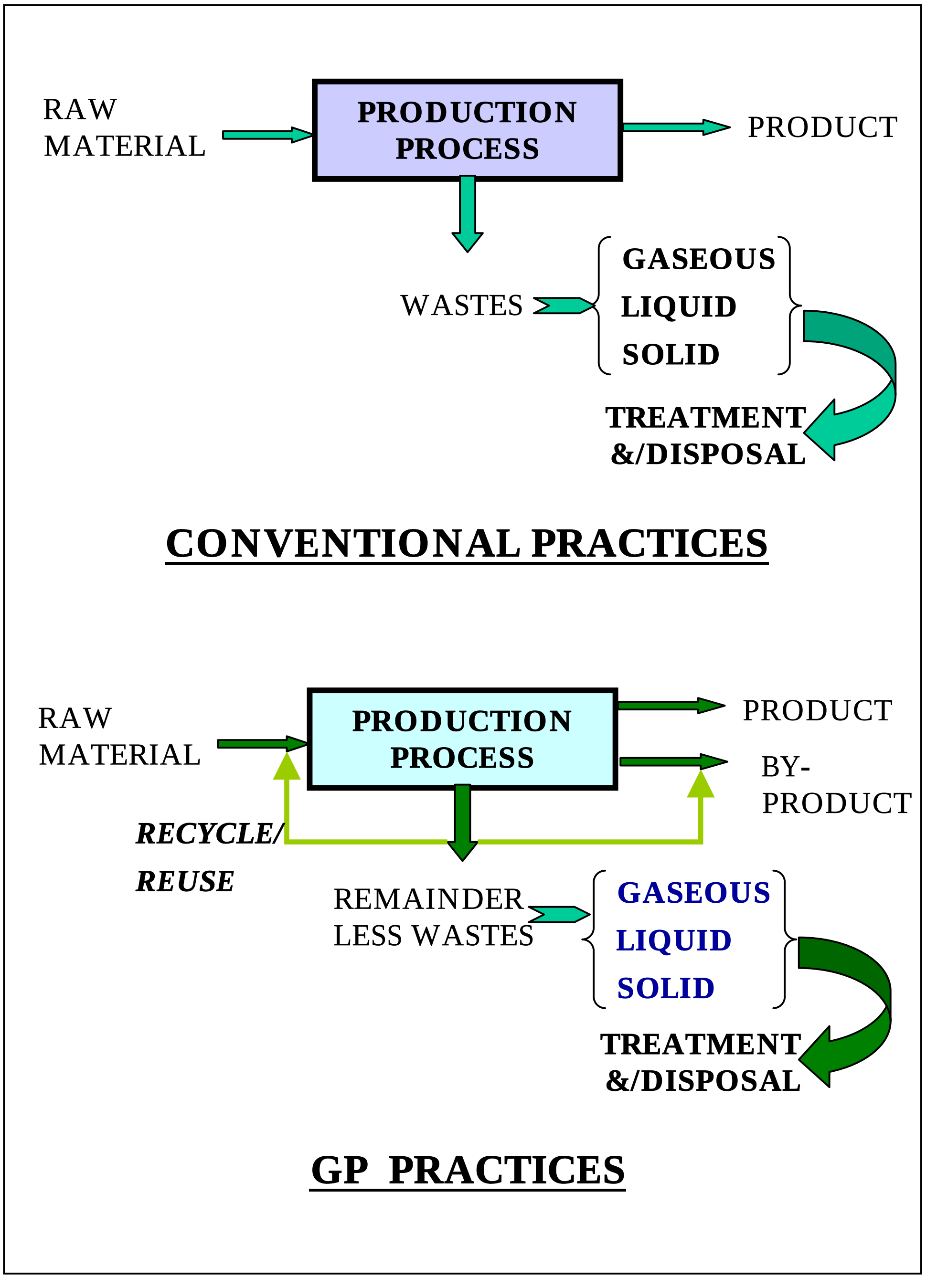
The integration between what is conventionally termed productivity improvement concepts and environmental protection concepts is thus evident.

To achieve this integration, innovative and/or advanced organizational systems may need to be adopted, which creates an opportunity for introducing green design, practices and production (agricultural and industrial) strategies.

Advanced systems does not necessarily mean cutting-edge technology or capital intensive equipment, but denotes a blend of technological and organizational changes within the enterprise. These could typically include self-directed work teams, worker rotation and continuous process improvement. Such a system would also be characterized by close and interdependent relationships across the production chain between the producers and consumers. GP adopts such an approach to steer development in a sustainable direction.

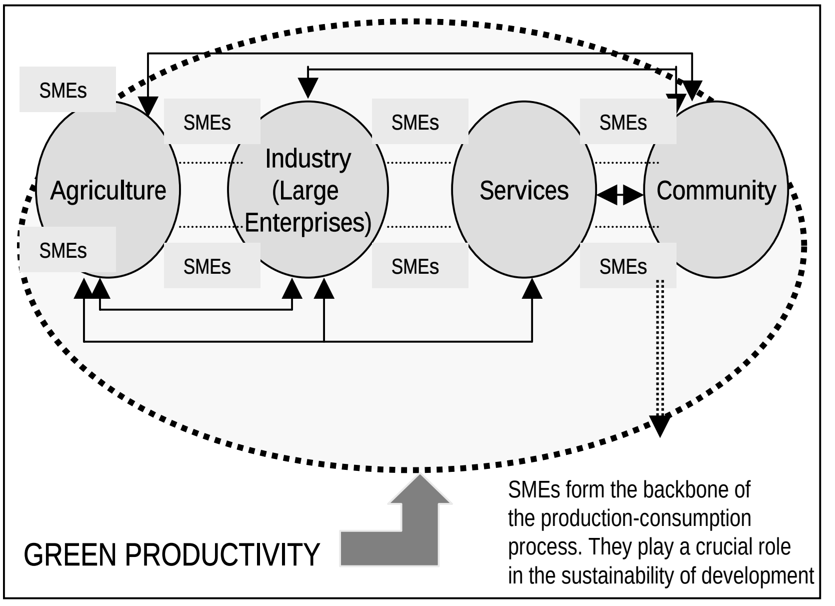
Businesses adapt, and have responded in the past, to increasing competition with effective strategies to transform the very nature of competition by overcoming traditional trade-offs. *GP could be one such strategy that businesses are looking for to retain their competitive advantage while ensuring environmental protection.*

Conventional Versus GP Practices



2.4.5 Multi-sector Coverage

Multi Factor Coverage of Green Productivity



Productivity by its very definition involves resource utilization. Any form of resource utilization will have an impact on the environment.

All forms of economic activity, be they industry, agriculture or services, utilize these resources in response to societal needs and, thus, impact the environment.

GP recognizes this aspect, and since sustainability is the driving force, the strategy must be *multi-sectoral in its application and coverage.*

Agricultural activities form the basis of industry in many sectors such as textiles, pulp and paper and sugar. Steering agriculture in a sustainable direction through GP will add value to the dependent industrial sector.

Within these sectors, the holistic approach adopted by GP necessitates that both large, and small and medium sized enterprises must be addressed.

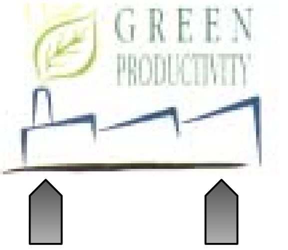
Given the crucial role played by SMEs in the Asian economy and the resource crunch they face, the focus is on them. Since SMEs form an integral part of the supply chain of large enterprises, any improvements in the business practices of the former will be reflected in the performance of the latter.

In view of these inter-relationships across sectors, one of the goals of GP is multi-sector coverage.

To enable this to be effected, the methodology developed for implementation of GP has been maintained in a sufficiently generic form.

2.5 Guiding Principles of GP

Guiding Principles of GP



- Accountability
- Polluter Pays
- Precautionary Approach

- Profitability
- Competitive Advantage
- People-Building

The guiding principles of GP have been drawn from both productivity and environmental domains. The elements of these principles have been incorporated in the development of the concept of GP, while their guiding role will become apparent in the practice of GP.

A large number of these principles are already guiding environmental management and productivity improvement practices. However, these are being implemented in a compartmentalized manner. While integrating the two domains and developing the concept of GP, care has been taken to select the relevant principles that are complementary in nature and that will strengthen the integration of environmental protection and productivity improvement.

With this in mind, the ecological principles selected include:

- Accountability
- Polluter pays
- Precautionary approach

The complementary productivity principles that guide GP include:

- Profitability
- Competitive advantage
- People-building

To operationalize GP, a systematic, step-by-step methodology has been developed. These guiding principles have been integrated into the development of the methodology to enable the practice of GP to be in keeping with the spirit of these principles.

2.5 Guiding Principles of GP

Ecological Principles Guiding GP

GREEN PRODUCTIVITY

Ecological Principles

- Accountability
- Polluter Pays
- Precautionary Approach

Ecological principles of accountability, polluter pays and the precautionary principle bring in the element of responsibility and place the onus for environmental restoration on the polluter.

Accountability is a guiding principle which stresses the need for an element of responsibility for actions taken in developmental activities. The principle prescribes the need for businesses to be accountable to various stakeholders. Typically, in law they are accountable to regulators. However, other stakeholders like the suppliers, customers, consumers and the public at large are all increasingly seeking accountability for the actions and impacts of business activities.

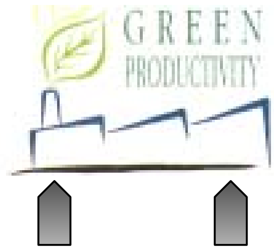
In practice, the principle of accountability has spawned voluntary initiatives such as Corporate Environmental Reporting, product stewardship programs, as well as voluntary used-product "take back" schemes by the producer. Businesses are increasingly subscribing to voluntary initiatives such as Responsible Care of the Chemical Industry as proof of their willingness to be accountable, thereby improving their market image, credibility with regulators and consumers. In GP, the principle of accountability is captured in the phrase "*for overall socio-economic development,*" which is part of the definition of GP.

Polluter Pays also brings the element of responsibility by placing the onus of the cost of environmental clean-up on the polluter. The entity creating the damage is penalized and made responsible for remediating the damaged environment. This principle forms the basis of penalties and pollution taxation systems. It also emphasizes that the polluter is responsible for incurring the costs of clean-up. This may be in the form of end-of-pipe treatment systems, new technology to enable source reduction, etc.

Precautionary Principle advocates a cautious, proactive and anticipatory approach. It is typically applicable in situations when the impact of an event is long-term and difficult to reverse. Pollution prevention, cleaner production and source reduction are all based on this precautionary principle of environmental protection.

2.5 Guiding Principles of GP

Productivity Principles Guiding GP



Productivity Principles

- Profitability
- Competitive Advantage
- People-Building

Productivity principles that guide the practice of GP aim at cost effectiveness.

Profitability is the cornerstone of any business and it advocates the need to generate profits, be it through savings on raw materials by practicing resource efficiency, or improved productivity, quality or sales. GP recognizes the significance of this principle in that, for any form of economic activity to be sustainable, profitability is an essential ingredient.

Competitive Advantage is essential for businesses to establish and maintain a market position. This also translates into profitability. This principle advocates competitiveness in pricing, quality and, in the case of GP, in eco-friendliness, too. In the practice of GP, the integration of environmental and productivity improvement will create new business opportunities and provide competitive advantage in a market where “quality” has been the focus.

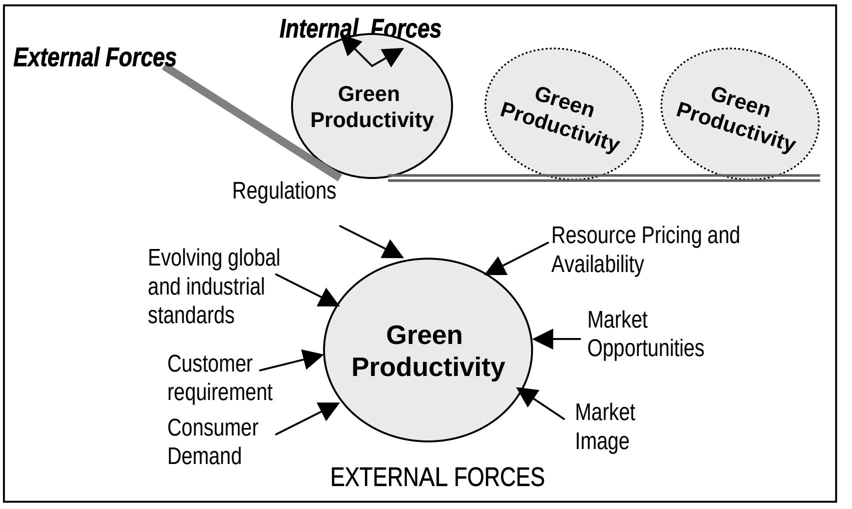
In the quality revolution, businesses realized eventually that, apart from cost reduction, quality could increase profitability. Similarly, the advantages of integrating environmental protection into business strategies will be realized with the practice of GP.

People Building or Employer Orientation is crucial at two levels. One is the commitment of the top management, since it is this that sets priorities for the company, allocates resources and motivates and encourages employees. For GP to be successfully adopted in business, a pre-requisite is employer (top management) commitment to adopting this “green” approach. The second level is worker involvement in the practice of GP. Without involvement and commitment of the line workers, effective implementation of GP is not possible.

2.6 Driving Forces of Green Productivity

2.6.1 External Forces

Driving Forces of Green Productivity



GP is driven by forces both external and internal to the organization.

External forces are typically:

- pressure from regulations, national and international;
- demands from various stakeholders such as consumers and suppliers.

Regulations may be in the form of increasingly stricter and more complex national regulations and standards; fiscal instruments such as taxes and penalties; and judicial directives. Many of the national regulations are a reflection of the international regulatory developments in environmental and natural resource protection.

Evolving global and industry standards are serving as driving forces for the move towards GP. These include international conventions such as the Montreal Protocol and Climate Change Convention; Responsible Care of the Chemical Industry; Marine Stewardship Council for the food processing sector; Forest Stewardship for pulp and paper sector; and codes of conduct for environmental and social responsibility.

These trends have much greater implications for businesses in developing economies due to their technological and resource constraints. Opening up of world markets and the increased globalization has further intensified the pressures on these businesses, as they have to meet international expectations.

Customer requirements usually focus on quality, cost, reliability, and, most importantly, promptness of delivery. However, as environmental requirements are expected to become an integral part of business strategy, pressure from customers, particularly in industrialized countries, is increasing on suppliers to provide environmentally sound goods and services. The need to obtain standards such as ISO 14000 and SA 8000 certification is increasing pressure on suppliers to improve their environmental and social performance.

Contd…..

2.6 Driving Forces of Green Productivity

2.6.1 External Forces

A number of multinationals are moving to green their supply chains, and purchasing policies are reflecting the environmental requirements. To stay in the market, suppliers have to modify their business practices.

Another dimension of this pattern of development has been the increasing, albeit slow, shift among consumers towards sustainable consumption. This has led to a demand for more eco-friendly products such as garments manufactured without azo dyes, vegetable-tanned leather products, organically grown produce, coffee that has been obtained through fair trade practices, cosmetics manufactured through fair trade practices, etc. This trend is prominent, particularly among consumers in North America, Europe, and Japan. Green consumerism is fast becoming a driving factor for businesses to change their practices.

This trend has put enterprises under pressure to adopt more environmentally sound, efficient manufacturing processes. This, however, must be done without compromising on the quality of the products in answering consumer needs.

A very important issue pertaining to sustainability of consumption and production is resource pricing and availability. Policies favoring realistic resource pricing are an essential economic instrument to drive production towards resource conservation and efficiency. Availability of a resource would typically govern its pricing, and this in turn would be indicative of the priority that should be placed in the conservation of the resource.

All these trends are also creating new market opportunities for goods and services produced in a more sustainable manner and promoting a sustainable lifestyle.

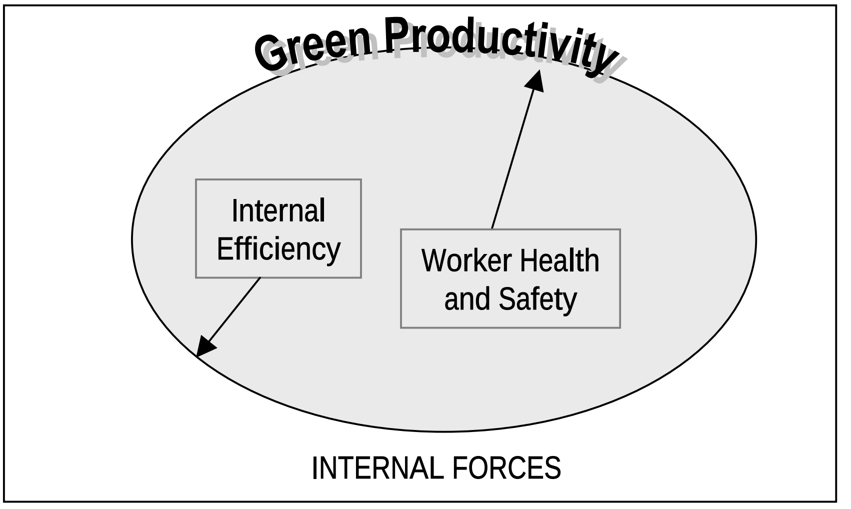
Greening of the supply chain by corporations is forcing SMEs – an integral part both upstream and downstream in the supply chain – to re-examine their business practices. Those organizations that take advantage of these trends and modify their business practices, making them more resource efficient, find themselves with a competitive edge in the marketplace.

Such trends, new opportunities and changes in the perceptions of competitive advantage are serving to drive businesses towards practices like GP, which will help them to systematically strengthen their market positions.

2.6 Driving Forces of Green Productivity

2.6.2 Internal Forces

Driving Forces of Green Productivity



Internal forces that affect GP are those that are integral to the enterprise such as:

- worker health and safety; and
- internal efficiency.

Establishment of standards such as SA 8000; adoption of the International Labor Organization's (ILO) standards for social welfare; and social codes of conduct adopted by corporate and retail chains are driving businesses to recognize worker health and safety as a crucial issue in business.

The advantages of ensuring worker health and safety include: reduced health and insurance costs; reduced absenteeism; lower liabilities; and an increase in the morale of workers. This is reflected as improved labor productivity, which is a strong driving force for the adoption of a strategy like GP.

Internal efficiency of processes and operations in an organization that serve as a driving force for GP primarily involve resource efficiency, which typically results in:

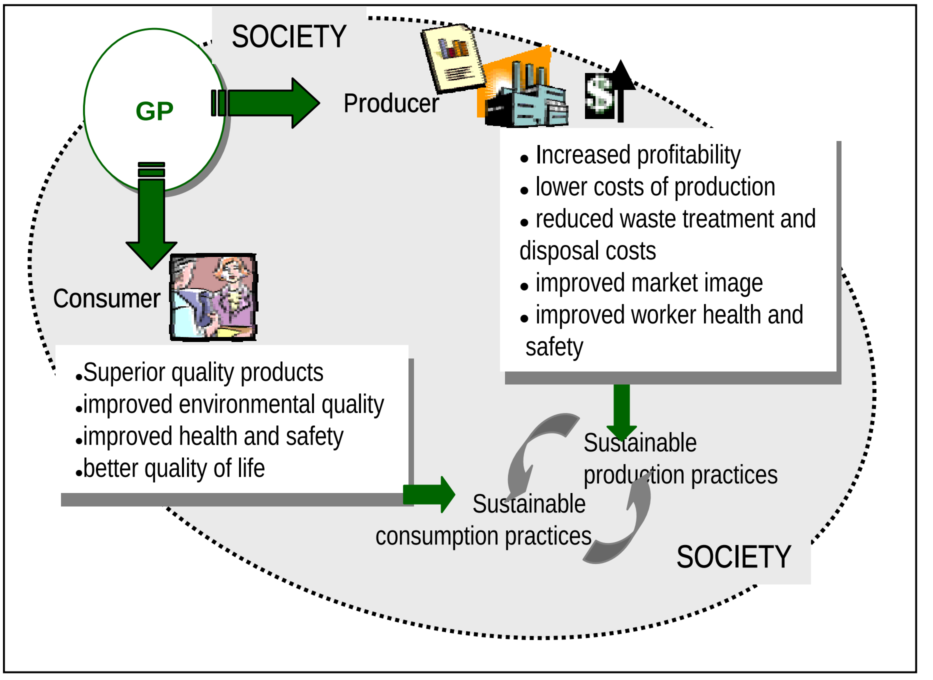
- reduction of waste by improving process conversion efficiency, and equipment efficiency, recycling, and recovering useful raw materials and by-products, thereby reducing off-spec product formation;

- improvement in quality of products by increasing the proportion of Right First Time, using better and safer raw materials and reducing defects;

- cost reduction as a result of the above measures.

2.7 Benefits of GP

Manifold Benefits of GP



Implementation of GP will have both immediate as well as long-term benefits. The benefits accrue to **producers**, as well as **consumers,** and include increased efficiency gains in resource use; lower costs of production, decreased costs of waste treatment and disposal.

GP will benefit a business by lowering its operational and environmental compliance costs and by preventing the generation of waste through efficient resource utilization. This can also reduce or eliminate long-term liabilities and clean-up costs. Furthermore, disposal costs are reduced when the volume of waste is decreased.

Adoption and practice of GP will also provide businesses with a competitive advantage. It will increase productivity growth rates in businesses, driving up market share and profitability.

This shift towards integrating "environment" and "productivity" enabled by GP has much greater implications for businesses in developing economies due to their technological and resource constraints. Opening up of world markets and the increased globalization have further intensified the pressures on these businesses, as they have to meet international expectations. The fall out from this trend has been more intensive on the SME.

Workers will benefit from GP because it justifies wage increases, and improves health and safety in the workplace.

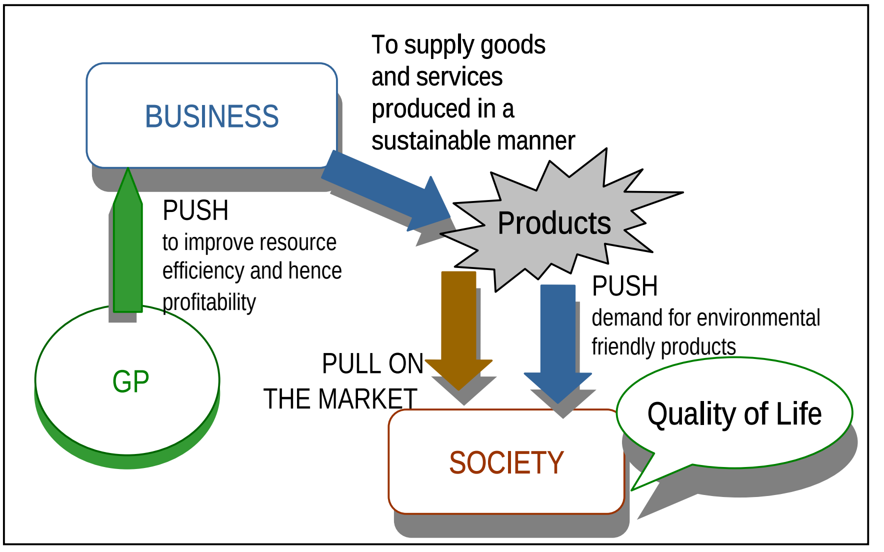
Policy makers, economists and environmentalists are interested because GP will accelerate economic growth in a sustainable manner.

GP thus forms an integral part of the broader sustainable development agenda; *moves society towards sustainable production and consumption;* and makes business sense.

2.7 Benefits of GP

2.7.1 GP Enhances Quality of Life

GP enhances Quality of Life



By improving productivity and environmental performance for overall socio-economic development, GP enhances quality of life. GP achieves this through its multi-sector coverage focus and its role in building up the community as a whole.

GP aims eventually at shaping business to answer the societal demands for quality of life through supply of goods and services produced in a sustainable manner. It has a strong SME focus here, as they form the backbone of not only businesses, but development as a whole in Asia.

This demand is being exerted in the form of environmental standards of the authorities and consumer demands for cleaner products. Businesses resist or comply with the societal demand for a cleaner environment, leading to higher costs in the medium to long term.

A better and cost-effective approach is to anticipate, by identifying and implementing efficient and innovative solutions. Initially, this strategy leads to additional costs, but in the medium to long term, companies gain through competitive advantages and a cost-effective reduction of waste and emissions.

Business also shapes society's demands through market maneuvers. Markets evolve according to a "push - pull" process. In this situation, businesses or the producers (supply side) offer products, which push demand in a particular direction. *GP can provide this push in the direction of sustainable consumption.*

Consumer needs (demand side) then evolve, exerting a pull on the market. The product becomes an active interface in this push-pull situation. Environmental protection and economic benefits are judged by the form and type of product and the service it provides.

Any changes that are to benefit society, therefore, have to be made at the marketplace. This means that a development strategy like GP must aim at changing consumption by pushing products and services so that societal economics is not compromised, while ensuring the natural environment on which society depends is not degraded.

Learnings from the Lecture

At the end of the lecture participants should know the formal definition of GP and should understand the guiding principles of GP. It should be clear that both ecological and productivity principles guide GP.

The distinguishing characteristics of GP presented in this lecture should have also convinced the participants that GP is different from other environmental management and productivity improvement programs in as much as it is an integrated strategy. This difference is both conceptual and in its practice.

The lecture should have also illustrated through the various case studies the focus and framework of GP required to enable its application. It should have clearly indicated that the practice of GP is feasible and both economically and environmentally viable.

The lecture should convince the participants enough to want to implement GP in their respective organizations.

At the end of this lecture, you should have answers to the following questions:

1. What is the concept and principle of productivity ?
2. Is GP different from Cleaner Production and EMS under ISO 14000?
3. Are there any other productivity principles that should govern the practice of GP? Should “quality” be considered as a principle?
4. Is the framework of GP clear and is GP presented in an implementable form?

The next lecture will present the methodology to be used for the establishment and implementation of GP in an industry.

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CHAPTER 3

Green Productivity Methodology

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Objective of the Lecture

This lecture is aimed at introducing the GP methodology and its underlying concepts. The GP methodology consists of three components. The first component is a step-by-step problem solving framework. The second is a set of tools, techniques and technologies that is used in conjunction with this framework. The third is a set of social, economic, environmental and cultural principles and values that guide the design of the GP process and determine the tools, techniques and technologies to use. The integration of these three components constitutes GP methodology.

A progressive description of the GP methodology is provided in this lecture, supported with some illustrations. References are made to some of the supportive productivity and environmental management tools and techniques at appropriate points in the lecture notes. Where relevant, descriptions have also been provided on how some select tools can be used to implement a task in the GP methodology.

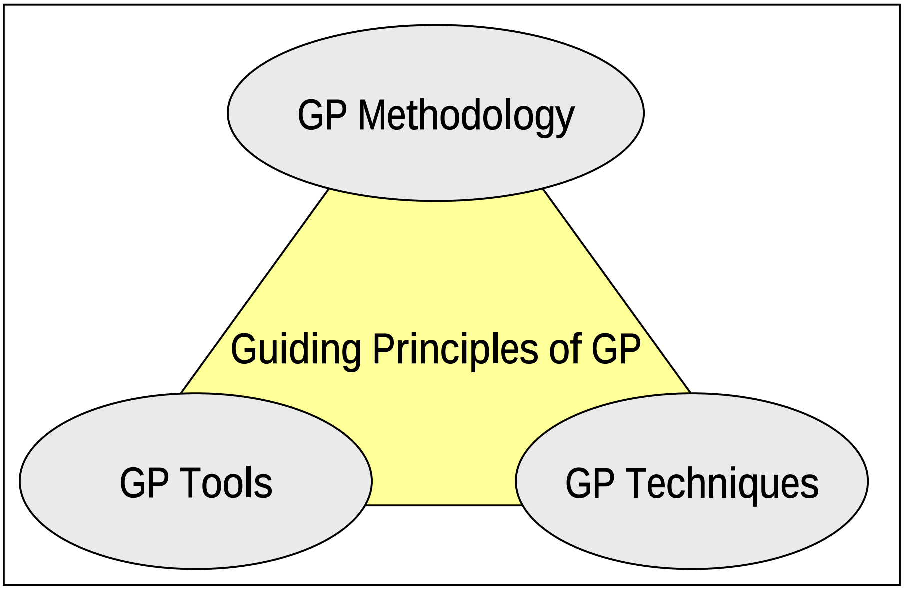
A more detailed presentation of some of the commonly used techniques is included later in the lecture.

The choice of technologies depend on social, economic, environmental as well as technical factors.

The emphasis of this lecture is on “how to,” so as to familiarize the reader on the actual implementation of GP methodology. Though the methodology can be used in many different types of situation, this lecture is based on the manufacturing industry.

Questions at the end of this lecture are basically to assist in self-assessment, and encourage further inquiry and additional reading. To obtain further information, refer to the section on GP Resources.

Overview and Framework of GP Methodology



Overview of GP Methodology

GP methodology was developed originally to solve environmental and technical problems in the manufacturing industry. It adopted and adapted some of the proven methods of process engineering and quality control. The concept of continuous improvement and steady incremental and systematic improvement inherent in GP methodology owes much to Deming's PDCA cycle and Kaizen, commonly used in quality improvements in factories.

In the early implementation of the APO Green Productivity Demonstration Projects from 1996 to 1998, the projects centered on SMEs, such as electroplating, textile, food processing and paper making. As such, there was a very strong emphasis on the manufacturing process in the methodology used.

Subsequently, the application of GP extended to farms and also to solving problems of village communities. The methodology had to be modified and made more general so that it could be applied to other areas related to productivity and environment.

GP methodology can be broken down into three components. These are: (1) the step-by-step problem solving framework, (2) the set of tools, techniques and methodologies used in conjunction with the frame-work, (3) The social, economic, environmental and cultural principles and values that govern the choice of tools, techniques and technologies and the design of the GP process.

(1) **The Step-by-step Problem Solving Framework**

The problem solving framework, in one form or another, is widely used in many organizations and enterprises. The actual number of steps is, in a sense, arbitrary but the logic of the sequence is consistent.

We first identify the problem and try to understand it by analyzing it systematically and thoroughly. After determining the root causes, we consider all possible options to solve the problem. We then evaluate the options to determine the optimal one and then devise a plan to implement the option chosen. We monitor and review the implementation and adopt and incorporate the best solutions in the whole process. We then go to the next problem and repeat the cycle. In this way there will be a continuous incremental improvement.

After the implementation of a number of GPDPs, APO decided to adopt a 6 step approach with 13 different tasks, as it is simple enough to be adopted by the factories, farms and communities practicing GP. Some flexibility is to be expected and one need not be dogmatic about the actual number of steps as the conditions in different situations can be very different.

(2) **Tools, Techniques and Technologies**

The number of tools, techniques and technologies available now is very broad. They can be management, engineering, environmental, economic and other technical tools and techniques.

These will be described in this lecture when we go through the steps in the problem solving framework. The useful tools and techniques will also be described in different sections of the group work exercise.

The technologies that are used in GP will depend on the issue or problem to be solved. Technologies tend to be more knowledge based and, therefore, the advice of resource persons knowledgeable in the field will be essential. However, they may not know the GP process methodology and they should be asked to understand the whole GP concept before they give their usual solutions. These standard solutions may or may not be appropriate. The GP team will have to evaluate these options with the resource persons.

(3) **Principles & Values (Social, Economic, Environmental, Cultural)**

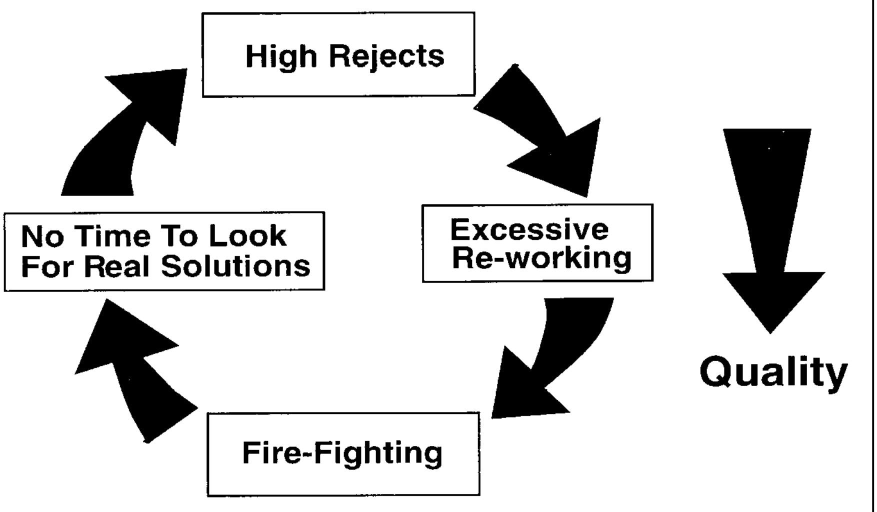
These principles and values are often not explicit, but hidden in the choices that we make concerning the use of tools, techniques and technologies that we adopt and use.

Since the objective of GP is socio-economic improvement of people and environmental protection at the same time, and with the ultimate aim of sustainability, we need to consider productivity from a broader basis. Considerations such as the more efficient use of energy and natural resources, the phasing out of the use of toxic chemicals, the reduction of waste at source and social objectives will have to be incorporated into the GP process.

From past experiences in GP demonstration projects, we have seen that the GP methodology is flexible and robust and can be applied to many different sectors of the economy as well as to problems of community development.

3.2.1 Vicious Cycle of Bad Quality

Introduction to GP Methodology



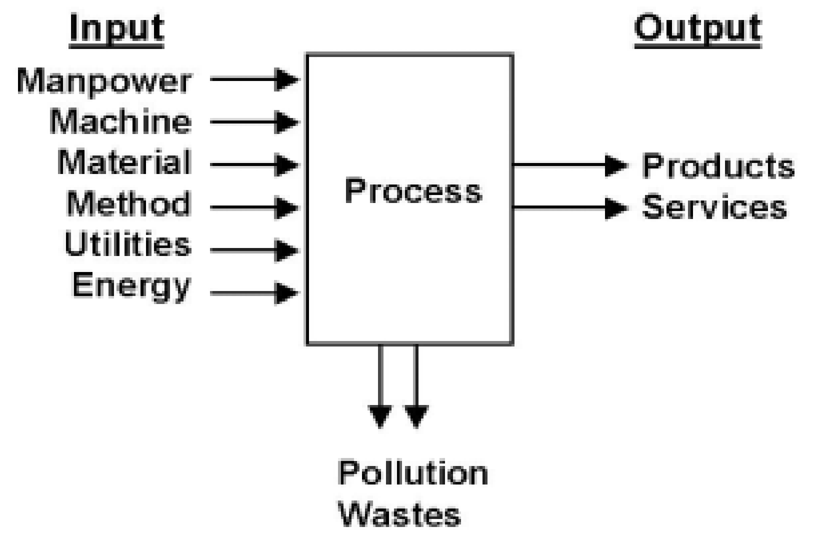
The Vicious Cycle of Bad Quality

After managing a company's processes for 10 or more years and busy coping with daily work, some of us may think that improvements to operations are impossible. As time passes, you might find that you have been overtaken by competitors and are struggling to survive. You might also be facing customer complaints as requirements become more stringent.

All bad things seem to come at once. The situation looks hopeless, as you do not have enough funding to upgrade your operations. It makes things worse when someone tells you that you have to improve productivity and, at the same time, take care of the environment.

You then channel an excessive amount of your resources into re-working current modes of operating. You get yourself entangled in what we call the "fire-fighting" mode and there is no time to look for real solutions. You are now in the "vicious cycle of bad quality". What we need is a determination to get out of this vicious cycle and improve quality, which can be defined as meeting our customers' requirements.

Introduction to GP Methodology



The Conversion Process

Many people have the impression that improving their operations requires a lot of money. This is not true! The latest developments in productivity techniques will enable companies to improve even though they do not have the extra funding.

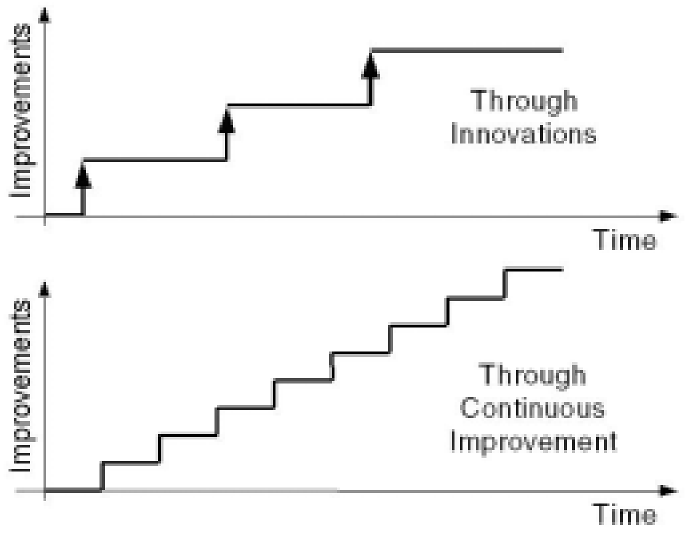
If we take a look at our business processes, we will find that there are a lot of inputs, such as manpower, machines, materials, methods, utilities, energy and so on. These inputs will then be processed in the workplace, which can be a factory, warehouse or office, before they are converted into the output that can be products or services. These products or services must then meet customer requirements. If they do not, they face customer rejection!

If you observe your operations carefully, you will find that there are other things that come out of the process, i.e., wastes and environmental pollution. We need to address the problem of waste, as it will unnecessarily consume valuable resources and make us less competitive. As for environmental pollution, we may have to use much of our financial resources to treat the waste before discharging it into the environment.

3.2 Introduction

3.2.3 Kaizen Vs Innovation

Introduction to GP Methodology



KAIZEN Vs. Innovation

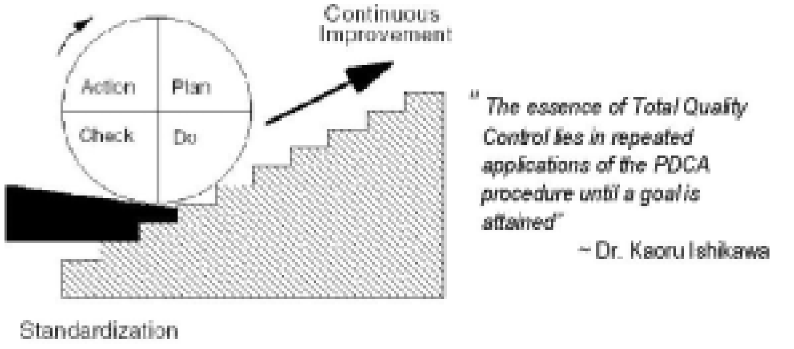
Of course, it is very pleasant when we have the funding or when we have a very brilliant idea. We can leapfrog to the next improvement level immediately. However, not many companies have the extra funding to spare and also brilliant ideas are very hard to come by.

We can apply the concept of small incremental continuous improvement to our processes so that we can in the long term reduce our waste and environmental pollution. This will make us more competitive after each day of improvement. The Japanese call this process **Kaizen**. As defined by Masaaki Imai, "kaizen means continuing improvement in personal life, home life, social life, and working life. When applied to the workplace Kaizen means small continuing improvement involving everyone – managers and workers alike."

We can work on improving small areas in our processes and make it an ongoing process. In this way, we will attain the level of productivity that innovations can bring us in a slightly longer time frame.

3.2.4 PDCA Cycle

Introduction to GP Methodology



Continuous Improvement Through PDCA

With Kaizen in mind, we still need a sound approach for improvement. There are many improvement systems in the world. The approach adopted in GP methodology is modified from the famous PDCA cycle developed by Dr. Edward Deming.

When combined with the concept of Kaizen, we can rotate the cycle up the improvement ladder by improving one area at a time in our processes. When we are happy with the improvement we can then standardize it by "wedging" the cycle on the improvement ladder. For those companies with ISO 9000 or ISO 14000 management systems implemented, standardization would mean changing some procedures or work instructions to reflect the new operation methods.

This process is best explained by Dr. Kaoru Ishikawa, a quality control guru from Japan: "The essence of total quality control lies in repeated applications of the PDCA cycle until a goal is attained".

3.2.5 Commitment and Involvement of Top Management

Before you proceed…..

Commitment and Involvement of Top Management

- Identify Team Leader
- Review objectives and Targets
- Review and approve the implementation plan
- Identify barriers for implementation and means to overcome
- Incorporate appropriate changes in management system for continuous improvement

The top management plays a critical role in the success of the GP Program

•Take the initiative to identify a GP team leader and recommend composition of the GP team.

•Review the objectives and targets to ensure compatibility with the company policy, check the timeframes, resource and fund requirements.

•Review and approve the implementation plan.

•In the case of SMEs in particular, the owners may need to supervise the implementation of options.

•Review the post-implementation report to check for the following:

⇒whether objectives and targets are being met;

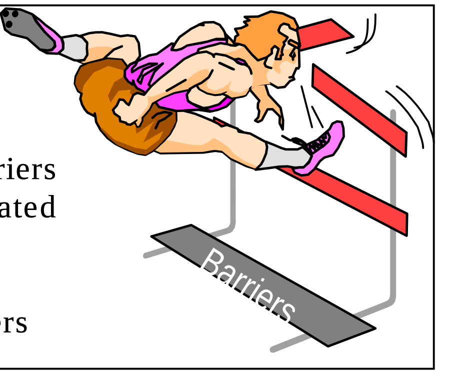
⇒whether benefits and savings are as envisaged, e.g., productivity, profitability and better environmental management;

⇒main constraints and barriers to GP program;

⇒ whether training programs were effective.

•Ensure that the GP program is established by incorporating appropriate changes into organization's system of management to enable continuous improvement.

Barriers to Commitment



- Attitudinal barriers
- Information related barriers
- Technical
- Financial barriers

Barriers to Top Management Commitment could be grouped as:

- Attitudinal
- Information related
- Technical
- Financial

Attitudinal Barriers

Resistance to change is one of the common attitudes observed in top management, particularly among SMEs. Fear of the unknown and fear of failure are the primary reasons for such an attitude.

SMEs are often indifferent towards environmental management and good housekeeping. Good housekeeping is a habit rather than a technique. In most of the family-run SMEs, good housekeeping and management of environmental issues are often treated as a low priority compared to the business operations.

A common myth in most of the organizations is that efforts on environmental management are expensive with no accrual of financial benefits.

Information Related Barriers

Lack of Awareness and information. Often the management may not be aware of what is going wrong in the organization. They may not understand the environmental impacts of activities of the organization. Also, internal communication in the organization may be weak.

Lack of Exposure. Management does not have information on what initiatives have been taken by other organizations and how successful they have been. Benefits of a system based and business-environment integrated approach are often not known to the top management.

Technical Barriers

State-of-the-art information on new technologies, operations, and industrial processes is often not available to the top management (particularly in SMEs) and technical support is not updated within the industry. Lack of technical expertise is also a major barrier.

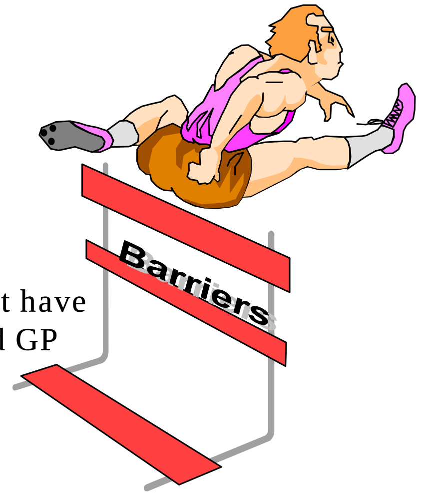
Economical Barriers

Lack of Financial Resources. One of the main barriers for small companies to implement CP options is access to capital. Internal financing is just not possible in many cases. Access to capital is difficult and will continue to be a problem for small companies.

3.2.7 Means of Achieving Commitment

Means of Achieving Commitment

- Awareness programs
- Visits to industries that have successfully implemented GP



An effective way of achieving commitment of top management is through awareness and training programs.

The awareness programs can be tailor-made for specific organizations based on the type and size of operations and existing level of awareness.

The awareness programs should target the following:

- Understanding of environmental impacts
- Elements of productivity
- Introduction to GP concepts and benefits
- Illustrations of GP success stories
- Overview of GP methodology

Visits to industries that have successfully implemented GP should be organized. The visits should be preferably in the same sector and scale of operations. The management would then have a chance to examine the implemented GP options, and the benefits achieved. During industry visits, the emphasis should be:

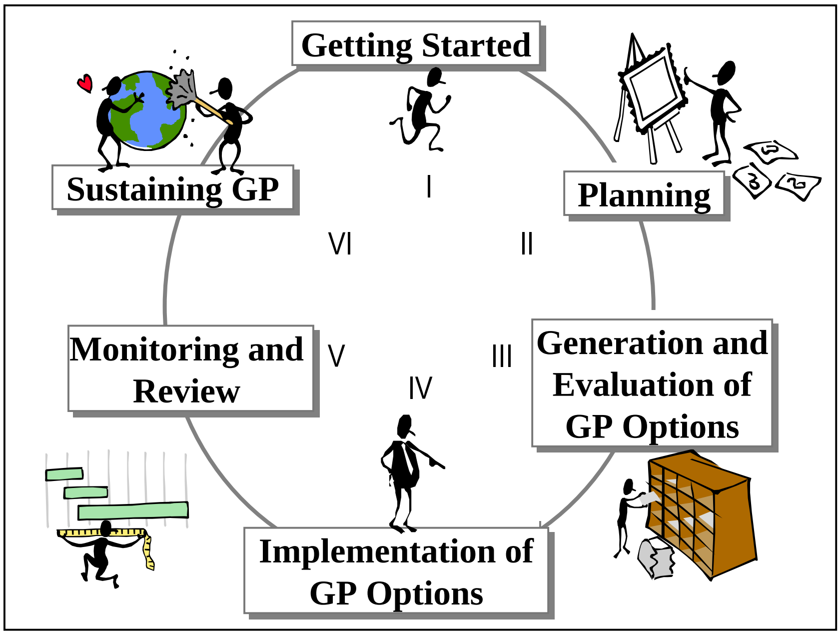
- What were the problems faced by the industry?
- What GP options were generated and implemented in response to these problems?
- What were the results in terms of the productivity and environmental improvement? What were the costs and the benefits?
- How is continuous improvement practiced

3.3 Steps of GP Methodology

GP methodology consists of six major steps. A step can be completed by following certain tasks. The six steps of GP methodology consist of thirteen tasks

The tasks are listed in the box.

6 Steps & 13 Tasks of GP Methodology



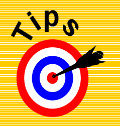
Box 1

Step I : Getting Started	
Task 1	Team formation
Task 2	Walk through survey and information collection
Step II : Planning	
Task 3	Identification of problems and causes
Task 4	Setting objectives and targets
Step III : Generation, Evaluation and Prioritization of GP Options	
Task 5	Generation of GP options
Task 6	Screening, evaluation and prioritization of GP options
Step IV : Implementation of GP Options	
Task 7	Formulation of GP implementation plan
Task 8	Implementation of selected options
Task 9	Training, awareness building and developing competence
Step V : Monitoring and Review	
Task 10	Monitoring and evaluation of results
Task 11	Management review
Step VI : Sustaining GP	
Task 12	Incorporating changes into organization's system of management
Task 13	Identifying new / additional problem areas for continuous improvement.

3.4 Step 1: Getting Started

3.4.1 Task 1: Team Formation

Team Formation



• Team Should be dynamic and involving in nature

• Member should be drawn as per need analysis

• Can be a core team and sub-teams in large organizations

• Core team to supervise the overall GP program and sub team to assist core team on specific tasks.

• A dynamic, open minded and versatile person should be a Team Leader

Tasks required to be done by the GP Team could include:

- ☑ Conduct walk-through;
- ☑ Collect baseline information;
- ☑ Identify problems;
- ☑ Generate and evaluate GP options;
- ☑ Prepare GP implementation plan;
- ☑ Implement GP options;
- ☑ Take corrective actions as needed;
- ☑ Build documentation;
- ☑ Communicate with top management and seek approval at various milestones.

Brainstorming
Attribute Analysis
Needs Analysis

Responsibilities of the Team Leader

- Preparing an agenda;
- Summarizing and getting agreements;
- Making assignments for taking action;
- Setting and conducting review procedures;
- Reporting to management;
- Communicating management's views to the members of the team.

Qualities of a Team Leader

Team leader should have:

- ☑ in-depth knowledge of processes and operations in the industry;
- ☑ access to all departments;
- ☑ healthy relationships with staff;
- ☑ managerial qualities.

What is to be adopted and what avoided while working in groups?

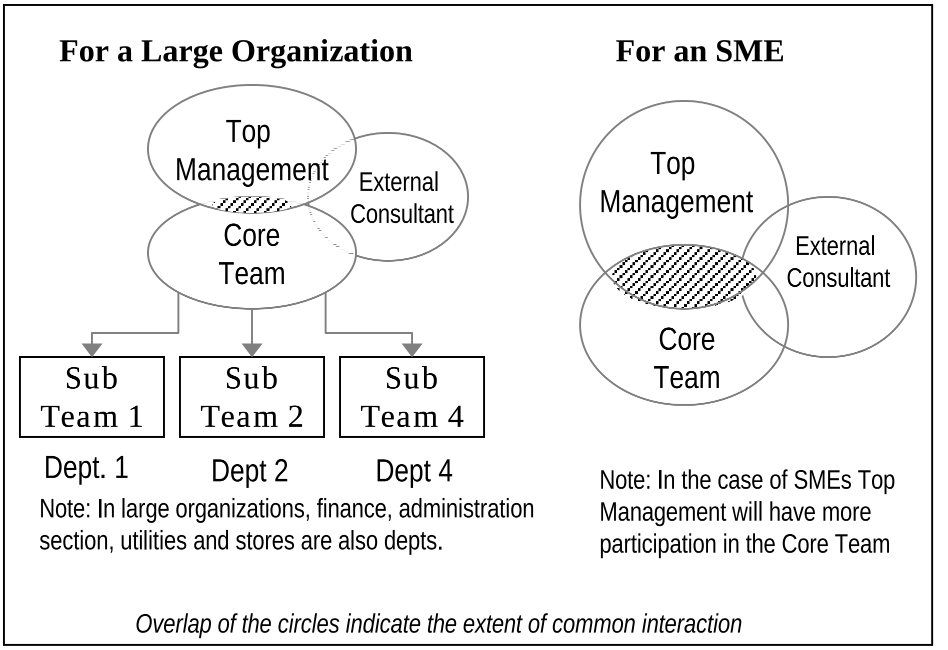
Adopt

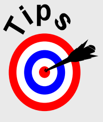
- Cooperation
- Openness to feedback
- Honesty
- Active listening
- Patience

Avoid

- Arguing
- Closed mind
- Interrupting
- Intolerance

A Sample GP Team for an SME





Other important issues to be considered in GP Team formation include:

- Particularly for SMEs, external expertise for production / operations and environment-related aspects may be required. Tapping the experience of ex-staff of the industry may be useful.
- Frequent meetings are a must to consolidate the work done and decide future strategy to avoid straying from team objectives. This meeting could be coincided with the weekly management-staff meets.
- Integration of GP team with teams operating on any other quality or management systems in place, like ISO 9000, or ISO 14001 can be effective.

A department-wise allocation of tasks for a large organization:

Purchasing
Develop and implement controls of materials, maintain inventory, procure information on material hazards, environmental impacts, eco-friendly alternatives.

Human Resources
Define competency requirements and job descriptions for various roles in GP. Develop training programs based on training needs analysis. Integrate GP system into reward, discipline and appraisal systems.

Maintenance
Implement preventive maintenance for key equipment. Track equipment performance, cost efficiency etc. Maintain logs and inventory on equipment, machine parts etc.

Legal
Check requirement on compliance to all applicable regulations and laws, update legal documents, communicate risks of non-compliance.

Finance
Evaluate GP options for economic feasibility; prepare budgets for GP options, track data on costs incurred and benefits accrued in GP program.

Engineering
Prepare relevant drawings such as process flow diagrams, eco-maps, control charts, check sheets etc.; prepare material balances; carry out benchmarking; set objectives and targets; develop performance indicators, generate technical evaluation of GP options; prepare implementation plans; implement GP options; carry corrective actions if required; support training of line workers.

3.4.2 Task 2: Walk-through Survey / Information Collection

Important

Plant Walk through is necessary to:

- Introduce the operations to the team
- Help generate/re-affirm Process Flow Diagram and Layout / Eco-maps
- Identify problem areas

Tips

- Ask questions but do not find faults
- Take notes
- Make sketches
- Take photographs
- Cover units such as pollution control facilities, boiler house, laboratories, canteens, wash areas and toilets, etc. in the walk-through exercise

The points that could be considered for developing an Eco-map are:

- Leaks/overflows and other housekeeping practices in the production area,
- Transportation practices for raw material/finished products and material handling and storage losses of the same,
- Working conditions, ambient noise levels etc.,
- Safety issues, disposal practices for wastes, reject raw materials and products,
- Variances in the operating practices, discrepancies if any.

Walk-through Survey

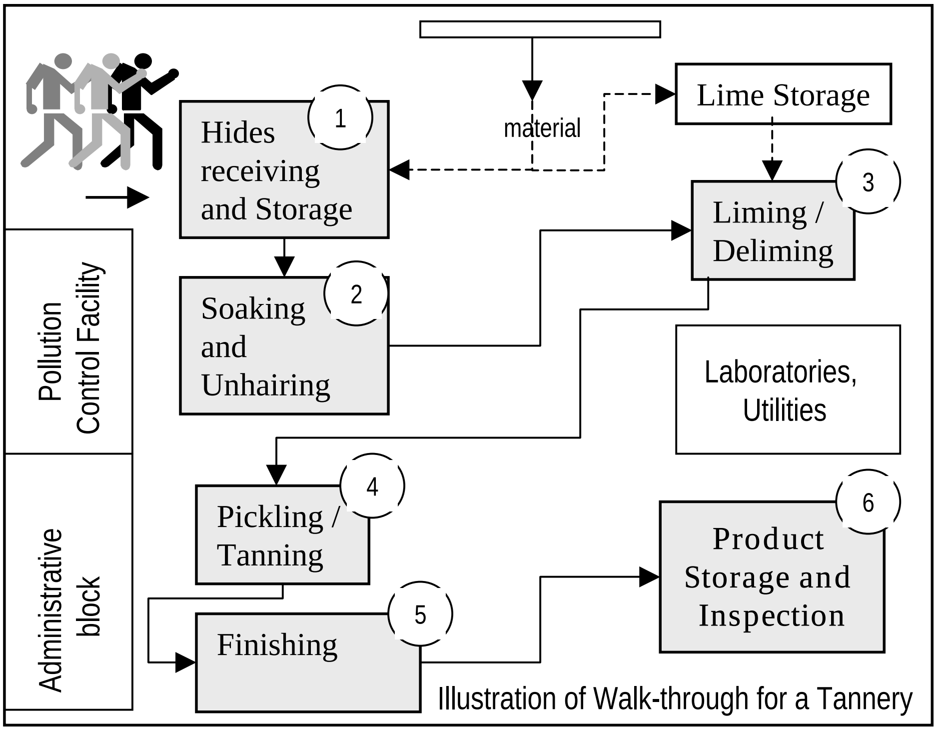


Illustration of Walk-through for a Tannery

A walk-through is necessary for several reasons:

- It is quite likely (especially in the case of large industries) that the members of the team may not be very familiar with the production activities in the departments other than their own.
- People from other production departments may look at the entire scenario more objectively with an independent perspective.
- Identification of more and more opportunities for improvement is possible.

It is a good idea to have a briefing *before* the walk-through. The briefing should cover the scope of the exercise, provide a basic description of sequence and operations, points of emphasis and the time schedule.

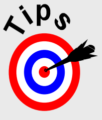
Before conducting a walk-through, the following information should be collected for the benefit of the GP team members:

- Layout showing process equipment, utilities, storage areas and offices;
- Process flow diagram (at least on the block level) and the date of last update of the diagram;
- Layout of water supply lines, drainage channels, steam lines etc. as applicable;
- Production related information in terms of scheduling.

A debriefing session after the walk-through should consist of reactions from the members; questions that are critical but have remained unanswered; and a listing of additional information required. For this meeting, the team leader may like to invite select members of the staff who assisted in the walk-through.

3.4 Step 1:
Getting Started

3.4.2 Task 2: Walk-through Survey / Information Collection



The following steps can be followed for collecting information.

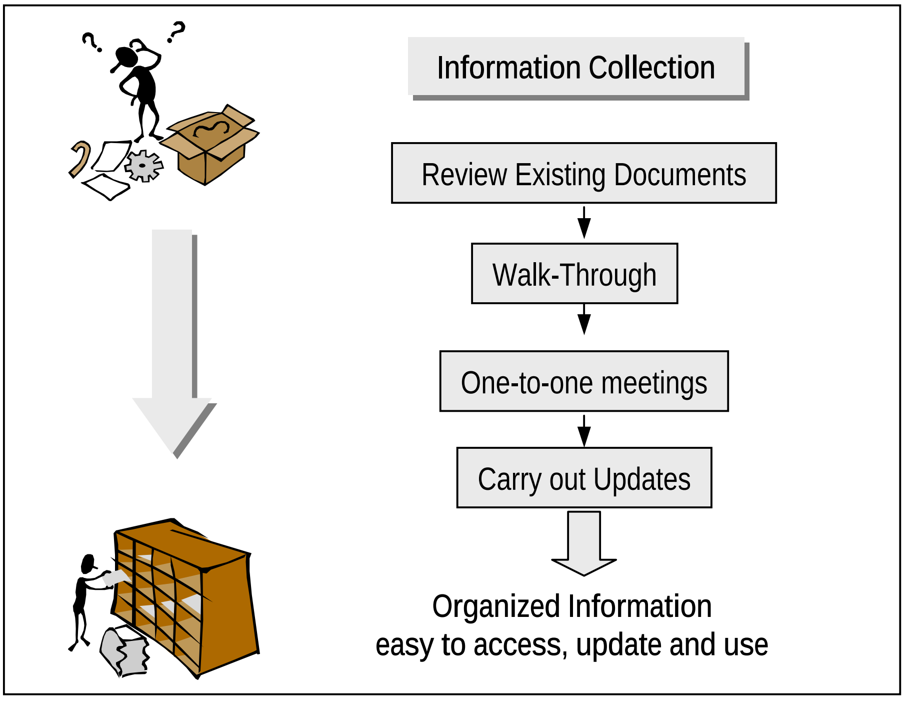
Review Documents (existing and updates) Existing documents could help in identifying problems, whereas updates could help in generating options.

Assimilate information.

Clarify Issues - for example if an operator reports that the Stenter is underutilized, the Production in-charge would be able to assist in finding any possibility of doing additional jobbing.

Discuss with staff, external consultants, suppliers.

Information Collection



Techniques for Information Collection

Review Existing Documents
Existing industry documents should be studied, including:
Organizational
- Resource-related
- Production
- Service-related
- Materials and product
- Environmental
- Financial

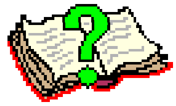
Walk-through the Industry
Conduct a walk-through with the primary aim of getting the GP Team acquainted with the operations; validate existing information such as process flow diagram, layout, etc.; identify problems; and mark them to develop Eco-maps.

One-to-One Meetings
Points arising during the review of documents and walk-through could be further discussed by conducting one-to-one meetings with concerned staff so as to seek clarification and crystallize the understanding of the information collected.

Queries unanswered during internal meetings could be discussed with external experts, vendors, suppliers.

Carry Out Updates
Updates would include state-of-the-art information on technologies, processes, material and resources.

Review Existing Documents



Organizational

Employee information
Organizational and Reporting structure

Financial

Balance sheets and income-expenditure cash flows
Unit costs of labor, water, steam, fuel, electricity, raw materials

Service

Packaging and disposal
Supply chain requirements

Environmental

Waste collection/conveyance system
Waste treatment and disposal operations
Environmental Impacts of Operations

Production

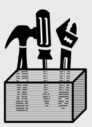
Technologies, processes, equipment, efficiencies

Resource

Material Inventories
Supplier Information
Fuel type and requirements

Materials and Product

Material Inventories, MSDSs, consumption patterns, properties



Checklists
Flowcharts
Process Flow Diagram
Tally Charts

Items to be covered during the information collection could be:

Organizational information
- Organization structure and reporting systems
- Employee number, shifts and profiles in terms of skills and experience

Resource related Information
- Material procurement data and inventories maintained
- Consumption patterns of utilities like water, steam, fuel and electricity. (This data may be collected on monthly averaged and daily averaged basis).
- Supplier information / quality of raw material

Production Related Information (for industries)
- Description of technologies and processes used
- Equipment details, utilization and conversion efficiencies
- Quality control related information in terms of quality thresholds and percentage of rejects
- Productivity related norms and benchmarks

Service Related Information (for hotels)
- Services provided
- Services utilized
- Levels of services

Materials and Product Related Information
- Packaging and disposal
- Supply chain requirements

3.4.2 Task 2: Walk-through Survey / Information Collection

Potential sources of information could be:

- Documentation on the Operating procedures
- Documentation on the Design and equipment specifications
- Documentation if any on ISO 9000, ISO 14001 EMS, TQM/TQEM
- Environmental Assessment reports, Environmental Monitoring reports, Industrial health and hygiene surveys
- Internal reports on Resource Consumption and Productivity
- Libraries / Internet / Research Organizations

While collecting information, due consideration should be given to:

- Seasonal variation in product demands and raw materials
- Operational variations including shut downs for maintenance or deviations from normal operating procedures

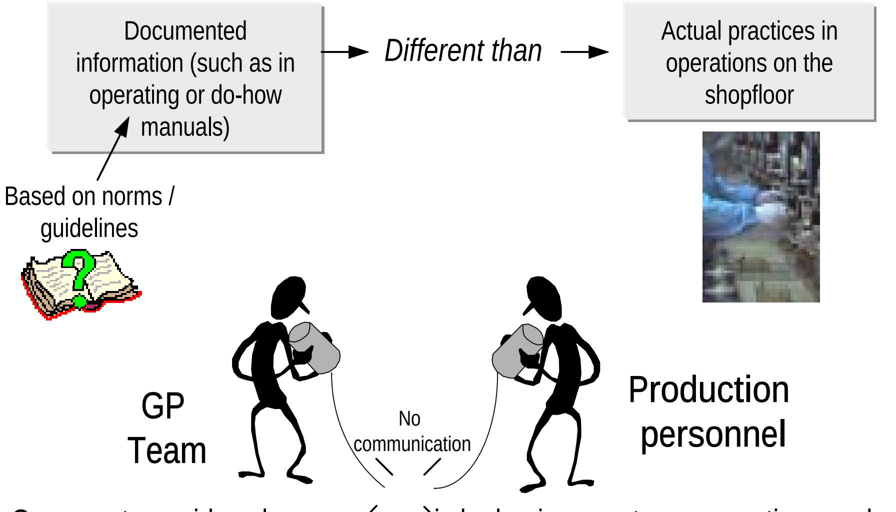
Environmental Related Information

- Waste collection / conveyance system
- Waste treatment and disposal operations
- Any common waste collection, treatment and disposal systems in the neighborhood
- Any environmental measurements on the working environment, e.g., noise, air pollutants, odor
- Any records on occupational safety and health
- Any data on environmental quality of air, water and land in the neighborhood
- Environmental regulations applicable
- Local government policies
- Any relevant national agreements made on international issues

Financial Information

- Balance sheets and income-expenditure cash flows
- General cost structure showing contribution of labor, water, steam, fuel, electricity, raw materials.
- Unit costs of labor, water, steam, fuel, electricity, raw materials.
- Capital and operating costs of waste collection / conveyance, treatment and disposal systems

One-to-One Meetings



One way to avoid such occurrences is by having one-to-one meetings and asking the right questions to the right people so as to ensure that the answers obtained are valid and reliable

Tips

While gathering information during the walk-through operators and staff should be interviewed to validate the information collected.

Questions That Could Be Asked in One-to-one Meetings

- What is the time taken for each batch operation?

- What are the raw material requirements? How are they weighed and transported to the production area?

- What are the water and energy requirements? How are they measured to achieve the desired optimum level?

- How is the completion of the production batch ascertained? Is there any indicator / alarm or is it dependant on the operator's judgement?

- What are the kind of rejects from the processes? What is their quantity? What is the frequency of discarding these rejects?

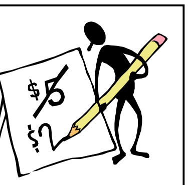
- What is the frequency and water / energy consumption for the operations, such as floor washing, container cleaning etc.?

As mentioned before, it is beneficial to have a briefing after the walk-through.

The meeting should consolidate answers to questions such as those given above; questions that are critical but have remained unanswered; and a listing of additional information required.

Collection Of Field Data

Estimating Water Consumption



Install Water Meter

- Cost / investment
- Needed time period to order, procure, install and test
- Could get damaged during use

Using Available Information

- Amount of fabric processed in a batch
- Number of batches in a day
- Ratio of fabric to water (Material Liquor Ratio)
- Wastewater measured by bucket and timer
- Moisture in fabric was accounted for using calculations based on weight of fabric before and after dyeing process

Conclusion:
Same purpose achieved in lesser amount of time, easily and without any major investments

A dyeing machine did not have a water meter to measure the input water consumption.

Water consumption was estimated by knowing how much of knit fabric was processed in a batch; the number of batches in a day; and the ratio of fabric to water (called as the Material to Liquor Ratio, or MLR) that is maintained in the machine.

Allowance was made in the water balance by considering the additional moisture pick-up in the fabric after dying. This was done by comparing the weight of semi-dry fabric before putting in the machine and the weight of fully wet fabric that was drawn after dyeing.

Consider that a jigger machine is used for processing the fabric:

Fabric processed in a batch = 250 kg
Batches per day = 3
MLR = 1:10, that is, for every 1 kg of material, processed 10 L of liquor is required;

Liquor required (water consumption) = 250x3x10 L = 7.5 m3.

Wastewater volume can be estimated by providing allowance for wet pick-up in the fabric:
Wet pick-up = 90% of the weight of fabric processed
= 225 kg of water = 225 L = 0.225 m3
Evaporation losses (20% of fabric processed) = 0.05 m3;

Total wastewater estimated in a day = 7.5 - 0.225 - 0.05 = 7.225 m3 (drained from all batches in a day).

Tips

Material balance may require collection of data on inputs as well as outputs. This can be done through secondary or documented information as available. In some cases, calculations supported by field measurements could be carried out to fill any gaps.

Tips

The estimated wastewater flow can now be compared with the actual flow measured with the bucket and stop-watch method

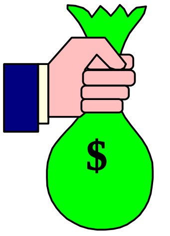
3.4.2 Task 2: Walk-through Survey / Information Collection

Tips

In order to determine the monetary losses due to the generation of wastes, it is useful to assign costs to the waste stream.

Such a strategy helps in prioritizing which waste stream needs to be tackled first and what types of options need to be looked at for obtaining cost reduction.

Assigning Cost to Waste Streams: A Way to Set Objectives and Targets



Cost components typically associated in waste streams are:

- **Cost of raw materials in the waste**
- **Cost of product in the waste**
- **Cost of treatment of waste to comply with regulatory requirements**
- **Cost of waste transportation**
- **Cost of waste disposal**

Waste streams from a process can be a source of resources, e.g., fiber in the wastewater from pulping; maleic anhydride in wastewater from pthaleic anhydride production; and metals in plating wastewater.

Very often these resources have been found to generate extremely high revenue. To identify this profit potential of waste streams, a basic requirement is to assign costs to them.

The first step in cost assignment to waste streams, however, is detailed analysis of each waste stream to assess the pollution load in terms of both volume and characteristics. Based on this, the treatment and other costs can be worked out.

While the detailed analysis of the streams provides data for identification of problems that then leads to the cause analysis, the cost assignation provides a basis for generation of viable options.

Cost assigning to waste streams can be used at several points in the GP methodology: identification and prioritization of problems; setting objectives and in monitoring / corrective action.

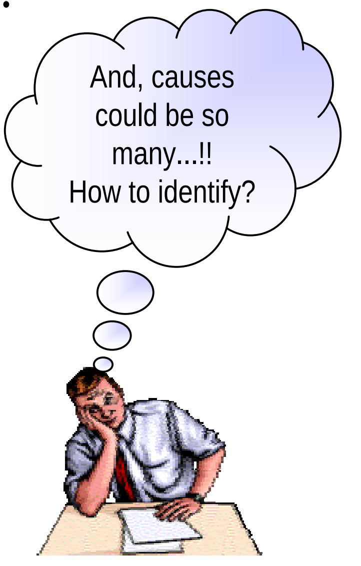
3.5.1 Task 3: Identification of Problems and Causes

Identification of Problems and Causes

WHERE DO WE STAND ?

Problems could be with the

- Process
- Water
- Chemicals
- Energy
- Labor
- Costs
- Waste Generation
- Production
- Capacity Utilization
- Product Quality
- Market demand



Identification of problems and causes is done by analyzing the compiled information supported by the observations made in the walk-through.

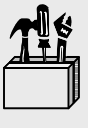
Often, the basis of problem identification is:

- Process flow diagram (PFD), layout and eco-map;
- Material / energy balance;
- Cost of waste streams.

The next step is to verify operating conditions and process parameters with the standard instructions / operating practices, and by comparing them against norms and benchmarks, to identify deviations. This can provide an idea about the likely causes.

Problem-specific cause identification can be done through cause-effect analysis using tools such as brainstorming, Ishikawa diagram etc.

This may require collection of process specific or specialized information or, in some cases, controlled experimentation / system operation.

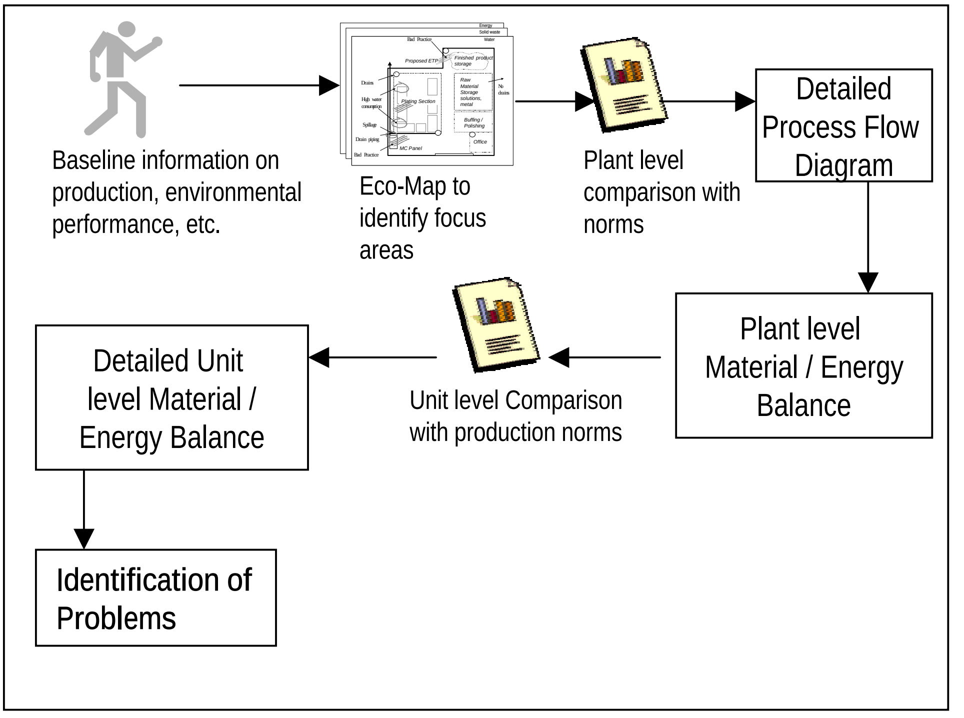


Flowcharts, Eco-Mapping, Plant Layout, Benchmarking Control charts, Concentration Diagrams, Ishikawa (fishbone) diagrams, and Material Balance

3.5 Step 2: Planning

3.5.1 Task 3: Identification of Problems and Causes

Identification of Problems



A systematic approach to problem identification involves a moving from "whole to parts."

At the outset, a macro-level assessment of the plant as a whole is done to identify the problem areas. For this exercise, tools such as eco-map may be used. Eco-maps are useful in identifying focus areas in the plant for various themes such as water, solid waste, and energy.

Benchmarking is an effective tool that can be used to compare processes with the norms, both at the plant and unit operation level.

PDF and material balance form the basis of problem identification. They can be used together with benchmarking to identify problems at the level of the plant, department, as well as individual unit operations.

Using a hierarchy of tools from eco-maps, and benchmarking to PDF and material balance, problems can be identified.

Tips

Problems in the context of GP refer to:

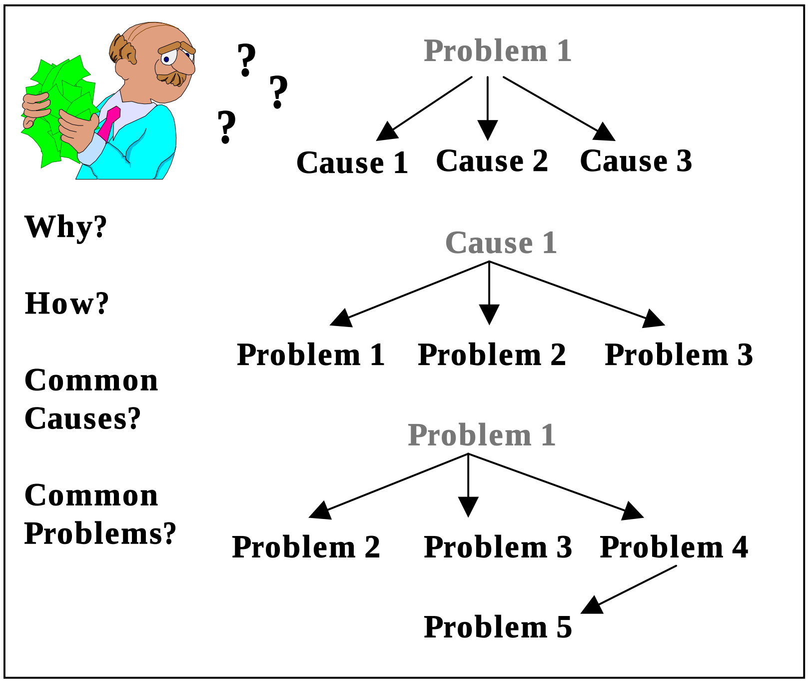
- Poor product quality
- Poor equipment efficiency
- Poor capacity utilization
- Environmentally unfriendly practices
- Regulatory non-compliance

These aspects need to be studied in order to identify problems

Plant Layout, Eco-maps, Concentration diagrams, Benchmarking, Process Flow Diagram Material Balance

3.5.1 Task 3: Identification of Problems and Causes

Identification of Root Causes

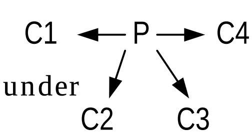


Once the problems are identified, the next step is to carry out a cause-effect analysis. What are the cause(s) of the problems?

A problem may have several causes. The key is to focus on the most critical causes.

In a knit-fabric processing company, the main problem identified was that of low "right first time." A number of causes, however, were found to be responsible for this problem. Some of them were:

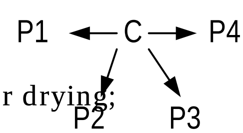
- Poor bleaching efficiency;
- Low quality dyes with poor fastness;
- Winches used for dyeing were not operating under optimum conditions;
- Poor process water quality.



Sometimes many problems may stem from a common cause.

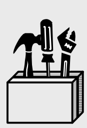
In a knit-fabric processing company, following problems were identified.

- High consumption of scouring and bleaching chemicals;
- Pin hole problems in dyeing;
- Frequent problem of color matching;
- White spotting on the cylinder rollers used for drying;
- Excessive formation of scaling in the boilers.



The root cause of all the problems listed above was **poor quality water**.

- Check whether operations are close to the design and operating guidelines
- Check on the material movement and conversion efficiencies
- Check the equipment utilization efficiency



Ishikawa diagram (fishbone)
Brainstorming

Prioritizing Problems

3.5.1 Task 3: Identification of Problems and Causes

Problem	Severity	Frequency	Cost implications for resolving the problem	Cost of Inaction (waste stream costing)	Score (1- 10 scale) 10 is top priority
Productivity					
Material Consumption	High	Always	High	High	9
Product Quality	Medium	82% success	Moderate	Moderate to High	6
Housekeeping	High	Always	Minimal	Moderate	10
Environment					
Legal Compliance	Medium to High	Occasionally on air, always on effluents	High	High	7
Business					
No. of Rejects from Customer	Minimal	5%	Minimal	High	4

Tips

Having developed the material and energy balances and identified the problems and their causes, the next essential input for setting objectives and targets is costs of waste streams, including resources (raw materials / products/ by-products). In simple terms this cost is the cost of inaction. Using this information as an additional criteria, the problem areas can be prioritized.

Problems identified in the earlier tasks need to be prioritized to set objectives and targets.

The primary criteria for prioritization could be:

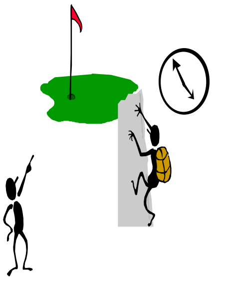
- Severity of the problem – this refers to the scale and implications of the problem.
- Frequency – this indicates the recurrences of the problem. An insignificant problem repeating several times in a production cycle can cause greater damage than a severe problem once in five years.
- Cost implications – cost information of the possible solution is needed so as to check the affordability before setting an objective.
- Lastly, but most importantly, the estimated cost of inaction – this is the cost of not taking any action on a problem. This is estimated by costing the waste streams.

A final score based on the integration of the above parameters would compare the problems on a macro-level and aid in deciding the objectives and targets.

3.5.2 Task 4: Setting Objectives and Targets

Setting Objectives and Targets

Objectives and Targets should be **SMART**:



- **S**pecific,
- **M**easurable,
- **A**ttainable,
- **R**elevant and
- **T**rackable

Once the problems and likely causes are identified, then it is necessary to set objectives and targets.

Points to Be Considered in Setting Objectives and Targets:

- Objectives should be based on problems identified.
- One objective can have multiple targets, which could be introduced over time.
- Targets should be developed based on the need. For example, if legal compliance is to be sought within one year, then the target for an objective which addresses a compliance parameter should be set for one year.
- Indicators to track the target with objective should be established.

Objectives Can Include Commitments To:

- Meet the sector-wide production norms;
- Design products to minimize their environmental impact in production, use and disposal;
- Control environmental impact of extraction of raw materials;
- Promote awareness among employees and the community on GP.

Example

Techniques such as Cost assignment to waste streams could also be of assistance.

Tips

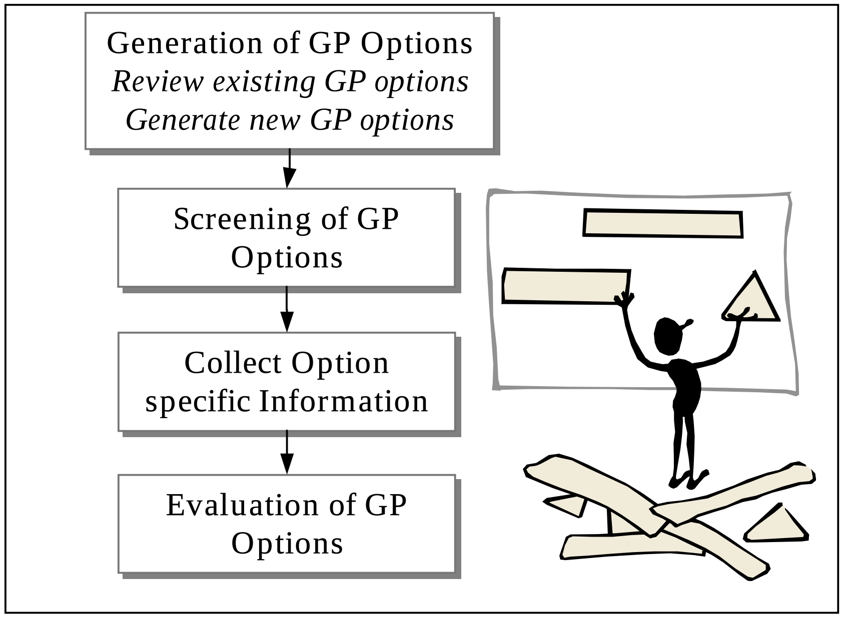
The targets need to be tracked by setting performance indicators and dovetailing them in the monitoring and reporting program. Some of the basic tools like control charts, Cusum charts, Multi-vari charts or other graphical charts also can be used to indicate the progress of the target over a period of time.

Pareto Analysis
Critical Path Analysis
Gantt Chart
Multi-vari Chart
Cusum chart

3.6 Step 3 : Generation and Evaluation of GP Options

3.6.1 Hierarchy of Tasks in Generation & Evaluation of GP Options

Hierarchy of Tasks in Generation and Evaluation of GP Options



The hierarchy of (i) generation of GP options, (ii) screening, (iii) evaluation and (iv) final selection should be logically sequenced so as to generate and select the most appropriate GP options.

The generation of options should logically begin with what has already been implemented in the industry. These options need to be considered while generating new options.

The next step is to brainstorm on the problems, causes and available information to generate new GP options.

An initial screening may be required for most options so as to eliminate the obviously unsuitable or conflicting GP options. This minimizes the effort of detailed evaluation of unsuitable GP options.

Once the screening is completed, in order to evaluate the selected options, substantial option specific information may be required (technology details, operating guidelines, fabrication and design details, cost information etc.). This information should be sought before actually evaluating the options. Sub-teams specific to the nature of the screened options may be made use of to collect the option specific information.

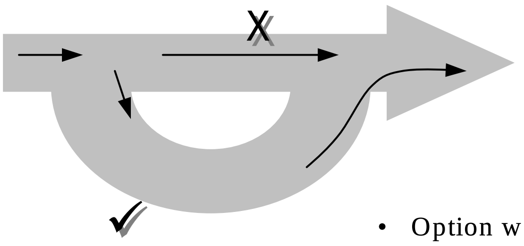
Based on the collected information, evaluation of options should be conducted using the various tools as applicable. Cost-benefit analysis is one of the most significant tools that would be required in the evaluation of options. Cumulative evaluation of options should be conducted to ensure that options do not conflict or minimize each other's benefits.

3.6 Step 3 : Generation and Evaluation of GP Options

3.6.2 Generation of GP Options

Reviewing Exiting GP Options

Ways of Generation of GP Options



Generating New GP Options

Reviewing options already implemented or thought of in the past.

- Option was not implemented
- Option was implemented but did not work at all
- Option did not succeed as expected (partial achievement / elimination of concern)
- Option succeeded as expected but has not been evaluated and documented

Review of Options That Were Earlier Identified

- Option was not implemented.
- Option was implemented but did not work at all.
- Option did not succeed as expected (partial achievement / elimination of concern).
- Option succeeded as expected but has not been evaluated and documented.

1. The first case provides an option as a starting point for proceeding with a more detailed inquiry into *why* the option was not implemented, followed by a comprehensive evaluation of the option.

2. The option that did not work at all gets naturally eliminated from further discussions. The reasons for *why the option did not work* can, however, lead to additional ideas in the group discussion.

3. In the third case, the option should be taken for cause analysis to improve it. Of course, whether any alternative option exists that can be more effective is a matter for investigation.

4. In the fourth case, the option should be evaluated and recorded as a reference in the GP documentation.

Example

Due to a water shortage, the soaking liquor for hides in a tannery, was recirculated over successive hides. The hide quality was severely affected. Clearly, this was an example of failed option.
In the option brainstorming session, it was suggested to evaluate an option of adding a biocide in the main soak to suppress any biodegradation. Apparently, such a practice was carried out at another tannery without any problems. This led to a revival of the failed option.

3.6.3 Task 5: Generation of New GP Options

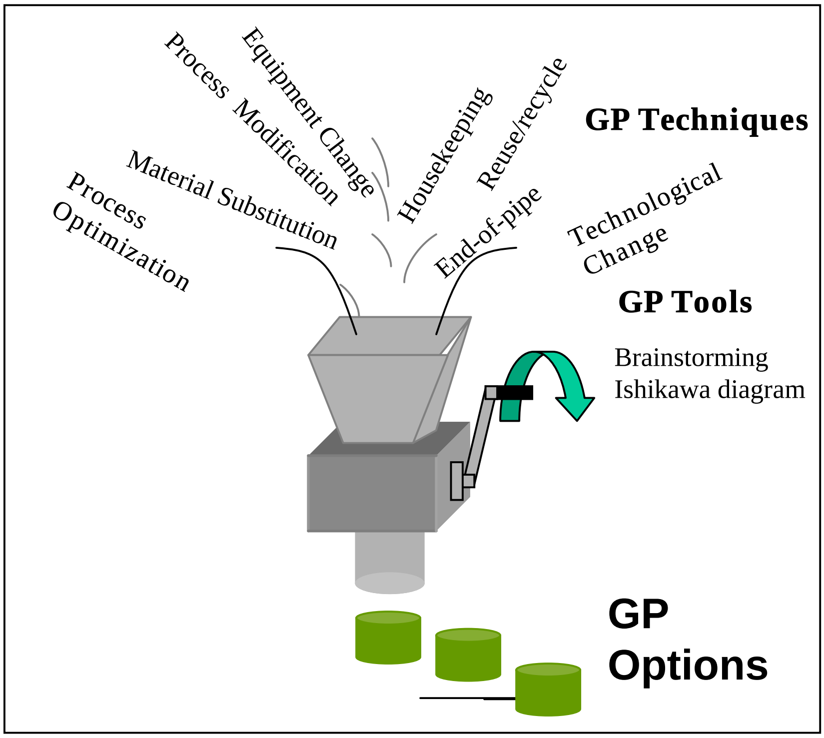
Sometimes individual options may not suffice and adopting a system like TPM would have to be considered to address the problems

UNEP TIE's International Cleaner Production Information Clearinghouse ICPIC CD-ROM Version 1.0 contains more than 600 Cleaner Production case studies.

Developed by: United Nations Environment Programme Technology, Industry and Economics (UNEP TIE) http://www.uneptie.org

Brainstorming, Checklists, Ishikawa diagram

Generation of New GP Options



It is important to note that to generate an innovative GP option, one needs to go beyond the conventional and the most obvious ways of thinking.

A Logical Approach to Generating New Options

- Identify causes based on the tools such as the *Ishikawa* diagram for each problem.

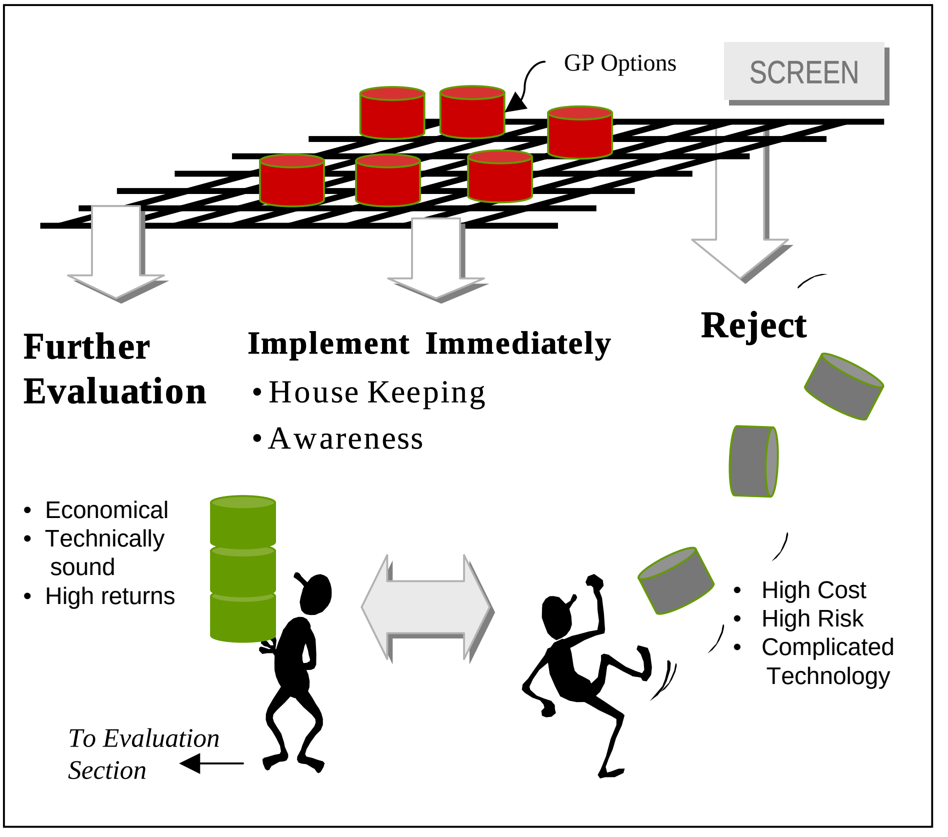
- Set up a *brainstorming* exercise for generating options based on the identification of causes. Brainstorming sessions greatly assist in the generation of new ideas. The ideas should flow freely without interference so that all possible creative options are looked at.

- Determine the nature of the solution required; whether to tighten supervision, quality control and housekeeping;, whether to explore recycling, recovery and reuse of output streams; whether to change the input materials or modify the equipment; whether to change the process or layout of plant. From this, potential GP Techniques will follow.

3.6 Step 3 : Generation and Evaluation of GP Options

3.6.4 Task 6: Screening & Evaluation of GP Options

Screening of GP Options



Sieve Method
This method involves setting up cutoff values for certain critical parameters such as cost, time, and person power. All GP options which exceed this cutoff value are directly eliminated. This is the first level screening where the obviously unsuitable GP options are eliminated.
This eases further exercises of option evaluation. For example, an option costing beyond the affordability of the organization would be eliminated during sieving.

Causes of Rejection of Option

- Option is very expensive and unaffordable for the organization;
- Implementation of the option is complicated and demands special skills that are not presently available;
- Options may need to be deferred if they have a good potential but enough information does not exist or they demand considerable resources that are not presently available;
- The option poses a risk to the production and product quality. The option needs incorporation of risk aversion measures;
- The option is not proven and, hence, may require a phased implementation, such as lab scale trials or pilots.
- Many times, options are undertaken on a pilot or demonstrative basis, gradually shifting them to full-scale production.

The option screening criteria

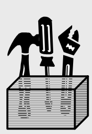
- Cost of implementing and maintaining the option and the cost of inaction.
- Technical feasibility / complexity – this relates to the technical expertise required within the industry to implement this option.
- Risk – this refers to the risk of failure as compared to the investments, benefits expected or physical hazard due to implementation.
- Time required for implementing – this is to establish a link between time necessary for implementation and working of the option, and the target set for the objective of that option.
- Benefits – important to judge the potential of the option in resolving the problem and in meeting the targets set. Benefits can be broadly divided into economic, environmental and social.

Screening can also be used to prioritize the options based on certain criteria. Pareto charts could also be used here to prioritize the options based on their impacts or causal relationship with the concern or benefits accrued.

3.6 Step 3 : Generation and Evaluation of GP Options

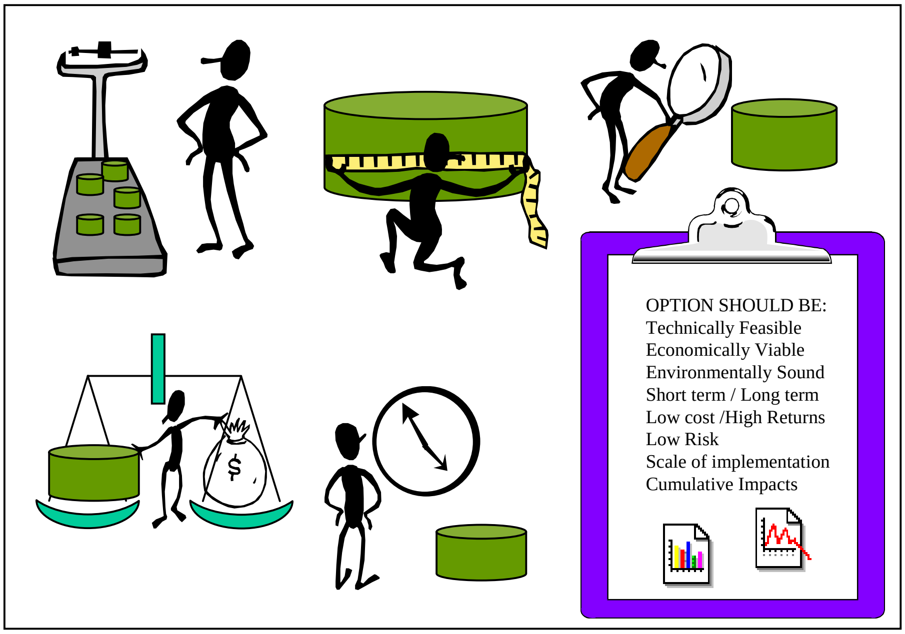
3.6.4 Task 6: Evaluation of Options

An anticipatory or proactive approach should be adopted while evaluating options. It is worthwhile to look beyond the implementation of the options and try to predict how they would fail, why, and what the probability is.



Failure Mode Effect Analysis (FMEA)
Cost Benefit Analysis (Payback, NPV, IRR)

Evaluation of Options



Possible questions to be answered in evaluation of options could be:

✓ Which options will best achieve the objective and targets?
✓ What are the benefits to be gained by implementing this option? (production / yield, financial, compliance, pollution management, workplace , safety etc.)
✓ Nature of technology to develop the option (complex, expensive, difficult to control during operation)
✓ Are there any parallel adverse effects because of the option?

Options should be evaluated and compared on the basis of:

Technical

❑ Nature of requirements to implement the option (space requirements, utilities, and operators)
❑ Feasibility of technology
❑ Necessary process modification

Environmental

❑ How much environmental improvement / waste reduction is expected from the option?
❑ What is the nature of the benefit? (improved productivity, odor control, better health and safety)
❑ Is the solution short term or long term? (will it be easy to adopt to new regulations?)

Financial

❑ What are the investment requirements?
❑ Is the option financially viable?
❑ What would be the source of investment and difficulty involved?

3.6 Step 3 : Generation and Evaluation of GP Options

3.6.4 Task 6: Collection of Option Specific Information

Tips

Nature, amount of data and time required would depend on the specific options e.g. new equipment or process, modification in existing process, operating practices, options external to the company.

Option specific information is required to ensure that all information necessary for option evaluation (technical, environmental, financial, etc.) is available.

Example

Option to be evaluated: Change from a mono-functional dye to bi-functional dye

Bi-functional dyes have a greater degree of dye-fixation. This allows for less consumption of dye and less release of pollutants in the wastewater. There is also an advantage of better wash-off properties after dyeing. Hence, it is possible that one of the after-washing operations could be eliminated. This can lead to reduction in water consumption, processing time as well as reduction in the generation owastewater..

Collection of Option Specific Information

GP Options	*Option Specific Information required*
New Equipment	Suppliers, Installation space, Cost (capital, operating), personpower requirement
New Material / chemical	Suppliers, Quantity, Cost, effects on other processes, safety sheets, transport
Change of Supplier	New Suppliers, reliability, costs, effect on market, other clients of the new supplier
Modification in existing process	Installation, fabrication, commissioning requirements, costs
Change in operating practices	Effects of new practice, changes due to new practice, time scheduling

Technical

- Technical literature on dye fixation properties of bi-functional dyes
- Available color shades and a comparison with the shade card of the presently used mono-functional dye
- Present level of dye-fixation for various shades and anticipated level of dye-fixation
- Results of trial runs
- Market availability and reliability of supply
- Any special requirements on the operating use (quality of water, salt levels and temperature)
- Methods of quality control
- Present consumption of the recipe (consisting of dye, auxiliaries, salt etc.) and anticipated consumption based on the new recipe
- Present consumption of water and anticipated consumption of water after the change

Environmental

- Detailed Material Safety Data Sheet for the bi-functional dye
- Special storage / handling requirements related to health and safety?
- Is the new dye or its functional group on the list of banned or red substances adopted internationally?
- Will the efficiency of the treatment plant be affected in terms of biodegradability of the dye in wastewater?

Economic

- Cost of the dye across various and frequently used color shades; similar data on the presently used dye
- Capital and operating costs of treatment of wastewater in terms of costs per m^3 of flow and costs per kg Chemical Oxygen Demand (COD)
- Cost of water (including purchase, processing and pumping costs)

3.6.5 Task 7: Formulation of GP Implementation Plan

Formulation of GP Implementation Plan

GUIDELINE OF IMPLEMENTATION PLAN

- STATING OBJECTIVES AND TARGETS
- NATURE OF OPTIONS / REUSE, PROCESS CHANGE ETC.
- ACTION NEEDED FOR IMPLEMENTATION
- RESPONSIBLE PERSON OR DEPARTMENT
- TIMING AND WAY OF IMPLEMENTATION

For every option to be implemented, information needs to be gathered on the following:

- Department / location / points of application of the option
- Nature of the option (housekeeping, recycle, reuse, recovery, process / equipment modification, change in raw materials, end of pipe etc.)
- Option prerequisites (any linkages to success of other options)
- Resources necessary in terms of materials, equipment, information, expertise and finance
- Procurements to be made, if any, based on identification of resources. Procurements may be internal (requested from other departments) or from external agencies.
- Timing and way of implementation (first lab scale, then pilot or direct, full-scale implementation)
- Any isolations to be done from other processes; risk mitigation plans
- Support personnel necessary; any procedural requirements to that effect
- Any insurance measures
- Responsibility matrix and task allocation
- Monitoring program and setting up indicators (background or baseline must be recorded before implementation of the option)
- Milestones to be set in the implementation sequence

All this information and other relevant instructions on implementation of GP options are included in the implementation plan.

Implementation Plan serves three major purposes:

- Guidelines to implement selected GP options
- A means for management to review
- A means of training and awareness

Tips

The supporting documentation can take varied forms like: guidelines, procedures, instructions, flowcharts, checklists, plans, standards and operating manuals.

GANTT, PERT charts
Operating Manuals / Commissioning guidelines

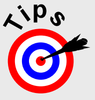
Example of Implementation Plan

Objectives	Targets	Program	Action	Responsible	Time
1. Minimize Water Use	1. Reduce water consumption by 15% of present level by 1 year	1. Water reuse	1. Install equipment to recycle water 2. Reuse of rinse water in A to B	1. Tech M. 2. Purch.M 1. Tech. M 2. Q.C.M	Jan.'01-Mar.'01 Mar '01-May '01
		2. Process change to reduce water consumption	1. Recycle cooling water 2. Improve washing methodology 3. Train workers	1.Tech. M 1.Q.C.M 2.Tech. M 1. Personnel 2. Q.C.M 3. Tech. M	
		3. Introduction of new machine	1. Introduction spray gun 2. Change washing machine	1. Tech.M 2. Purch.M 1. Tech. M 2. Purch. M	

Objectives	Targets	Program	Action	Responsible	Time
2. Minimize Energy	1. Reduce fuel for boiler by 10%	1. Heat recovery from hot wastewater	1. Install recovery system for make up water 2. Use cooling water for cooking	1. Tech. M 1. Q.C.M 2. Tech. M	
		2. Process change in disinfection	1. Change open heating to pressurized heating 2. Change temperature and time	1. Q.C.M 2. Tech.M 1. Q.C.M 2. Tech.M	
	2. Reduce electricity by 10%	1. Promote awareness	1. Train workers 2. Stickers	1. Personnel 1. Public relation	
		2. Change lighting system	1. Use saving bulbs 2. Automatic cut-off lighting	1. Purch.M 2. Tech.M 1. Tech.M	
		3.Check starting time of mech. equipment	1. Design the staring time of daily operation	1. Tech. M 2. Q.C.M	
Etc.					

3.7 Step 4 : Implementation of GP Options

3.7.1 Task 8: Implementation of Selected Options

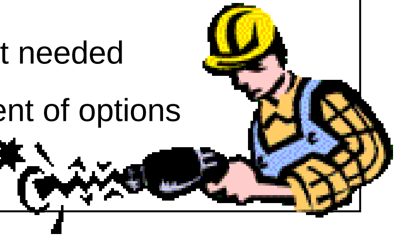


Implementation should follow the time schedules as given in the Gantt charts in the implementation plan

The sequence of implementation of options is important

Implementation of Selected Options

- Trial and small scale implementation
- Regular meetings and trouble shooting sessions
- Follow-up and Accountability
- Allocate resources and schedule the pilot implementation
- Management support needed
- Review and refinement of options



Suggested guidelines for implementation of the evaluated and selected GP options are as follows:

- Implement the options on a trial and small-scale basis to reduce the impact on the existing system.

- Regular meetings and troubleshooting sessions may be required among people who are involved during implementation.

- The GP team may face difficulties such as:
  - Inadequate follow-up on actions by various parties;
  - Poor accountability;
  - Lack of resources, e.g., manpower, funds and time
  - Lack of support from management
  - Increase in production time causing insufficient time being allocated for implementation.

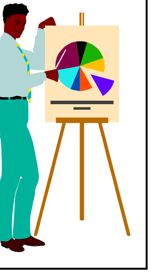
- Review and refinement of implemented options should be done whenever possible.

- Information or photograph of before-and-after effect of the implemented options must captured to highlight achievements during management review or GP promotional activities.

3.7.2 Task 9: Training, Awareness Building and Developing Competence

Training, Awareness Building and Developing Competence

- Assessing training needs
- Selecting suitable programs, methods and material
- Preparing a training plan (5W1H))
- Implementing training programs
- Tracking and recording training programs
- Evaluating training effectiveness
- Improving training program as needed



Training is not a one-time activity and is essential at all levels of the organization, including external suppliers and customers. Training can help us:

- To upgrade the skills of the people implementing the GP options;
- To improve competence of the personnel involved in monitoring and evaluating the GP program;
- To build awareness about the GP program in the organization and among suppliers and customers.

Planning and scheduling is necessary, and the key steps in designing training programs are:

An important part of effective training is to have a dedicated training department or a person attached with training related responsibility

- Assessing training needs;
- Selecting suitable programs, methods and material;
- Preparing a training plan (who, what, when, where and how);
- Implementing training programs;
- Tracking and recording training programs;
- Evaluating training effectiveness;
- Improving training program as needed.

Ways to find needs

Interviews with staff
Ask questions

Training needs of organizations may include:

- Motivating the workforce;
- Explaining the concept of GP and how it relates to the overall business vision / strategy;
- Ensure understanding of roles and expectations;
- Demonstrate management commitment;
- Monitor performance; and,
- Identify potential system improvements.

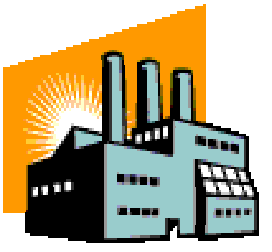
Use existing documents for training as much as possible (e.g. quality circles, ISO 9000 etc.)

3.7 Step 4 : Implementation of GP Options

3.7.2 Task 9: Training, Awareness Building and Developing Competence

Ways of Training and Development

- Off-the-Job Training (Seminars & Lectures)
- On-the-Job Training
- Video presentations and Posters
- Operation Manuals and work instructions
- Field Visits



The following are ways that training, awareness building and competence development can be executed.

- Off-the-job training, including seminars, and classroom lectures on topics related to work processes

- On-the-job-training by sector specialists and experts as well as managers/supervisors, as explained above

- Videos, poster displays in the organization to enthuse the employees into participation

- Operating manuals, work instructions, “how-to-do manuals”, implementation manuals and guidance documents for specific processes can be used for training people at various levels.

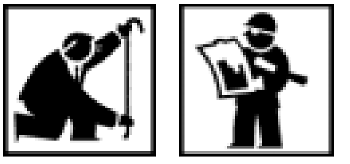
- Field visits to companies where GP has been successfully implemented. Information that can be collected are:
  - Integration GP practices in their business
  - Organization structure for implementation of GP
  - Problems faced by the industry
  - Method of problem identification
  - Methods for generating GP options
  - Difficulties in implementing the GP options
  - Ways of overcoming difficulties
  - Tangible and intangible results
  - Continuous improvement practices

3.8 Step 5: Monitoring and Review

3.8.1 Task 10: Monitoring & Evaluation

Monitoring and Evaluation of Results

- Parameters affecting the end results
- Performance indicators for the end result
- Appraise the performance of the option against the targets



Once the selected GP options have been implemented, it is necessary to check whether the options are producing the desired results. Management needs to be informed of the results of the monitoring and evaluation so that corrective action can be taken accordingly. Typical contents of a report are:

- Results and observations of monitoring and evaluation;
- Comparison of post implementation performance indicators with the expected targets;
- Identification of non-complying options (complete or partial failure to achieve stipulated targets);
- Cause-effect analysis (identify problem area – target?);
- Corrective actions already taken.

Some causes of typical problems requiring corrective action:

- Faulty or missing procedures
- Poor communication
- Equipment malfunction / lack of proper maintenance
- Inadequate training
- Option generation weak due to inadequate preparation
- Inaccurate implementation plan
- Unrealistic targets due to inadequate baseline data

Tips

Several aspects interfere in achieving the targets set for the options:

☹ Design of the option was faulty or was not anticipatory of all problems

☹ Conditions suitable to the working of the option were not provided

☹ Operators / staff were not trained adequately on the operation of the options

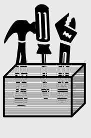
☹ Scale of the implementation was not appropriate

☝ how the GP options were implemented,

☝ what were the barriers / constraints, if any, in the process of implementation,

☝ how were they overcome, if they could not be overcome what are the possible solutions available,

☝ where were the failures in implementation and why.



Gap Analysis
Spider Web Analysis
Solution Effect Analysis
Failure Mode Analysis

3.8 Step 5: Monitoring and Review

3.8.1 Task 11: Management Review

Questions to be answered in Management Review

- Are the implemented options in line with the objectives and targets of the GP program? Are there any deviations? Why? How can they be solved? What are the modified objectives and targets? How realistic are they? Were these deviations recorded and documented? Have any alternative strategies been worked out to meet the new objectives and targets?

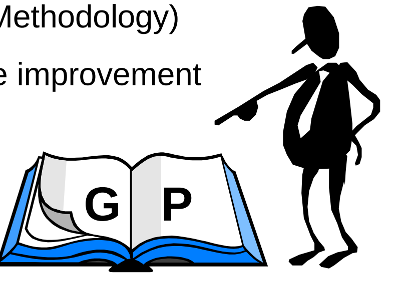
- What are the benefits of the implemented options? What is the improvement in productivity and environmental performance? Are they in line with the envisaged benefits? What is the improvement to the bottom line? How has the supply chain reacted to the desired changes? Has there been a reflection of the GP program on the market?

- What have been the main constraints / barriers? What is the strategy that can be devised to overcome them? What is the resource requirement if any for this?

- Has training and communication been effective?

Management Review

- Effectiveness of the GP Options Implemented
- Tangible and in-tangible benefits
- Financial savings achieved
- Difficulties faced (GP Methodology)
- Identify areas for future improvement



Management Review involves checking whether the overall GP methodology has been applied in the right direction and whether targets are being achieved as per the implementation plan.

Specifically, the followings are reviewed:

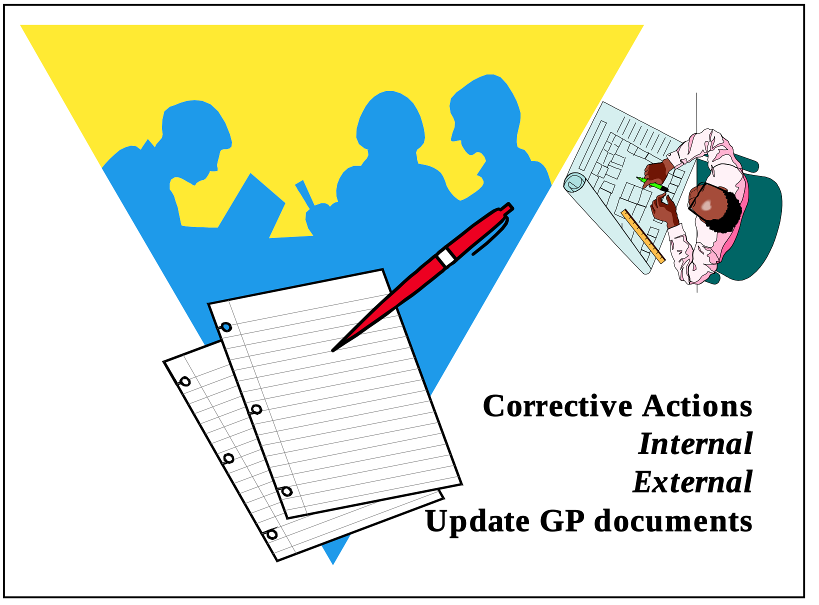
- Effectiveness of the GP Options Implemented
- Tangible and in-tangible benefits
- Financial savings achieved
- Difficulties faced when applying the GP Methodology
- Identify areas for future improvement

The key question that a management review seeks to answer is: "**Is the GP program working**?" (i.e., is it really *suitable, adequate and effective* in improving the organization's productivity and environmental performance?). People who make decisions and who have the right information should be in the review team.

The management review should assess how changing circumstances might influence the suitability, effectiveness or adequacy of the GP program. Changing circumstances may be internal to the organization (new facilities, changes in products or services, new customers, etc.) or may be external factors (new laws, new scientific information, or changes in adjacent land use).

Frequency of management reviews should be decided on the basis of best suitability for the organization. Management reviews are the key to continuous improvement and to ensure that GP continues to meet the objectives and targets set earlier.

Incorporate Changes into Organization’s System of Management



Procedures are an element of the continual improvement of the management of the organization. They will need to be updated in the light of findings from the monitoring and evaluation, changes to the corrective actions and other changes in the company.

Corrective actions are identified in the post-implementation report.

A corrective action could:

- be an action which directly intervenes in the operation of an option (operating procedure is modified or equipment is changed);
- be a modification in the target, if it is found that the set target cannot be met with the present GP option;
- be a change in the objective itself. This is a rare case and should not be common, since it would mean that the setting of objectives and targets was not conducted properly;
- modify an existing concern or generate a new concern;
- be a modification in the team structure and responsibilities.

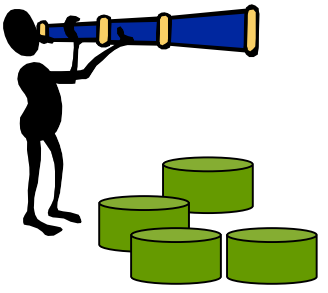
Based on the corrective actions, relevant sections of the existing documentation that would require updating would be:

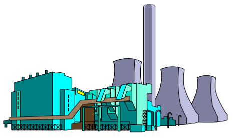
- Operating manuals;
- Targets for objectives;
- Responsibility allocation of the staff concerned;
- Training needs and activities.

3.9 Step 6: Sustaining GP

3.9.2 Task 13 : Identification of New / Additional Problem Areas for Continuous Improvement

Identification of New / Additional Problem Areas for Continuous Improvement





- **Prices**
- **Products**
- **Markets/ Competition**
- **Availability of Resources**
- **Regulations**
- **Technology**

New problems appear because of many factors such as,

- changing prices and availability of resources;
- formulation of newer products and newer markets;
- new legislation, especially those related to environment, products, labor and packaging;
- improvement in the operating norms and benchmarks;
- new competition;
- lost markets;
- change in the cash flow of the company;

It may be noted here that the cycle does not always have to go back to step 1 from step 6. The cycle loops back to different steps of the GP methodology for different GP options, depending on the findings of the monitoring and evaluation of results, and the corrective action decided and approved by the management. For example, it is possible that after the management review, it emerges that only the objectives and targets have to be modified. Then the relevant GP team goes back to Step 2, i.e., the planning step, rather than step 1. Thus, the principle of continuous improvement in the methodology is made possible through a feedback and correction / prevention actions for improvement.

3.10 Summary of GP Methodology

Summary of GP Methodology

Getting Started

- Decided on the members and formed the GP team/s
- Contacted external consultants if required
- Selected GP team leader
- Decided on responsibilities
- Prepared time schedules for regular meetings to discuss Progress
- Conducted walk-through
- Collected baseline information

Planning

- Identified problems and causes
- Set objectives and targets
- Identified performance indicators
- Decided on the sub-teams which would be involved in the generation of GP options for each objective

Generation and Evaluation of GP Options

- Generated GP options for each objective
- Screened GP Options
- Evaluated GP options
- Prepared an Implementation Plan for the selected GP options
- Decided on sub-team responsibilities and contributions to implementation

Implementation of GP Options

- Implemented the selected GP options
- Trained the staff and developed competence on the operation of the GP options and the monitoring & evaluation of the GP program

Monitoring and Review

- Monitored all implemented GP options according to their respective performance indicators developed earlier
- Evaluated and analyzed the performance of GP Options
- Reported the findings to the management for review in the form of a post-implementation report.

Sustaining GP

- Incorporated changes into organization's system of management
- Taken corrective action as per the Post-implementation report
- Established the system of identifying new problem areas and cycling through tasks 4 to 12 to ensure continuous improvement

Learnings from the Lecture

At the end of this lecture, the participant should have understood the GP methodology, how tasks are implemented and what the supporting tools are that can be used in implementing each task. The participant should emerge from this lecture with the confidence that he/she can implement a GP program in his/her industry.

Two questions that may need answering at the end of this lecture are:

- If there is an ongoing environmental management / productivity improvement program in an industry, how can GP be integrated into it?

- What kind of additional resources would be required if GP is to be (i) established afresh in an industry and (ii) be integrated into existing programs?

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CHAPTER 4

Tools for Green Productivity

Contents	Page No.

Objective of the Lecture

This lecture introduces and explains tools that can be used in the identification of problems and causes, and in setting objectives and targets. The task of the GP methodology covered in this lecture includes Task 3: Identification of problems and causes; and Task 4: Setting objectives and targets, under Step 2: Planning.

Identification of problems and causes requires taking stock of the baseline situation in the industry, comparing with standard operating practices or benchmarks in the industry and studying impacts of the industrial operations.

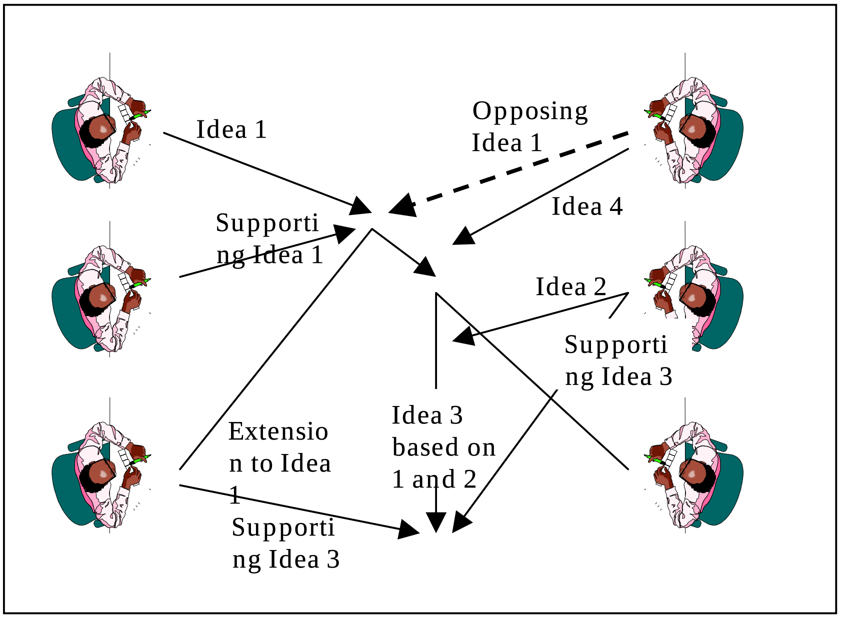
Setting objectives and targets requires prioritization of problems and setting realistic goals that can be achieved with best available technologies.

4.1 Tools for GP

Tools for GP Methodology

Tasks	Tools
	STEP I: GETTING STARTED
1. Form a GP Team 2. Walk through survey and information collection	Checklists, tally charts Plant layout Flowcharts and Process flow diagram Material balance Benchmarking
	STEP II: PLANNING
3. Identification of Problems and Causes 4. Setting Objectives and Targets	Brainstorming Cause and effect analysis (Ishikawa) Critical path analysis Eco-mapping Gantt chart
	STEP III: GENERATION AND EVALUATION OF GP OPTIONS
5. Generation of GP Options 6. Screening and Evaluation of GP Options 7. Preparation of Implementation Plan	Brainstorming Cost benefit analysis Eco-mapping Failure Mode and Effect Analysis Pareto charts Program Evaluation Review Technique (PERT)
	STEP IV: IMPLEMENTATION OF GP OPTIONS
8. Implementation of Selected Options 9. Training, Awareness building and developing competence	Training need analysis Team briefing Responsibility matrix Critical path analysis Gantt chart Spider web diagrams
	STEP V: MONITORING AND REVIEW
10. Monitoring and Evaluation of Results 11. Management Review	Solution effect analysis Eco-mapping Failure mode and effect and analysis Charts (control, tally etc.) / Spider web diagrams
	STEP VI: SUSTAINING GP
12. Incorporate Changes 13. Identify new / additional problem areas for Continuous Improvement	Some of the tools are repeated here, since the activities are loope back to the previous steps

Brainstorming



Brainstorming is a commonly used tool for generating ideas. The details of the ideas, however, are not explained at this level. Checking the feasibility of the idea is done by asking critical questions or brainstorming. The primary objective of brainstorming is to generate as many ideas to resolve a particular problem that has been identified.

This tool is used by teams trying to identify possible root causes or seeking solutions to a problem. Brainstorming can also be used while developing the implementation plan in terms of prioritizing and sequencing of various options.

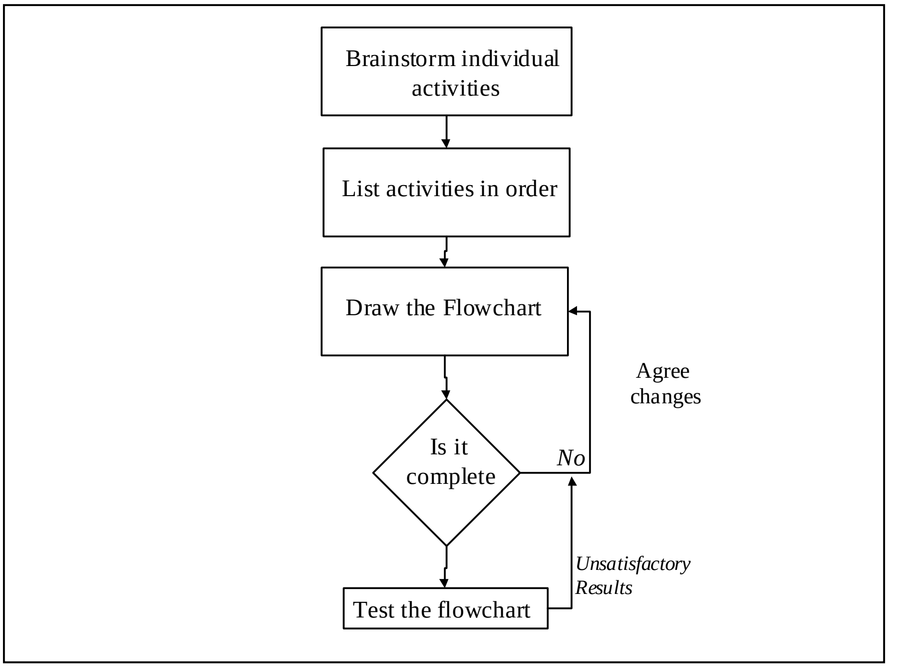
The following procedure may be adhered to while brainstorming. These steps are flexible and should be modified for specific situations.

Tips

Brainstorming exercise for identification of causes for a problem, can lead to development of an Ishikawa diagram

- Keep the meeting in a relaxed setting.
- The team leader should only facilitate the meeting.
- Involve the right (relevant) members of the team.
- Define the problem clearly. It is necessary that everyone in the meeting has the same understanding of the problem, otherwise the ideas would stray from the primary objective.
- Use *free wheeling* method (free generation of ideas) or the *round robin* (taking turns contributing ideas) to identify as many ideas as possible.
- Write down every idea. Ideas should not be struck off unless found to be infeasible.

Flow Charts



A flowchart is a graphical method of representing activities or decision processes. It explains pictorially how the work is done by linking together all the steps taken in a process. By definition, a flowchart presents the sequence of activities as well as the function of the activities, e.g., information collection, analysis, operation, decision making.

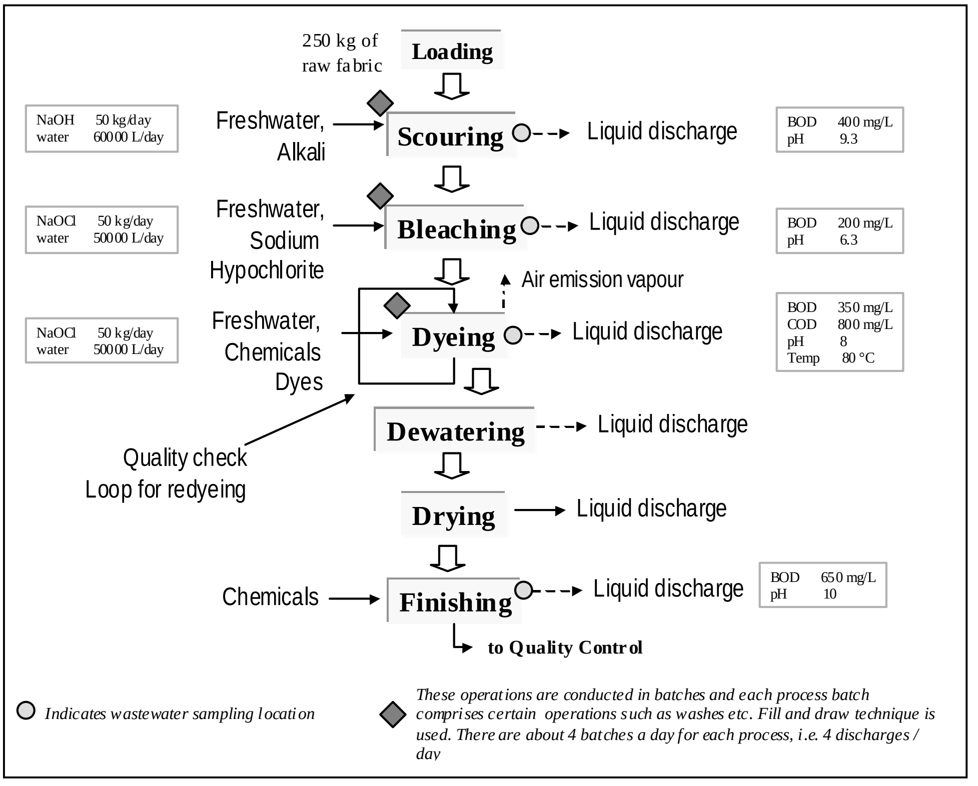
Flowcharting allows all relevant processes to be consolidated and gaps, duplications and dead ends identified. It therefore leads to process simplification. As very large process diagrams are hard to validate and control, they should be split into smaller levels. Care must be taken to keep elements of the chart at the same level of detail.

A specialized flowchart presenting the processes and their sequences in an industry is called a process flow diagram (PFD).

Often, individual processes on the production line have sequential batch operations, for example, dyeing process in a winch is a batch operation consisting of washes and dyeing activities. Such operations within a process could be captured in a specialized flow chart such as an operational sequence flow chart.

4.4.1 Process Flow Diagram

Process Flow Diagram (PFD)



Example

Process flow diagram (PFD) is a special flowchart that represents processes along with the material/energy flows at a company.

Existing PFD should be checked for completeness during the walk-through or a new PFD should be prepared. It is best to start with a general list of the main operations in the processing stage. A detailed listing can then be done for each unit operation that may be the focus for the productivity and environmental improvement program. By connecting the individual unit operations in the form of a block diagram, a PFD can be prepared.

A PFD should address the following:

- All processes and operations should be in the proper sequence.
- Inputs and outputs for each process stage should be clearly indicated.
- Details on any relevant process and/or monitoring data may be shown in the side boxes.
- Points of measurements and quality control should also be shown.
- Releases or emissions in all applicable forms such as air, water, solids should be clearly shown.
- Separate flow charts may have to be drawn for capturing special process variations. These variations may be applicable for certain products, seasons etc.

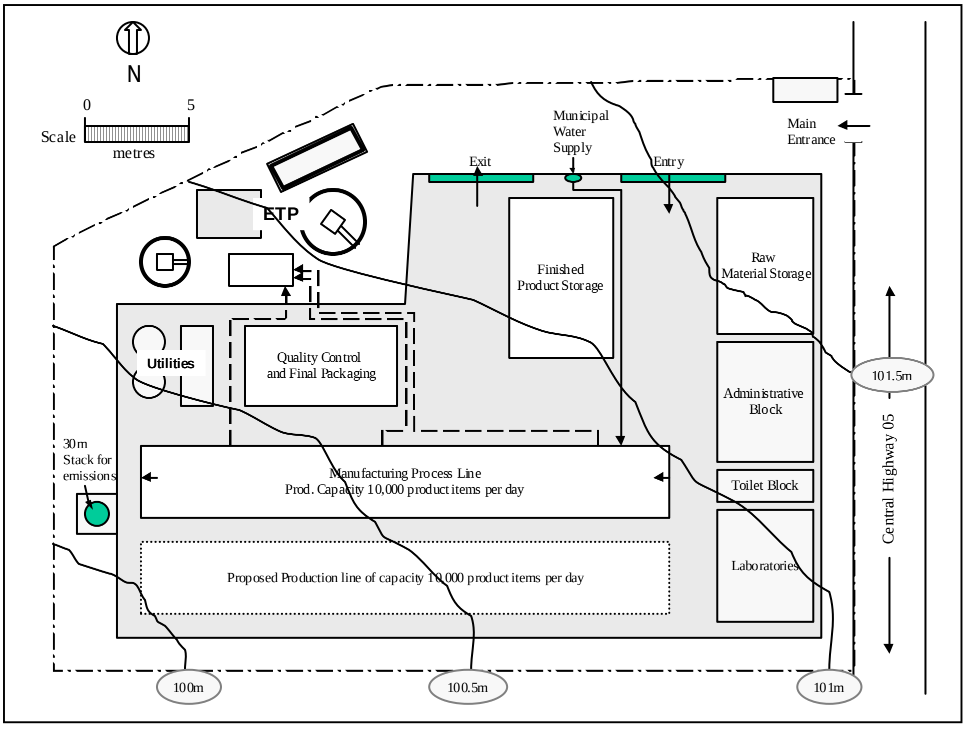
Tips

Colour coding can be used to indicate different media of releases, nature of discharge e.g. continuous / intermittent and recycle flows.

The PFD must start with raw materials at the top of the diagram and end with the final product at the bottom e.g., finished and packaged goods.

4.5.1 Plant Layout

Plant Layout



Tips

It is also useful to indicate existing and newly constructed portions of the facility.

Indicating contours on the layout is relevant for facilities that occupy large undulating or sloping areas.

Layout in combination with the PFD provides a good basis for the complete understanding of the process sequence and operations.

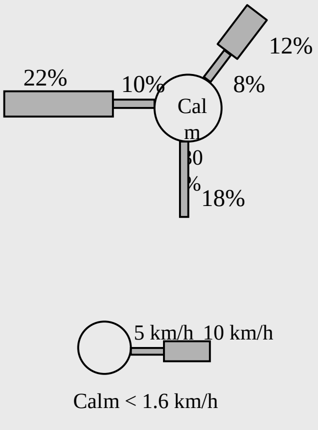
Layout should be drawn to scale, clearly indicating direction North.

Layout should show the facilities / operations as they exist on the floor. The locations of various utilities (e.g., boiler house), laboratories, canteens, administrative blocks, storage areas (especially of hazardous substances) should be clearly indicated. Areas that are marked for future expansion should also be shown. The compound wall should be indicated, clearly showing the entry and exit gates.

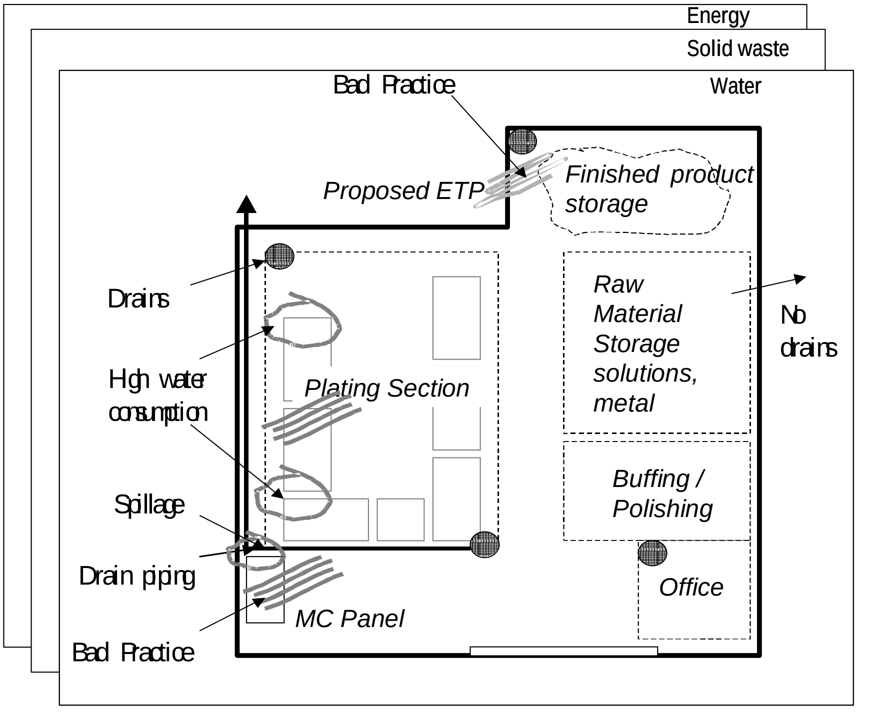
Special thematic forms of layout can also be prepared that show water supply lines, steam lines, cabling, effluent drains, storm water channels etc. Results of line balancing, time and motion studies can also be depicted on the layout as a specialized theme.

For facilities that have emissions to air (especially of odorous compounds), showing a wind-rose is useful in assessing the environmental impacts.

Finally, layout forms a base for the preparation of eco-maps that further assist in the identification of problems.



Eco-maps



Areas are marked on the Eco-map where practices are not correct, or deviate from the norms or where the housekeeping and storage practices are sloppy.

Eco-Map builds upon the basic concepts of a concentration diagram, where the spatial aspect of problems is emphasized

Eco-maps are drawn for various themes such as
- water
- solid waste
- energy
- wastewater

Eco-maps for various themes may be overlaid to identify problems in a more comprehensive manner as well as speculate upon options

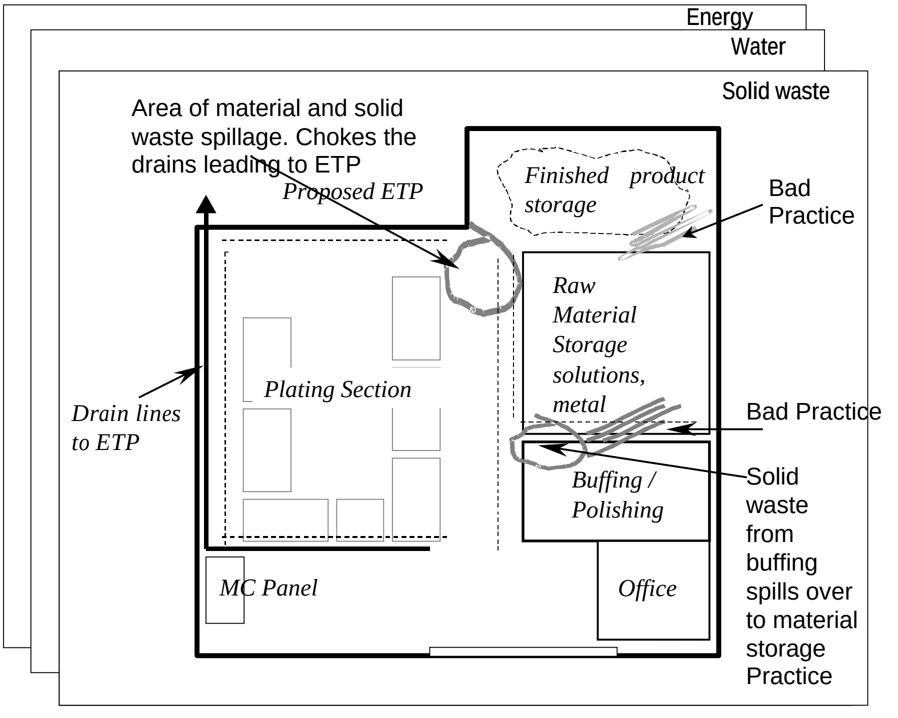
Eco-mapping is a very useful tool, especially for SMEs. It is a simple and practical visual tool to identify and represent environment and productivity related problems. Eco-mapping provides a bird's-eye view of the company's operations and gives a quick orientation to various problems.

Steps in Developing an Eco-map

- Draw a layout map of the factory or work-site. It should include roads, parking lots and nearby buildings.
- The interior spaces of the factory should be drawn to scale as accurately as possible. One or two significant objects may have to be integrated so that anyone looking at the map can immediately orient themselves in the site.
- If the factory covers two or more floors, a map of each floor should be made and marked accordingly.
- Use a copy of the layout to develop an eco-map for each of the problem areas.
- Any other valid problems may also be added.
- For each eco-map, everything that is related to that problem should be included. For example, an eco-map for water consumption and wastewater discharge must pinpoint the locations of spillage, over-consumption, contamination etc.

http://www.inem.org

Eco-maps to Identify Problem Areas



Tips

Eco-maps can also be used during monitoring and review. The Eco-map developed *before* GP option implementation can be compared with the updated map *after* GP option implementation so as to examine the change.

To ensure that Eco-maps continue to serve their purpose, they should be updated once a year or every time the work site is renovated or operations expanded.

This handout presents an example of an eco-map drawn for the theme of solid waste generation and material handling in an industry.

The four major activities in developing an eco-map are Draw, Document, Collect Data and Estimate. The subjects of these activities are given below.

Draw
- Areas where raw material is stored;
- The route for loading / unloading and hauling material;
- what happens to solid waste;
- Major areas of material use (plating tanks, soak tanks).

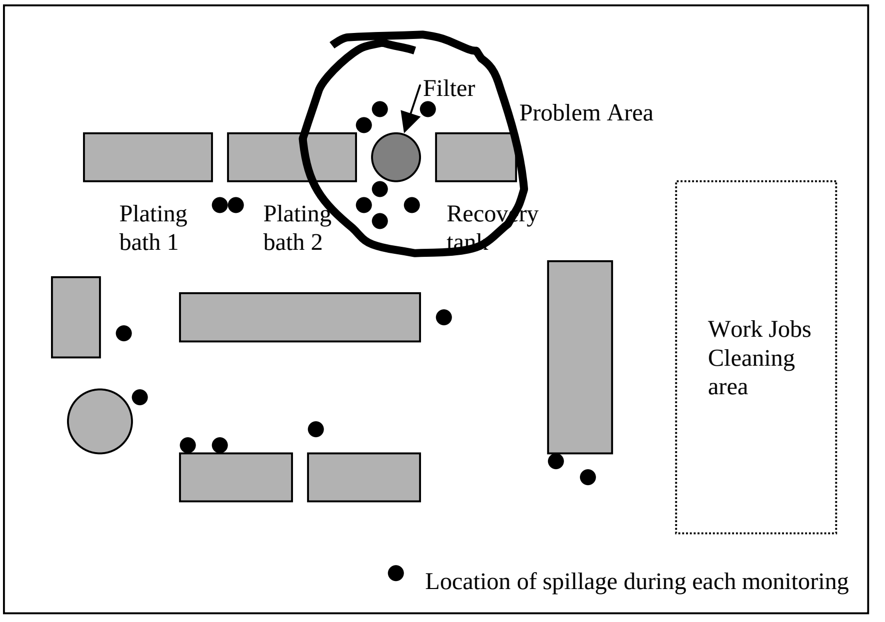
Document
- Material inventory;
- Permits for solid waste disposal;
- Plan of solid waste handling system.

Collect Data
- Material Consumption (relevant units);
- Spot checks on material / weights;
- On quantity and type of pollutants / contaminants in solid wastes.

Estimate
- Wastage of material;
- Bad practices;
- Impact of pollutants.

4.7.1 Concentration Diagram

Concentration Diagrams



Concentration diagrams provide information on the location of the events or problems. This helps in identifying the source or origin of a problem. Concentration diagrams are used as one of a number of tools to find out what is causing problems related to functioning and thereby find solutions. It should not be used as the first diagnostic tool, or the only one.

Tips

Concentration diagrams developed on various themes can be used as inputs in developing Eco-maps.

Like check sheets, concentration diagrams can be used for data collection during problem definition as well as during monitoring an implemented solution.

- Decide on the data requirements in the diagram (activity or event to be recorded).
- Decide on the background (plant layout, operations within a process etc.).
- Categorize the collected data with respect to the locations on the background.
- Plot data on the background diagram.

Example

An electroplating shop observed high flow in its floor drains. The GP team monitored the locations of the spills along the production line for a period of time, using concentration diagrams. The diagram revealed a particular plating bath, and the next dragout recovery unit as the area with maximum number of spills. On checking the area, it was found that a filter located between the two tanks (for continuous filtration of plating bath solution), increased the dragout spills during operation. Relocation of the filter solved the problem and the flow in the floor drains reduced.

Check Sheets

	Number in a week
No. of instances lights were kept on by the customer while leaving the room	
Number of instances water was left running by the customers	
Number of customers who demand daily change of room linens, towels…(unused)	

Tips

Checksheets developed for a particular problem can lead to its causes and assist in the development of Ishikawa diagrams.

Check sheets can be used for collecting data over time to show trends and recurring patterns that need to be understood and controlled.

Check sheets are particularly useful when the number of times a defect or value occurs is important to investigate the problem. Check sheets do not however, explain one-off incidents or random sequences. This tool can be used either during problem identification when baseline data is being collected, or after implementing the solution and data is being collected for monitoring the situation.

The benefits of check sheets are that by establishing the facts about the incidence of failure, a team can plan to identify the causes of failure. Action can then be taken based on evidence.

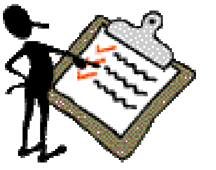
Example

A hotel was trying to develop environmentally sound options for their rooms. To devise such options, the GP team decided to use check sheets to study the behavior and habits of the customers. Items studied were energy consumption; water consumption; cleaning; and laundry requirements. The results helped the hotel management to assess which were the potential problems required to be attacked first.

Options included using room key controlled light switches that switch off on removal of key from holder; putting up banners and instructions for guests on optimum water use; and putting only used linen out for laundry.

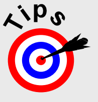
Checklists

Checklists could be developed on the following activities:



✓ Monitoring and Maintenance

✓ Changing equipment, processes and operations



Checklists can be devised as pointers to delve into probable causes. Options are identified when the checklist is applied to field and relevant data, followed by brainstorming

Some of the common checkpoints are:

- **Monitoring and Maintenance**
  - How about more frequent inspection of records and supervision?
  - What if a strict housekeeping program is initiated, supported by on-the-job training of works?
  - Will initiation of a total productive maintenance (TPM) help?
- **Changing Equipment, Processes and Operations**
  - How about the recycling and reuse of some of the output streams?
  - How about exploring the recovery possibilities from the various output streams?
  - What would be the effect of reducing or increasing the batch size?
  - Can there be a better job flow sequencing to handle odd lots?
  - Do we need this operation at all? Can this be skipped? (e.g., washing)
  - Are there better technological options if the production is slightly upscaled?
  - Can two operations be combined to produce same desired effect?
  - Can the method itself be changed? (ultra-sonic cleaning as against liquid cleaning)
  - How about investigating the possibility of automating operations?

Using Checklists as Pointers to Generate New GP Options

✓ **Materials and Inventory**

✓ **Meeting environmental compliance**

✓ **Training and Human Resource Development**

- **Materials and Inventory**
  - Is the inventory excessive in terms of the raw material quality?
  - Is the method of inventory and use in the first-in-first-out (FIFO) manner or the first-in-last-out (FILO)?
  - Could alternate materials be procured that may cost a bit more, but lead to more savings in terms of productivity?
  - How about eliminating toxic and hazardous materials from the purchase list so as to obtain eco-labels and to reduce the cost of waste treatment and disposal?

- **Meeting Environmental Compliance**
  - Can the waste generated be properly contained and segregated to allow recycling, reuse and / or recovery?
  - Should all waste be combined and then treated, or treated separately, especially for some select waste streams that may be toxic.
  - Does the treatment of waste lead to generation of difficult-to-manage residues? Are there alternative methods of treatment that are more environmentally sound as well as cost-effective, such as joint treatment of wastes with a neighboring industry.

- **Training and Human Resource Development**
  - Perhaps training and instruction for workers is necessary!
  - How about sending the mid-level technicians abroad to get more experience?
  - How about instituting a scheme of annual awards?

4.10.1 Material Balance

Material balance establishes the major inflows and outflows and highlights any discrepancies in a quantitative manner.

Exercise of Material Balance helps to carry out comparison with norms by working out specific consumption / production

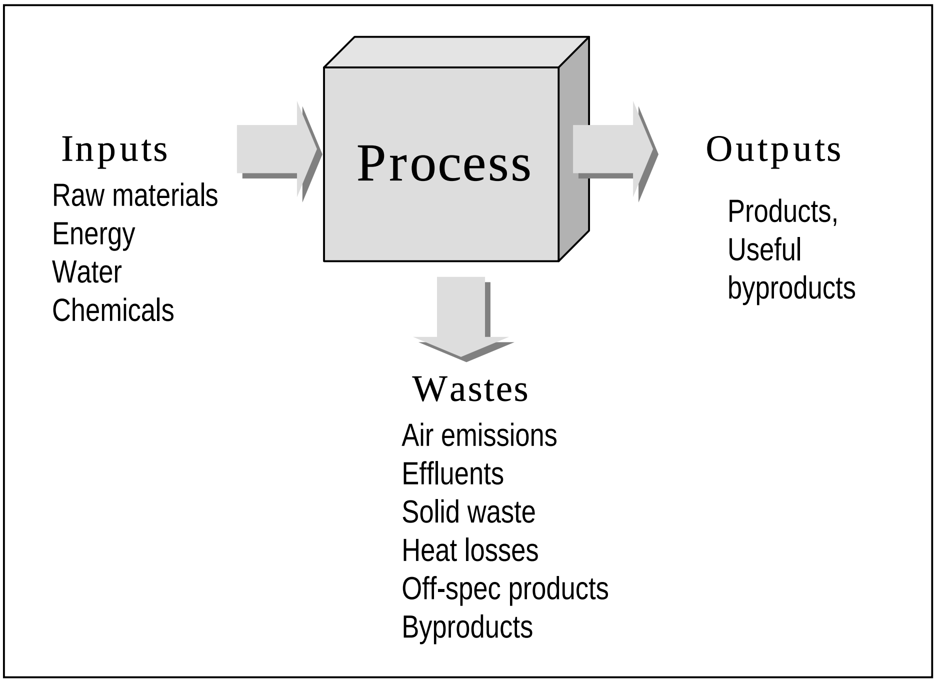
Material Balance also serves as a predictive tool to speculate on outputs for changed inputs or improved processes.

Discrepancies once identified leads to understanding of problems and causes.

Material balance carried out exclusively for energy is called Energy Balance

Material balance focused on toxic materials usage is called Toxic Release Inventory (TRI)

Material Balance



Material balance is a basic inventory tool, which allows for the quantitative assessment of material inputs and outputs. The basis of the material balance for a process-based environmental management program is the development of a process flow diagram.

Inputs to a process or a unit operation may include raw materials, chemicals, water, air and energy. Outputs include primary product; by-products; rejects; wastewater; gaseous wastes; liquid and solid wastes which need to be stored and / or sent off-site for disposal; and reusable wastes.

Basic Principle of a Material Balance

In it's simplest form, a material balance for any production system is drawn up according to the following principle:

Material and Energy Inputs = Products + Waste

Material inputs includes raw material, chemicals, energy etc.
Energy includes fuel, electricity etc.
Products include final products from the factory as well as by-products.
Waste includes effluents, air emissions, solid wastes, waste heat, off-spec products.

4.10.2 Steps in Developing Material Balance

Tips

Sources of Information for Material Balance

- Routine monitoring data on inputs and outputs;
- Raw material purchase records;
- Equipment cleaning frequencies & procedures;
- Process operating sequences;
- Log sheets by operators and supervisors;
- Right First Time (RFT) or reject statistics;
- Weekly material inventory statistics;
- Monthly statistics on water, fuel and electricity consumption.

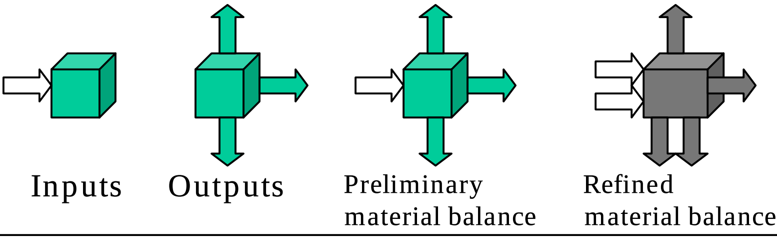
Tips

Before commencing measurements in a material balance, check with the operators and staff on the operating procedures, frequencies and amounts of material inputs

Steps in Developing Material Balance

Steps in Developing a Material Balance

1. Determining Inputs
Recording raw material procurement, water and energy usage,
2. Quantifying Outputs
Accounting for wastewater, gaseous emissions, solid wastes, energy
3. Selecting a Tie compound
4. Preparing a preliminary material balance
5. Evaluating and refining material balance



Planning a Material Balance

The process flow diagram (PFD) should be finalized and checked for correctness and accuracy before starting the material balance.

Equipment necessary to record and measure parameters should be installed and tested. Flows and concentrations should be simultaneously measured.

Sampling procedures and locations should be established based on the parameters involved, and laboratory arrangements should be made. Composite sampling should be preferred over grab sampling.

Doing a Material Balance

Determining inputs
Include raw materials, chemicals, water, energy, etc. for the process / operation. Measurements should be taken for an appropriate length of time so as to ensure that the results are representative. Averages should be taken wherever necessary and appropriate. Existing levels of material recycling should not be missed. They should be incorporated while balancing.

Quantifying outputs
Outputs consist of products, by-products and wastes. Attention should be paid to off-spec products and reprocessing sequences.

Selection of tie compounds
Suitable and representative tie compounds should be selected for preparing the material balance.

Preparing a preliminary material balance
Based on the inputs and the outputs, a preliminary balance should be constructed. Discrepancies should be calculated and, wherever in doubt, measurements or analysis should be repeated to refine the material balance.

Refining a Material Balance
The preliminary material balance should be improved by verifying the collected data during site inspections and by brainstorming.

4.10.3 Considerations in Developing Material Balance

Tips

Material Balance need not be excessively accurate (to the order of 99%).

It is difficult to achieve high accuracies when operations and processes are complicated.

Material Balance within the tolerance range of 10% should generally be acceptable.

However, If the tie compound for material balance is of a hazardous nature then, a higher order of accuracy should be targeted.

Considerations in Developing Material Balance

Tie Compounds

Tie compounds could be specific to the industry. They should be a measure of economic or environmental importance

- **Examples of Tie Compounds**

Water in textile industry
Heavy metals in electroplating industry

Estimation Procedure

In material balance, it is not always necessary to carry out measurements of inputs and outputs.

Instead estimation procedures could be used as shown in the example given below in this handout.

A tie compound is the parameter or substance for which the material balance is established around a unit operation or process. Selection of an appropriate tie compound for checking material balance is an important step.

Criteria for selecting tie compounds:
- an expensive raw material/intermediate;
- material common in most processing stages;
- a substance of hazardous nature;
- a substance/compound easy to measure/estimate.

A simple example of a tie compound is the water added to account for most wet operations. In practical situations, more specific tie compounds, e.g., nickel or zinc in electroplating shops or dyestuff in textile processing, would be ideal. Another good example is the chromium in leather tanning.

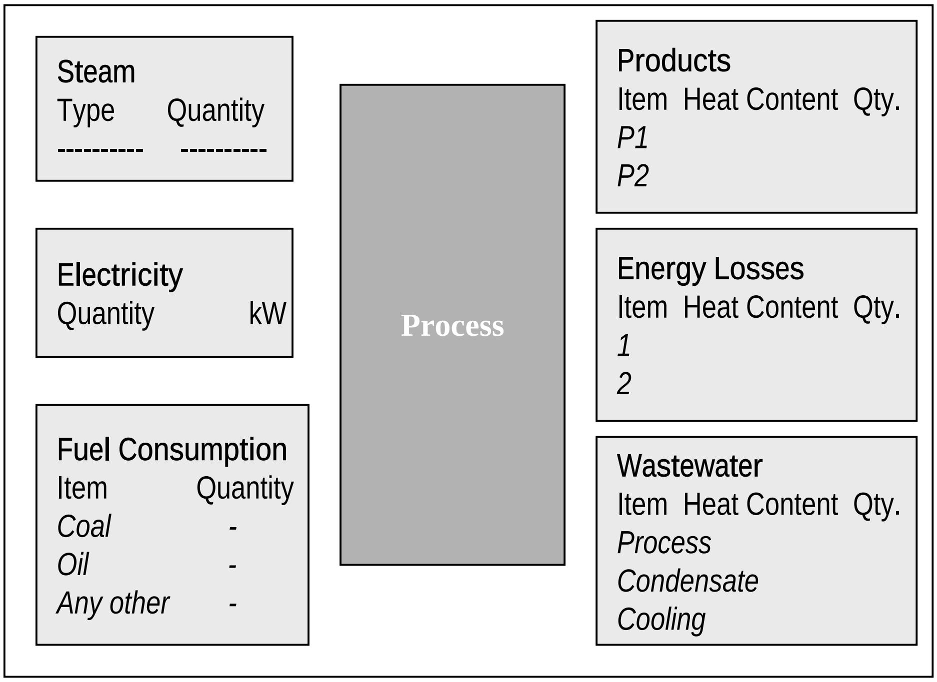
Chemical oxygen demand (COD), is another very useful tie parameter which sharpens the material balance exercise, especially to link the production areas with the effluent treatment plant. Contributions of each process department in terms of total COD load in kg/day; knowing the volume of wastewater and its COD discharged by each department; and cross-checking it with the COD load observed at the treatment facilities can provide a good check on the data.

Example

A medium scale electroplating shop uses a small drum to *clean* the work-pieces/jobs that have not been plated as per specifications.
Metal laden wastewater generated out of this drum is periodically emptied in the drains.
A drum has a capacity of 50 L and, in a week, the drum is emptied about five times.

Hence, the amount of wastewater dumped is in the range of 250 L/week and has a chromium strength of 100,000 mg/L.
Total Cr wasted is 25 kg/week.

Energy Balance



In addition to water, and chemicals, etc., energy is an important tie compound, particularly for energy intensive and process sectors such as iron and steel, coke oven, textile, and pulp and paper.

An energy balance may be defined as a quantitative account of the input and output forms of energy in a production process.

The first step in an energy balance would be to develop a PFD for the plant.

Quantities of various forms of energy input, such as fuel, steam, electricity for the plant/unit operation, would then need to be measured/completed. Energy inputs to a process or a unit operation may be in the form of steam, hot water, electricity etc. The fuel sources to generate the heat are also included in the inputs. The output is to be quantified in terms of the enthalpy of the products, wastewater (process, condensate and cooling) and any energy losses, such as steam leakage.

4.11.2 Example of Material & Energy Balance

Material and Energy Balance

Illustration from a textile dyeing mill

INPUT

Material Balance:
Condensate Water: 20 tons
Make up water: 60 tons
Fuel: 6 tons
Air (13% excess): 69.53 tons
Total: 175.55 tons

Energy Balance: 10^3 **kcal**
Condensate 95C: 1900
Make up 60C: 4800
Fuel 60C# : 180
Heat combustion*: 62250
Air (30 C)^: 501
Total:68431
 # Cp for fuel is assumed to be 0.5 kcal/kg C
** Calorific value 10375 kcal / kg fuel*
^ Cp for fuel = 0.24 kcal / kg C

Boiler House

OUTPUT

Material Balance:
Steam: 72 tons
Blowdown: 8 tons
Flue gases: 75.55 tons
Total: 175.55 tons

Energy Balance: 10^3 **kcal**
Steam: 50112
Blowdown (160C)^: 1488
Flue gases (231 C)#: 4608
Losses: 12223
Total: 68431
^Saturated temperature at 7.5 bar
 # Cp for gas = 0.264 kcal / kg C

Key:
Cp: Specific heat capacity

Energy and material balances are carried out, not only for the main process, but also for the various equipment and utilities that enable production.

An illustration of material and energy balance for a boiler house that generates process steam is shown above.

4.12 Tools for GP

4.12.1 Cause-Effect Analysis

Tips

Ishikawa diagram can be used when a team is trying to find potential solutions to a problem and is looking for the root cause. It is extremely useful when there is a fairly large-scale problem, perhaps involving a number of activities, which would have a number of causes

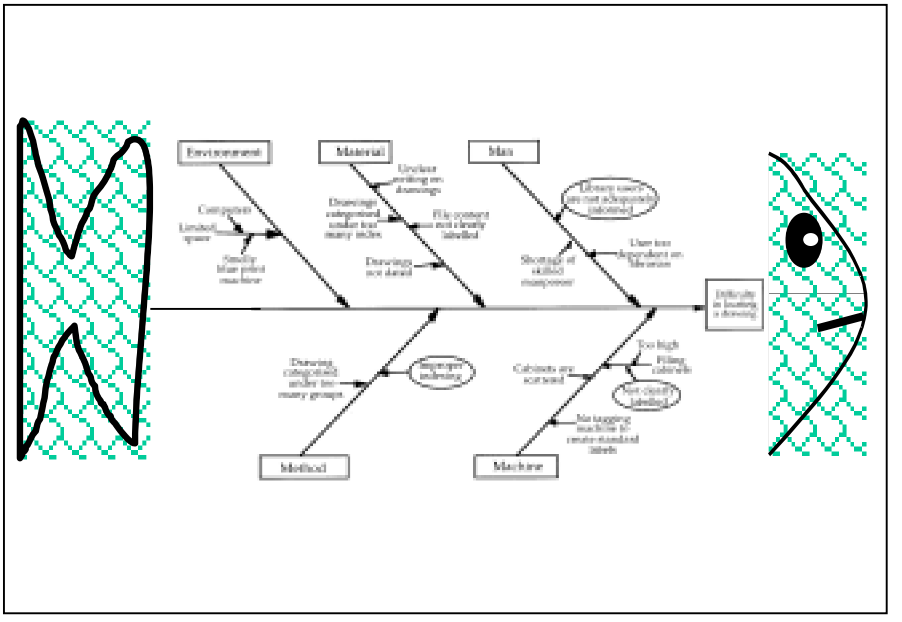
A fishbone diagram can be used to structure the cause - effect relationships in a problem area

The example in this handout presents example of how Ishikawa diagram can be used to identify causes of a problem area.

The problem area is decreased productivity
The primary causes identified are:
- High production cost
- Inadequate Material Inventory
- Process operation is not rational
- Equipment efficiency is low

The corresponding sub-causes to these primary causes are:
1. Improper housekeeping
2 High prices of raw material
3. Delay in material delivery by the supplier
4. Process Benchmark/norms are exceeded
5. Equipment Maintenance is inadequate
6. Equipment is outdated

Cause-Effect Analysis
Ishikawa (Fishbone) Diagram



Ishikawa, or fishbone diagram, is primarily used to identify causes of problems in the problem identification task or in the generation of options, where options stem out of avoiding or eliminating the causes of the problems.

Cause and effect analysis allows the analysis of the problem in a *systems approach* rather than proposing quick fix solutions to get around problems.

To construct a fishbone diagram, the simplest method is to use a 4M1E method of categorization.

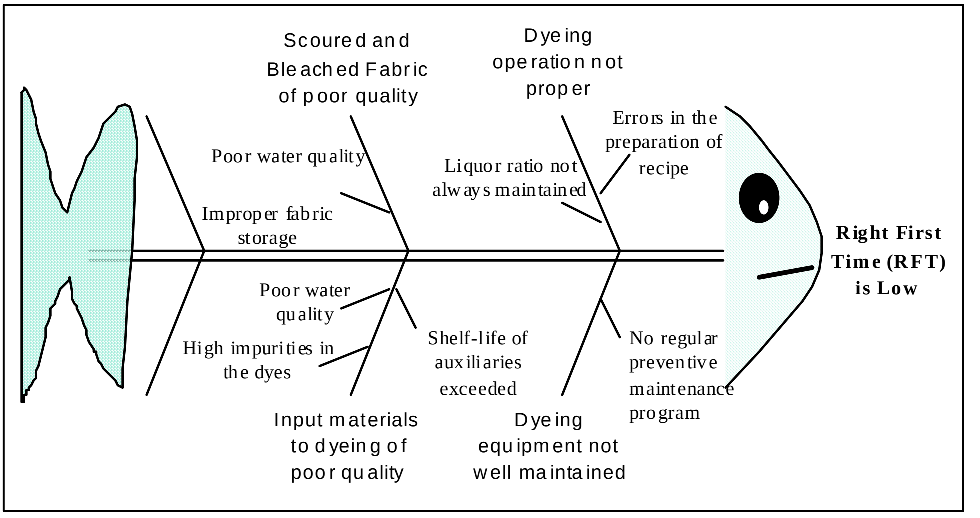
Here, all the causes and sub-causes should be divided into impacts due to Man, Machine, Material, Method and Environment. The 4M1E categorization may be a starting point and more refinements are possible.

The main steps in this tool are :

- Define problem and put it on right of the diagram, at the end of a horizontal line.
- Identify main causes and join to horizontal line by sloping lines.
- Brainstorm subordinate causes and attach to main cause lines.
- Look for root causes by identifying causes which occur more than once or which are related.
- Propose solutions to root causes.

4.12.2 Example of Cause-Effect Analysis

Ishikawa Diagram
Illustration for a Textile Industry



In a knit fabric processing industry, the right first time (RFT) in dyeing was found to be rather low, close to 60%. The following were identified as the likely main causes:

- Poor quality of scoured and bleached fabric
- Poor operation of the dyeing machines
- Poor quality of input materials used in dyeing
- Poor maintenance of the dyeing machines

Further analysis and brainstorming led to development of a detailed Ishikawa diagram.

The primary causes were further studied, and the secondary level causes identified as follows:

Cause for poor quality of bleached fabric:

- Poor water quality, as raw water contains impurities;
- Improper fabric storage, due to dirtying of fabric during storage.

Causes for improper dyeing operation:

- Errors in preparation of recipe;
- Liquor ratio is not always maintained.

Causes for poor quality of input material to dyeing:

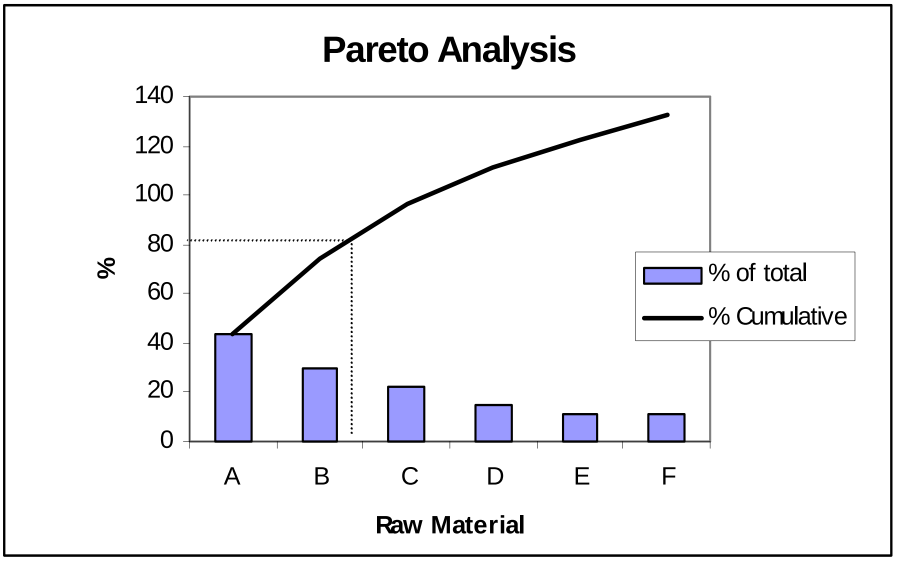
- Poor water quality;
- High impurities in the dyes;
- Shelf life of auxiliaries exceeded.

Causes for dyeing equipment not well maintained:

- No regular preventive maintenance program.

4.13.1 Pareto Diagram

Pareto Diagram



Pareto analysis is a method of identifying the vital few causes (typically 20%) that can answer most of the (typically 80%) problems.

Pareto analysis can be used in a wide variety of situations where there are a number of variables contributing to a problem and you need to know which are important. It is particularly useful in the task of option prioritization in selection as well as implementation. Pareto analysis provides a strong visual presentation of how to prioritize problems, and where to concentrate resources for the best results. While interpreting the results, it is essential to use common sense as well as data to ascertain causes and priorities.

Example

In an industry conducting GP program, an Ishikawa diagram identified some causes for the high generation of off-spec products. The causes were as follows:

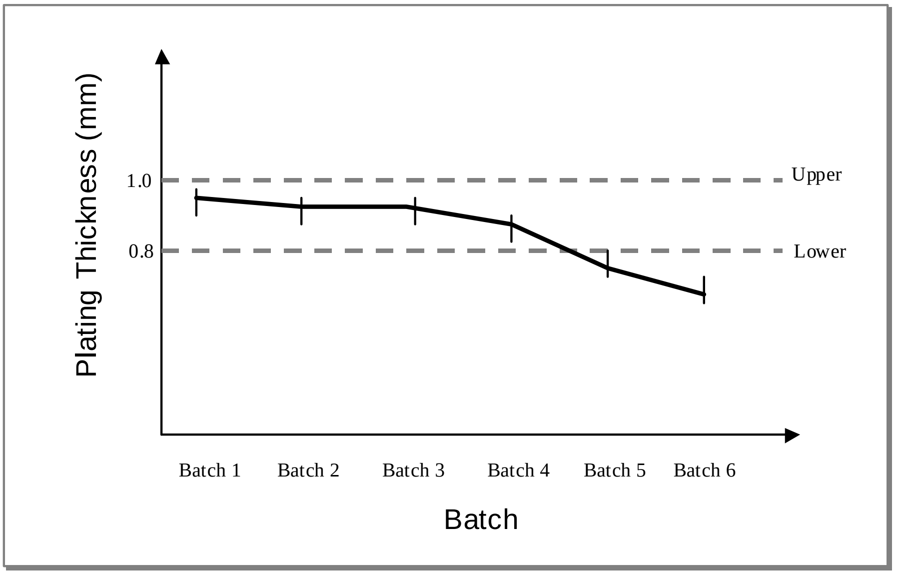
A	Impurities in Chemical A (raw material)
B	Low efficiency of mechanical equipment
C	High temperature in the process
D	Incorrect time period for the batch process
E	Operator fault
F	Amount of Catalyst B
G	Others

The GP team decided to use pareto diagrams to determine the major contributors to the problem. Off-spec production and its corresponding causes were monitored for a period of one month. The number of times each cause contributed was noted and the frequencies were determined. The diagram shown in the viewgraph above indicates that raw material impurity and equipment efficiency were the major factors. Accordingly, the supplier was contacted and necessary input material specification was included as the supply condition.

4.14 Tools for GP

4.14.1 Control Chart

Control Chart



Control charts are used to show deviations / variability of performance in a process from a benchmark (which may be a process / equipment / product parameter).

Procedure for drawing control charts is as follows:

- Decide the parameter to be tested;
- Decide the upper and lower limits of the parameter during operation, with appropriate units;
- Plot the selected parameter with the appropriate units;
- Mark the areas exceeding the limits.

A control chart as shown above was drawn for the plating thickness clearly showing the upper and lower limits of acceptance.

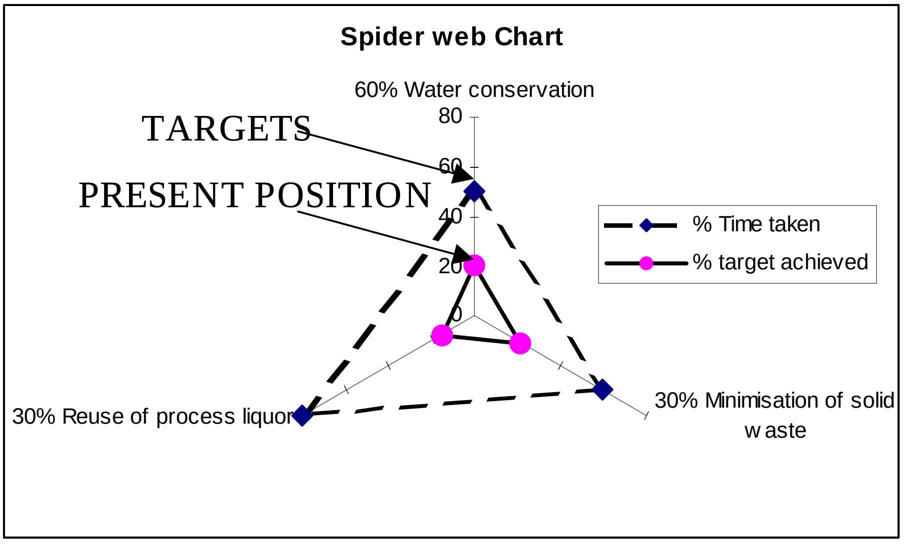
An automated metal finishing shop observed that the percentage rejects had increased and the client was dissatisfied with the plated workpieces. The GP team concluded after brainstorming that the plating thickness needed to be monitored to determine the frequency of deviation of the plating thickness from the desired product specs. An average of three samples was tested from every batch of 24 workpieces. Six such batches were examined.

It was observed that after batch 4, the deposits started to thin. An Ishikawa diagram was drawn to explain the causes of this decrease and it was concluded that after six successive batches of 24 workpieces, the metal bath solution needed to be replenished by 20% to maintain the desired plating thickness.

4.15 Tools for GP

4.15.1 Spider Web Diagram

Spider Web Diagram



Spider web diagrams show performance against a target when several criteria are being set. They give a visible or graphic way of showing progress and performance against several targets at the same time. During benchmarking, this tool can be used to show the current performance, the immediate objective, the average in class, or the overall best in class performance.

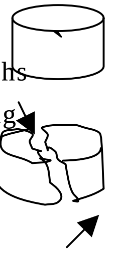
Example

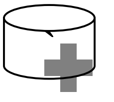
The example in the above viewgraph illustrates the use of spider web charts for tracking the progress of options in a knit-fabric processing company. It can be observed from the diagram that the target of 30% reuse of process liquor was lagging behind its slotted time. Only 20% of reuse of the process liquor was achieved in 80% of the decided time period. Thus, high priority action was needed to be taken on this GP option. The other two targets appear to be well within their time frames.

4.16.1 Failure Mode Effect Analysis

Failure Mode Effect Analysis

GP Option	Direct reuse of dyebath	Restrict reuse only for disperse dyebaths
Problems leading to failure	Shades not matching with standard	Shades not matching with standard
Detection	9	9
Likelihood of occurrence	8	3
Cost liability due to failure	8	8
Risk Priority Number	576	216
Corrective Measure	Restrict reuse only for disperse dyebaths	





In GP context, Failure Mode Effect Analysis (FMEA) can be used to assist in the foolproofing of a GP option (design, process or equipment). The most significant advantage of FMEA is that it is proactive in nature and allows preventive actions to be incorporated in the planning.

FMEA can be used while evaluating a GP option to investigate possible causes of failure, or when examining a product or service to look for what can go wrong. It offers a structure for thinking through the likelihood, intensity and detection of potential problems in a GP option.

How to Use

Brainstorm on what can go wrong (if the GP option is a technology or process, the operating manuals might be of use here to know about troubleshooting). A list of potential problems linked to the failure of the option should be generated.

For each potential problem, estimate how likely it is to be detected if it is wrong. This is graded on a 1-10 scale of very high to remote detection.

Then, for each problem, estimate the likelihood of failure to occur. Again this should be graded on a 1-10 scale with 1 indicating minimum likelihood and 10 indicating maximum likelihood.

Finally, for each of the problems, rank the cost liability of failure on a 1-10 scale. Here a score of 1 indicates low cost and 10 indicates high cost.

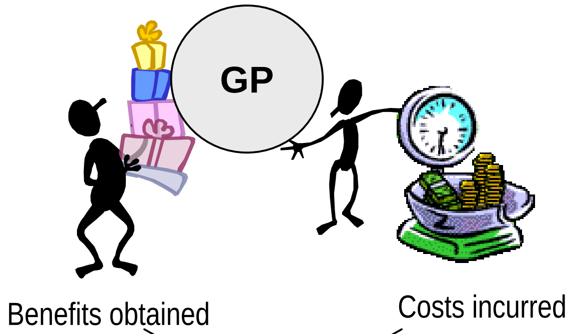
Multiply these three values to get the risk priority number (RPN). This number would be anywhere between 1 and 1000. Rank the problems by their RPNs thus obtained. Any problem with an RPN above 700 is high priority and should be tackled first.

Suitable corrective measures can then be designed and implemented to minimize the risk of the potential problems identified from the FMEA.

4.17 Tools for GP

4.17.1 Cost Benefit Analysis

Cost Benefit Analysis



The costs incurred and the benefits accrued to an organization in adopting the GP framework must be measurable. Metrics typically used to measure such impacts of GP on an organization's performance are profitability analysis.

While quantification of productivity using MFP is useful in indicating changes in productivity over a given period, and is a useful tool for analyzing such changes, the inputs provided and outputs obtained must be measured using a common measure. Measurement of productivity is based upon separately measuring the outputs and inputs to calculate the ratio. Due to the different types of outputs produced, a common measure is **the monetary unit** or value of outputs in a given period. Inputs can consist of labor and capital as well as intermediate inputs such as raw materials, semi-finished products, etc.

This common measure of money is the basis for the profitability analysis. It provides the "bottom line." In the GP framework, profitability analysis is useful at various levels (i) in selecting feasible options that are to be implemented and (ii) in evaluating the effectiveness of implemented options on the overall performance of the organization.

Profitability analysis typically uses three financial indicators:

☑ Simple payback
☑ Net present value (NPV)
☑ Internal rate of return (IRR)

Conventional profitability analysis does not consider environmental costs and benefits, as many of them are not tangible. In the GP framework, however, inclusion of measurable environmental costs are advocated. Use of supportive tools like total cost accounting can be made to enable a comprehensive profitability analysis.

contd….

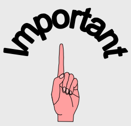
4.17 Tools for GP

Total Cost Assessment (TCA) is used to assess projects using environmental cost data, appropriate time horizons, and standard financial indicators. TCA is a comprehensive method for analyzing costs and benefits of a pollution prevention or design project. TCA includes:

- full cost accounting which is a managerial accounting method that assigns both direct and indirect costs to specific products;
- estimates of both short and long-term direct, indirect or hidden liability and less tangible costs;
- costs projected over a long horizon such as 10-15 years.

TCA is an approach to removing potentially unwarranted and misleading financial barriers to pollution prevention and other environmental investments. It assists in developing comprehensive financial analysis of the true profitability of an investment. TCA differs from conventional project analysis methods in four ways:

- the inventory of costs, savings, and revenues includes indirect, less tangible items typically omitted from project analysis, such as compliance, training, testing, liability, product and corporate image;
- costs and savings are directly allocated to specific processes and product lines instead of being pooled in overhead accounts;
- time horizons for calculating profitability are extended to capture longer term benefits;
- profitability indicators capable of incorporating the time value of money and long-term costs and savings are used.



P2/ FINANCE is a user-friendly series of software programs designed to facilitate the financial analysis of pollution prevention (P2), energy efficiency, and other projects to enhance resource efficiency. It enables the user to compare the costs/savings of business-as-usual practices with alternative scenarios using Total Cost Assessment (TCA).

P2/Finance, Tellus Institute, Massachusetts.

Cost Benefit Analysis

Cost benefit analysis is the comparison of costs and benefits accrued from a GP Option. Profitability analysis typically uses the following three financial indicators:

- ☑ Simple payback
- ☑ Net present value (NPV)
- ☑ Internal rate of return (IRR)

These indicators can be used to evaluate GP options, and select the most economically feasible. The profitability analysis can also form the basis of prioritization for implementation of the selected option.

Alternative GP options to address the same problem can also be compared in terms of their economic feasibility through profitability analysis.

Simple Payback: A simple payback period is evaluated based on the annual savings and the initial investment. It simply indicates the time period required to return the initial investment.

$$\text{Payback} = \frac{\text{Capital investment}}{\text{Annual savings}}$$

Net Present Value (NPV) : The present value of the future cash flows of an investment less the investment's current cost is called NPV. An investment is profitable if the NPV of the cash flow it generates in the future exceeds its cost, that is, if the NPV is positive.

$$NPV = \{CF1 / 1+k\} + \{CF2 / (1+k)^2\} + \ldots\ldots\{CFn / (1+k)^n\} - I$$

where: CF1 is cash flow in period 1, CF2 is cash flow in period 2, I is initial outlay or investment cost and k is cost of capital or discount rate.

Internal Rate of Return (IRR) : This calculates the rate of return on investment during the life of the equipment by way of cash inflows. Obviously, this rate should be compared with the cost of capital (rate of interest on loans) which is to be paid at the inception of the project.

Pay-Back Period

The concept of pay back period is used only for a rough assessment, because, it ignores depreciation and the time value of money. It ignores the present value concept. The present value of cash outflows or inflows in the future is important because the comparison is with investment . Thus interest rates of savings and borrowings come into the picture and decide the present worth of an investment or revenue in the future.

NPV and IRR depend on the period for which the analysis is carried out.

REFERENCE Look Up

P2 Finance (Excel Version)
Tellus Institute
http://es.inel.gov/partners/acctg

Example of CBA – No Capital Investment

Combined Scour-Bleach in a Cotton Textile Unit in Egypt

Savings in:	Conventional	Combined
- Chemical costs	(1.1)	107.0
- Water use	3.8	0
- Steam	16.5	0
- Electricity	3.4	0
- Labour	9.0	0
TOTAL per ton	31.6	107.0
Annual production	591 tons	591 tons
ANNUAL SAVINGS	**18,622**	**63,249**

Increased Productivity

The modified process considerably shortened the processing time thereby increasing production capacity. The processing time for half bleach has been more than halved, enabling capacity to be lifted.

Improved Fabric Quality

The whiteness and absorbency was improved with the modified process in the full bleach process at the mill.

Environmental Benefits and Improved Working Conditions

Sodium hypochlorite, a toxic and hazardous chemical, has been phased out of the bleaching process at the mill. As a result worker conditions and safety have improved and the amount of halogenated organic hydrocarbons (AOX) in the final effluent has been minimised. Water and energy consumption has also been reduced.

Economic Benefits

Savings on operating costs LE71,496
Net benefit on increased production capacity LE95,803
Total Annual Benefits LE167,299

Most of the fabrics used in trials were sold. The cost for local consultants and expenses was LE56,000, giving a payback period of just under 3 months.
The benefits and achievements included:

- Electricity consumption reduced by: 27%
- Steam consumption reduced by: 15%
- Water consumption reduced by: 88%
- Cost of chemicals increased by: 18%
- Processing time reduced by: 5 hours
- Productivity improved.
- Fabric quality improved.
- Working conditions improved.

Example of CBA – with Capital Investment

White Water / Fiber Reuse in Pulp and Paper Industry			
Capital Costs		Annual Savings *	$350,670
Saveall Equipment	$345,985		
Saveall and White Water Pump		*Financial Indicators*	
Materials	$374,822	Simple Payback period	4.19 years
Piping, Electrical, Instruments and Structural		Net Present Value - Years 1-15	$359,544
Installation	$397,148	Internal Rate of Return - Years 1-15	21%
Engineering	$211,046		
Contingency	$140,403	**Annual operating cash flow before interest and taxes*	
Equipment Life	15 years		
Borrowing Rate of Interest	15%		
Total Capital Costs	$1,469,404		

Example

A pulp and paper mill generates considerable wastewater. A waste stream called white water contains a large amount of fibre that is wasted. This fibre can be recovered by floatation or other similar techniques. This example presents the economics of one such technology, called Saveall, considered a GP option.

Financial Indicators

Simple payback period	4.19 years
Net present value - Years 1-15	$359,544
Internal rate of return - Years 1-15	21%

Annual Operating Cash Flow Before Interest and Taxes.

The financial indicators were developed on the basis of the annual cash flows. A positive NPV suggests that the project is profitable. An IRR greater than the cost of capital indicates that the rate of return on investment is high. Overall the financial viability of the project could be said to be high.

Tips

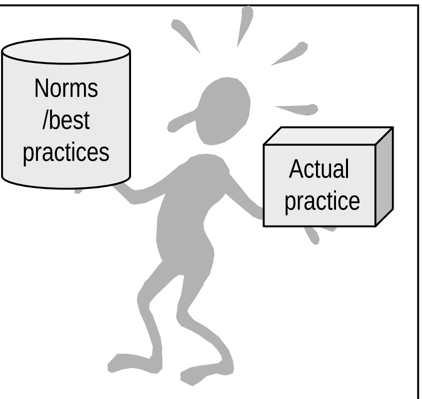
Based on payback, the company can then decide whether 4 years is an affordable option. NPV or IRR can also be used to detail out the analysis. A positive NPV and IRR greater than the cost of capital indicates a profitable situation.

4.18 Tools for GP

4.18.1 Benchmarking

Benchmarking

To compare operating practices with norms prevalent in the industry, the benchmarking tool could be used:



Internal i.e., between functions, departments or a similar organization as a means of improving performance;
Competitive i.e., comparison across industries within a given sector aimed at establishing best practice through identification of gaps in performance. This can be done on product, functional, departmental or on a company-wide basis.
Comparative i.e., across all business sectors aimed at establishing best practice in all areas of operation (*this type of benchmarking is restricted to common processes or technologies (sector non-specific) across business sectors)*

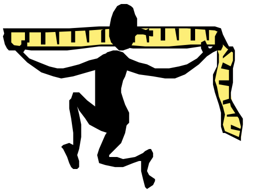
The benchmarking tool can be used to identify and fill gaps in performance by putting in place best practice, thereby establishing superior performance. It is used as part of total quality process when taking an independent look at performance by comparing it with that of others.

In the GP context, this tool introduces the idea of measurement, helps to focus on the mission and to identify measures and targets for important business processes. It is also the basis of continuous improvement.

Benchmarking can be used effectively for identifying problems and causes. The benchmarks normally assist in setting **objectives**.

Procedure for conducting benchmarking:
- Identify the functions / processes / parameters to be benchmarked;
- Decide the benchmark to be compared with based on research literature, other industries in the sector or competitors;
- Check for similarity of background conditions, for example the water consumption for a wool processing mill and a cotton textile plant will not be the same;
- Repeat procedure periodically based on the variability of the parameter due to technology improvement, performance efficiency etc. and changes in norms/ benchmarks.

Comparison with Norms to Identify Problem Areas



For knit fabric industry the following norms are used:

Energy consumption	70 MJ / Kg of fabric
Dye consumption	4 g/Kg of fabric
Water consumption	120 L/Kg of fabric

For many sectors, benchmarks have been developed for,

Resource Consumption
- Water
- Steam
- Electricity
- Fuel
- Raw materials

Production
- Capacity utilization
- Quality assurance and Right first time
- Labor deployed

Waste Generated
- Air emissions
- Wastewater effluents
- Solid / hazardous waste
- Noise levels

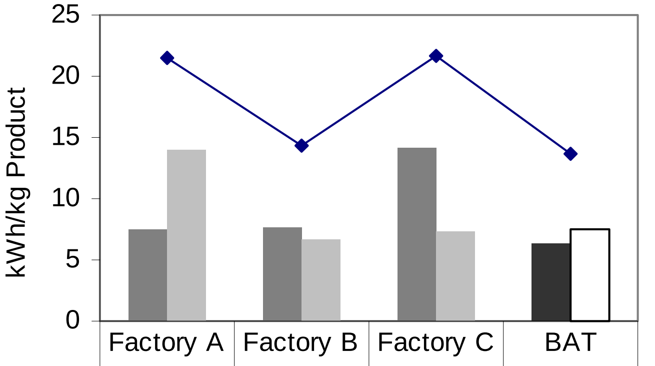
Benchmarks / norms for emissions in a typical cement manufacturing industry are listed below for the purpose of illustration shown above in the viewgraph.

Example

Dust	0.2 kg / ton of clinker
NOx	1.5 kg / ton of clinker (dry process)
	4.5 kg / ton of clinker (wet process)

4.18.3 Example of Benchmarking Energy Consumption

Benchmarking of Energy Consumption



	Factory A	Factory B	Factory C	BAT
Thermal Energy	7.5	7.7	14.2	6.3
Electrical Energy	14	6.7	7.4	7.5
Total Energy	21.5	14.4	21.6	13.7

This example presents a competitive benchmarking of energy consumption patterns for a particular process, observed in three textile factories situated in three different developing countries, and the observations are compared to the norms for the best available technology (BAT) for that process.

The observations in the benchmarking exercise:

- Factories A and C exceed energy consumption inherent in BAT by more than 80 per cent. In factory A, this is on account of excessive electricity consumption, most of which arises in the mercerizing, wet finishing and drying stages of the production process. *The resulting objective could be reduction of energy usage either through a change in technology and/or better housekeeping.*

- Factory C's consumption of thermal energy is almost double that of BAT mainly due to losses in steam generated for drying and wet processing.

Factories A and C need to set objectives addressing changes in technologies in their energy intensive stages of production and to move closer to best available technologies.

- Countries in which factories A and C operate also happen to be those where energy supplies are heavily subsidized. On the policy level, removal of price subsidies for energy in these countries is essential for better utilization of energy.

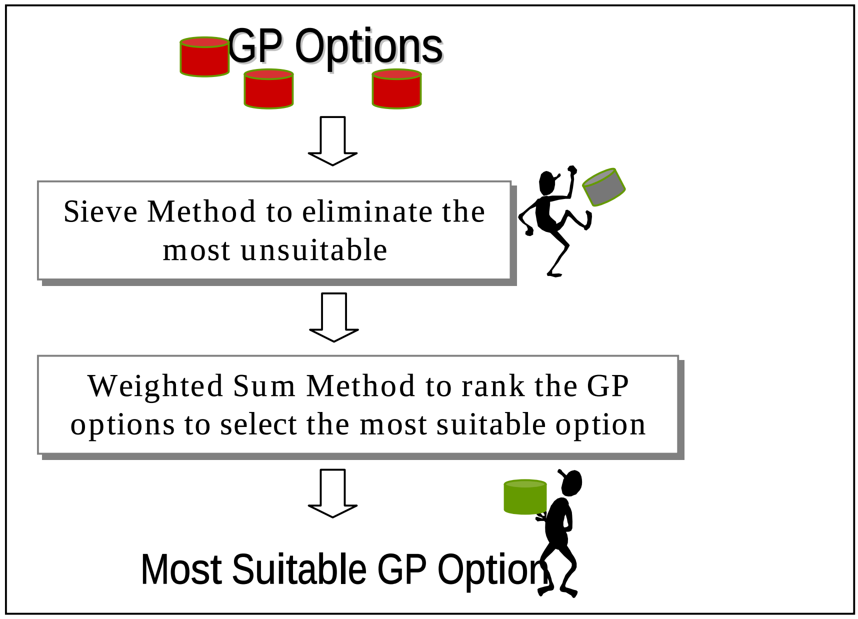
Example

Reference Look Up

Responding to Global Standards: A Framework for Assessing Social and Environmental Performance of Industries by R. Kumar and N. Gessese, UNIDO, 1998

4.19.1 Decision Matrix

Decision Matrix



Weighted Sum Method

Criteria	Criteria Weight	Stop overflow at winch machines Weight (product)	Countercu-rrent rinsing in dyeing Weight (product)	Change from hypochlorite to H_2O_2 bleaching Weight (product)	Introduce softflow dyeing machine in place of winch Weight (product)
Cost of action	10	5 (50)	7 (70)	8 (80)	5 (50)
Cost of Inaction	8	2 (16)	5 (40)	8 (64)	6 (48)
Time required	5	9 (45)	6 (30)	3 (15)	5 (25)
Risk	6	8 (48)	7 (42)	8 (48)	8 (48)
Benefits	8	5 (40)	9 (72)	6 (48)	10 (80)
Technology or complexity	4	4 (16)	6 (24)	6 (24)	8 (32)
TOTAL for options (products)	-	215 **Option 1**	278 **Option 2**	279 **Option 3**	283 **Option 4**

Scale 1-10 is used in the above example
1 indicates worst performance
10 indicates best performance

Option 4, which has the highest score is the Best option

The weighted sum method is an effective way to rank the available options according to their importance based on certain criteria.

In this method, the criteria are first ranked according to significance by giving weights. The options are then ranked by assigning weights for each criteria. The product of the criteria weight and the individual weight of an option for that criteria forms the score of that option. The scores of an option for each criteria are then added to get a total score. The total scores of all options are then compared and the option with the highest total score is selected as the most suitable option for the given criteria.

CHAPTER 5

Techniques for Green Productivity

S.No.	Contents	Page No.

Objective of the lecture

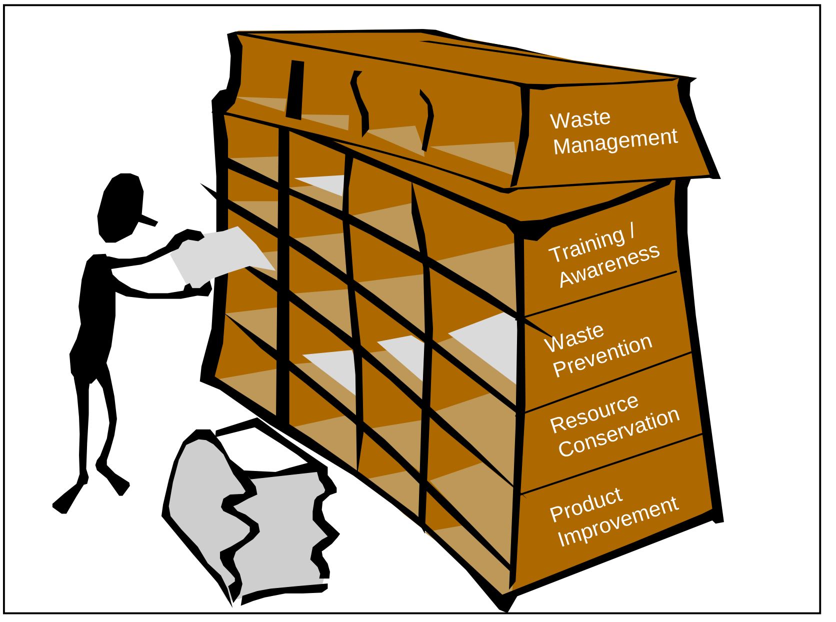
Implementation of the GP methodology requires integrating and applying various productivity and environmental management techniques.

The heart of the GP methodology is essentially identifying good options.

This lecture aims at introducing the participants to some of the potential techniques that could be used in GP. It attempts to explain GP techniques that provide ways and means to generate options.

5.1 Organization of the Techniques

Organization of the GP Techniques



Organization of the Techniques

The GP Techniques have been categorized as under:

Waste Prevention

1. Improved Operating Procedures
2. Waste Segregation
3. Good Housekeeping
4. 5S Program
5. 7 Wastes

Resource Conservation

Recycle , Reuse & Recovery

Off-site Recycling

On-site Recycling

Energy Conservation

Process Modification

Input Material Changes

Process / Equipment Changes

Pollution Control

Air Emission Control

Effluent Pollution Control

Solid Waste Management

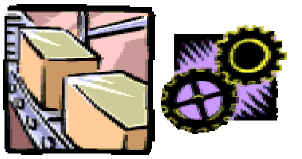
Product Improvement

Design for Environment

Productivity & Quality Improvement

5.2 Improved Operating Practices

Improved Operating Procedures



CHECK !

- Operating procedures and process specifications
- Scheduling Operations
- Equipment operation procedures
- Maintenance procedures
- Material and product handling and storage
- Safety considerations for staff
- Comparison with resource and energy consumption norms

Improved Operating Procedures

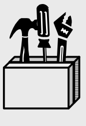
Procedural aspects of a manufacturing operation include the management, organizational, and personnel functions of production. Improved operating practices can be implemented in all areas -- production; maintenance; raw material, product, and waste handling; and storage. Because good operating practices can often be implemented at low cost, they usually have a high return on investment. Rational operating procedures should be employed.

Material Handling and Storage

All production facilities store raw materials, intermediates, products, and industrial wastes and transfer these items from one area of the plant to another. Proper material handling, transfer, and storage minimizes the possibility of spills, leaks, fire and/or explosion, or any other losses that could result in waste. Companies have strong economic incentives to handle and store materials properly.

Material and Energy Consumption

Industry and sector norms can be used to ensure that the consumption of resources and energy are within limits.



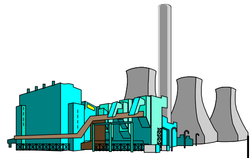
Benchmarking could be effectively used here to compare with norms in the industry sector so as to identify deviations. Walk-through exercise enables the team to observe and check the operating procedures in an industry.

Scheduling Operation

Batch production of a variety of products using common equipment plays an important role in generating wastes. Timing has a special significance in batch production operations, where the amount of waste from equipment cleanup waste is directly related to the cleaning frequency. To reduce cleaning frequency, batch sizes should be maximized or followed with a similar product, which may not require cleaning between batches. This action requires diligent managerial scheduling and planning, as it may affect inventories of raw materials, finished products, and shipping deliveries.

5.3 Improved Operating Practices - Example

Example of Improved Operating Procedures



Glycerin losses in process were high

High COD wastewater

↓

Improvement in Operating Procedure of Glycerin

↓

Increase in productivity by 32 per cent.
Daily glycerin yield increased by 5 per cent i.e., an additional 6 kilograms.
Reduced chemical oxygen demand (COD) of wastewater.

Example

Philipinas Kao Inc. manufactures chemicals and chemical products such as fatty alcohol methyl ester, refined glycerine, tertiary amines, alkanolamides and surfactants, monoalkyl phosphates.

The company identified that glycerine loss from the process contributed to high chemical oxygen demand (COD) of wastewater. Philipinas Kao's engineers, with the help of Japanese engineers, organized an evaluation team to analyze and evaluate the existing operating parameters of the glycerine process. This revealed a substantial deviation between the actual and design operating conditions of this process.

REFERENCE Look Up

United Nations Environment Program - Technology Industry & Economics (UNEP TIE) "International Cleaner Production Information Clearinghouse Web version, 1998".

Through constant monitoring, Philipinas Kao was able to optimize operating conditions of the glycerine process.

This led to an increase in productivity by reduction of glycerine loss by 32 per cent. Daily glycerine yield increased by 5 per cent, that is, an additional 6 kilograms.

Prevention of glycerine loss at the source reduced chemical oxygen demand (COD) of wastewater.

Economic benefits were as follows:

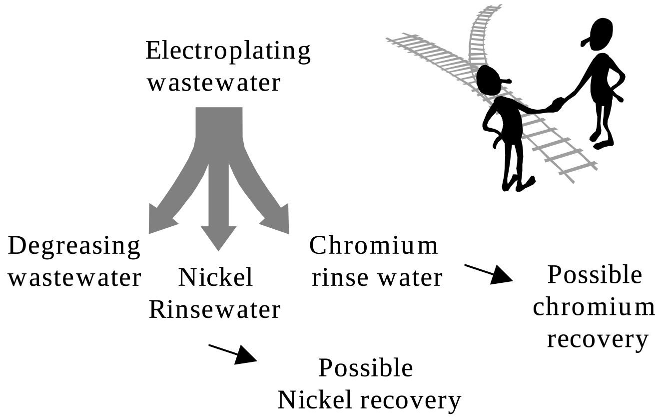
- Increased glycerine recovery generated P32, 000
- Savings on chemical treatment costs were P1 600000

5.4 Waste Stream Segregation

Waste Stream Segregation

Advantages of Waste Segregation

- Ease in end-of-pipe treatment of a non-compatible pollutant stream
- Increased possibility of recycling / reusing a waste stream



Waste segregation refers to the separation of waste streams according to points of generation, composition, volume or media as may be beneficial from the point of view of management, recyclability, treatment and disposal.

Segregation at the source can reduce the quantity of disposal of hazardous wastes. When a non-hazardous waste is mixed with hazardous waste, the entire mixture is classified as hazardous; not allowing hazardous and non-hazardous wastes to mix reduces the amount of hazardous waste disposal and yields substantial savings. Furthermore, isolating hazardous waste by contaminant (i.e., by segregating wastes) often reduces disposal requirements.

Incompatible hazardous waste types should not be mixed. For example, segregating spent solvents from metal parts cleaning and used motor oil fosters the reclamation of each.

Some Benefits of Waste Segregation

- Ease in end-of-pipe treatment of a non-compatible pollutant stream
- Increased possibility of recycling / reusing a waste stream

Difficulties in Segregating Waste

- More space requirements
- Higher capital and operating costs for waste transportation and storage

Normally, due to increased recyclability and better treatment / disposal, the benefits outweigh the initial investments incurred for segregating waste streams.

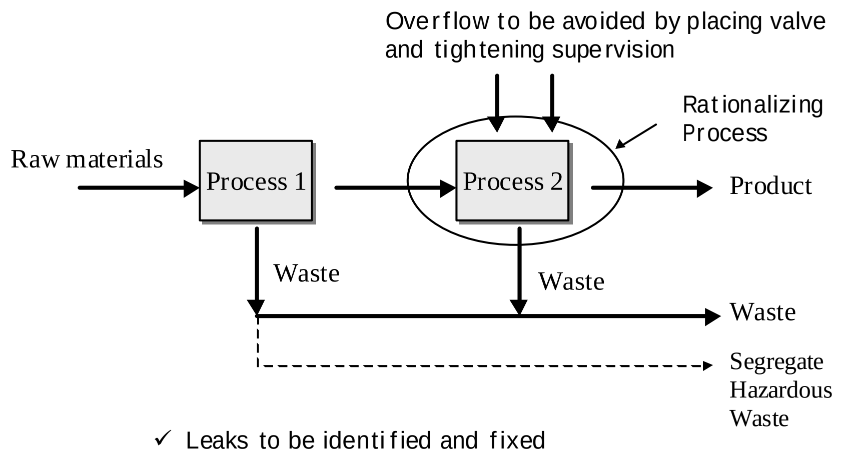
5.5 Good Housekeeping

An important statistic to consider:

50% of waste can be reduced by adopting 'Good Housekeeping ' practices and making small operational changes

Source: UNEP, France

Good Housekeeping



- ✓ Leaks to be identified and fixed
- ✓ Accidental spillage to be avoided
- ✓ Maintain up-to-date operating manuals and update records

Good housekeeping refers to a number of practical measures based on common sense that organizations can undertake to improve their productivity, obtain cost savings and reduce the environmental impact of their operations.

Good housekeeping is more of a *habit* than a technique.

Housekeeping is aimed at :

- Rationalizing the use of raw materials, water and energy inputs;
- Reducing the volume and / or toxicity of waste, wastewater and emissions related to production;
- Conserving material and energy;
- Improving working conditions and occupational safety.

The implementation of these good housekeeping practices is relatively easy and the cost is usually low. Thus, they can be readily implemented by SMEs.

'Good Housekeeping' practices can provide a real economic asset and advantage for a company in terms of minimising waste, as well as the use of raw materials and energy. Minimising waste can enable enterprises to reduce the loss of valuable material inputs and therefore reduce operational costs.

The example in the viewgraph presents the use of housekeeping techniques to minimize wastewater overflow.

REFERENCE Look Up

'Good Housekeeping' Guide GTZ - Pilot Programme for the Promotion of Environmental Management in the Private Sector of Developing Countries (P3U) Wachsbleiche 1, 53111 Bonn, Germany

Walk-through Eco-mapping

The 5S Technique

- Seiri - Sorting
- Seiton - Arranging
- Seiso – Cleaning and Inspecting
- Seiketsu – Improving and Standardizing
- Shitsuke - Self-Discipline

The 5S are a set of management techniques that focus on maintaining processes, equipment, workplaces and people the way they should be.

Seiri
In general terms, this means sorting out what is necessary and disposing of those that are unnecessary.

Seiton
Seiton means arranging the necessary things in a systematic manner. This means having things in the right places or the right layout so that they can be used in a hurry. It is a way of eliminating searches.

Seiso
This means cleaning and inspection. This step ensures that things can be kept clean and in good functional order when required.

Seiketsu
Seiketsu means improvement and standardization. This process is continually repeated until the required standard is achieved.

Shitsuke
Shitsuke means self-discipline and doing what had been decided as a habit. By teaching everyone what needs to be done and having everyone practice, bad habits are broken and good habits are formed.

REFERENCE Look Up

The 5S's, Five keys to Total Quality Environment
Takashi Osada,
Asian Productivity Organization,
1991

7 Wastes

- **Waiting** — Leaving resources waiting during production
- **Transporting** — Moving materials unnecessarily in the factory
- **Processing** — Wastes inherent in the process or design itself
- **Inventory** — Keeping high inventory or work-in-process (WIP)
- **Motions** — Unnecessary movements of the worker during operation
- **Defects** — Producing defective parts or poor service
- **Overproduction** — Produce more than what is needed

Tips

The 7 wastes can be used as a guide when identifing areas for improvement.

We often think of waste as physical things like materials, water, electricity, etc. However, in the context of productivity, waste is defined as any form of work which does not add value to the final output. In the famous **Toyota Production System**, waste has been defined as 7 Wastes to include things like excessive stocks, waiting, movement or transport.

Waiting

This is one form of waste that is very familiar to us. We encounter it everywhere. For example;

- Waiting for a machine that has broken down;
- Delay in arrival of materials;.
- Somebody is late for meeting

The causes of such waste are often bad planning, bad organization, lack of proper training, lack of control and sometimes laziness and lack of discipline.

Transporting

This is another common form of waste; transporting or moving things from one place to another. This does not add to the value of the product. Hence, it should be eliminated or reduced as far as possible. There are two aspects to be considered.

- Eliminate the need for transport by better layout;
- Improve the method of transport by using materials handling equipment.

contd...

7 Wastes

Processing

These are wastes inherent in the process or design itself. For example:

- An electronic type-writer has much less parts and processes than a mechanical type-writer.
- Replacing a metal dust-bin with a plastic one can reduce several steps in the production process.
- Using pre-printed forms can save a lot of paper work.

Inventory

When excessive inventory is carried, it ties up valuable financial resources and may deteriorate over time. It also takes up space in the factory.

Motions

All physical work can be broken down into basic motions. Motion Study is one aspect of Industrial Engineering that assists us to reduce wasted motions. Usually this is done by improving the workplace layout, practicing good housekeeping and workplace organization, and introducing jigs and fixtures and low cost automation.

Defects

Waste caused by producing bad quality products and defective parts or poor service is another common form of waste. Time is often spent to rework bad products or addressing customer complaints. Space is wasted to store them. Last minute urgent requirements may disrupt our systems and cause delays in delivery to our customers. Sometimes bad quality can even cause accidents.

Overproduction

Very often in manufacturing, we produce more than what we actually need. The unused products may have to be discarded when not required at a later stage. This is very costly. Over-production is caused by poor planning, poor forecasting, producing too early and lack of quality control.

Preventive and Productive Maintenance

The Preventive Maintenance comprises of the following active items:

- Cleaning
- Lubrication
- Inspection of protective coating
- Replacement of parts & overhauls

Design of a Cost Effective Maintenance System:

These are the following steps in designing a cost-effective maintenance system:

- ➔ Classification and identification of equipment
- ➔ Collection of information
- ➔ Selection of maintenance policies
- ➔ Preparation of preventive maintenance program
- ➔ Preparation of corrective maintenance guidelines
- ➔ Organizing for maintenance

In the changing times, as more and more industries are going for hi-tech capital intensive and complex equipment, maintenance system has a major role to play in the organization. The objective of maintenance is to achieve the desired plant availability at an optimum cost. As the machinery becomes older, the maintenance becomes essential and requires a comprehensive program for preventive maintenance.

The plant or equipment availability depends on the following factors:

Reliability
Down time due to

- Off-line preventive maintenance
- Corrective maintenance
- Non-availability of resource
- Non-availability of information

Reliability of the equipment essentially depends on the extent of preventive maintenance and the design. Improvement in preventive maintenance practices and development of a suitable preventive, maintenance plan is vital for improving the reliability of the equipment.
The preventive maintenance comprises the following active items:

Cleaning
Lubrication
Inspection of protective coating
Replacement of parts & overhauls

Productive Maintenance

Maintenance techniques and systems over the last two decades have witnessed significant developments and have progressively changed from the concept of breakdown maintenance to that of Fixed Time (Periodic) Preventive Maintenance, Condition Based Maintenance, Corrective Maintenance, Predictive Maintenance and Reliability Engineered Maintenance. Though each of these maintenance systems is quite powerful by itself, its singular application has failed to produce desired results in industries.

In fact, the better strategy would be to integrate these different techniques and systems and make their application as per the given situation and requirement to improve overall maintenance effectiveness and thus derive best economic advantage and productive improvement.

Proper maintenance of equipment is indispensable to ensure its higher operational availability for higher output and productivity. Thus, scientific maintenance, an important requirement of equipment for maximizing its uptime, cannot be viewed in isolation from other related management techniques and systems. This necessitates integration of various functional disciplines and Productive Maintenance (PM) Concept is the result of such integration of maintenance with production to achieve higher productivity.

The concept of Productive Maintenance as a means to improve productivity was first mooted at General Electric of the U.S. in 1954. This idea found wide application in Japanese industries, where the scope of PM was further broadened taking into account life cycle performance and costing. PM ushered a positive meaning in Maintenance Culture and widened the frontiers for all concerned.

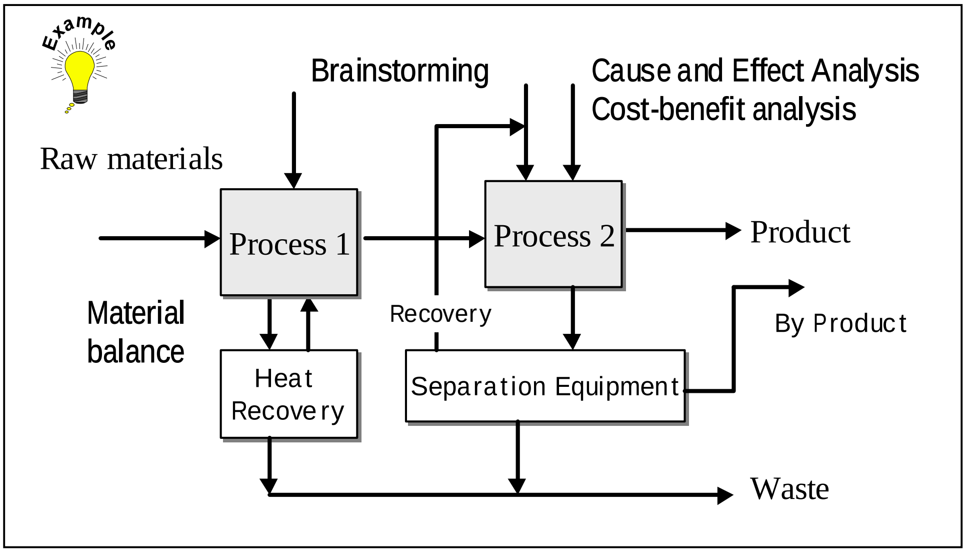
Design of a Cost Effective Maintenance System

These are the steps to designing a cost-effective maintenance system:

- Classification and identification of equipment
- Collection of information
- Selection of maintenance policies
- Preparation of preventive maintenance program
- Preparation of corrective maintenance guidelines
- Organizing for maintenance
  - -Resource structure
  - -Administrative structure
  - -Work planning and scheduling system

The classification and identification of equipment is the first step for successful implementation of the maintenance system. All equipment should be classified and codified to enable keeping of the maintenance records, instruction manuals, drawings, cost data, down time data, etc., and it will aid computerization and control.

Recycle, Reuse and Recovery



Recycle refers to recycling materials and energy within the process.

Reuse involves selling materials or waste to external dealers i.e. off-site or on-site, where the material or waste is reprocessed / recovered and reused within the industry.

Recovery is the process of reclaiming valuable resources from wastes in the form of raw materials, by-products / products. Recovery normally is the preceding activity to recycle or reuse.

However, recycling and reuse options can incur somewhat increased risk and liability due to threats to product quality risks.

Recycle Within the Industry (on-site)
Waste generated in a manufacturing process in many cases can be recycled to the original process with or without treatment to remove impurities. For example, material containers can be reconditioned and re-used with minimal efforts. If waste cannot be directly reused in the original process because of potential contamination, it may be treated to remove contaminants. For example, organic solvents used in parts cleaning and pharmaceutical manufacturing processes are often collected, distilled, and recycled to the original process. Sometimes if the impurities in the material are high it may not be recycled in the original process but used in a secondary process (e.g. water in washing, used solvents in degreasing)

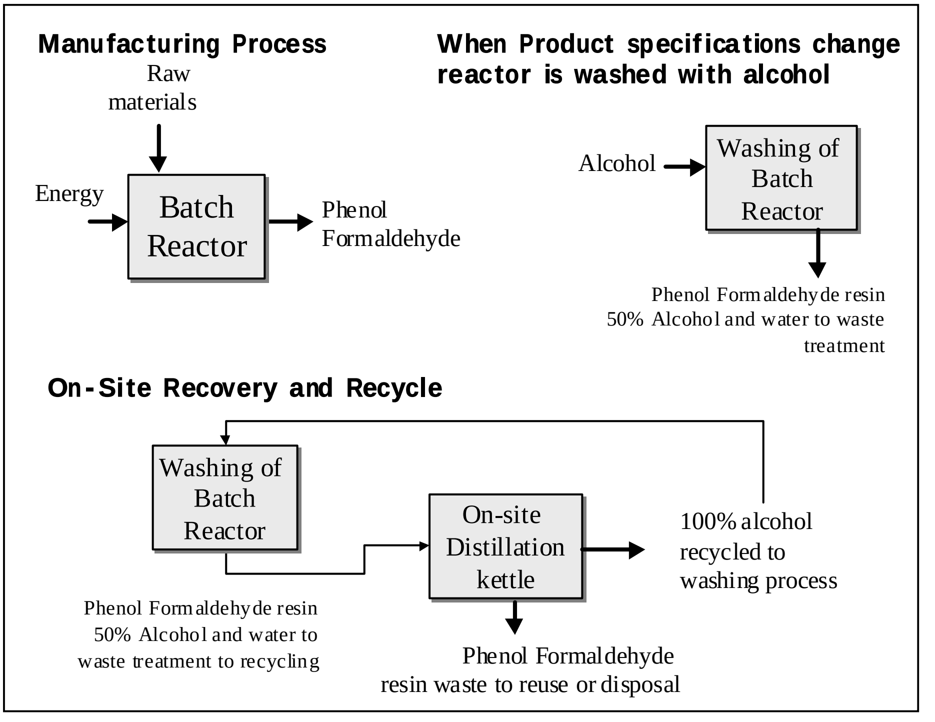
Recycle Outside the Industry (off-site)
This refers to recycle options which send material to external users. The waste that is not of any use on site is sold off to other industries / users for whom this waste could be an process input.

Tips

It may not always be feasible or economical to recover waste at the operating unit that generates it. If a plant has a number of different departments and processes generating waste solvents, a central distilling department within the plant may offer economic advantages. A single recovery operation may be less expensive from both a capital and operating labor standpoint. The disadvantages of this type of operation are the additional storage, segregation, and handling requirements, all of which increase the possibility of environmental risks and liability. The overall economics of centralizing a recovery operation must be assessed on a case-by-case basis.

Material / Energy Balance would identify the resources, that are wasted and should be recovered. Other tools that can be of use in deciding on how to recycle / recover /reuse are Cause-Effect analysis (Ishikawa), Cost-benefit analysis

On-site Recovery and Recycle



Cost assignment to waste streams conducted in the planning step identifies and prioritizes resources wasted according to their worth. On-site recovery and recycling is practiced by industries to recover these valuable resources to be reused in the process or sold. On-site recycling is employed when the resource can be easily segregated, it has a substantial reuse value to the industry or a external market and when there are no risks involved to the industry in recovery process.

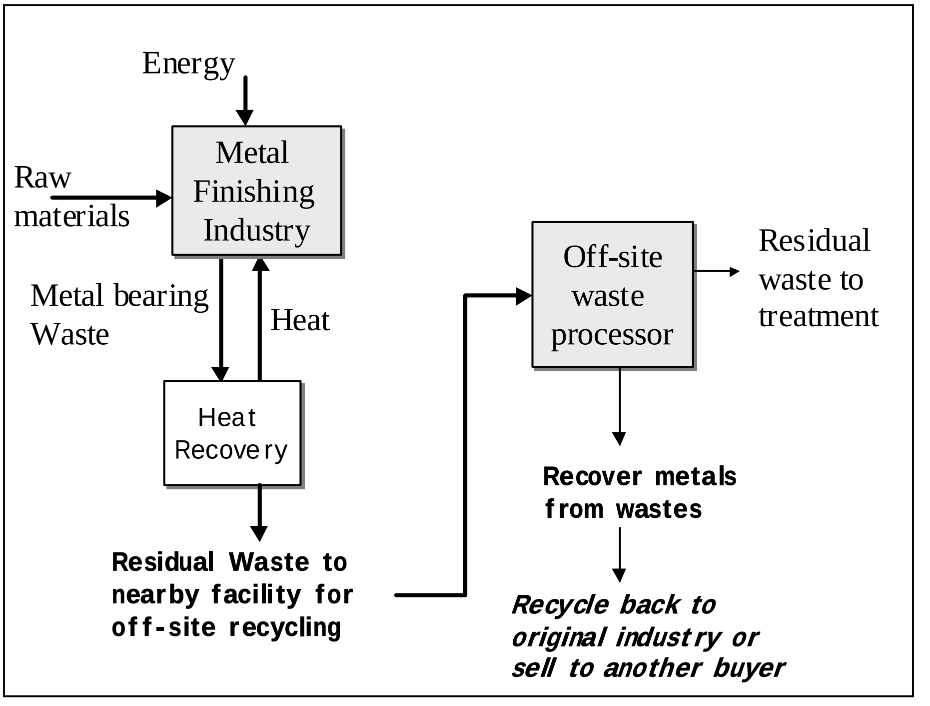
On-site Recycle and Reuse in a Chemical Industry

In this plant, Phenol formaldehyde is manufactured in batch reactors. The reactors are cleaned with alcohol every time a change is made in product specifications. The plant generated 6,000 gal / year of reactor wash solution containing approximately 50% alcohol, phenol formaldehyde resin, and water. Economic considerations prompted the plant to recycle on-site by distilling and reusing the alcohol. A distillation kettle was already available on site. Steam was available at negligible costs. The resin removed from the reactor could also be reused.

More than 67% reduction of waste generated was possible. Liabilities were reduced due to reduction of the quantity of hazardous waste generated and $15,000 annual savings in material and treatment costs were achieved.

International Cleaner Production Information Clearinghouse (ICPIC DV 3.0) UNEP, Paris France 1997

Off-site Recovery and Recycling



On-site recovery options are normally attempted first by the industries so as to recover valuable material from waste and save costs. But if such on-site reuse options are not feasible, then the next step is to investigate off-site recovery & recycling and save on treatment and disposal costs. The recycled material could be either returned to the generator for reuse at the generation site, or sold for use at other facilities. Material exchanges, waste exchangres, waste brokers, commercial recyclers or co-operative agreements can assist in mnatching the generators and potential end-users.

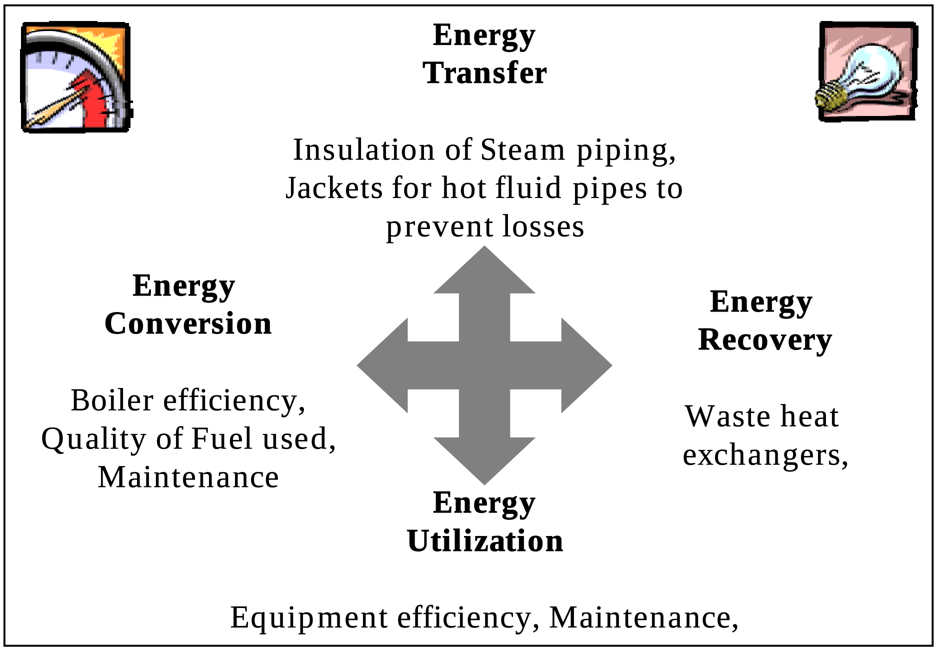
Example

The example in the above viewgraph presents a case of off-site recycling where a metal finishing industry sends its metal bearing wastewater to a recovery firm which extracts valuable metals from the waste and disposes the residual wastes.
The recovered metal can either be sold to the original generator or could be sold to other buyers.

5.7 Resource Conservation

5.7.2 Energy Conservation

Energy Conservation



Energy conservation at a facility or process is possible at three points:

Energy Conversion – Here, the focus is on the energy conversion efficiency of the units such as industrial boilers, power reactors, etc., that convert fuel to steam, or fuel to electricity.

Energy Transfer - When energy is transferred from the point where it is generated to the point where it is used, there could be losses. The energy transfer efficiency of the energy conduits and steam piping can contribute significantly to reduce losses in energy transfer.

Energy Utilization - This refers to the actual end usage of energy in a process. Here, the individual equipment efficiency in terms of unit product output per energy utilized comes into the picture.

Energy Recovery - Energy can be effectively recovered and recycled back to the processes. Sometimes, hot effluents are discharged to the treatment plants. If heat exchangers are employed to draw the excess heat in the effluent, it can be used back in the process. Sometimes, the material in a waste or by-product which is disposed off, could have a high calorific value. This component could be used as secondary fuel.

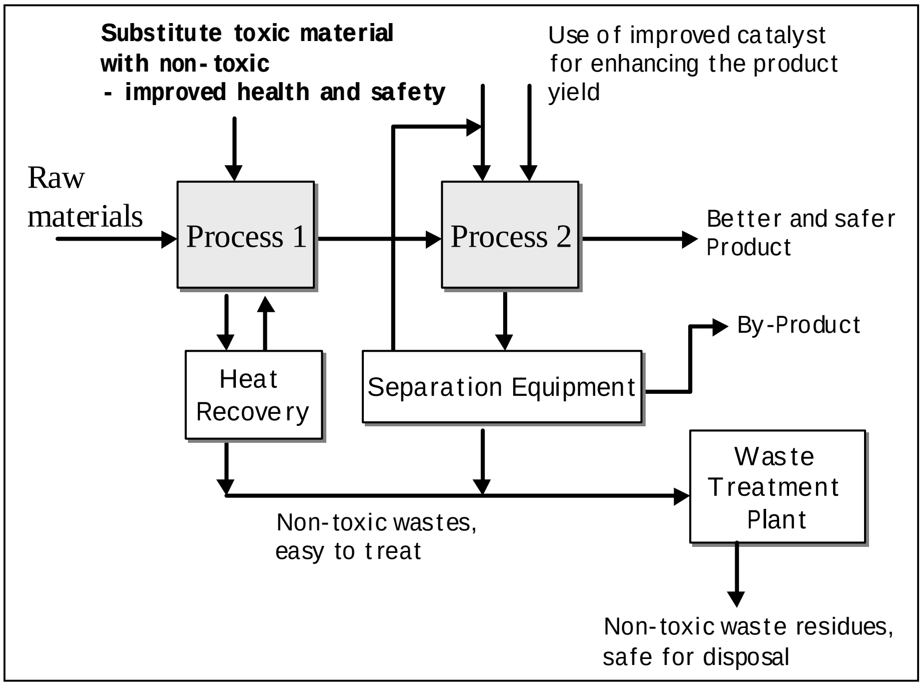
Tips

Electricity
- Efficient and optimal use
- Use appliances consuming lesser electricity
- Reduce transmission losses

Process Heat
- Select environmentally friendly fuel
- Use fuel optimally
- Reuse / recycle heat wherever possible
- Reduce transmission losses

5.8 Input Material Changes

Input Material Changes



Example

Input material changes could be described as the substitution of existing material inputs to a process, by materials that are environmentally friendlier, without adversely affecting the product quality.

Environmentally friendlier materials are those,

- that are less toxic to the environment
- that can be easily treated
- that make the working place safer
- that are more efficient, i.e., less energy intensive

Input material changes fall into two major categories:

- for reducing and eliminating hazardous process residues
- for enhancing the process conversion efficiency

Under material substitution, for example, water-soluble cleaning agents can be used, in many cases, in place of organic solvents that may have to be disposed of as hazardous wastes or recycled off-site after they are used.

Benchmarking

Higher purity raw materials may be used to reduce the quantity of wastes generated. For example, using an organic liquid or acid that is relatively free of metals or other impurities may reduce waste typically generated due to reaction or non-reaction of these substances. Another example could be using coal with lower percentage of sulphur, in the industrial boilers, so that SO_2 emissions of the boiler are minimized.

Certain input materials may be more effective in reaction or catalytic actions on the process and hence would increase the process efficiency.

Examples of Input Material Changes

Dunalakk Paint Producing and Servicing Ltd., Hungary

Industry sector: Paint manufacture

Size: SME

Push Factor: Pressure from the Western European market, stricter legislation, community pressure, worker health and safety.

Measures: replacing solvent-based paints in its product range with solvent-free, water-soluble or aqueous dispersion paints; reusing paint wastes generated during application through use of air filters.

Productivity benefits: Improved working conditions; increased sales; improved market position; improved community image; superior product quality.

Economic benefits: Investment of HUF 50-60 million and 10 to 30% higher costs for eco-friendly product development. Turnover increased from HUF 830 million in 1994 to HUF 1,300 million in 1995 and exports from HUF 16 million to HUF 80 million.

Environmental benefits: Waste recovery and reuse, regulatory compliance and improved worker health and safety.

REFERENCE Look Up

http://www.inem.org. This case study was provided by KOVET (INEM Hungary) for inclusion in the INEM Casebook, Case Studies in Environmental Management in Small and Medium-Sized Enterprises.

Dunalakk Paint Producing & Servicing Ltd., Budapest, Hungary.

The company was under pressure from the requirements of the Western European market and the introduction of stricter environmental legislation in 1995. Initially, one of the main factors causing the company to consider the development of environmentally sound products was the fact that the factory, which had once been on the outskirts of Budapest, was now surrounded by the city and a residential area. So in addition to dealing with new environmental legislation (lower emission limits, etc.) on the national level, it was also being put under pressure by the local community and authorities concerning its environmental impact.

The implementation of environmentally sound practices was further perceived by Dunalakk as an opportunity **to improve health and safety conditions for its employees**. Without consideration of Western European standards and legislative developments in this market, Dunalakk also realized that its products would be in a weaker competitive position.

As early as 1972, Dunalakk's management realized that powder coating paints, which they had first produced in 1968, could become the most significant future coating material. These powder coatings produce no chemical emissions during application. In 1972, Dunalakk bought the production process patent from the first powder coatings producer in the world in, Liber, Belgium.

Since 1976, the Dunalakk plant has produced powder coatings as an independent product line. Dunalakk decided to develop further environmentally sound painting products for its product range, such as solvent-free two-component paints, water-soluble and aqueous dispersion paints.

contd...

5.8 Input Material Changes

5.8.1 Example

Dunalakk outlined several areas that needed to be dealt with in order to develop an environmentally sound product strategy. These areas are as follows:

- minimization of manufacturing process emissions;
- reduction in the use of hazardous raw materials;
- reduction of chemical emissions during paint application;
- minimization of the fire and safety hazards associated with certain raw material usage, accompanied by improvement or preservation of product quality;
- reduction of hazardous wastes produced during paint application.

Alternatives for replacing solvent-based paints in its product range were explored. The main objective was development of solvent-free, water-soluble or aqueous dispersion paints.

In 1996, the company's solvent-based concrete enamel was replaced by an aqueous dispersion-based paint, Naofix, a paint that can be used for concrete and asbestos slate.

The company has also developed technologies for reusing paint wastes resulting from the application process.

During application of powder coatings, the use of air filters facilitates collection and reuse of six per cent of the material used, which is normally incinerated. The recovered material is reprocessed in a special mixtruder. *Use of the air filters improved health and safety at the workplace.*

Dunalakk also advises the companies to whom it provides paint application technology on the recovery alternatives available.

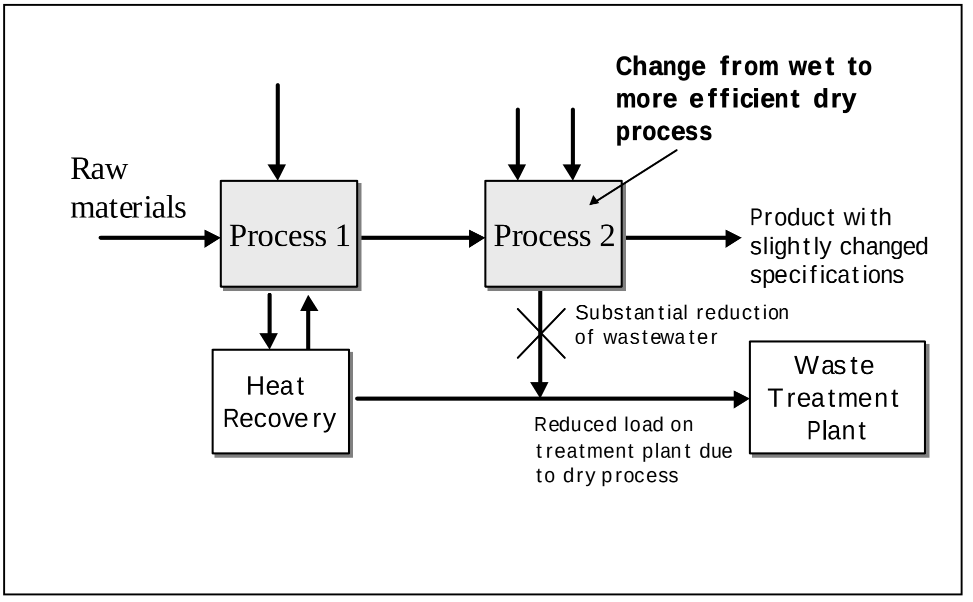
Installation of special mixtruder required investment of HUF 50-60 million. In addition, the development of environmentally sound products has involved 10 to 30 per cent higher costs than those associated with the development of more traditional products.

In 1994, turnover was HUF 830 million, and the value of exports was HUF 16 million. In 1995, turnover increased to HUF 1,300 million, and exports to HUF 80 million.

The company estimated that between 50 and 60 tonnes of paint waste is collected for reuse per year. The payback period on this investment was about four to five years.

5.9 Process/ Equipment Changes

Process / Equipment Changes



Modifying a process to reduce waste means developing an alternate process to obtain the same or better product specification, while generating less waste.

Replacing inefficient or old processes with newer technology can often reduce waste.

Reactor design changes can also significantly reduce waste by providing proper mixing and catalyst and reactant contact, minimizing temperature and concentration gradients, and optimizing procedures for reactant addition and temperature profiles.

The illustration in the above viewgraph presents the use of process modification such as changeover from wet process to dry process, thereby reducing wastewater generated as well as processing time.

Tools such as failure mode effect analysis could be effectively used while making process changes, for example to assess the product quality risks involved.

Failure Mode Effect Analysis can be used to investigate the failure modes of a proposed process modification and corrective actions can be planned

Example of Process/Equipment Change

Print Works, Massachusetts, USA

Industry: Textile printing and finishing **Size:** Medium Scale **Push Factor:** Inferior product quality and health and safety concerns for the workers. **Measures:** Modification of the acid ageing process during dyeing using azoic dyes. Control charting used to identify and implement minimization of usage of toxic substances like acetic acid during dyeing. **Productivity Benefits:** Product quality improved extensively; Improved worker health and safety. **Economic Benefits:** Reduction of acetic acid procurement costs by over $33,280 annually. Total savings in chemical costs approx. $78,520 while wastewater treatment costs have been saved by $200,000.

Print Works in Massachusetts, USA

This is a case where productivity is the driving force and productivity tools were used in problem diagnosis and rectification.

Azoic dyes were being used at the plant for dyeing. Acetic acid is being employed in the process. Acetic acid was being manually fed into the process. This led to variability in the process conditions affecting product quality. Moreover, being a toxic substance, it had health and safety implications on the workers, too.

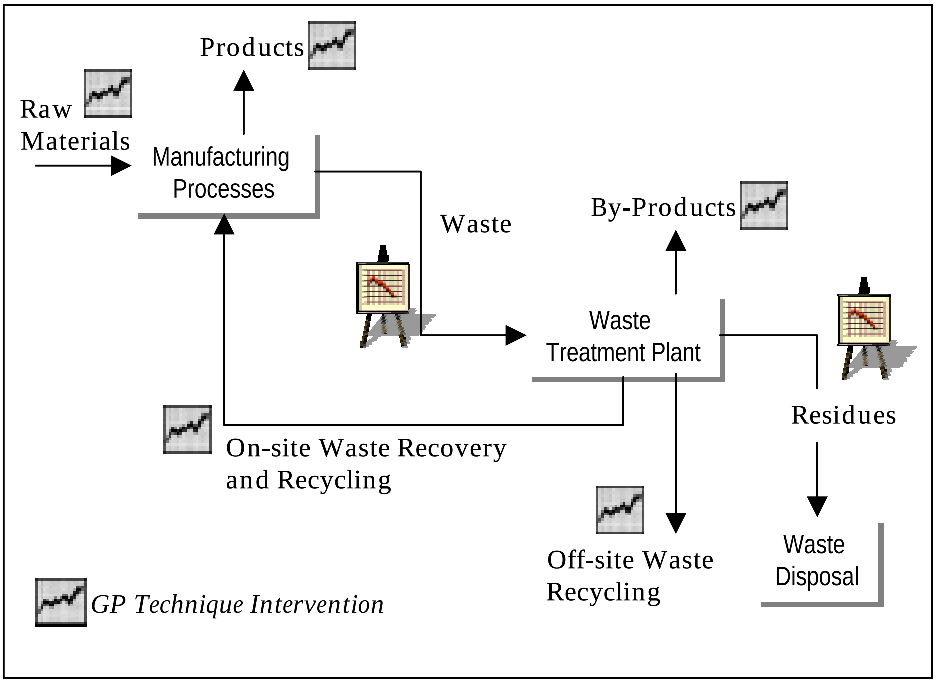
A multi-disciplinary team applying the Deming Quality Process adopted control charting for processes throughout the plant with the intention of minimizing use of toxic substances while improving product quality.

Using control charting, the management identified and implemented a set of measures involving modification of the acid aging process to minimize environmental impacts and generate economic benefits for the company.

Process improvements resulting from control charting have reduced annual acetic acid usage by over 128,000 pounds. The quality of the product improved extensively and it has dramatically reduced worker exposure to acetic acid.
Acetic acid procurement costs have reduced by over $33,280 annually. Total savings in chemical costs have been approximately $78,520 while treatment costs have been saved by $200,000.

5.10 Pollution Control

Pollution Control



The waste treatment facilities for air,effluent and solid waste should also be treated like manufacturing processes.

Wastes from manufacturing processes become inputs to these facilities whereas treated wastes are the products. If the conversion process is inefficient off-spec product would be produced. That is, the treated waste, would not comply with environmental standards, and would have to be further treated.

Manufacturing processes do not have a 100% conversion efficiency. Consequently, some waste in the form of air emissions, effluents, solid wastes and heat releases is generated. GP techniques described in this lecture attempt to improve on the conversion efficiency and reduce generation of wastes.

The wastes need to be treated and disposed in a scientific manner abiding the applicable environmental legislation. This task is achieved by setting of waste treatment and disposal facilities, either on-site or off-site. Waste treatment facilities also do not have a 100% conversion efficiency and residues & rejects get generated in the process of treatment. These residues can be minimized once again by following some of the GP techniques.

The waste management / treatment typically includes:

Air emission control for:

- Stack emissions
- Fumes/odors at the workspace

Effluent treatment plant for:

- Industrial effluents
- Domestic / sanitary wastewater (cooling water)

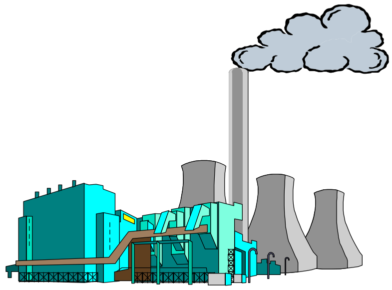
Solid waste management for:

- Industrial solid wastes (hazardous and non-hazardous)
- Effluent treatment plant solid / sludge residues

5.10 Pollution Control

5.10.1 Air Emission Control

Air Emission Control



Particulates
Gaseous pollutants

- Industrial Boiler emissions
- Acid Bath Fumes
- Chemical Odours

Techniques for Air Emission Control

- Gravitational settlers
- Cyclonic collectors
- Bag filters
- Wet scrubbers
- Electrostatic precipitators
- Adsorption towers
- Adsorption columns

Tips

The air pollution control equipment and devices mentioned on this slide are not a complete treatment system in themselves.

Residues would be left in the wastewater (liquids from wet scrubbers) or solid waste (particulate from filters) forms for which again proper residual treatment and disposal needs to be adopted.

Industry contributes to air emissions in several ways:

All combustion reactions generate emissions containing unburnt carbon and its compounds such as CO, CO2, etc., gaseous compounds arising due to impurities (e.g. sulphur in coal forms SO2).

These combustion reactions occur in the industrial boilers or process furnaces.

Fumes and odor from the reaction and storage tanks and piping systems are other sources of fugitive emissions.

Some of the Primary Air Pollutants of Concern Are:
Carbon monoxide, oxides of nitrogen, hydrogen sulphide, methyl and ethyl mercaptans, hydrogen fluoride, etc.

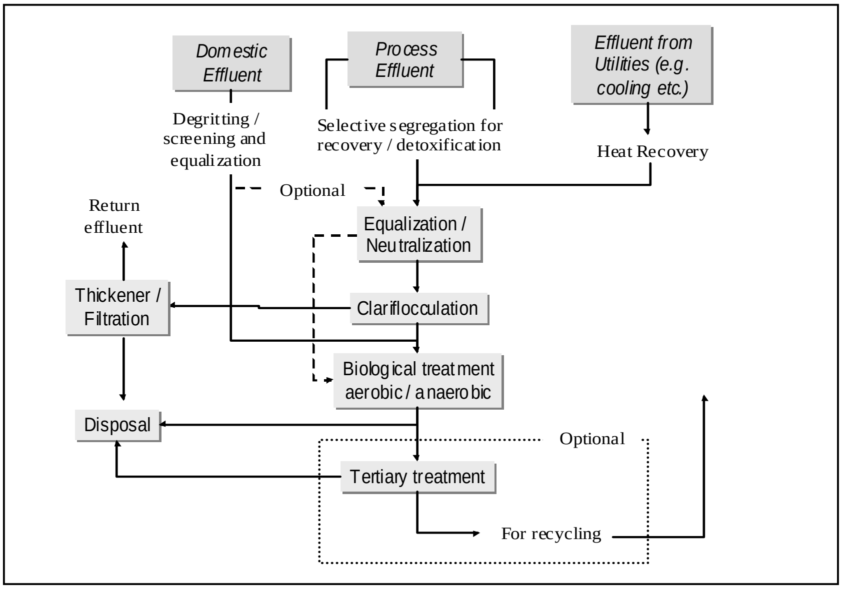
Devices That Control Particulate Matter Are:
- Gravitational settlers
- Cyclonic collectors
- Bag filters
- Electrostatic precipitators
- Fabric filters

Devices That Control Gaseous Pollutants Are:
- Adsorption equipment using adsorbents like activated carbon, alumina, bauxite etc.
- Absorption units like spray towers, plate or tray towers, packed towers and venturi scrubbers
- Condensors using surface and contact condensors
- Combustion equipment using direct flame or thermal or catalytic combustion

5.10 Pollution Control

5.10.2 Wastewater management

Wastewater Management



Design of the treatment plant should be robust yet economical. It should achieve and maintain the desired treatment efficiency and most important of all comply with the outlet regulatory standards.

Residues of the wastewater treatment would be in the form of sludge and dried cakes of settled matter. These residues need to channeled to the proper solid waste management and disposal system

Any industry generates three kinds of effluents. One is the domestic effluent (this would include wastewaters from the offices, administrative blocks and canteens). Second is the industrial process effluent. Third is the effluent released from cooling water operations and washings. The pollutant loads in these streams are such that they cannot be discharged without treatment. Different techniques are employed to treat these wastewaters.

It would be beneficial if effluent streams were segregated prior to treatment, according to the treatment required, flows, and concentrations so as to facilitate handling, treatment, recovery, reuse and disposal.

Domestic effluent is mostly highly organic in nature with little or no inorganics or heavy metals. For this wastewater, mainly biological treatment (with some essential unit operations such as screening, grit removal etc.) alone is used to reduce the organic load. Sometimes domestic and process effluents are blended to increase the treatability.

The industrial effluent contains several contaminants of varying nature and concentrations and is the most difficult to treat. Industrial effluents are typically characterized by high Chemical Oxygen Demand / Biochemicalk Oxygen Demand, heavy metals, toxic chemicals, inorganics etc. Many techniques need to be applied in the proper sequence and with adequate control to achieve the desired outlet effluent standards.

Most of the treatment technologies require a uniform flow pattern for effective treatment and hence the various flows from the industry need to be equalized first. Process effluent is acidic or alkaline in nature and needs to be neutralized. Further, depending on the amount of organics, anaerobic treatment might be necessary before aerobic biological treatment to bring down the BOD. Heavy metal streams on the other hand are segregated, oxidized / reduced before blending with the rest of the industrial effluent.

If high volatile organics are present in the effluent, then it might be economical to recover or separate these by stripping / extraction and recycled to the same process or other secondary uses. The effluents are sometimes treated at tertiary level if it merits recycling either on-site or off-site.

Example of Wastewater Management

Peter Paul Philippines Corporation, Philippines

Industry sector: Food Processing (dessicated coconut production)

Size: Medium scale

Push Factor: Serious environmental non- compliance due to very high levels of Biological and Chemical Oxygen Demand (BOD and COD).

Measures: Utilization of 80,000 liters of wasted coconut water through a recovery process to produce a commercial drink; improvement of operational practices.

Productivity benefits: Profitability due to new by-product; Increase in production of dessicated coconut.

Economic benefits: Annual savings of US $ 370,000 due to increased production; treatment cost savings of US $ 3700 per year.

Environmental benefits: Regulatory compliance possible due to reduction in effluent BOD by 50%.

Example

Peter Paul Philippines Corporation, Philippines

This project was carried out under the Industrial Environmental Management Project (IEMP) of the Philippines.

This case is an illustration of how waste can be utilized as a resource to generate revenue as well as improve environmental performance.

Waste coconut water generated from the production of dessicated coconut had high BOD and COD levels.

Collaboration with a Chinese company resulted in the recovery of the coconut water which was collected from Peter Paul Philippines Corp. and channeled to the Chinese company's plant for processing and freezing. It was sent to Taiwan for sale as a commercial drink.
Breakers were installed to improve coconut water collection.

Operating practices such as paring of coconut were improved. Incentives were provided to workers in the form of payment for each full pared coconut resulting in improvement of quality of dessicated coconut.

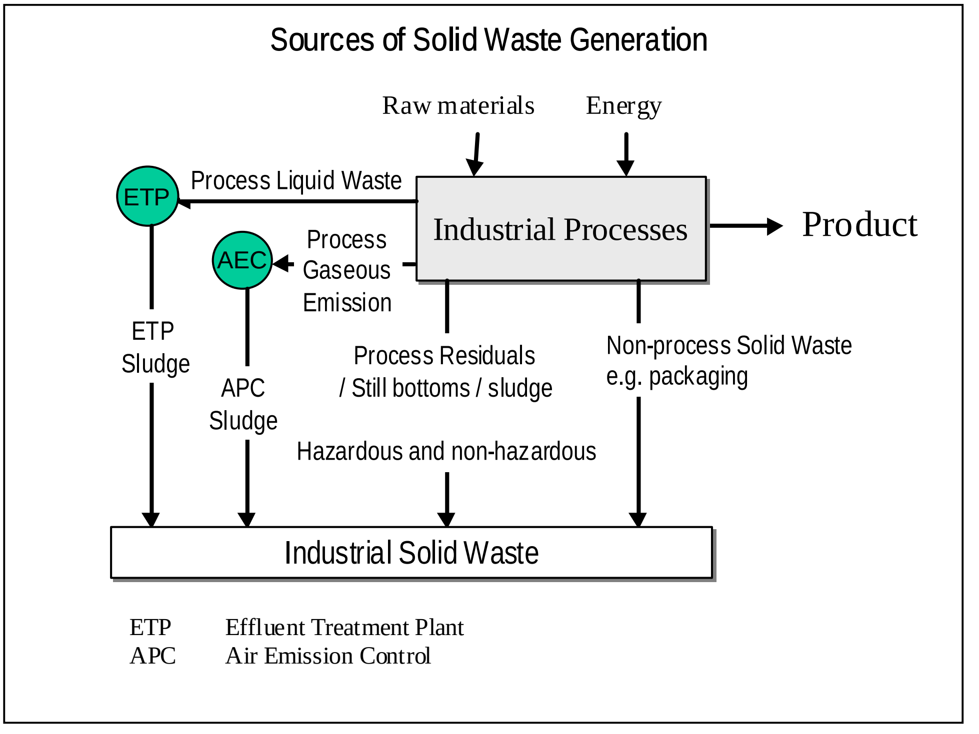
Production of dessicated coconut increased by 13.6 kg / ton of coconut processed. This led to annual savings of US$ 370,000.

The main environmental benefit is the reduction in BOD level by 50%. This reduced the annual operating cost of the wastewater treatment plant and thus the treatment cost is reduced by $3700 per year.

5.10 Pollution Control

5.10.3 Solid Waste Management

Solid Waste Management

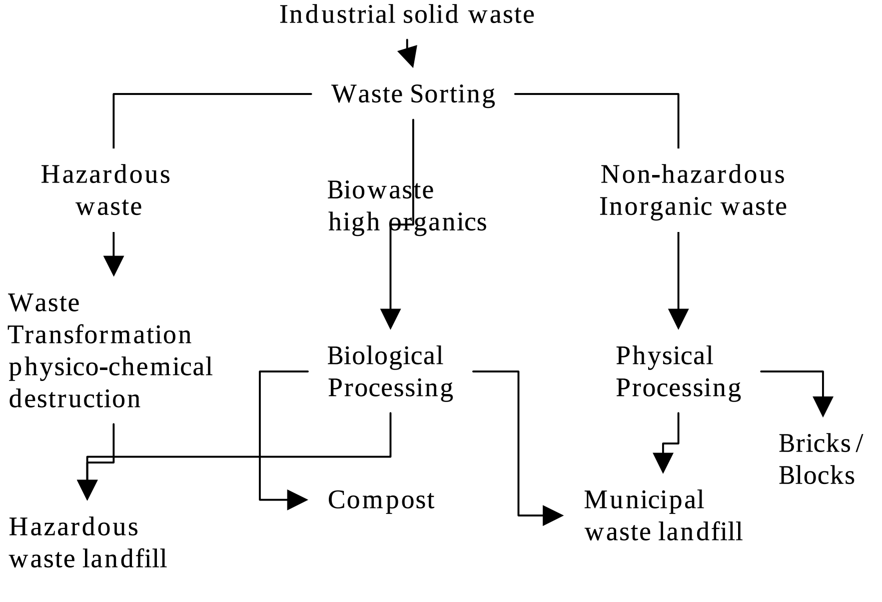


Various sources of solid waste generation at an industrial facility are shown in the viewgraph.

The major components are:

- Residual solid wastes / sludge from effluent treatment plant (e.g. from thickeners, filter press or sludge drying beds)
- Residual solid wastes from air pollution control equipment (e.g. particulate from bag filters)
- Direct process solid waste (e.g. tank bottoms, stills etc.)
- Non-process solid wastes (e.g. unused raw materials, containers, packaging material, etc.)

The solid waste strategy to manage these wastes is summarized in the chart below.



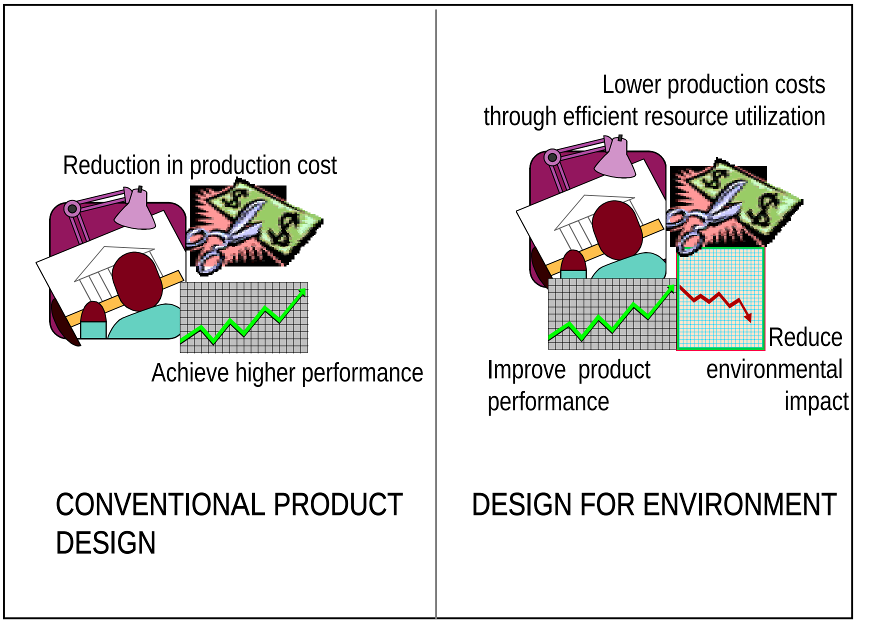
Tips

Solid waste management presents several opportunities of waste recovery, reuse and recycle whereby material, money and energy can be saved.

As mentioned earlier, residues from the air pollution and wastewater pollution control facilities finally come to the solid waste management facility where they are further treated required and are disposed in a suitable landfill

5.11 Design for Environment

Design for Environment



The conventional product design and development process emphasizes how economic value can be enhanced i.e., how to reduce production costs and achieve higher performance. Today, recognizing the power of tools like LCA, the GP framework has incorporated the principles of eco-design into its framework. Product design therefore becomes design for environment.

Design for Environment (DfE) is currently interpreted as a design process in which environmental attributes are treated as a design objective rather than a constraint. What is important in DfE is to increase eco-efficiency i.e., lower the environmental impact and improve the performance of products.

Increasingly industry is redesigning existing products. This is being done by increasing the amounts of recycled or recyclable materials used in manufacture; substituting toxic and hazardous materials by suitable less / non-toxic alternatives; reducing material intensity for a given product. The aim is to reduce the environmental impacts of consumption. This however must be done while ensuring that the quality of the product is maintained or improved.

Opportunities for substituting toxic and hazardous materials as well as those which have long-term impacts on a regional as well as global scale, have been taken by industry and the services sector. This has resulted in an impact on the life cycle of the product leading to manufacture of products that are less demanding on natural resources while at the same time satisfying the needs of the customer.

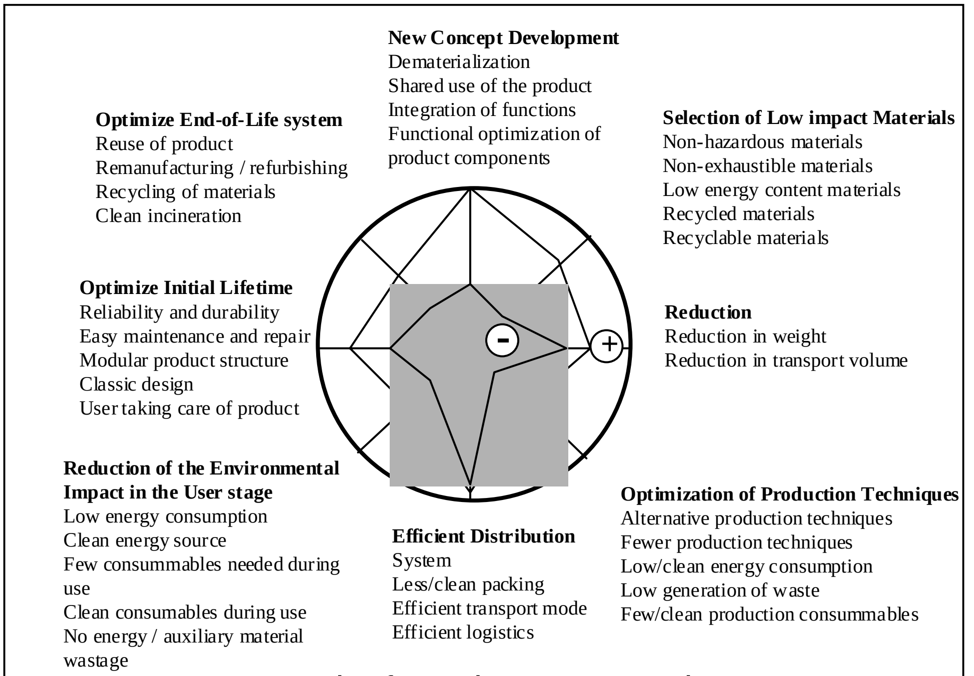
Manufacture here includes not only the product but also its packaging. The way it is used and disposed by the consumer also impacts the environment. A number of companies worldwide are substituting conventional packaging with more environmentally benign materials which has led to improved productivity.

DfE guidelines vary between different countries, however the focus is on eco-friendly product design.

5.11 Design for Environment

5.11.1 Strategies for Design of Environment (DFE)

Design for Environment (DFE)



Design for Environment Strategies

Environmentally compatible products minimize the adverse effects on the environment resulting from their manufacture, use, and disposal. The environmental impact of a product is to a large extent determined during its design phase. By taking environmental considerations into account during product planning, design, and development, a company can minimize the negative impact of its products on the environment.

Various product improvement techniques address various aspects involved in product development and design, such as:

- New concept development
- Selection of low impact materials
- Optimization of production techniques
- Reduction of the environmental impact in the user stage

Product design changes involve manufacturing a product with a lower composition of hazardous substances, or less toxic materials being formed, or changing the composition so that no hazardous substances are involved. For example, a manufacturer could use an active ingredient in a formulation with a non-hazardous solvent rather than a chlorinated solvent. Other examples include using mineral oil in electrical transformers instead of PolyChlorinated Biphenyl (PCB) liquids or organic pigments in paints rather than heavy metal pigments.

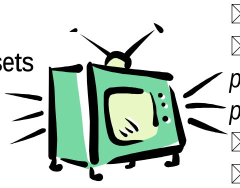
An illustration of an environmentally friendly design of a bicycle is presented in the next handout.

5.11 Design for Environment

5.11.2 Design for Environment (DFE)- Illustrations

Design for Environment - Illustration from SONY

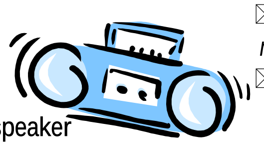
DfE for TV sets



- *Reduced the number of materials used;*
- *Plastic parts marked with the symbol of plastic to assist recyclers in identifying the parts;*
- *Water based lacquers for finishing;*
- *Snap and slide connections to facilitate easy disassembly;*
- *Only a small part of the TV cannot be recycled.*

DfE for monitors

- "take back" label part of every SONY monitor sold in Germany.



- *Cabinet for a new line of speakers is made out of recycled tetrapak cartons;*
- *Better sound quality.*

DfE for loudspeaker cabinets

UNEP Industry and Environment, Volume 20, No. 1-2, 1997. P.28

SONY has made a number of initiatives to minimize environmental burden without compromising on quality by addressing various stages of the product's life cycle.

Design changes have been made in the materials used for the manufacture of their modern TV sets. As a result, theoretically only 1% of the total weight of the product will have to be disposed; the rest can be recycled. Design changes have reduced the number of materials used and all plastic parts are marked to facilitate recycling.

Air moulding technology has been used in the manufacture of the TV cabinet as a result of which the amount of plastic used has been reduced drastically. An LCA to compare the air moulded cabinet, a steel cabinet and mixed cabinet shows clear advantages for the air moulded model. It not only imposes a lower environmental burden but has better mechanical qualities and lower production costs.

The disassembly time for this TV unit (time needed to dismantle the unit and sort components according to materials) has been reduced drastically. In fact, due to snap and slide connections, the need for tools has been minimized and it can easily be opened by hand. Water based lacquers are used in finishing the product.

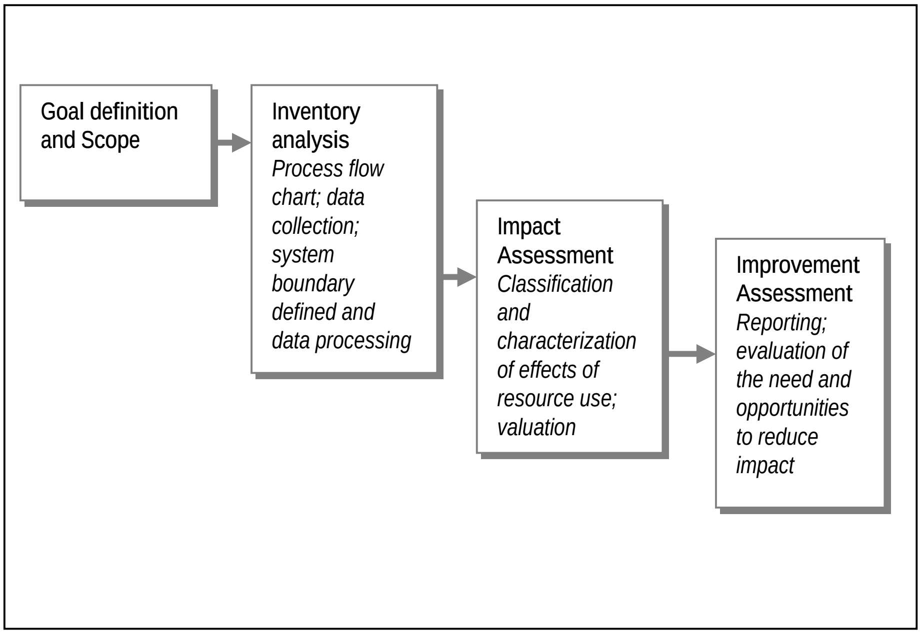
A new line of loudspeaker cabinets has been made with recycled material (Tectan a material made from shredded and pressed tetrapak cartons). This cabinet has better sound quality than that of similar boxes made of conventional material.

As part of its product stewardship initiatives, in Germany, a "take back" label is part of every SONY monitor sold since March 1996. When the monitor is to be disposed of, the customer sticks the label on the product and returns it to one of the 800 take-back points. In cooperation with Rethmann Electrorecycling GmbH, SONY guarantees that the monitor will be dismantled and recycled in an environmentally sound way. Thus LCA to ecodesign can be a very feasible and sound route both environmentally and business-wise.

5.12 Life Cycle Assessment

UNEP, CML, Novem, RIVM, Govt. Of Netherlands, *Unilever, Life Cycle Assessment: What it is and How to do it*, UNEP, 1996.
Guidelines for Life Cycle Assessment : A Code of Practice, from the SETAC workshop at Portugal, 1993. Society of Environmental Toxicology and Chemistry (SETAC), 1993.
The LCA procedures have been structured into a framework with the formulation of a Code of Practice by the Society of Environmental Toxicology and Chemistry.

Life-Cycle Assessment



Life cycle assessment (LCA) is the process of evaluating the effects that a product has on the environment over the entire period of its life cycle. LCA sets out to provide objective answers and its aim is to suggest more sustainable forms of production and consumption. It uses a scientific approach in which the quantification of effects plays a dominant role. A complete LCA is composed of three separate but interrelated components :

Life-cycle inventory: An objective data-based process of identifying and quantifying the environmental loads involved – the energy and raw materials used, and the emissions and wastes consequently released (e.g. air emissions, liquid effluents, solid waste) throughout the life cycle of a product, process or activity.

Life-cycle impact analysis: A technical quantitative and / or qualitative process to characterize and assess the effects of the environmental loading identified in the inventory component. The assessment should address both ecological and human health considerations as well as such other effects as habitat modification and noise pollution.

Life-cycle improvement analysis: A systematic evaluation of the needs and opportunities to reduce the environmental burden associated with energy and raw materials use and environmental releases throughout the whole life cycle of the product, process or activity. This analysis may include both quantitative measures of improvements such as changes in product, process and activity design; raw material use; industrial processing; consumer use and waste management.

Using LCA , the environmental impact of processes, product cycles, and economic activities can be minimized by reducing the material flow through cleaner processes, cycles, and activities. If the reduction in material flow occurs without loss of service or quality of the product as required by the consumer, then it leads to improvement in the material efficiency of those processes.

5.12 Life Cycle Assessment

Together with information on costs, convenience, and consumer safety, the information obtained from an LCA, can be used by organizations to make decisions on how to develop, improve, and produce products.

Efficiency improvement can occur at various points in this cycle. In production processes, improving the material efficiency could mean for example avoiding leaks and spills, better materials handling, closing internal material loops for auxiliary materials and designing and redesigning processes for improved material and energy efficiency. It is important that material efficiency should include energy efficiency, because energy supply is either explicitly or implicitly dependent on material flows.

In terms of consumption patterns, improved material efficiency means improving the utilization of products, designing products for longer service lives, and reversing the throw- away mentality of the existing consumer society.

Improving the material efficiency of the economy in the broadest sense means reducing the material needs of any given service provided by the economy and therefore reducing the material requirements upon which economic welfare is based.

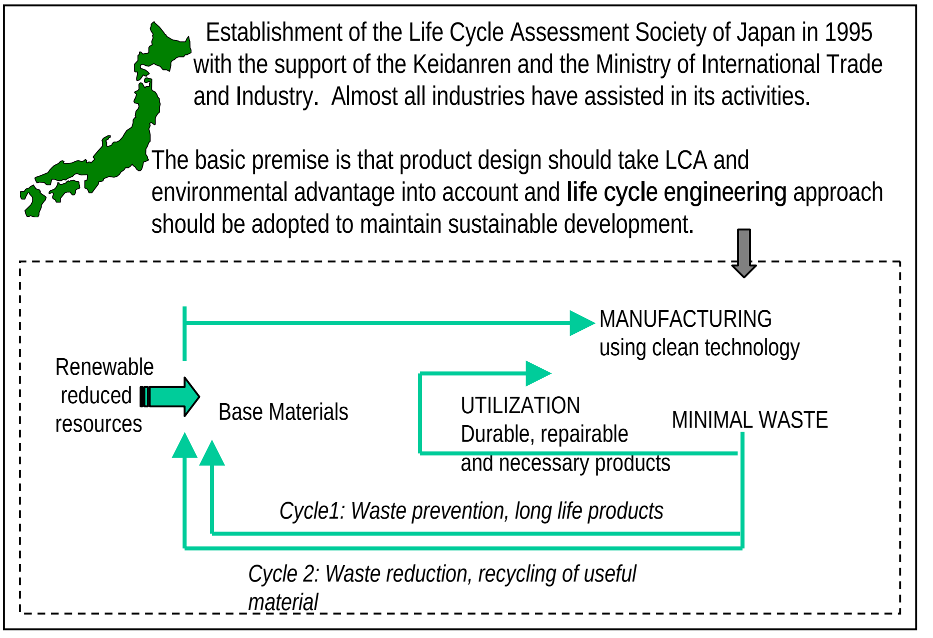
By adopting the life-cycle approach and focusing on efficiency of processes leading to productivity improvement, GP moves upstream and downstream of a product. It encompasses the environmental impact of not only raw materials but also the usage of the product by the consumer. Therefore it integrates the supply chain into the strategy for environmental improvement.

This approach has implications for SMEs today. They form part of an extensive supply chain of a number of large enterprises. As the business strategies of these enterprises move towards sustainability the SME suppliers will have to suitably modify their approaches too. The current demand for quality in the supply chain will be expanded to include environmentally and socially sound practices.

5.12 Life Cycle Assessment

5.12.1 Life Cycle Assessment - Illustrations from Japan

Life-Cycle Assessment - Illustration from Japan



The significance of Life Cycle Assessment in sustainable product design was recognized in Japan leading to the formation of the Life Cycle Assessment Society of Japan in 1995. The Society was established with the support of Keidanren and the Ministry of International Trade and Industry. (MITI)

LCA has formed the basis for product assessment in Japan where recycle-conscious design has begun to play a very important role particularly in the household appliances and automobile sectors.

The origin of this concept of product assessment in Japan began with the enactment in 1991 of the Law for Promotion of Utilization of Recyclable Resources (Recycling Law). Following this in 1994 the Industrial Structure Council, a consulting council for MITI issued a guideline that must be referred to when manufacturing companies prepare manuals for implementation of assessment required to be conducted when they design products. LCA serves as a very useful tool in the conduct of such an assessment.

Product assessment guidelines have been developed by various industry associations for each industrial sector.

Using the principles of LCA, national projects were carried out in Japan between 1993 and 1998 to identify ecomaterials showing that e.g., impact of recycling aluminum and glass has a much lower impact than recycling virgin copper. Such findings were very important for materials based industries. A list of 55 categories of products that exert a lower burden on the environment vis-à-vis their conventional counterparts has been developed by MITI.

LCA is thus being used by Japan to (a) examine the contribution that products make to reducing global problems (b) determine their environmental impact using ecoindicators and (c) develop newer safer and more sustainable products based on this information.

Top Management Forum. Green Productivity and Role of Top Management in Search of Sustainable Asia through Green Products and Services. APO, Tokyo, 1998.

A copy machine made by Fuji Xerox has incorporated a number of reused parts. As of 1996 the ratio of reused parts had reached 30%.

An electric vacuum cleaner designed by Hitachi uses optic fibre instead of Copper wire because the latter has higher environmental impact.

5.13 Green Purchasing

Green Purchasing

Three basic principles of Green Purchasing

- ⌧Consideration of product cycle
- ⌧Management policies and practices regarding Green Purchasing
- ⌧Availability of eco-related information to evaluate products manufacturers and distributors

Green Purchasing is at two levels
- Procurement of safer eco-friendly materials, technology etc.by the producers
- Consumers seeking ecofriendly products

LCA identifies the environmental impact of a product through various stages in its life cycle. Using this information DfE is initiated by product manufacturers. In order to incorporate principles of DfE, one of the avenues is to use safer and more environmentally benign materials. This is where Green Purchasing comes into the GP framework.

Green Purchasing is at two levels: (I) that of the producer procuring and using raw materials goods and services that are more eco-friendly and (II) that of the consumer demanding more sustainable goods and services.

Under the concept of Green Purchasing, priority is given to the acquisition of products and materials that place less load on the environment, in addition to price and quality considerations. Green Purchasing for industry has far reaching implications along the supply chain. The impact particularly on SMEs is significant. Those supplying larger corporations that adopt green purchasing policies would be under pressure to develop and provide goods and services that are environmentally friendly.

In Asia Green Purchasing has seen great strides in Japan. A Green Purchasing Network was organized in Japan in 1996. By 1998 there were 1000 firms, local governments and NGOs participating in this network. Europe and the US saw emergence of such networks in the late 1980s and 1990s.

contd…..

5.13 Green Purchasing

JUSCO the largest retail chain in Japan served as a board member on this Network. It recognized three major principles in green purchasing.

The first emphasizes the importance of the product life cycle and therefore a product is bought only after considering its cumulative environmental load through its life-cycle. The second principle is to assess adoption of green purchasing policies so as to select products manufactured and distributed by corporations with an active interest in environmental protection. The third is to gather and apply environmental information to evaluate products, manufacturers and distributors.

These three principles of green purchasing are valid and applicable both for industry and the consumer.

Apart from business and government initiatives to make consumption patterns sustainable and to promote green purchasing, the GP approach can also trigger citizen initiatives, which will in turn, have an impact on greening the supply chain.

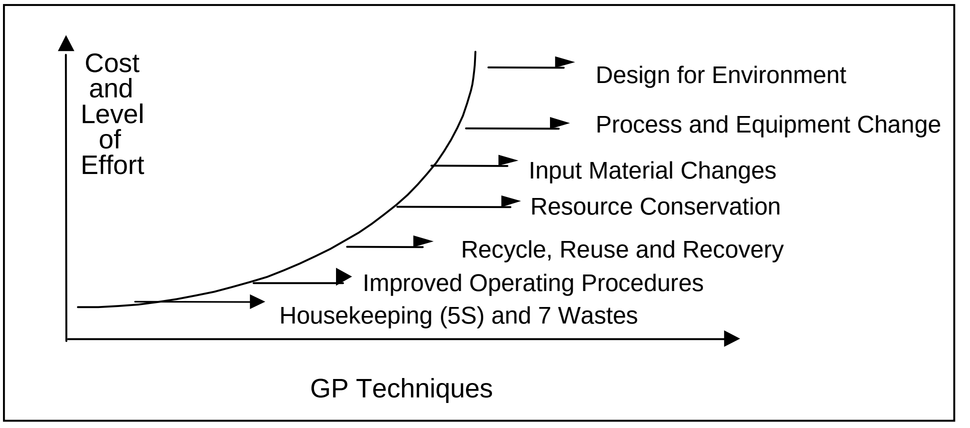
Two such initiatives are provided below:

1: In Mumbai, India over 16,000 households now belong to the Mumbai Grahak Panchayat which operates a collective purchasing system that provides good quality foods and other products at a competitive price. It provides its members with a fair and efficient system of consumption, the system also benefits local producers, provides an incentive for sustainably produced food, reduces traffic, cuts waste by re-using cloth bags and restrains impulse buying.

2: In Japan, the Nippon Ecology Network operates a weekly organic food home delivery service for over 25,000 households. Recently this has been supplemented by the Green Purchasing Network bringing together over 1000 companies, public authorities and citizen groups to promote the choice of sustainable goods and services across Japan.

Green Purchasing initiatives of consumers can serve as one of the driving forces creating a market demand for eco-friendly products as discussed in Lecture 2. This in turn would "push" producers towards eco-design which would drive Green Purchasing by producers from their suppliers. As a result the entire supply chain would be addressed.

GP Techniques, Cost and Level of Effort



As we move up from simple housekeeping techniques to design of environmentally compatible products the cost of implementing the technique rises correspondingly.

Implementing simple techniques like housekeeping, rationalization of operation, reuse, recycle in most cases is easy. Moreover, it is possible to implement these techniques in a fairly short period of time and relatively less capital investment.

The techniques presented in the above viewgraph, bring about incremental improvements, although some increments might be significant than the others. Techniques are applied in combination and rarely in isolation.

Sometimes moving directly to Design for Environment (DFE) may result in a complete change of product lines resulting in substantial benefits. This is because, all environmental and productivity aspects are already incorporated in the product development process. As indicated in the viewgraph however, the cost and the level of effort required for DFE would be rather high and the time schedules also could be longer.

Learnings from the Lecture

At the end of the lecture the reader should have a very clear idea of the techniques to be used in implementation of GP. In fact, the reader should feel confident in applying these techniques independently in support of GP methodology. The principal use of the GP techniques is in the generation of options.

Some of the questions for which answers may be sought from this lecture are:

- ❑ What is the relationship between GP Tools and GP Techniques? Provide illustrations.
- ❑ Compile a sector specific list of preferred GP techniques, e.g., for a tannery or a textile processing industry.