Indira Gandhi
National Open University
School of Agriculture

MVP-003
Principles of Food Safety and Quality Management

Block

1

FOOD SAFETY AND QUALITY MANAGEMENT SYSTEMS

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MVP-003 PRINCIPLES OF FOOD SAFETY AND QUALITY MANAGEMENT

The creation of Food Trade Qrganization (WTO) has opened up international market access for food commodities. For country like India which is highest producer of milk, second highest producer of fruits and vegetables and has 11% of the worlds livestock population trade liberalization promises new market opportunities. Many of our food products could find access to new export market. However, food products to be traded in the international market should be manufactured and handled in accordance with globally accepted norms and standards. Food safety which implies absence or acceptable levels of contaminants, adulterants, naturally occurring toxins or any other substance that may make food injurious to health on an acute or chronic basis may be achieved by the proper handling of food during production of raw material, manufacturing of the products, their transportation and storage. To achieve this good food handling practices like good agriculture practice, good animal husbandry practice, good hygienic practice, good transportation practice and good retail practice must be adopted. All the players in the food chain must be aware of HACCP and risk analysis (risk assessment, risk management and risk communication) to avoid different type of hazards (biological, chemical and physical). Further, aspects like nutrition labelling and food traceability which is necessary in the food surveillance and recall are also important for food safety point of view.

Block 1 Food Safety and Quality Management Systems deals with important aspects of food safety including its importance in the food trade. Food safety system and total quality management is also covered in this block.

Block 2 This block covers different aspects of risk analysis including risk assessment, risk management and risk communcation.

Block 3 Deals with all the aspects of HACCP including its history, background, structure, prerequisites and principles. For making the subject more clear some case studies on HACCP are also presented.

Block 4 Other food safety practices like good agriculture practice, good animal husbandry practices, good manufacturing practice, good retail practice, good transportation practices and nutrition labelling is also explained in this block alongwith traceability studies.

BLOCK 1 FOOD SAFETY AND QUALITY MANAGEMENT SYSTEMS

Recent years have witnessed a very rapid growth of food industry and a resulting increased movement of foodstuffs around the world. This is evident in the variety of foods that are now available to us as consumers. However, this increased reach to different type of food articles has increased the risk for the consumers. Potential for food contamination starts from the primary level of production, processing, transportation, storage, personnel, equipments, surroundings and waste disposal. Therefore, organisations in the food sector need to manage risks, demonstrate good corporate responsibility and meet legal requirements if they want to remain competitive, protect their reputation and enhance their brand. To achieve these goals they have to adopt an effective food safety management system based on process standards.

Unit 1 Introduction to Food Safety describes the biological, chemical and physical hazards of the food. The unit provides an insight into issues of how to maintain hygiene and how to protect food from contamination.

Unit 2 Food Safety System: describes the terms and definitions associated with food safety system and the need for food safety systems. It makes us aware that how food safety relates to the entire food chain.

Unit 3 Total Quality Management: enumerate different aspects fo Total Quality Management and the guiding principles of ISO 9000. The unit describes the need for Safety and Health Management, the approach towards safety, general occupational health problems and how to control of health risks in industries.

Unit 4 Project Management: explains the project management and related activities along with the different phases and framework of project management. The unit also explains the role of strategy in project management and the importance of time planning and role of team in project management. The unit provides us an insight into issues that deals with different control systems, constraints and corrective actions required for effective project management.

UNIT 1 INTRODUCTION TO FOOD SAFETY

Structure

1.0 OBJECTIVES

After studying this unit, we shall be able to:

- explain biological, chemical and physical hazards;
- know hazards to safe food;
- how to maintain hygiene; and
- understand how to protect food from contamination.

1.1 INTRODUCTION

Eating is fun and all of us enjoy doing so. It provides us nutrients necessary for our well being and conduct of our everyday activities. We eat our food both at home and also at places away from home. Today having meals away from home is a social activity that rivals with other activities like watching a movie or a cricket match. Eating helps us to meet our social as well as physical needs. We love to get together over food and friends meet for lunch, for cocktails after work, or go to a dinner after an evening movie. Similarly eating also takes care of business as meetings over food provide a suitable and conducive platform for discussions, negotiation and planning. As enjoyable as eating out is, it is also true that many of us simply have to eat out away from home at some time or the rather, like men and women at work, passengers travelling, guests in a hotel, patients in a hospital, students at school and colleges. This is not to forget the food that we carry home from the market, supermarkets, restaurants/ hotels, or simply as packaged food products, and ready to eat foods.

All of us rightfully expect that the food we eat is tasty, of good appearance, safe and suitable for consumption. We all know that some of us sometimes fall sick from what we eat. It doesn't happen too often, and when it does we may not get very sick or else be sick for a long time. Moreover, in many cases we are inclined to shrug off the sickness with the thought that we ate too much. "It was probably something I ate ", "It was just a touch of flu "are the very common expressions we use that mask the problem of a food borne illness. Most of us do not readily identify the source of the ailment / sickness and are understandably more concerned about obtaining relief. On getting sick we go to different doctors and hospitals, or else may even do nothing about it. However, the end result more often than not is that we are reluctant to eat that food again from the place where we had last consumed. The reason for this is simply that eating unsafe food is not what we expect. However, there are increasing signs that the public is becoming more aware of the connection between food and illness. Media coverage, newspaper and TV reporting's contributing towards this awareness.

A food borne illness is a disease that is carried or transmitted to us by food. Any kind of food can be a vehicle for the food borne illness. Some of the foods responsible for the foodborne illness are poisonous by nature, for example certain types of mushrooms or fish. However, it is mostly the high protein foods we eat regularly like meat and dairy products that are responsible for most food borne illnesses. These foods are receptive hosts to certain forms of bacteria and other disease agents, and the problem is further made worse by poor storage, preparation, handling and service. And not to forget all the illnesses that are related to drinking water, and food contaminated by water.

Food borne illnesses can occur anywhere, through errors/carelessness in purchasing, receiving, storage, preparing/cooking, packaging, storage of cooked products and service.

Every food producer needs to be aware of the fact that they are selling a food product which is a biological material and is, therefore, susceptible to degradation and/or spoilage. We consume these food products for nourishment and pleasure. The human system has a marvelous defense system, but when a hazardous material is ingested, the chances for food related problems are greatly enhanced.

1.2 HAZARDS TO SAFE FOOD

The Codex Alimentarius Food Hygiene Committee defined a food hazard as: "A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect".

It is generally recognized that food safety hazards are of three types. These are biological, chemical and physical in nature.

1.2.1 Biological Hazard

Biological Hazard are micro-organisms and their toxic metabolites which can cause illness when transmitted to humans through food. A great variety of micro-organisms are found in nature. Some can grow on food causing spoilage, others constitute a hazard to man through illness caused either by;

Food Infections: Caused by ingestion of sufficient number of micro-organisms of public health significance to cause an illness. Salomonellosis and listeriosis are results of invasions by microorganisms.

Food Intoxication: Caused by ingestion of a preformed bacterial toxin. Staphylococcal poisoning and botulism are intoxications.

In most cases micro-organisms use our food supply as a source for their own nutrients for their own growth. By increasing in number, utilizing nutrients, producing enzymatic changes and contributing off flavours by means of breakdown of a product or syntheses of new compounds they spoil or food. It is only when the micro-organisms involved are pathogenic, their association with our food supply becomes critical and assumes importance with respect to food safety. Many of our food support the growth of pathogenic micro-organisms or at least serve as vectors for them. Micro-organisms that can constitute food safety hazards include bacteria, yeast and moulds, viruses and parasites.

Microbiological hazards are of great significance to food safety, because despite technological capabilities the number of cases of food borne illness from micro-organisms of public health significance is staggering. Though many cases may not be reported in our country, like in very many other countries, developed, developing and under developed, the actual cases are much higher. A few examples of micro-organisms of great concern to food safety are: Clostridium botulinum, Salmonella sp., Stapylococcus aureus, Clostridium perfringens, Listeria monocytogenes, Enterovirulent, Escherichia coli, Shigella etc.

As society becomes more complex, so too it seems do the hazards to which we are exposed.

Other biological hazards include parasites such as *Trichinella* and *Anisakis*, found in pork products and marine and freshwater fish, respectively. Parasites in the flesh of animals can be transmitted to the consumer if the food has not been properly cooked. Seafood and pork producers should be aware of parasitic concerns and assess these hazards when developing their food safety management system.

1.2.2 Chemical Hazard

Chemical hazard is any chemical introduced into the food system, which may cause illness or injury to the individual using the product. Toxic chemicals such as residues of

pesticides, cleaning agents can also find their way into the food and make us fall sick. Chemical hazards also include foods that are in themselves poisonous to humans, such as certain forms of fish and mushrooms. A few examples of chemical hazards are:

- Agricultural Chemicals – These are used to enhance the livestock production, and include Insecticides, Fungicides and Fertilizers in crop production, and pesticides, antibiotics and growth hormones in livestock production. These allow farmers to produce crops more efficiently.
- However there is another class of chemical hazards that enters the food chain at the primary production step on account of pollution. These include toxic metals such as mercury lead, arsenic and cadmium discharged into the sea by industry progressively accumulates in marine life along the food chain.
- Processing Plant / Facility Chemicals – These include the likes of cleansers and sanitizers, oils and lubricants, used by food processing industry for purposes of operations and sanitation of the facility and the equipment. Inappropriate design of manufacturing equipment and selection of chemicals used for operating machines and their maintenance increases the risk of contamination of the food. Chemical residues left on vessels and food contact surfaces due to improper cleaning operations contaminate the food products.
- Naturally occurring toxicants – Some foods contain naturally occurring toxins. The most extreme example is the potentially fatal tetrodotoxin found in puffer fish. The puffer fish is a prized delicacy in Japan served only in licenced restaurants employing highly trained staff to remove the toxin containing organs from the fish. However, it is still not well established whether the fish itself is poisonous or is it the bacteria present in the fish that produces the toxin. Nonetheless it is related to a naturally occurring toxin. Other examples of naturally occurring toxins are mycotoxin - aflatoxins in grains and processed foods, presence of histamine in spoiled fish, ciguatera in fin fish and saxitoxin in shellfish causing paralytic shellfish poisoning.
- Food chemicals – Food additives such as smoke, alcohol, vinegar, oil and spices have been used for thousands of years to preserve food, enhance flavor and improve maintain food consistency. However, changes in the distribution of food and the increase in processed food products, has seen an increase in the use of food additives. It is estimated that more than 2500 different chemicals are currently being used after having undergone extensive toxological screening. Today food chemicals are being used in actual food processing for imparting flavours, protecting and preserving the food from microbiological deterioration, to impart a functional characteristic, as a processing aid, or even for improving appearance. At established levels, these materials are not toxic or dangerous. But lack of proper controls can result in violation of prescribed levels and may result in illness for consumers.. Consequently adverse health effects such as hypersensitivity to certain substances have been reported. Children tend to be affected more than adults and in most cases the effects reported are of concern but not life threatening. There is, however, a worrying increase in the number of children who develop allergies to naturally occurring products such as peanuts.
- One class of chemicals hazards which is an area of concern is that of allergens. Under FALCPA, The Food Allergen labelling and Consumer Protection Act of 2004 (FALCPA) (Public Law 108-282) , a "major food allergen" is an ingredient

that is one of the following five foods or from one of the following three food groups or is an ingredient that contains protein derived from one of the following - milk, egg, fish, crustacean shellfish, tree nuts, wheat, peanuts and soybeans

Today, we also have hazards associated with packaging materials, with chemicals, lacquers and polymers migrating from the packaging material into the food product it is holding.

1.2.3 Physical Hazard

Physical hazard is defined as any physical materials not normally found in a food, which may cause illness or injury to the individuals using the food product. Physical contaminants like pebbles, chips of glass, piece metal wire, or for that matter a fragment of fish bone all have the potential to injure us when consumed along with food.

Physical hazards include a variety of materials often referred to as extraneous materials or foreign objects emanating from various sources and having a potential to inflict injuries. Some examples are listed below;

Material	Source	Injury Potential
Glass	Bottles, jars, light fixtures, glassware, gauge covers etc.	Cuts, bleeding, may require surgery for removal.
Wood	Fields, pallets, boxes, buildings.	Cuts, infection, choking, may require surgery for removal.
Stones	Fields, buildings.	Choking, broken teeth.
Metal	Machinery, fields, wire, employees.	Cuts, infection, may require surgery for removal.
Insects	Fields, plant, post process entry.	Illness, trauma, choking.
Bone	Fields, Improper processing.	Choking, trauma.

Unlike micro-organisms, whose presence may or may not constitute a problem depending upon the process the food has undergone i.e how it is handled, or how it is prepared, materials which constitute physical concerns may not be able to be removed, inhibited or detected in process. Health and safety problems from these sources commonly occur and can be dangerous to our health and safety. There are five general sources from where physical hazards gain access to our foods;

- Inadvertent materials from the field like stones, metals, insects, thorns, wood, insects.
- Inadvertent materials resulting from processing and handling like bone, glass, metal, wood, nuts, bolts, wire, cloth, rust.
- Material entering the food during distribution like metal, insects, dirt, stones, and other miscellaneous physical objects,
- Materials intentionally placed in food in case of sabotage or tampering by the employees.
- Miscellaneous like struvite and other such materials in this class. Struvite is a hard crystalline material which may be formed in canned proteinaceous seafood. The material resembles glass in appearance to us as a consumer and on ingestion may break teeth and is thus a food safety hazard.

1.3 CONTAMINATION AND SPOILAGE

Contamination is the presence of harmful substances in food. If a food contains any substance that can cause injury or disease to a person who eats or tastes it, the food is contaminated. The contaminants may be biological, chemical or physical, and may even be tasteless and odorless. However, since contamination may not always result in a food safety issue on account of presence in smaller quantities or size, we are focusing on contaminants that pose a threat to food safety and thus are being identified as food safety hazards.

Spoilage is damage to the edible quality and suitability of food. Food that acquired an unacceptable taste, appearance or aroma can be said to be spoiled. Spoiled food may also be contaminated with food safety hazards, but this is not necessarily the case. Sour milk, for example, is spoiled for such uses as drinking, but it may still be perfectly wholesome and suited for the making of cheese/paneer.

In many cases, however, the micro-organisms that cause diseases will also spoil food. The conditions that lead to spoilage of food are frequently the same that allow pathogenic micro-organisms to flourish. So the presence of spoilage is a strong indication that food has become unsafe to eat. It must always be remembered that food can be contaminated with dangerous micro-organisms or toxins without betraying this condition in its outward appearance at all. Some contaminants cannot be detected by smell or even taste. So do not assume that every food that looks unspoiled is actually safe. In our analysis of the problem of safe food it is clear that the condition of the food itself has to be brought into central focus.

1.4 WHAT IS HYGIENE?

Contamination of food is preventable, if proper precautions are taken to keep the disease causing agents away from food in the first place or to keep these agents from growing if they do get into food. The existence of a case of a food borne illness usually means that some unhygienic conditions exists that must be identified and eliminated. The most powerful tool for protecting people against illness from food contamination is hygiene.

In the food sector situation, hygiene means wholesome food, handled in a hygienic environment by healthy food handlers in a way that the food is not contaminated with illness causing, harmful agents. In other words, hygiene is what keeps safe food stay safe. There is a direct relationship between hygiene and safe food. Conversely there is a direct relationship between a lack of hygiene and illness caused by food.

But does hygiene simply mean clean? Not necessarily. That which appears clean may not be hygienic.

Clean means free from visible soil. Hygiene means free from disease causing organisms and other hazards/harmful contaminants. Clean refers to aesthetics and relates to outward appearance – a shelf wiped clean of dust or a sparkling glass. However these object, though clean on surface may infact be harbouring disease causing micro-organisms or harmful chemical hazards? On the other hand, baby bottles boiled in water for over ten minutes may be splotched and have water marks. They may not appear to be clean when visually examined, but they would be free from disease causing micro-organisms and can actually be called as hygienic.

In understanding food safety it is useful not only to understand the food safety hazards and the point of entry into the food chain, but also to look at the factors involved in keeping food safe, as well as the inherent risks. They generally fall into 3 categories:

Food – It's safe condition initially and subsequent protection in preparation and service.

People – Those involved in handling food both as employees and as customers

Facilities – The hygienic conditions of the plant facility and the equipment used in food service operation.

1.4.1 The Food itself

Not all food is safe when it is under primary production. Agricultural products and animals have a wide range of microbes on them or in them at the time of harvest/ slaughter. Soil and seed treatment with chemicals, spraying of pesticides for plant protection, use of veterinary drugs for treatment of diseased animals, fishing from contaminated waters, use of growth promoters in plant and animal kingdom, diseased plants products and diseased animals – in all cases the food emanating from primary production is exposed to the risk of contamination with food safety hazards. Plants become contaminated with pesticide and herbicide sprays and can accumulate toxic materials from contaminated soil. Animals can also build up levels of toxic substances. Substances such as antibiotics and hormones administered to animals to aid growth or prevent diseases are also suspected of having a potential adverse effect on us.

Likewise not all food is safe when it arrives in food processing operations. Food products such as fresh poultry and frozen fish may already be contaminated by the time they are received. We must thus ensure that we source them from reputable suppliers and implement tight receiving procedures to help ensure safe food. Once the food arrives it must be stored, prepared and served using methods that maintain its safety. This is the everyday challenge to the food sector/industry.

1.4.2 People – Safety of Food

People – Safety of food depends to a great extent on the people – those who produce and process it, those who transport and deliver it, and finally the food handlers who prepare it for the ultimate consumer. In a most fundamental way the success of a food service in dealing with the food borne illness problems depends on how the human factor is handled, how workers are trained and how managers follow up and reinforce that training. Very often it is observed that food sector concentrate on elementary hygiene and basic rules of personal hygiene. They are fighting plain ignorance on issues of hygiene and food safety with their employees, as with a cook who just refuses to understand the danger in using the hand that has minor but infected cut or burn, or in using a knife without washing for cutting salads, when the knife had previously been used for cutting raw chicken, or a person serving food handles money, clears away soiled tableware, makes a new set up, catches a cigarette, and serves more food, all without once washing hands.

People pose the number one risk to safe food. Employees and customers both pose the biggest threat to food safety. Hiring healthy workers, training them in procedures on hygiene, and supervising and monitoring them on the job, all help prevent safe food from becoming contaminated with food safety hazards.

Well customers pose an equally big problem. The people who hate to see food wasted and put their handled but uneaten slice of bread or Roti, samosa, salad, or a kabab which looked a shade small for that matter back into the serving dish, while another one of our customers is engaged in uncontrolled and unshielded coughing.

1.4.3 Facilities and Equipment

Investigations of food borne illnesses often reveal refrigerators with temperatures varying from 11 to 15 ºC show presence of pathogenic micro-organisms during laboratory analysis in large numbers in the food product. Breakdown of other hygienic practices aspects are also detected.

Faulty or inadequate equipment is one major threat to safe food. Food should never be allowed to stay in the temperature danger zone for any length of time. The temperature danger zone includes those temperatures in the range where bacterial contaminants multiply most rapidly.

Difficult to clean work areas, faulty or overloaded refrigerators or other equipment, dirty surroundings and conditions attractive to pest infestation add to woes of food safety. Sometimes, the equipment is improperly used - putting the auto flow diversion valve on the pasteurizer in the manual mode, or overloading of a refrigerator or a cold room are few examples. Hygiene thus must be the first concern when choosing equipment. Ease of cleaning, maintenance and regular cleaning of equipment can eliminate the source of food contamination. All features of a plant's should be constructed with clean ability in mind, thus setting the stage for safe operations. Material of construction, design, construction and installation of equipment and layout of equipment – all with a view to facilitating clean ability and maintenance and eliminating entry points and breeding places for pests and insects and rodents need as much attention for creation of hygienic conditions for ensuring food safety.

1.5 SOURCES OF CONTAMINATION

Complex and multiple operations in a food system increase the chances of contamination. By the time the food reaches us, it has several opportunities to become contaminated. Multiple foods handling from food grower to processor to supplier to finally us multiplies the chances of food contamination.

a) Firstly, the food could have been contaminated at the source - food grower, food processor, food packaging – through poor control methods or mishandling.

b) Most if not all food products go through additional steps of warehousing and storage, distribution and retail thus adding to another ladder for food to become contaminated.

c) Finally, the food reaches the final food processing facility or our homes, and it is here that we need to protect it from the point of receiving, through storage to its preparation for its intended use and upto consumption by us.

The few steps that the food travels before it reaches us are primary production, purchase, storage, production (preparation and packaging), distribution and delivery and service. Each of these steps offers opportunities for contamination if they are performed improperly. Controls at each of these steps need to be built into ensure that the food is safe right upto the time it is consumed by us.

1.5.1 Primary Production

Agricultural products and animals have a wide range of microbes on them or in them at the time of harvest or slaughter. The number and types of microbes that comprise the primary contamination of the food varies from one commodity to another, with geographic regions and with the methods employed for harvesting/slaughtering. Care with procedures may limit and reduce the contamination with food safety hazards, this contamination, a point is reached where the cost of such procedure outweighs the benefits. Thus the focus here is to reduce the likelihood of introducing a food safety hazard which may adversely affect the safety of food, or its suitability for consumption, at later stages of the food chain. Mechanization and increased scope of operations would improve the microbiological condition of the food at harvest or slaughter.

1.5.2 Purchase

Purchasing safe food is an important step in keeping it safe. Purchase from reputable approved suppliers, proper checking during receiving and accepting only those ingredients that the organisation has the potential to process and handle with respect to food quality and safety are important requirements for purchase and receiving, which gives an assurance that what is received is what had been ordered. Receiving inspection should include inspecting the product for its packaging, if any, appearance of the product – should be characteristic of the product, not rotten, spoilt or damaged, physical and chemical properties for quality and safety, and receiving temperature in case of perishable and frozen supplies.

1.5.3 Storage

Until the food is not going to be processed it must be handled and stored safely. Storage is where many breakdowns in hygienic conditions occur. Storage of freshly harvested paddy provides conducive conditions for proliferation of micro-organisms some of which may be pathogenic or toxin producing, storage of raw products above processed food products specially those requiring no further processing within the same storage facility, overcrowding deep freezer with various raw meats increases the risk of cross-contamination and multiplication of disease causing micro-organisms already present in the meat, are examples of faulty storage. Planning ahead for storage space and usage help protect foods.

1.5.4 Production (Preparation and Packaging)

Food safety hazards in food are normally controlled by exclusion or removal, inhibition of growth or by destruction. The process to be employed depends on the sensitivity and the type of the hazards to be controlled and the food itself. Microbes in particular need water, nutrients and appropriate conditions of temperature and pH in order to multiply. The inherent properties of the food being processed with respect to its pH, water activity and temperatures largely determine which microbes among those initially present in food can multiply and constitute the spoilage flora and a food safety threat. Microbial Food safety hazards during processing are largely controlled through these factors. It is these characteristics that provide the platform for food safety during chilling, freezing, pasteurizing, canning, drying, salting / brining sugaring, fermenting, using preservatives and radiation.

The possibilities of contamination and introduction of food safety hazards multiplies at this step. Production/processing under unhygienic conditions may lead to not only

contamination of the food, while processing failures lead to survival of such microbes, their toxins and coupled with time and temperature abuse pathogenic bacteria and moulds are allowed to multiply and proliferate. For example, the food handler has a sore throat and a slight cough. He clears his throat and is careful to cover his mouth with his hands, but unfortunately he forgets to wash his hands as he gets prepared to handle the food product again, results in contamination of food. To compound the problem further, the food handler also has other jobs in hand to attend to in the process of production/preparation, and as a result after processing one product he puts it aside as it can wait, but in case he has a chance to further work on it, he leaves it on the processing counter – well may be for a few hours till he gets back to further process it. With the food being in the temperature danger zone, the micro-organism present in the food begins to multiply. Now as this product undergoes further processing, which may be heat processing, the toxins produced may not be destroyed. This food may require further handling like cutting of a roast chicken and the food handler/cook cuts it using a knife previously used for cutting raw chicken and that too on a chopping board scored with old knife cuts.

This may sound like an extreme case, but bear in mind that such breakdowns do occur not only in food processing units but also in our homes in our very own kitchens, the same chopping board and knife being used for cutting salads and boiled eggs while fixing an early morning sandwich in a hurry. Sounds true, doesn't it?

Processing and preparation procedures must be controlled to ensure that:

a) Food is not held in the temperature danger zone longer than is necessary, during and even after preparation;

b) Food handlers do not harbor diseases or expose food to contamination through careless and negligent personal habits; and

c) Food is not contaminated by unclean utensils or equipment or by contact with raw food.

1.5.5 Distribution and Delivery

Food may become contaminated, or may not reach its destination in a suitable condition for consumption, on account of inadvertent variations in conditions of temperature, moisture content (water activity) and integrity of the packaged product due to inappropriate handling, damaging and resulting ingress of moisture and temperatures for storage and transportation. Frozen products like ice creams and frozen peas undergoing a break in the cold chain are bound to deteriorate and pose potential food safety threat. Cold chains should be maintained effectively. Food products need to be protected from contamination and damage during storage, transportation and delivery. Damaged packets of milk powder and biscuits when picked from the shelves of a market store may have imbibed moisture and supported the growth of microbes, or may be even infested with insects. Effective control measures as appropriate to the food being transported are required to be taken during transport and delivery, even where adequate hygiene control measures have been taken earlier in the food chain.

1.5.6 Service

Let's say the food has been processed through all the above stages without being contaminated thus rendering it safe for consumption. However, there is still another step of service in case of a restaurant / hotel / hostel / hospital / in flight etc. which provides one more opportunity for safe food to become unsafe at the very final step of

consumption. The opportunities at this stage may not be as great as the earlier ones, but they exist nonetheless. Unhygienic practices like picking the spoons and knives the wrong way or may be still worse carrying spoons in the front pocket of the apron the persons is wearing. To add to your problems the food server wipes the spoons with the same apron. Other examples include handling the clean spoons and plates after having wiped a dirty table or counter top, wiping hands with the aprons prior to serving of food, or even permitting un-well operators to handle and serve food. Another common instance of unhygienic practice at this point is the absence of sneeze guards in food service areas or buffets. We need to have hygienic procedures while serving of food, because else it is meaningless to implement hygienic procedures in all the preceding steps only to expose them to food safety hazards during food service.

1.6 FOOD QUALITY

Food safety and food quality are critical to the bottom line. Food that is dry, or appears stale and not pleasant, having off odours does not impress customers. We may even mistake them to be unsafe and not accept any for consumption. Preservation of food quality is another objective of food hygiene. May be it would be an oversimplified statement if we say that hygiene procedures may also address food quality issues to a large extent. Food that is prepared and served properly is more likely to retain its quality. The standards for quality of food include its safety, appearance, texture, chemical properties, consistency, taste and above all its nutritional value. And any of these can be destroyed by unhygienic practices from primary production through processing and upto consumption by the customer.

1.7 THE FOOD SAFETY CHALLENGE

Providing safe food is a necessary challenge before every food industry, but not an impossible task or barrier. Recognizing the importance of hygiene and its relevance to food safety is the primary task in establishing food safety. Developing procedures and systems to keep the food facility / plant hygienic and protecting its people from disease and illness is the second step. Thus we need to develop a system for food safety revolving around the specific food facility engaged with specific products. However, the two pronged strategy that we need to apply is:

a) protect food from contamination; and

b) reduce the effect of contamination that does occur.

1.8 PROTECTING FOOD FROM CONTAMINATION

1.8.1 Biological Food Safety Hazards

We must recognize that pathogenic micro-organisms capable of contaminating a food are present practically everywhere – in soil, air and dust, on insects and rodents, on unclean vessels and utensils, and above all on food handlers themselves. We as human beings and thus as food handlers harbor micro-organisms on our skin and hands as well in their noses, throats, mouth and intestinal tracts.

Besides most raw foods no matter how reliable the supplier or the source, are contaminated to some extent before they arrive at the food processing facility whether that's is a factory, a hotel our kitchen at home. Proper cleaning and processing, cooking helps reduce the disease causing organisms. The food industry has thus to prevent raw foods from contaminating the cooked foods, to reduce the opportunities for further

contamination of food from unhygienic workers / food handlers and facilities. This implies that they need to control the environment in a manner that reduces the likelihood of introduction of food safety hazards in food stuffs.

1.8.2 Chemical Food Safety Hazards

The use of pesticides is generally strictly regulated by the government. For each chemical, usage levels, time and frequency of usage, handling procedures are all well defined. Finally, for most commonly used agricultural chemicals, the regulatory authorities have established and defined maximum allowable limits in the foods. Since a large part of the chemical hazards enter the food chain at the stage of primary production itself, and their elimination during subsequent processing may not be entirely practical or feasible, reliance on Good Agricultural Practices would assist in minimizing the chemical hazards in food. Procurement procedures should be such that emphasis is placed on the purchase of known sources and supplier approvals based on their previous record in supplying the appropriate type of material. Within the processing facilities, the equipments should be so designed that neither the materials of construction nor the lubricants, oils and grease used for facilitating their operations are toxic, reactive and has the potential of gaining entry into the food. Plant chemicals like detergents and sanitizers should be stored in such a way as to prevent the finished products from being contaminated or affected. Hazards resulting consequent to employee sabotage should be controlled through good management and employee education.

1.8.3 Physical Food Safety Hazards

Having understood where the physical food safety hazards come from, manufacturing facilities and food processing operations should be designed to remove or eliminate the inadvertent materials from the field like stones, metals, insects, thorns, wood, insects and those resulting from processing and handling like bone, glass, metal, wood, nuts, bolts, wire, cloth, rust above. While distribution and storage practices along with in store handling practices should control and or be designed to prevent the finished products from being contaminated or affected. Hazards resulting consequent to employee sabotage should be controlled through good management and employee education. The chances of physical contamination are greatly reduced once the containers particularly made of metal, glass or thermoplastics are sealed. Tampering can be controlled by having packages that are designed to prevent tampering or are tamper evident – thus we often read “Do not use if seal is broken / damaged”.

Once again let’s find out how food becomes contaminated with food safety hazards, and the main offenders are:

a) Improper agricultural and animal husbandry practices;

b) Infected food handlers;

c) Contaminated food supplies;

d) Unhygienic food handlers;

e) Unhygienic equipment and facility;

f) Inadequate processing for preservation for minimizing risk from food safety hazards; and

g) Hazardous chemicals.

1.9 REDUCE THE EFFECT OF CONTAMINATION THAT DOES OCCUR

As mentioned previously, some foods are contaminated with food safety hazards and other contaminants well before they enter the facility and others will get exposed to harmful micro-organisms during preparation and production. Fortunately, the food industry has several very effective ways of counter acting this contamination.

From ancient times, mankind has apparently had a fairly good idea about how to protect themselves from food safety hazards. They killed animals and sun dried, smoked, salted or even chilled them for preservation and food safety. Even the primitive man knew that purifying by fire improves the taste and texture of meat and probably also rendered it safe. However, we understand the same scientifically. We now know that purification by fire has to do with the value of temperature control, salting and sun drying is to do with reduction in water activity, in keeping the food safe. Even today we sort our rice and pulses before cooking for removal of foreign particles, chop of the green potato while cutting potatoes, thus minimizing the threat from physical and chemical hazards respectively. Very often we resort to washing and peeling of vegetables and fruits for minimizing physical hazards like insects, soil and dirt, hoping that residues of chemical hazards would also be minimized to certain levels.

Micro-organisms require a moist, warm, nutritious environment to prosper and multiply. Their growth can be slowed or stopped by refrigeration and can be destroyed by heating, but at temperatures between 7.2º and 60°C micro-organisms multiply to large numbers at a very hectic pace and may also produce toxins . Food thus needs to be kept out of this temperature zone whenever possible.

1.10 ROLE OF FOOD PROCESSING INDUSTRY/ SECTOR

Typical food industry personnel may take their activities as activities in any other normal business, that of marketing, procuring, processing, storage and providing food to customers and service to business management. It is quite unlikely that they see their role or identify themselves in the role of a hygiene practioner who is responsible for providing safe food. A knowledge and understanding of good hygienic practices and good management practices coupled with an appreciation of their importance can transform the hygiene aspect and make food safety manageable and achievable. The stumbling block is the awakening people to the existence of the food safety problem and getting them around doing something about it.

Check Your Progress Exercise 1

Note: a) Use the space below for your answer.

b) Compare your answers with those given at the end of the unit.

1) What is food safety?

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2) Difference between clean and hygienic?

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3) What is a food safety hazard?

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4) List the types of food safety hazards along with five examples of each?

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5) How do these hazards gain entry into the food?

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6) Identify the various steps in the food chain where food may get contaminated with food safety hazards?

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7) What is a food borne illness?

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8) What is the difference between a food infection and a food intoxication?

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9) Describe how people, food, equipment and facilities, can contribute to food safety hazards at all steps of the food chain?

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1.11 LET US SUM UP

Eating is a necessity for staying alive and when we eat food we logically expect it to be safe, good and a pleasant experience. A food borne illness is a disease or an injury caused by ingestion of food contaminated with food safety hazards that gain access to the food at any point in the food chain, from primary production, through processing, storage, distribution and upto the point of consumption. Hygiene is the creation and maintenance of healthful conditions to prevent food contamination and meeting customers requirements. Hygiene is directed towards elimination of food borne illness through the reduction of opportunities for food contamination and correction of contamination that does occur. This task gets complicated because pathogenic bacteria are present virtually everywhere. The three hazards to food safety are biological, chemical and physical. Though all are important, but of these biological food safety hazards are of major concern to the food sector, probably because of their presence virtually everywhere and their capability to survive and multiply under various conditions. Three points that merit attention are the food itself as a source of food safety hazards, and these are:

a) Systems for obtaining safe food, how to keep it safe through receiving inspection and control of temperatures and other measures;

b) How to train and motivate food handlers and other employees in a food organisation, to learn and apply food hygienic practices; and how to build hygiene in the facility itself; and

c) Management of operations in a systematic manner.

It is our effort to keep food safe from contamination and food safety hazards, and to reduce their adverse health effects.

1.12 KEY WORDS

Cleaning : The removal of soil, food residue, dirt, grease or other objectionable matter.

Contaminant : Any biological or chemical agent, foreign matter, or other substances not intentionally added to food which may compromise food safety or suitability.

Contamination : The introduction or occurrence of a contaminant in food or food environment.

Disinfection : The reduction, by means of chemical agents and/or physical methods, of the number of micro-organisms in the environment, to a level that does not compromise food safety or suitability.

Establishment	:	Any building or area in which food is handled and the surroundings under the control of the same management.
Food Hygiene	:	All conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain.
Hazard	:	A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.
Food Handler	:	Any person who directly handles packaged or unpackaged food, food equipment and utensils, or food contact surfaces and is therefore expected to comply with food hygiene requirements.
Food Safety	:	Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.
Food Suitability	:	Assurance that food is acceptable for human consumption according to its intended use.
Primary Production	:	Those steps in the food chain up to and including, for example, harvesting, slaughter, milking, fishing.

1.13 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Your answer should include the following points:

Check Your Progress Exercise 1

1) Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.

2) Clean refers to aesthetics and relates to outward appearance, any discharge indicative of free from visible soil. Hygiene means free from disease causing organisms and other hazards / harmful contaminants.

3) Physical, Chemical and Biological hazard.

4) Physical – stones, wires, wood, glass, insects,

   Chemical – residues of pesticides, veterinary drugs, hormones, heavy metals, aflatoxins, food colours, food additives, and

   Biological – Any five pathogens should include parasites as well.

5) Through food itself, people, equipment and facilities, and food production process.

6) Primary production, procurement, production, packaging, storage, transportation, and at home / point of consumption.

7) i) Food Borne illness: Disease transmitted to humans by eating contaminated food.

ii) Disease caused by ingestion of sufficient number of micro-organisms of public health significance to cause an illness. Salmonellosis and listeriosis are results of invasions by micro-organisms.

iii) Disease caused by ingestion of a preformed bacterial toxin. Staphylococcal poisoning and botulism are intoxications.

8) Food Infections: Caused by ingestion of sufficient number of micro-organisms of public health significance to cause an illness. Salmonellosis and listeriosis are results of invasions by micro-organisms.

Food Intoxication: Caused by ingestion of a preformed bacterial toxin. Staphylococcal poisoning and botulism are intoxications.

9) 1.4.1 The food itself

1.4.2 People – safety of food

1.4.3 Facilities and equipment

1.14 SUGGESTED READING

Codex Alimentarius Commission - Recommended International Code of Practice, General Principles of Food Hygiene, CAC/RCP 1-1969, Rev. 4-20031.

UNIT 2 FOOD SAFETY SYSTEM

Structure

2.0 OBJECTIVES

After reading this unit, we shall be able to:

- understand the terms and definitions associated with food safety system;
- understand the need for food safety systems; and
- know how food safety relates to the entire food chain.

2.1 INTRODUCTION

Recent years have witnessed a very rapid growth in food industry and a resulting increased movement of foodstuffs around the world. This is evident from the variety of foods that are now available to us as consumer. Food grown in one country, processed and packaged in yet another is available for consumption virtually across the world. Our markets are flooded with products hitherto unknown to us. With few exceptions, most forms of fruits and vegetables can now be purchased throughout the year from food retailers throughout the world. It seems that growth seasons and location are no longer relevant to the consumer. The reasons for these changes have been attributed to the greater affluence of the population throughout much of the developed and developing world and emerging markets. Increased foreign travel for holidays or work purposes, and the growing cultural diversity in many countries has brought many people into contact with different cultures and their cuisines. The result has been a greater demand for more exotic food leading to new business opportunities for food traders and retailers.

However, this increased reach to different type of food articles has increased the risk for the consumers. For the food article coming from another country it is not known wheather it contain any chemical hazards like pesticide residues, antibiotic residues or

heavy metals or bio-chemical hazards like microbial toxins or pathogenic micro-organisms. Food contamination starts from the primary production level, processing procedures, transportation, storage, personnel, equipments, surroundings, waste disposal and water with the realization food may get contaminated. The current practices for ensuring food safety which are product oriented and have been built on inspection procedures are not adequate and are not sufficient to meet food safety requirements emerging due to scenario of world food trade. Therefore, organisations in the food sector need to manage risks, demonstrate good corporate responsibility and meet legal requirements if they want to remain competitive, protect their reputation and enhance their brand to achieve these goals they have to adopt an effective food safety management system based on a process standards.

2.2 CHANGES IN THE PATTERNS OF FOOD CONSUMPTION

Changes in life style of modern society are reflected by changes in consumer choice towards processed and convenience food that are readily available, easy to handle and require minimal time and effort to prepare. Currently food processing involves very large volumes of food, and these could be as ready to eat, frozen foods, semi processed foods, or even cleaned and cut fresh vegetables that are ready to be cooked without any further processing. All these processing operations are taking place in specific purpose built factories very much like any other engineering factory that we are more familiar with. Most of these processed foods largely chilled or frozen and ready to eat (RTE) can be purchased which require only heating prior to consumption.

However, we must understand that most of the convenience food contain high risk ingredients such as fish, meat and poultry and represent a new type of risk that can be realized during production, transport, storage, point of sale and preparation prior to consumption. It has been suggested that the continuing rise in incidence of food poisoning in many of the developed countries may be linked with this shift of emphasis towards convenience foods.

2.3 THE INCREASED RISKS OF FOOD BORNE INFECTION

Every year, the number of people at risk of food borne infections and related serious consequences are increasing. Opening up of trade in food from around the world offers far greater consumer choice but also increases the potential risk to human health. In spite of advances in scientific knowledge and stronger food regulations, food safety hazards in the form of prions, genetically modified foods, the incidence of bovine spongiform encephalopathy (BSE), and dioxin-contaminated foods are some of the new food safety concerns. Let us know about them.

Prions are one of the new sources of food borne diseases. A prion is the short form of proteinaceous infectious particle. Dr. Stanely Prusiner coined the word "prion" as a name for the infectious agent by combining the first two syllables of the words "proteinaceous" and infectious" while the infectious agent was named a prion, the specific protein that the prion was made of was named PrP, an abbreviation for "protease- resistant protein". The normal form of the protein is called PrPC, while the infectious form is called PrPSc, which stands for prion protein of scrapie. Prions are generally quite resistant to denaturation by protease, heat, radiation and formalin treatments, although potency or infectivity can be reduced.

Prions enter cells and apparently believed to infect and propagate by refolding abnormally into a structure which is able to convert normal molecules of the protein into the abnormally structured form. The proteins accumulate in the brain causing holes or plaques and the subsequent clinical symptom leading to death.

Prions diseases are grouped as transmissible spongiform encephalopathy (TSE). The diseases associated by prisons are: Creutzfeldt – Jakob Disease (CJD), Bovine spongiform encephalopathy (BSE- commonly known as "mad cow disease"), fatal familial insomnia and kuru (translated as "to tremble with fear").

Bovine Spongiform Encephalopathy (BSE): Bovine Spongiform Encephalopathy is commonly known as mad – cow diseases. It is a progressive neurological disorder (brain disease) of cattle that results from an infection by an unconventional transmissible agent. BSE is one of a transmissible Spongiform Encephalopathies (TSEs) that affect a number of different mammals.

Creutzfeldt – Jakob Disease (CJD): It is one of the most commonly known diseases among humans. This is a rare and fatal form of dementia and mainly occurs in individuals between the ages of 40 and 80.

Dioxin – Contaminated Foods: Dioxin is the popular name for the family of halogenated organic compounds, the most common consisting of polychlorinated dibenzofurans (PCDFS) and polychlorinated dibenzo-p-dioxins (PCDDs). PCDD/ PCDFs are industrial pollutants that persist in the environment. They have been shown to bio-accumulate in humans and wildlife due to their lipophilic (fat loving) properties. Dioxins are carcinogen in higher amounts, and cause developmental and reproductive problems. They are absorbed primarily through dietary intake of fat, as this is where they accumulate in animals, including humans.

Genetically Modified (GM) Foods: The GM foods are produced from genetically modified organisms (GMO). A GMO means: an organism that has been modified (manipulation of DNA) by gene technology. Genetically modified (GM) crops and food are being grown and consumed by the public. The advantages associated are: increased yields from agriculture, more powerful control of pests and weeds, reduced use of some agrochemicals and enhancement of nutritional value or other characteristics of crops, etc. There are many things which people hold up as possible dangers of genetic modification: risk of transferring crop traits to wild species, negative impacts on wildlife from more powerful control of pests and weeds, increased use of some agrochemicals, increased corporate control of seed supply and; limited studies on food safety concerns on human health in form of toxins/allergenic reactions/ reduction in good micro flora of duct, etc.

2.4 INADEQUACY OF THE EXISTING METHODS TO CONTROL THE RISK

Potential for contamination of food starts from the primary production on account of plant and animal disease, drug / pesticide residues, farm processing procedures, storage and transportation, personnel, equipment / vessel, surroundings, waste disposal and water. Further during food processing potential for contamination and food safety hazards arises from layout and surroundings of the processing facility, raw materials and packaging material used, transportation, storage conditions, time, handling. Processing including packaging, machine and equipment, maintenance, personnel, water, steam, ice, chemicals – detergents, sanitizers, pesticides, pests – insects flying, crawling, rodents, birds and waste disposal. With this realization that food can get contaminated

at any stage in the food chain, the current practices for ensuring food safety which are product related and have been built on inspection procedures, do not appear to be adequate to control the food-related illnesses from occurring and may not be sufficient to meet the complexities and needs for food safety emanating from the changing scenario in food world trade, usage of vast numbers of ingredients and additives, complex processes, improved packaging and food processing technologies and emergence of new hazards.

The food manufacturing industry has seen many changes, including newly recognized pathogens, more sophisticated technologies, and increased automation. While GMPs can control many food safety problems, it is not clear that current GMPs adequately address these new developments.

Check Your Progress Exercise 1

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of the unit.

1) How modern life style has changed the pattern of our food consumption?

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2) How the opening up of trade in food from around the world has increased the risk from food born infection?

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3) Why the existing methods of food safety are inadequate to meet the need of food safety?

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2.5 NEED FOR FOOD SAFETY MANAGEMENT SYSTEMS

Safe food is critical for consumers and business. Many of us have grown up trying to avoid various common hazards and try to protect our children from getting injured by

these despite our familiarity with food poisoning from microbiological and chemical causes, or injury from glass, wire and other dangerous physical objects, their control is difficult and occasionally they result in serious consumer safety exposures and expensive product recalls and retrievals for the food industry.

As we witness a tremendous growth in diversity of food products and processes, we must not lose sight of the associated enhanced risks of food borne illnesses. While much of our food supply is safe, several recent high profile cases around the world underline the potential danger of food borne illness to consumers, employees and damage to brand value. A few recent examples include BSE infected beef, the salmonella contamination of poultry and eggs and high levels of listeria in dairy products. For these reasons and others, global retailers, distributors, food manufacturers and food service companies are now concerned more about the safety of their food supply chain than ever before.

Organisations in the food sector need to manage risk demonstrate good corporate responsibility and meet legal requirements if they are to remain competitive, protect their reputation and enhance their brand. And hence an effective food safety management system based on a proven standard will help the food processing / food industry achieve these goals.

2.6 EMERGING TRENDS IN FOOD SAFETY

2.6.1 Food Safety Legislation

World Health Organization (WHO) and Food and Agriculture Organization (FAO) set up the "Codex Alimentarius" in 1963. The mission of the Codex Alimentarius is to set international food standards to help governments and business to achieve adequate consumer protection.

The Codex Commission helps to raise the awareness of governments on food safety issues, and serves as a reference for food safety standards and food regulations. It helps also facilitate international trade in foods by preventing unscientific restrictions while considering differences in tradition, culture and legal systems among countries.

An increasing number of governments are working with the Codex Alimentarius Commission and adopting to the concept of controlling food safety through legislation and regulation. For example, the model adopted for regulating food producers in US is based on the following five principles:

a) Only safe and wholesome foods may be marketed;

b) Regulatory decisions making in food safety is science based;

c) The government has enforcement responsibility;

d) Manufacturers, distributors, importers and others are expected to comply and are liable if they do not; and

e) The regulatory process is transparent and accessible to the public.

At home in India, the Government of India has recently enacted the Food Safety & Standards Act, 2006, stating its objectives as: "An act to **consolidate the laws** relating to Food and to establish Food Safety & Standards Authority of India for laying down **Science based standards** for articles of food and to regulate their manufacture, storage, distribution, sale and import, to ensure availability of **safe and wholesome** food for human consumption and for matters connected therewith or incidental thereto".

It is evident that most of the Governments frame food laws that have precautionary approaches embedded in them and are more often than not based on science-based risk analyses. Compliance to the law of the land which is binding on all producers of food is a means practiced for protecting and safeguarding the health of its citizens adequately from illness or injury caused by food, and providing an assurance that food is suitable for human consumption.

2.6.2 Customer Audits of Food and Food Products

Likewise large food organisations supplying food sourced from a wide number of countries, suppliers, including the large retail chains, are responsible for the safety and quality of food products supplied by them. For ensuring this they take the precaution of auditing their supplier's food hygiene arrangements and carry out testing of their products. These organisations recognize that they need to show due diligence in assuring themselves of the food safety and quality of the food products they supply to their customers. Failure to carry out appropriate testing can be interpreted as lack of due diligence and lead to prosecution if their food products are shown to be unfit for human consumption. But what is emerging from all these customer requirements and audits is a multiplicity of systems for ensuring food safety and thus an added burden on the food industry of complying with all such requirements.

Many organisations operate structured quality assurance systems to ensure that information regarding product quality and safety is available to them in the form of records. Food businesses generally require their suppliers to have similar quality assurance systems, and to make information from suppliers systems available to them as part of the due diligence approach to food safety. The system of checks of balances, which constitute quality assurance systems, will thus be a requirement at every stage of the food chain from primary producers through to the retailer. Although, it is generally accepted that precaution is a legitimate element if food safety decisions, disputes arise when such decisions adversely affect the economic performance of the agriculture and food industries.

2.6.3 Food Safety Management Systems

The Industry thus needs to deploy systems with a view to:

a) providing food which is safe and suitable for consumption;

b) ensuring that consumers have clear and easily-understood information, by way of labelling and other appropriate means;

c) enabling them to protect their food from contamination and growth/survival of food borne pathogens by storing, handling and preparing it correctly; and

d) maintain confidence in internationally traded food.

We are all aware that customer's requirements are often incorporated in specifications, but specifications may not in themselves guarantee that customer's requirements will be met consistently. Normally deficiencies in the organizational system to supply and support the products lead to inconsistency in meeting the customer's requirements.

The frontline defense against the growing and evolving threat of food borne diseases and illnesses is the application of a preventive risk assessment based food safety programme like Hazard Analysis Critical Control Points (HACCP) and ISO 22000 designed to prevent the occurrence of potential food safety problems. A common

foundation for building a food safety management system is based on HACCP, or Hazard Analysis and Critical Control Point methodology.

Today worldwide we are recognizing the importance of risk assessment in achieving food safety goals. Adoption of the recommendations of the Codex Alimentarius and the application of the excellent principles of risk assessment suggests that controversy should not be an issue with food safety.

Risk assessment on food safety is generally based on the best available scientific evidence which may reach the conclusion of reasonable certainty of no harm based on the available scientific data at the time. Unfortunately, this is no guarantee of safety, as it does not mean there is no risk. In practice, it is taken to mean that the risk is no greater than is socially acceptable. It is also the case that quantitative risk assessments are only valid where the data is good and well understood. It is suggested that risk assessors tend to discount risks where data is less than conclusive. There is a tendency to stress what is known and to overlook what is unknown, thus equating lack of proof of harm with proof of lack of harm.

The need for risk based food safety management systems is further fueled by the growing trend in the international trade for worldwide equivalence of food products and the Codex Alimentarius Commission's adoption of HACCP as the international standard for food safety. HACCP represents an important food protection tool which can be practiced by all companies and integrated into the existing system of any establishment, irrespective of their size.

To ensure that food safety risks are minimized, food sector businesses need to operate a food safety management system. With so many food safety regulations to comply along with demanding customer requirements, many businesses do not know where to start.

Today management systems need to take into account not only basic food regulations and acceptable workplace practices, but include contingency plans for potential crises such as product recall. All these types of practices form the basis of a food safety management system.

HACCP is a systematic, science based process that identifies hazards and the measures necessary for their control to ensure a safe food product. HACCP systems seek to prevent the expression of hazards rather than relying on end product testing. It can be applied throughout the food chain from primary production on the farm to consumption of food in the home, or restaurant. HACCP is a management tool that can be audited, which aids inspection by the regulatory authorities and engenders product confidence within the food industry. Codex HACCP propagates aspects of food safety management with the aim of ensuring that the organisation can time and again deliver the product that meet the customer's requirements. However, the design and implementation of the quality and food safety systems are influenced by the changing needs of the organisation, its objectives, products and services it provides. ISO 22000 is an International Standard on Food Safety Management Systems. ISO 22000 is a generic Food Safety Management Standard and can be used by any organisation directly or indirectly involved in the food chain. It applies to all organisations in the food chain. It doesn't matter how complex the organisation is or of what size it is, ISO 22000 can help ensure the safety of its food products.

The food chain consists of the entire sequence of stages and operations involved in the creation and consumption of food products. The food chain also includes organisations that do not directly handle food. These include organisations that produce feed for animals used as food. It also includes organisations that produce materials that will eventually come into contact with food or food ingredients as per details given below:

a) Primary producers

- Farms
- Ranches
- Fisheries
- Dairies

b) Processors

- Fish processors
- Meat processors
- Poultry processors
- Feed processors

c) Manufacturers

- Soup manufacturers
- Snack manufacturers
- Bread manufacturers
- Cereal manufacturers
- Dressing manufacturers
- Beverage manufacturers
- Seasoning manufacturers
- Packaging manufacturers
- Frozen food manufacturers
- Canned food manufacturers
- Confectionery manufacturers
- Dietary supplement manufacturers

d) Food service providers

- Grocery stores
- Restaurants
- Cafeterias
- Hospitals
- Hotels
- Resorts
- Airlines
- Cruise ships
- Seniors lodges
- Nursing homes

e) Other service providers

- Storage service providers
- Catering service providers
- Logistics service providers

- Transportation service providers
- Distribution service providers
- Sanitation service providers
- Cleaning service providers

f) Product suppliers

- Suppliers of tools
- Suppliers of utensils
- Suppliers of equipment
- Suppliers of additives
- Suppliers of ingredients
- Suppliers of raw materials
- Suppliers of cleaning agents
- Suppliers of sanitizing agents
- Suppliers of packaging materials
- Suppliers of other food contact materials

ISO 22000 shows organisations how to combine the **HACCP plan** with prerequisite programs (or programmes) and operational prerequisite programs into a single integrated food safety management strategy.

Today, it is widely recognized by the industry that meeting the business challenges through the implementation of quality and Food Safety Management Systems may be more effective and less costly than simply responding to concerns as they arise. The benefits associated with approaching quality and food safety issues in a proactive, rather than a reactive, manner are numerous. Needless to say that demonstration of implementation of these systems shall go a long way in achieving commercial business goals.

Check Your Progress Exercise 2

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of the unit.

1) What is Food Safety Management System?

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2) What are the emerging trends in food safety?

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3) What are the five principles for regulating producers in the U.S.?

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4) What are the aims of Food Safety Management System?

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2.7 LET US SUM UP

We all know that food borne illness and food borne injury are at best unpleasant, at worst, they can be fatal. But there are also other consequences. Outbreaks of foodborne illness can damage trade and tourism, and lead to loss of earnings, unemployment and litigation. Food spoilage is wasteful, costly and can adversely affect trade and consumer confidence.

International food trade, and foreign travel, is increasingly, bringing important social and economic benefits. But this also makes the spread of illness around the world easier. Eating habits too, have undergone major change in many countries over the last few decades and new food production, preparation and distribution techniques have developed to reflect this. Effective hygiene control, therefore, is vital to avoid the adverse human health and economic consequences of food borne illness, food borne injury and food spoilage. Everyone, including farmers and growers, manufacturers and processors, food handlers and consumers, has a responsibility to assure that food is safe and suitable for consumption.

2.8 KEY WORDS

Food Safety : Assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use.

Food Chain : Sequence of the stages and operation involved in the production, processing, distribution, storage and handling of a food and its ingredients from primary production to consumption.

Food Safety Hazard : A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

Flow Diagram : Schematic and systematic presentation of the sequence and interactions of steps.

Control Measure : (food safety) Activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

2.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Your answer should include following points:

Check Your Progress Exercise 1

1) Creation of nuclear families in which both husband and wife are working has created a demand for convenience food and for health of consumers of the present day, customers has created the increased market for minimal processed food.

2) Opening of the trade in food from around the world has increased the risk of food hazards in forms of Bovine Spongiform Encephalitis, Avian flue, Listeria monocytogness and pesticides and antibiotic residues and heavy metals due to lack of control of the discharge of waste form industrial units and exercised use of pesticide and antibiotics in agriculture and animal husbandry.

3) The current practices for ensuring food safety which are product central and built on inspection procedures are not adequate to control the food related illness from the emergence of new hazards.

Check Your Progress Exercise 2

1) Food Safety Management System (ISO -22000) specifies requirements for a Food Safety Management Systems where an organisation in the food chain need to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the line of consumption. It is integration of quality management system, food safety and environment management system.

2) Emerging trends in food safety are the new food safety legislations at international level like Codex Alimentarius raise the awareness of governments on food safety issues and serve as a reference for food safety standards and regulations. At national level the Government of India has recently enacted the Food Safety and Standards Act 2006 and established Food Safety and Standard Authority.

3)
- Only safe and wholesome food may be marketed.
- Regulatory decisions making in food safety is science based.
- The government has enforcement responsibility.
- All the players in food chain are expected to comply and are liable if they do not comply.
- The regulatory process is transparent and accessible to the public.

4)
- Providing food which is safe and suitable for consumption.
- Enabling the consumers to protect their food from contamination by storing, handling and preparing it correctly.
- To maintain confidence in international food trade.

2.10 SUGGESTED READING

Codex Alimentarius Commission - Recommended International Code of Practice, General Principles of Food Hygiene, CAC/RCP 1-1969, Rev. 4-20031

UNIT 3 TOTAL QUALITY MANAGEMENT

Structure

3.0 OBJECTIVES

After studying this unit, we shall be able to:

- enumerate different aspects of Total Quality Management;
- state the need for Safety and Health Management;
- know the approach towards safety;
- understand the system approach to management of safety and health;
- understand the guiding principles of ISO 9000;
- general occupational health problems; and
- state how to control of health risks in industries.

3.1 INTRODUCTION

Total Quality Management (TQM) has become a buzzword in the business management field all over the world. Its philosophy and approach seem to have caught the imagination of organizational managers who find themselves in the midst of intense competition and are thus concerned with their survival. The concept, however, has not appeared overnight but has evolved over a period of time.

In this unit, we address ourselves to several issues related to the philosophy and approach of TQM. First, we attempt an answer to the basic question as to why there is a need for quality management, and why organisations all over the world find it essential to look to this approach as a panacea to their problems?

After getting convinced about the need for adopting a strategic approach in the form of TQM, we then proceed to understand the basic concepts on which the TQM approach is based. You will also learn the necessary vocabulary so that you can communicate in the language of TQM.

Equipped with this basic knowledge, we will finally discuss the important ingredients of the TQM philosophy, its approach and it's principles.

The significance of Safety and Health in business can be perceived from the following statement of Peter Drucker.

The first duty of business is to survive and the guiding principles of business economics is not the maximization of profits, it is the avoidance of loss.

Any accident can lead to the loss of three Ps i.e. People, Property and Process, which affect the bottom line of a business.

Safety and Health Management deals with the avoidance of such accidents and thus prevents occurrence of losses.

A systems approach to management of safety and health is very important for an organisation attempting to imbibe a TQM culture. You are all aware that the overall success of a business enterprise depends on:

- The people;

- The process; and
- The customers

A) **People:** TQM requires involvement of all the people in the organisation. The business activities are perceived, processed and delivered by the people. Commitment and contribution of people are achieved through various pro-active measures like empowering them, providing training to enhance their capabilities; and above all recognizing their excellent performance.

   Performance of the people can be achieved provided management takes care of their safety and health at the work place.

B) **Process:** The business inputs (raw materials) need to be processed to convert them into value added products. The conversion process may involve use of machinery and equipment. Safety, health and environment are therefore essential elements to be considered in order that the processes become effective and efficient. The processes directly affects the productivity of the organisation. Suppose there is an accident in a machine shop, the immediate effect will be loss of production due to downtime of the machine, operators' injury and curiosity amongst co-workers.

   Some chemical processes generate obnoxious fumes in the plant which are a health hazard. Unless the hazard is removed the people cannot work in the plant continuously. Productivity and quality will be affected.

C) **Customers:** In the present scenario, customers are becoming more and more aware about the safety and health problems regarding the products and services they buy from the suppliers. This is not only true for western customers but also for Indian customers as well. You will recall, recently a number of chemical industries like galvanizing plants have been ordered to be shifted out of the capital (Delhi) for health reasons.

The importance of safety and health in relation to TQM can be better understood by looking at Malcolm Baldrige Criteria (National Quality award of USA) for business excellence. One of the criteria of the Malcolm Baldrige award scheme is Employee well being and satisfaction. This requires examining how the company includes employees' well being factors such as health and safety into its quality improvement activities.

This requires us to understand how the company determines the root causes of employee accidents and work place hazards and how these hazards are eliminated.

We will study more in this unit about managing safety and quality in systematic way.

3.2 WHY QUALITY MANAGEMENT?

Total Quality Management (TQM) in its various forms appears to dominate business life now-a-days. In the earlier days, before the emergence of the industrial Revolution, quality did not pose any problem as the emphasis was on individual craftsmanship, workmanship and skills. The era of mass production initiated the industrial revolution and quality started getting attention, from then on, quality has been a problem addressed for a long time and has progressed from stages of playing a purely reactive role (inspection) to its present prominence in shaping the competitive strategy of business. Fig.3.1 depicts this evolution. The development of quality management through phases

involved the work of pioneers such as Juran, Feingenbaum, Deming, Crosby, Ishikawa and many others. The quality movement has thus progressed until the present day when quality has taken a central place in determining the organizational objectives and competitive positives.

It seems that, besides the Japanese, the rest of the world has suddenly woken up from a long sleep with eagerness and a sense of urgency to be updated on all the potential benefits of quality which is being adopted as a way of conducting business. Let us now look briefly at some of the important factors, which caused this realization. They are:

3.2.1 Question of Survival in an Intense Competitive Environment

The industrial development in any society/country takes place in phases. In the initial phase, subsequent to identifying a need, one or few suppliers emerge to provide the product/service to satisfy the need of customers. This near-monopoly situation dominated by the suppliers creates a seller's market enabling the suppliers to provide a product/service of the quality they are capable of providing without bothering whether their products satisfy the need or not. However, soon in the later phase, more and more suppliers looking for business opportunities emerge on the scene creating a buyer's market enabling the customers to choose a supplier. As you must have observed, over the last 10 years or so, phenomenal changes have taken place in the economic scenario all over the world. By now, we are sure, you are familiar with the terms "globalization" and "liberalization". Economic barriers, which existed in many world economies, have broken down and the whole world, economy-wise, has shrunk as one big market allowing almost free exchange of goods and services. Suppliers now not only face competition from domestic suppliers but also from the international ones. All the suppliers try their best to retain and possibly increase their market share. We are in the era of intense competition, and for suppliers all over the world it has become a question of survival. Just conforming to specifications and satisfying the needs of the customer is no more enough. The emphasis now is on delighting and winning over customers. The earlier concepts of quality management have been found inadequate to meet this objective, giving rise to the present concept of **Total Quality Management**.

3.2.2 Increasing Customer Consciousness

Customers all over the world are becoming increasingly conscious about getting more than just value for the money paid for products and services they buy. Backed by government laws and regulations, a number of agencies (governmental and non-governmental) have emerged which are working for protection of consumer's interests. The needs of the customers also keep on changing fast. Unless the suppliers are fast enough and are capable of satisfying the changed needs, they just lose the customers, ultimately resulting in a reduction in their market share.

3.2.3 Need for Earning Profit instead of Making Profit

All business organisations have to be profit-oriented as profits are essential for the very survival of the organisation and are also needed for its growth. In the earlier economic situation of seller's market, organisations used to make profit through the age-old equation of cost price (CP) + Profit (P) = Sales price (SP). The selling price used to be fixed in such a way that it automatically ensured making of as much profit

as desired by the supplier organisation. In the present prevailing competitive buyer-dominated situation, this equation is no more valid as the market forces now determine the selling price. Therefore, if the supplier organisation has to achieve the profit objective, it has now to earn profit by controlling the cost price. As you are aware, some of the major components which make up cost price are costs of material, energy and human resources. You are also aware how all the three costs keep on rising and the supplier organisation has no control on the cost of these inputs. So, for controlling the cost price, the only major way in the hands of the supplier is to reduce what is known as 'quality cost' i.e. cost incurred by an organisation for making nonconforming products from a big chunk of the total sales turnover – as much as 20 to 30 % as revealed by way of case studies. You will learn more about quality cost as you go along. To reduce the quality cost, the objective of the supplier should, therefore, be to make things right first time and every time – a TQM approach.

3.2.4 Organizational Issues Pointing to the need to Focus on TQM

- That Leadership plays a very crucial role in the total business performance of the organisation has now been realized. The quality of an organisation is largely influenced by the quality of its leader. And, therefore, it has to be a major ingredient of quality management.
- Human resource management is one issue that is receiving increasing attention in organisation all over the world. In fact, it has been a major factor for many Japanese organisations to become world leaders. Though not considered important enough earlier, it now forms another major component of quality management.
- The advent of revolution in information technology:

  This has an impact on the total quality performance of the organisation in following ways:

  i) It intensifies the need for everyone in the organisation to be computer literate.

  ii) The distribution of power relating to technical, problems solving, and decision-making abilities in the organisation through computer networks.

  iii) The speed, directness and immediacy of information exchange, both within the organisation at all levels and between organisations and key external stakeholders (suppliers and customers), is redefining business relationship and responsibilities.

If you appreciate the factors listed above, you will realize the inadequacy of the earlier static approach to quality management and the need for some dynamic approach. This is provided by what has come to be known as Total Quality Management approach (TQM). As per definition provided by the International Organisation for Standardization (ISO), TQM is a "management approach of an organisation, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction and benefits to all members of the organisation and to society".

Before we discuss and understand the philosophy and approach of TQM and its implications, let us get acquainted with some of the basic concepts on which TQM approach is based and clear understanding of basic concepts is very essential.

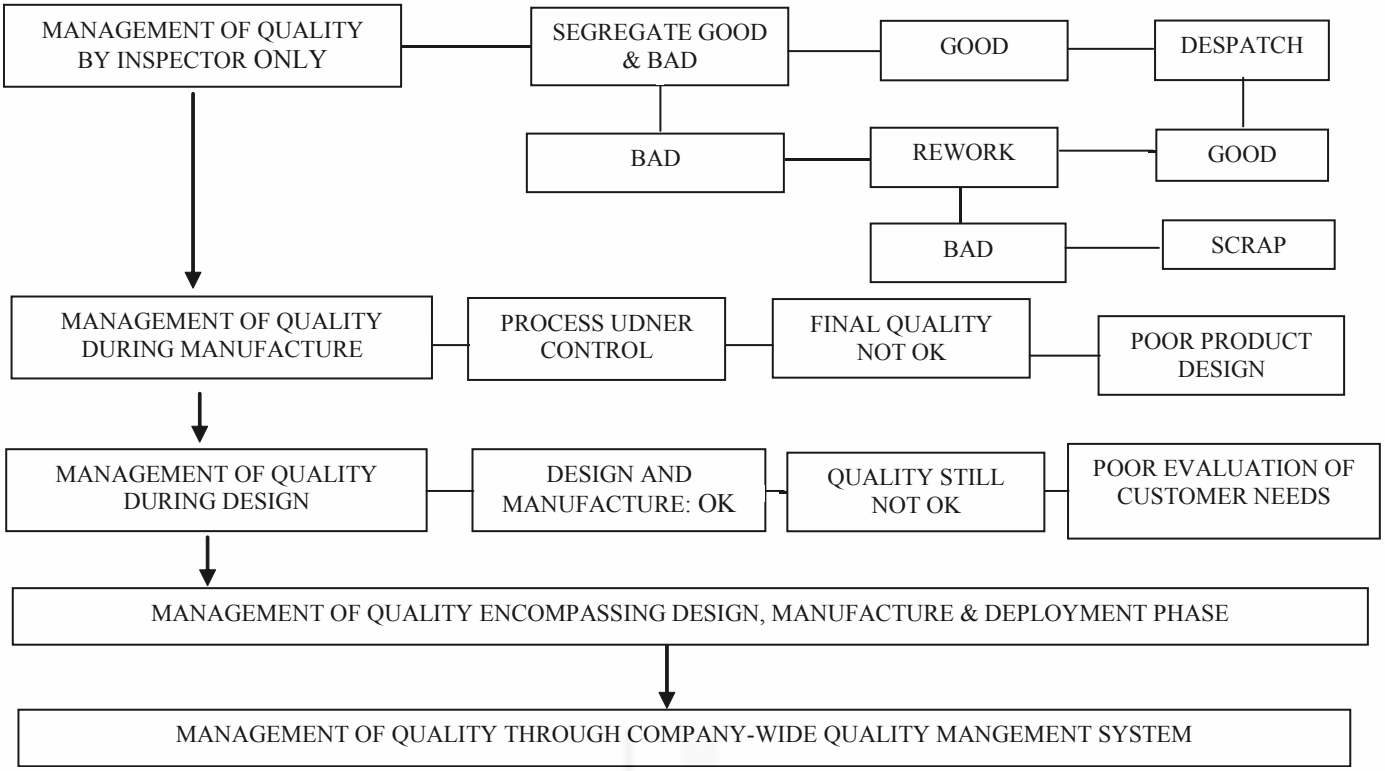

Fig. 3.1: Quality Management Concept

TQM is the application of quantitative methods and human resources to improve:

i) The material and services supplied,

ii) All the processes within the organisation, and

iii) Degree to which the needs of the customers are met

The TQM is a process and a journey and continuous; it is not a destination. It is a philosophy, culture and a way of doing business.

3.2.5 Basic Tenets of TQM

- Focus on customer satisfaction,
  - Internal customers
  - External customers
- Continuous improvements,
- Employee investment and empowerment,
- Measurement and documenting the work,
- Doing it right the first time,
- Effective communication, education and training,
- Leadership from top, and
- Providing everyone with the opportunity to do their job properly.

3.2.6 Benefits of TQM

- Improvements in leadership qualities and more visible leadership from executives and senior managers.
- Involving personnel in decision making process.

- Increased confidence of personnel in their ability to carry out their work and to achieve targets.
- Reduction of mistakes, increased pride in work, sense of achievement for workers.
- Opportunity for self-development and self-improvement of personnel through a pro-active involvement in work.
- Opportunity to engage in creative thinking to improve product quality and work environment.
- Increased co-operation, quality and work environment.
- Increased co-operation, improved teamwork and reduced conflict.

3.3 UNDERSTANDING SOME BASIC CONCEPTS

3.3.1 Definition of "Quality"

Quality of foods may be defined as the composite of those characteristics that differentiate individual units of product, these characteristics should have significance in determining the degree of acceptability of that unit by the buyer.

The word 'quality' is the most commonly used word by all of us. At the same time, it is one of the most difficult words to define properly. It is a perception of what you are looking for in a product or service and therefore varies from individual to individual. It is akin to another word 'beauty' about which it is said, "beauty lies in the beholder's eyes". In the context of quality management also, there are as many definitions of quality as there are books, authors and protagonists. Some of them, spelt out by very prominent Gurus and widely accepted, are as follows:

i) Quality is a predictable degree of uniformity and dependability, at low cost and suited to the market (Deming).

ii) Quality is fitness for use (Juran).

iii) Quality is conformance to requirements (Crosby).

iv) Quality is the (minimum) loss imparted by a product to society from the time of the product is shipped (Taguchi).

v) Quality is, in its essence, a way of managing the organisation (Feigenbaum).

vi) Quality is correcting and preventing loss, not living with loss (Hoshim).

Each of the above definitions (and several others by various authors) holds a strong but limited vision of quality. The universally accepted definition of 'quality', which is provided to us by ISO, is as follows:

Quality is the degree to which a set of inherent characteristics fulfils requirements **(ISO 9000:2005)**

This is sentence definition, though it appears simple enough, conveys a lot of meaning about requirements of quality. The second part of the sentence is crucial as it emphasizes the ability of the entity to satisfy stated and implied needs of a customer. An entity may be a process, a product or an organisation. Needs or requirements may be stated in the form of a specification by the customer or they may be unstated but implied either by convention, customers' expectations or by statutory requirements of society. The implied needs are expected to be identified by the supplier.

3.3.2 Definition of "Product"

It is important that we understand what the term 'product' in terms of quality management. A 'product' is the result of a process and includes service, hardware, software and processed materials. It can again be a tangible (e.g. assemblies or processed materials) or intangible (e.g knowledge or concepts) or a combination thereof.

3.3.3 Dimensions of Quality

Based on the stated and implied needs of the customer, the product to be provided by the supplier has to have certain characteristics and features and ultimately it is the customers who determine whether or not quality has been achieved. Standards have, therefore, to be established enabling the characteristics to be measured either by determinants or by subjective criteria or a combination of both. The various dimensions of quality, which the customers look for in a product in order to satisfy their needs, determine the characteristics of the product.

Dimensions of Quality

1) For Manufactured Product
   - **Performance:** Product's primary operating characteristics.
   - **Features:** Secondary characteristics that supplement the product's basic functioning.
   - **Reliability:** The probability of a product's surviving over a specified period of time under stated conditions of use.
   - **Conformity:** The degree to which physical and performance characteristics of a product match pre-established standards.
   - **Durability:** The amount of use one gets from a product before it physically deteriorates or until replacement is preferable.
   - **Serviceability:** The ability to repair a product quickly and easily.
   - **Aesthetics:** How a product looks, feels, tastes or smells.
   - **Perceived Quality:** Subjective assessment resulting image, advertising or brand name.
2) For a service
   - **Time:** How much time must a customer wait?
   - **Timeliness:** Will a service be performed when promised?
   - **Completeness:** Are all items in the order included?
   - **Courtesy:** Do front-line employees greet each customer cheerfully and politely?
   - **Consistency:** Are services delivered in the same fashion for every customer and every time for the same customer?
   - **Accessibility and Convenience:** Is the service easy to obtain?
   - **Accuracy:** Are the services performed right the first time?
   - **Responsiveness:** Can the service personnel react quickly and resolve unexpected problems?

3.3.4 Facets of Quality

For the supplier, the following are the four facets of quality, which cover most of the quality dimensions that are key contributors to product quality:

i) **Quality due to definition of needs for the product:** The first facet of quality is due to the extent and completeness of defining and updating the product needs to meet market places requirements and opportunities.

ii) **Quality due to product design:** The second facet of quality is due to designing into the product the characteristics (based on quality dimensions) that enable it to meet marketplace requirements and opportunities, and to provide value to customers and other stakeholders.

iii) **Quality due to conformity to product design:** The third facet of quality is due to maintaining day-to-day consistency in conforming to product design and in providing the designed characteristics and values for customers and other stakeholders.

iv) **Quality due to product support:** The fourth facet is quality due to furnishing product support throughout its life cycle, as needed, to provide the designed characteristics and values for customers and other stakeholders.

3.3.5 Concept of a Process and its Networking

In any organisation, all work is accomplished by a process. According to the definition provided by ISO "a process is a set of inter-related or interacting activities which transform inputs into outputs" (ISO 9000:2005). The resources may include personnel, finance, facilities equipment, techniques and methods. Every process, therefore, has to have inputs and, after value addition, results into outputs. The output of a process, for example, may be an invoice, computing software, liquid fuel, a clinical device, a banking service or an intermediate food product.

The absence of a clearly defined process makes the activity subject to an arbitrary mode of execution and its outcome or output subject to unpredictable performance. In order to "do it right the first time" and "do the right things right", processes must be effectively managed. When processes are not adequately managed, quality may regress to mediocrity.

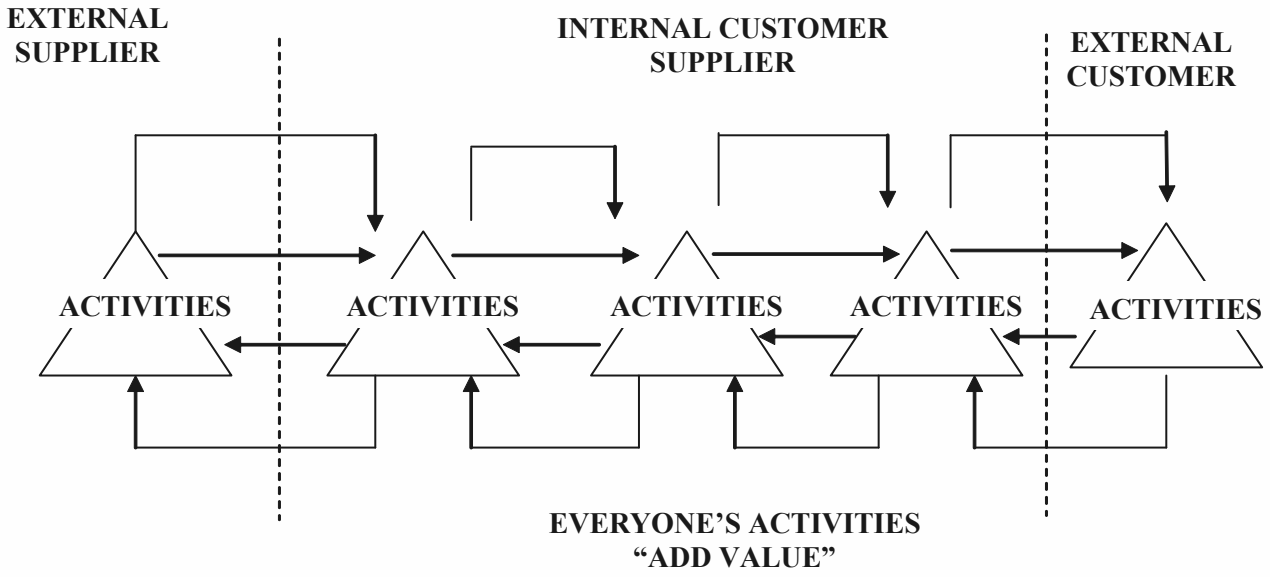

Fig. 3.2: Customer – Supplier chains and value additions

Every organisation exists to accomplish value-addition work. The work is accomplished through a network of processes and sub-processes. An external customer is affected by any one or more processes at any given time. Every process has internal customers (those who depend on it or affected by it) and internal suppliers (those who provide the necessary input for that process). Consequently, everyone in the organisation serves a customer or serves someone who is serving a customer. This supplier-customer chain is formed by all the processes/subprocesses and persons operating them right upto the time the external customer receives the product or/and service. The quality of the work of a person or a process, which servers as a link in the chain decides the quality of the product provided to the customer as per the saying "The strength of the chain is determined by its weakest link." Fig. 3.2 describes the value addition in the process network.

3.3.6 Stakeholders and their Expectations

Stakeholder(s) is an individual or group of individuals with a common interest in the performance of the supplier organisation and the environment in which it operates. Every organisation as a supplier has five principal groups of stakeholders. The supplier should meet the expectations and needs of all its stakeholders. See Table 3.1 for details.

Table 3.1: Stakeholders and their Expectation

	Suppliers Stakeholders	Typical Expectations or Needs
1.	Customers	Product quality
2.	Employees	Career/work satisfaction
3.	Owners	Investment performance
4.	Sub-suppliers	Continuing business opportunities
5.	Society	Responsible Stewardship

3.3.7 Quality Control and Quality Assurance

a) **Quality Control:** As per the definition provided by ISO **"**part of **quality management** focused on fulfilling quality requirements (ISO 9000:2005)". The activities and the techniques used, therefore, have the following objectives:

i) to ensure true expression/correct translation of stated and implied needs of the customer (both internal and external) in the form of standards specifying quantitative and qualitative measurable characteristics;

ii) to monitor the process for realization of the product at various stages of its operation and eliminating causes of unsatisfactory performance at all stages of quality loop in order to achieve economic effectiveness;

iii) inspection of the product/service package to determine conformance to customer needs;

iv) to provide a feedback of data for bringing about improvements wherever possible.

b) **Quality Assurance:** As per the definition provided by ISO, Quality assurance means "part of **quality management** focused on providing confidence that quality requirements will be fulfilled" ISO 9000:2005. In other words, it means all the planned and systematic activities, implemented within the organisation for

quality management, to provide adequate confidence that a product or service will satisfy given requirements for quality.

Essentially, quality assurance is a preventive activity and is, therefore, required to be systematically planned in advance. The activity includes identification and planning of the checks, inspection and control of process as a part of quality control. Quality assurance also means establishment of a quality system which can demonstrate. If required, the capability of the organisation to satisfy the requirements of the customer. Quality assurance provides confidence internally to the management and externally to the customer.

3.3.8 Standardisation

a) The concept and its evolution

The concept of standardization is as old as nature itself. In its broader sense, the standardization has furnished the base on which nature has created the universe. The various natural phenomena which furnished the base on which have been taking place for millions of years like the movements of planets, changing seasons on the earth, living beings reproducing themselves and maintaining their features, all reflect a definitive pattern of things.

Perhaps the most striking example of standardization in the early history of human civilization to establish language as a means of communication enabling the early humans to convey their thoughts, feelings and messages to each other. Another example of standards consciously and deliberately developed by the ancients is that of weights and measures which formed the basis of all measurements.

With the onset of industrial revolution caused by the concept of mass production, through interchangeability of parts, necessitated the development of modern standardization. By the time, the First World War broke out, standardization had been well recognized as an industrial process capable of ensuring productivity through interchangeability, not only within a given factory but also from one factory to another, and the importance of creating industry-wise standards and national standards slowly began to be realized. Where the experience of the First World War revealed the potentialities of standardisation, it was the Second World War, which brought even more pointed urgency for national and international standardization. The supply and maintenance facilities of the Allies were severely strained because of differences in standards, which prevented interchangeable use of tools and even of common engineering items like bolts, nuts and screws. Supply management during the War also re-emphasized the importance of standardization and reduction in variety of materials and products, and brought about evolution of many new techniques, including operational resource, value analysis linear programming, statistical quality control and so on. Another factor, which gave a spirit to the standardistion movement after the Second World War, was the creation of United Nations Standards Co-ordinating Committee for bringing together the existing national standards bodies into an international forum. Standardistion now is recognized as a vital ingredient of industrial efficiency and a pre-requisite for quality management systems. It is firmly believed that efficient and effective standardization techniques, correctly interpreted and properly applied in almost all functional areas of the organisation, form the essential requirement of successful quality management systems. Standardization and quality management go hand-in-hand.

b) Definition of Terms

Standardisation: According to the ISO definition "Standardisation is an activity of establishing, with regard to actual or potential problems, **provisions** for common and repeated use, aimed at the achievement of the optimum degree of order in a given context". ISO Guide 2:2004

Notes

i) The definition implies that the process is for both formulating the standard and its implementation.

ii) The emphasis is on cooperation of all concerned and on achieving consensus (agreement).

iii) The standardization process is dynamic as it keeps pace with progress.

iv) The process of standardistion, as the definition requires, is quite an involved process. It calls for pooling together of all knowledge, expertise and experience of all those who are concerned. The approach, therefore, involves setting up groups well represented by the major players in the activity like the supplier, the customer, the statutory authorities etc. The process tries to achieve maximum consensus through circulation of draft standards.

v) Some particular applications of standardisation are:

- Units of measurement
- Terminology and symbolic representations
- Products and Procedures
- Safety of person and goods

c) Standard

According to the ISO definition, "standard is a document, established by **consensus** and approved by a recognized **body**, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context" ISO Guide 2:2004. It may take the form of:

- a document containing a set of conditions to be fulfilled;
- a fundamental unit or physical constant (example : absolute zero); and
- an object for physical comparison (example : metre).

It may be noted that –

i) As the standard is the result of standardistion, it is established with the cooperation of all concerned.

ii) It is a living dynamic document liable to continual change through amendments/ revisions due to the following:

- Technology upgradation;
- Change in the needs of consumers;
- Improved methods of quality evaluation; and
- Change/upgradation of materials used.

iii) As a standard has to be approved by a recognized authority, following categories of standards are prevalent (See Fig. 3.3)

- International standard – Standard that is adopted by an international organisation. (example: ISO 9000 Standards)
- Regional Standard – Standard that is adopted by a regional organisation; (example: EN standard adopted by European Committee for Standardistion).
- National Standard – Standard adopted by a National Standards organisation; (example: Standard of Bureau of Indian Standards).
- Company Standard: Standard adopted by an organisation for its own use only.

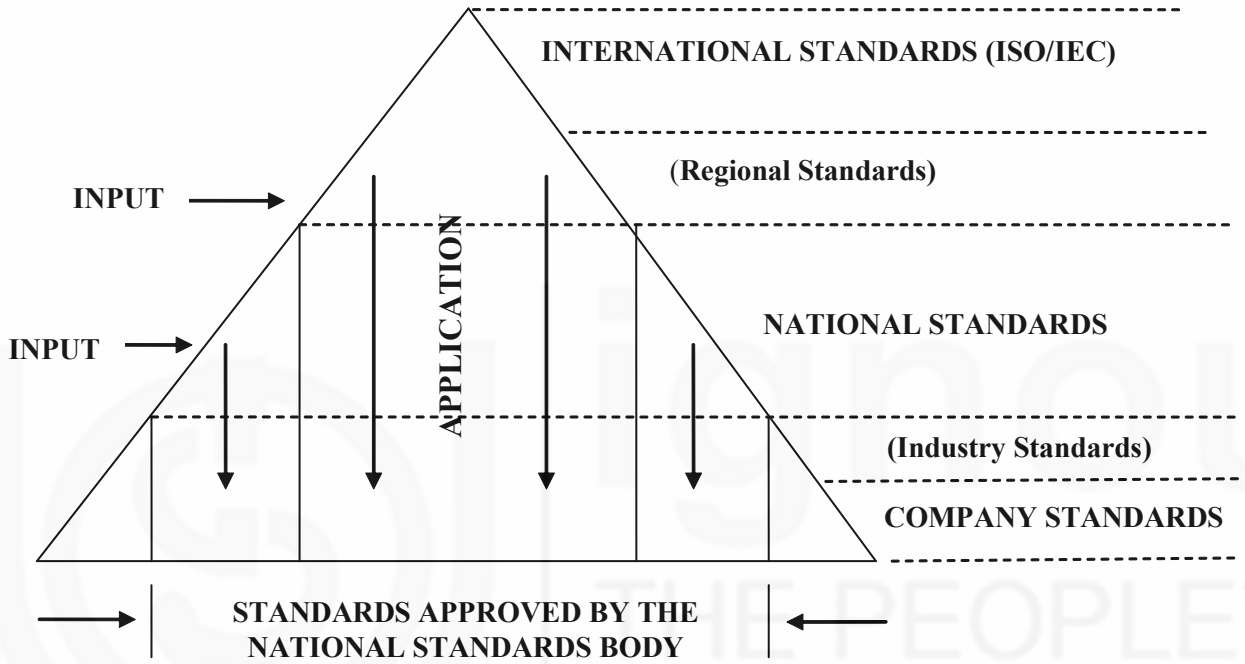

Fig. 3.3: Standards at various levels

*(**Source:** Institute of Standards Engineers, Mumbai, Monograph on Standardisation; 1986)*

iv) Depending on the contents of the document, a standard could be broadly categorized as follows:

- **Basic Standard:** Standard that has a wide-ranging coverage or contains general provisions for one particular field (example: IS 626 – Code for Engg. Drawings).
- **Terminology/Vocabulary Standard:** Standard that is concerned with terms, usually accompanied by their definitions and sometimes, by explanatory notes, illustrations, examples etc.
- **Testing Standard:** Standard that is concerned with test methods, sometimes supplemented with other provisions related to testing, such as sampling, use of statistical methods, sequence of test etc.
- **Product Standard:** Standard that specifies requirements to be fulfilled by a product or a group of products, to establish its fitness for purpose.
- **Process Standard:** Standard that specifies requirements to be fulfilled by a process, to establish fitness for purpose.
- **Service Standard:** Standard that specifies requirements to be fulfilled by a service to establish its fitness for purpose.

3.4 NEED FOR SAFETY AND HEALTH IN INDUSTRY

In the introduction we talked about the significance of safety and health in Total Quality Management. You may still be intrigued with the question "Why safety and health are so important?"

The answer is apparent from the following Fig. 3.4.

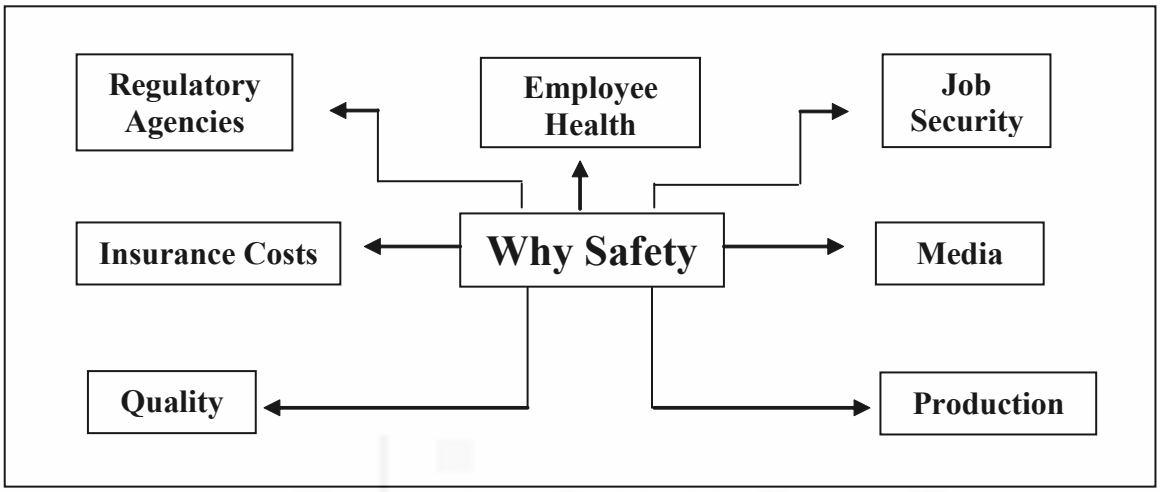

Fig. 3.4 : Why Safety

The first and foremost concern for safety is employee health. Good health is a pre-requisite for commitment to quality work and growth. We need to earn our livelihood on a continuous basis which again depends on maintenance of good health. *Job security* is influenced by ill-health, be it due to occupational hazards or otherwise. Efforts are required to maintain general health and keep off occupational hazards so that we do not fall ill and are thus unable to attend to our jobs. Poor performance on safety may lead to adverse opinion in the publicity. **"Media"** which ultimately may affect market share. Accidents sometimes cause downtime of machinery and loss of available man-days which in turn affect *production* and profitability of an organisation. Poor working conditions and unsafe acts are also the contributing factors for '*Poor Quality*'. Frequent accidents in an industrial plant lead to more spending on worker compensation. Insurance company may tend to increase the premium for such industries. Accidents/ fatalities also call for investigation by "*regulatory agencies*" like the police, factories inspector, Pollution Control Board representative etc. This causes avoidable wastage of man-hours. The urge to prevent loss of people, property and process leads to the implementation of Safety and Health Management in industry.

The losses due to accidents can be classified into the following two major categories of cost (examples are given):

Direct Cost

- Emergency medical care.
- Replacement / Repair of damaged equipment.
- Payment of compensation to the victims / their families.

Indirect Cost

- Loss of production.
- Loss of productivity due to follow-up care.

- Loss of productivity after resumption of work.
- Fellow workers assisting the injured colleague.
- Loss of productivity due to inspection / investigation.
- Fellow workers watching events and discussing accident, thus leading to loss of productivity.
- Cost of training the replacement worker.
- Supervisor's time spent in investigation and preparation of reports.
- Time spent with regulatory authorities.

All the above elements of cost influence the bottom line of business. More particularly accident-prone industries do not enjoy reputation as good employers and find it difficult to engage people.

All these factors make it a must to go in for proper management of safety and health.

Let us look at the following cases to appreciate the need for safety in industry.

i) Suppose in a building construction activity masons are to work at a height of 10ft from the ground. As an employer we should provide them with a safe place to work. This means we should make arrangement for proper acaffolding and a comfortable platform to work at that height. But these alone are not sufficient to prevent an accident due to a fall. In addition to this we have to force the contractor to provide necessary personal protective equipment (PPE) to the workers, like full body harness and tie it to a life line (firm support) so that the mason can be protected from a fall hazard.

ii) Let us consider two welders who are to work inside a confined space (closed tank). How do we ensure that they do not get harmed due to suffocation? This can be done by using an oxygen analyzer to establish the availability of oxygen inside the confined space. While welding is going on (inside), we should arrange for forced ventilation to ensure supply of oxygen. One person should be outside the confined space to be able to rescue the person working inside in case of an emergency.

Both the cases highlight examples of situations warranting safety.

3.5 THE APPROACH TOWARDS SAFETY

From the standpoint of safety management three distinct management styles can be observed (Pascal Dennis Quality, Safety and Environment – Synergy in the 21st century; ASQC Quality Press, Milwaukee, Wisconsin, pp-60 as follows:

SWAMP – Safety Without Any Management Process (16% of all companies).

NORM - The Naturally Occurring Reactive Management (77% of all companies). Also known as Reluctant Compliers.

World class – Leaders amongst industries where most are today (7% of all companies).

What differentiates the three types?

During the 70s a study was carried out by the National Institute of Occupational Safety and Health (NIOSH) of U.S.A to understand what made the difference in the three types of styles described above. It was found that the conventional safety practices

like establishment of a safety committee, adhering to safety rules, promotion of safety, accident investigation and reporting were present in all the companies of three different styles with little degree of variance. The factors responsible for improved safety performance were:

- Management commitment and ownership; and
- Planning, interpersonal relations and peoples involvement.

Thus the Core Management Group need to define the role of safety management. The approach to world class safety management style is possible if there is a sincere desire on the part of management, as expressed by W.E. deming:

Table 3.2: Analysis of Characteristics for the Three Types of Styles

Sl	Characteristic	The SWAMP Style	The NORMS Style	World Class
1.	Safety Responsibility	Not recognized or rejected	Not understood or defined	Line Management owned/ drive
2.	How it is perceived	As a burden	As a cost	Good business investment
3.	Management practices	• Accidents to happen • Autocratic style Safety next to production • Planning minimal, short time • Communication one way (down the line) • Solution-make do/ make fit approach • Minimal employee involvement • Adversarial climate	• Accident are excused away • Recognises problem (unwilling/unable to solve) • Willing to go half way • High visibility (many labels, little result) • Significant line/staff authority conflict • Programs/campaign short lived • "Line accountability" lacking	• Accidents are intolerable Safety is an element of management effectiveness • Responsibilies and expectations are clearly defined • Employees are empowered and rewarded • Communication informal, open • Efforts closely measured and responded to

"Management must feel pain and dissatisfaction with past performance and must have the courage to change. They must break out of line, even to the point of exile among their peers. There must be a burning desire to transform their style of management".

3.6 SAFETY MANAGEMENT

General concept

Management of safety depends heavily on the **root cause analysis**. You will remember the saying *Accidents do not happen,* ***they are caused.***

What causes an accident?

Predominantly, two factors either individually or in combination lead to an accident. They are:

i) Unsafe act, and

ii) Unsafe condition.

Unsafe act is attributable to an individual. This may be due to lack of understanding of the hazard facing the task being performed or the negligent act.

Unsafe condition like slippery floor, lack of ventilation, inadequate lighting may be the cause of an accident. Unsafe condition is attributable to management responsibility.

From the above discussion you will appreciate that management of safety involves a two-pronged approach, *viz*. prevention of the unsafe act and providing a safe work place (i.e. elimination of unsafe condition). This is the fundamental principle of any Safety Management.

As is evident from the above we must endeavour to identify the hazard/risk associated with the accomplishment of a task and then adopt suitable measures for corrective and preventative action through systems approach in the context of safety management.

Let us now see how this principle can be applied to practice.

3.6.1 Risk Assessment through Hazard Identification and Job Safety Analysis

In safety parlance very often we come across the term 'hazard' and 'risk'. It is necessary to clearly understand what these terms actually mean.

'Hazard" is something that has a potential for harm.

'Risk' is the likelihood of the harm happening, and the consequences in case it happens.

Approach

The assessment of risk is carried out through **Job Safety Analysis** (JSA). Safety implies freedom from risk, danger and harm. Job Safety Analysis therefore helps us to:

- Identify the risks/hazards,
- Protect from danger, and
- Eliminate the potential to harm.

The JSA approach, involves the following basic steps:

- Identification and selection of task.
- Breaking it down into steps.
- Identification of potential hazards.
- Assessment and elimination of risks.
- Recommendation of safe work procedure.

3.6.2 Selection of Task

From the safety point of view and for effective management of safety, each job needs to be analysed prior to its starting. The operators should be briefed about the risks involved in the performance of a job and the procedures and precautions to be followed for safe performance of the tasks. While more than one job needs to be analysed, the priorities can be decided based on the following criteria:

- High frequency of accidents or near misses.
- History of serious accidents or fatalities.

- Potential for serious harm.
- New jobs.

3.6.3 Breaking Down the Task into Various Steps

A complex task may involve various risks at different steps. A comprehensive study of the various steps is essential to evaluate the risks associated.

Job Safety Analysis starts with:

- A discussion of how the job is performed. Once the process familiarity is obtained, the job can be divided into steps.
- Watching out an operator performing the task completely.
- Noting down the crucial steps as the job progresses.

Now corresponding to each step we can identify the existing hazards. An example of steps involved in replacing of a flat tyre are identified in Box.

Identify Basis Job Steps: Replacing a Flat Tyre

While proceeding to your work, you discover that your car has a flat tyre. The car is parked on a level ground and the parking brake is already set. The bumper jack and the car tyre are both in good condition and kept in the car's trunk. The steps involved in replacing the flat tyre are:

1) Remove jack, spare tyre and lug wrench from trunk
2) Loosen lug nuts
3) Raise the jack
4) Remove flat tyre
5) Install spare tyre
6) Lower jack
7) Tighten lug nuts
8) Place flat tyre, jack and lug wrench in the trunk

The five major factors listed below will help ascertaining risks associated with any step:

a) Physical Actions
b) Materials
c) Equipment
d) Conditions
e) "What if" question

Identification of Hazards

The basis tool used to identify a hazard is through Inspection. Inspection provides a reliable way to identify and eliminate conditions that could lead to an accident, illness or environmental damage. In order to conduct an inspection it is important to know what is to be looked for in a specific area. A checklist of potential hazards is prepared to carry out the inspection.

Creating a checklist involves the following four steps:

i) Write down every potential hazard within the category that exists in your work area

ii) Check availability of written resources

iii) Examine the work area

iv) Have the employees review the list

The sources of information to develop a check list are:

- Job hazard analyses or process reviews
- Maintenance records
- Material safety data sheets (MSDS)
- Accident investigation reports
- Work environment studies

3.7 ASSESSMENT AND ELIMINATION OF RISKS

Once the hazards are identified it is an obvious expectation to have the risks eliminated from the job sites. Many times a situation encompasses a number and variety of risks.

The following techniques can be helpful in assessing the risk factor and in classifying the various hazards according to the seriousness of impact and priority for remedy.

Methodology

Complete the Risk Assessment format (as given in Fig.3.5) and proceed with the determination of risk factors as follows:

Job Site:
Date: Location :
Supervisor Responsible :
Contractor's Name :
Name of Safety Personnel :

Sl. No	Identification of Hazard	Severity Level			Likelihood of Occurrence			Population Affected			Risk Factor
		Low	Med	High	Low	Med	High	Low	Med	High	

Fig. 3.5: Risk Assessment

Severity level

Low = Effect of risk is minimum (not serious)

Med = Moderate effect tending to become serious

High = Dangerous to life

Likelihood of Occurrence

Low = Very less probability

Med = May take place often

High = Very frequent changes of happening

Population Affected

Low = Upto 5 persons

Med = 5 to 15 persons

High = More than 15 per persons

RISKS FACTOR = Severity Level × Likelihood of Occurrence × Population Affected.

Based on the assessment of **Risk Factors** we go on to tabulate the risks in order of their diminishing severity. This helps in developing a corrective action plan.

The format (Fig. 3.6) can be used for this purpose.

Sl. No	Risks in order of Severity Levels	Control Measures recommended	Remarks Action Taken/ Action by (Person & Date)

Fig. 3.6: Prioritization of risks to be Eliminated / Minimised

Recommendations of Safe Work Procedures

The final phase of Job Safety Analysis process involves recommending ways to control the hazards associated with each of the job steps. The following aspects shall be recognized while making recommendations:

- Recommendations should be developed at the job site whenever possible.
- Recommendations should be in sequence, beginning with the first hazard (so that not a single hazard is missed).
- Recommendations must be specific.
- As many solutions as are possible should be listed.

The preparation of recommendations needs expertise and knowledge on the part of the JSA team. However, the following documents may be helpful a great deal in formulating Corrective Action Plans/ Safe Work Procedures:

- Utilise company's Accident Prevention Manual while developing safety procedures on site.
- Refer to earlier recommendation validated with successful observations for a similar problem.
- Statutory regulations prevailing in the work areas.

Safety Task Assignment (STA)

Many a time recommendations indicate instruction/direction for Safety Task Assignment. This STA is not as formal as a JSA. The JSA involves:

a) Reviewing the safety issued of any new tasks;

b) Appraising the task performance about the risks involved in carrying out the task;

c) Procedures to be followed for performing the task; and

d) Personnel Protective Equipment to be used.

STA has the following advantages:

- It raises safety awareness within each crew and is a reminder that hazards to exist.
- Assigns each member of the team a safety responsibility
- Demonstrates management's commitment to safety

A typical JSA for changing a flat Tyre is given in Fig.3.7

JSA – Changing a Flat Tyre

Date: Job: Change Flat Tyre

Title of Person performing job Supervisor Analysis by:

Sl. No.	Sequence of Basic Job Step	Potential Accident or Hazards	Recommended Safe Procedures
1.	Remove jack, spare tyre and lug wrench	a) Lifting strain b) Trip hazard	a) Proper lifting technique b) Material out of working area
2.	Loosen lug nuts	a) Arm & wrist strains Pinch paints	a) Good body positioning b) Use gloves
3.	Jack up car	a) Car tripping b) Strains to back and lower body	a) Jack level & positioned properly b) Back Straight
4.	Remove lug nuts	a) Car tripping b) Strains to upper extremities	a) Remove under control b) Good body positioning
5.	Remove tyre	a) Car tripping b) Lower back strains	a) Remove under control b) Put back tyre with straight legs
6.	Replace tyre	a) Lower back strains b) Pinch paints c) Car tripping	a) Lift with legs & back b) Gloves c) Replace under control
7.	Tighten lug nuts	a) Arm & wrist pain b) Pinch paints	a) Use all of body b) Gloves
8.	Lower Car	Car Tripping	Lower Slowly

Fig. 3.7: A typical JSA for changing a flat tyre

Risk assessment is the first step in establishing a safety program to achieve the goal of safety excellence i.e. "Zero Accident"

Safety Implementation – The Systems Approach

Safety means freedom from risk, harm and danger. Implementation of a safety program helps us avoid unnecessary costs from any accident/injury and loss of production. Enlightened management sets a target of "zero" injury to attain excellence. This is a journey towards continuous performance improvement, an essential element of **Total Quality Management.**

Systems approach to safety management rests on :

i) setting targets / goals to be achieved during project execution;

ii) continuous monitoring of the goals to effect corrective action; and

iii) providing resources and training for successful implementation of the program.

The elements of a Safety Programme

The basic elements of a safety programme include the three :

- Engineering
- Education
- Enforcement

In the Engineering phase attention is given for the planning and development of an affective Safety Program. While developing the program emphasis is given to the particular type of industry and its associated hazards.

Hazard Identification and Job Safety Analysis (JSA) are important techniques involved in the development of a suitable safety plan.

Hazard identification involves a basic knowledge about the project activities and their potential hazards. Past experience, thorough inspection and checklists can be useful in the process of hazard identification.

Job safety analysis is a technique which involves a study of tasks to know their associated hazards and practical recommendations of provide for corrective actions. JSA involves the following five essential steps:

i) Selection of the task.

ii) Breaking down the task into component steps (sub-tasks).

iii) Identifying the hazards associated with each of the steps (sub-tasks).

iv) Assessment of Risk (quantification) for prioritization of the corrective action.

v) Providing recommendations for elimination of the hazards.

With the knowledge of the outcome of Job Safety Analysis a comprehensive Safety Plan is developed so as to attain the goal of Zero-Injury.

The Second phase of an effective Safety Program is the education of all the people (contractor's people included) as associated with the project execution. Like any weak unit of a chain the total strength make the Safety Program weak and thus may be susceptible to work related injuries/accidents. Education is therefore a very important aspect of a Safety Program. Education can be imparted through.

- Training and orientation programme.
- Display of poster/banners.
- Use of sign age's (cautionary, preventive, warning).
- Safety Task Assignments (STA).

Management System for TQM

Having developed a Safety program and having provided education to the employees, concerned, the next important activity that brings in success to the program is its' enforcement'. However good a Safety Plan is, or however excellent the education given to the workers, the ultimate result depends on enforcement.

Enforcement requires a strong will and determination on the part of management. Management commitment is expressed through safety promotional measures like.

- Reward for better safety performance.
- Safety Competition (slogan, cartoon, essay, etc).
- Operating safety related disciplinary programs, i.e. punishment commensurate with extent/ nature of safety violation.
- Carrying our Accident/ Incident investigation for ascertaining corrective and preventive actions.

3.8 STATISTICAL QUALITY CONTROL

The concept of TQM is basically very simple. Each part of the organisation has customers, some external and many internal. Identifying what the customer requirements are and setting about to meet them is the core of a total quality approach. This requires a good management system, methods including *statistical quality control* (SQC), and teamwork.

A well-operated, documented management system provides the necessary foundation for the successful application of SQC. Note, however, that SQC is not just a collection of techniques. It is strategy for reducing variability, the root cause of many quality problems. SQC refers to the use of statistical methods to improve or enhance quality for customer satisfaction. However, this task is seldom trivial because real world processes are affected by numerous uncontrolled factors. For instance, within every factory, conditions fluctuate with time. Variations occur in the incoming materials, in machine conditions, in the environment and in operator performance. A steel plant, for example, may purchase good quality ore from a mine, but the physical and chemical characteristics of ore coming from different locations in the mine may vary. Thus, everything isn't always "in control."

Many of these variations cannot be predicted with certainty, although sometimes it is possible to trace the unusual patterns of such variations to their root cause(s). If we have collected sufficient data from these variations, we can tell, in terms of probability, what is most likely to occur next if no action is taken. It we know what is likely to occur the next given certain conditions, we can take suitable actions to try to maintain or improve the acceptability of the output. This is the rationale of statistical quality control.

3.8.1 The Six Sigma Principle

The *six sigma* principle is Motorola's own rendering of what is known in the quality literature as the ***zero defects (ZD)*** program. Zero defects is a philosophical benchmark

or standard of excellence in quality proposed by Phillip Crosby. Crosby explained the mission and essence of ZD by the statement "What standard would you set on how many babies nurses are allowed to drop?" *ZD* is aimed at stimulating each employee to care about accuracy and completeness, to pay attention to detail, and to improve work habits. By adopting this mind-set, everyone assumes the responsibility toward reducing his or her own errors to zero.

For the typical Indian, a 10 hour train delay, an incorrect eye operation or drug administration, or no electricity or water half a day is no surprise; he/she routinely experiences even worse performance. Quantitatively, such performance is worse than two-sigma. Can this be called acceptable? One - or two-sigma performance is downright non-competitive.

Besides adopting TQM as the way to conduct business, many companies worldwide are now seriously looking at six-sigma benchmarks to assess where they stand. Six sigma not only reduces defects and raises customer acceptability, it has been now shown at Allied Signal Inc., Motorola, Raytheon, Bombardier Aerospace and Xerox that it can actually save money as well. Therefore, it is no surprise that Motorola aggressively set the following quality goal for itself in 1987 and then didn't want to stop till they achieved it.

Improved product and services quality ten times by 1989, and at least one hundred fold by 1991. Achieved six-sigma capability by 1992. With a deep sense of urgency, spread dedication to quality to every facet of the corporation, and achieve a culture of continual improvement to assure total customer satisfaction. There is only one goal: zero defect in everything we do.

3.8.2 The Steps to Six Sigma

The concept of six sigma quality is shrinking the inherent variation in a process to half of the spec range ($C_p = 2.0$) while allowing the mean to shift at most 1.5 sigma from the spec midpoint (the target quality) is explained by Fig. 3.8. The area under the shifted curves beyond the six sigma range (the tolerance limits) is only 0.0000034, or 3.4 parts per million. If the process mean can be controlled to within $\pm 1.5\ \sigma_x$ of the target, a maximum of 3.4 defects per million pieces produced can be expected. If the process mean is held exactly on target, only 2.0 defects per billion would be expected. This is why within its organisation Motorola defines six sigma as a state of the production or service unit that represents "almost perfect quality".

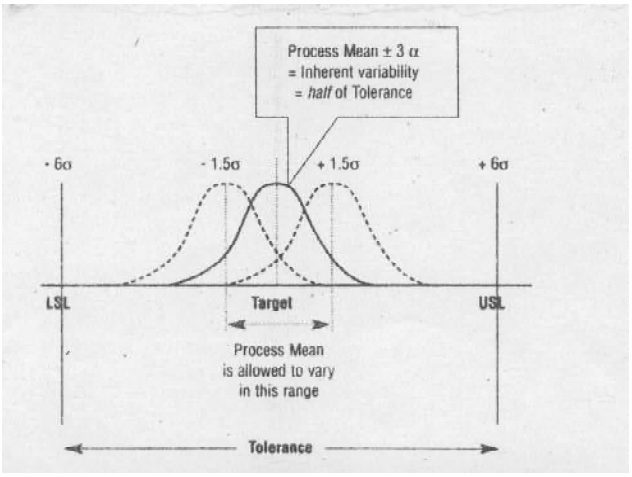

Fig. 3.8: The Six Sigma Process: USL = Mean + 3 sigma, LSL = Mean – 3 sigma

Motorola prescribes six steps to achieve the six-sigma state, as follows.

Step 1 : Identify the product you create or service you provide.

Step 2 : Identify the customer(s) for your product or service and determine what they consider important.

Step 3 : Identify your needs to provide the product or service that satisfies the customer.

Step 4 : Define the process for doing the work.

Step 5 : Mistake-proof the process and eliminate waste effort.

Step 6 : Ensure continuous improvement by measuring, analyzing and controlling the improved process.

Many companies have adopted the Measure-Analyze-Improve-Control cycle to step into six sigma. Typically they proceed as follows:

- Select critical-to-quality characteristics.
- Define performance standards (the targets to be achieved).
- Validate measurement systems (to ensure that the data is reliable).
- Establish Product Capability (how good are you now?).
- Define performance objectives.
- Identify sources of variation (seven tools etc.).
- Screen potential causes (correlation studies, etc.).
- Discover relationship between variables and causes or factors and the output (DOE).
- Establish operating tolerances for input factors and output variables.
- Validate the measurement system.
- Determine process capability (C_{pk}) (Can you deliver? What do you need to improve?).
- Implement process controls.

One must audit and review non-stop to ensure that one is moving along the charted path.

The aspect common between six sigma and ZD ("zero defects") is that both concepts require the maximum participation by the entire organisation. In other words, they require that unrelenting effort by management and the involvement of all employees. Companies such as General Motors have used a four-phase approach to seek six sigma:

1) **Measure:** Select critical quality characteristics through Pareto charts; determine the existing frequency of defects, define target performance standard, validate the measurements system and establish existing process capability.

2) **Analyze:** Understand when, where, and why defects occur by defining performance objectives and sources of variation.

3) **Improve:** Identify potential causes, discover cause-effect relationships, and establish operating tolerances.

4) **Control:** Maintain improvements by validating the measurement system, determining process capability and implementing process control system.

It is reported that in General Motors a new culture has been created. An individual or team devotes all its time and energy to solving one problem at a time, designs solutions with customers' assistance, and helps to minimize bureaucracy in supporting the six-sigma initiative.

3.8.3 Beyond TQM

The Japanese have recently evolved the "Bluebird Plan", which is a "third option" beyond SPC and TQM designed to achieve the four objectives of business excellence. These objectives include establishing corporate ethics, maintaining and boosting international competitiveness, ensuring stable employment and improving national quality of life.

The Bluebird Plan provides a forum for government, labour and management to discuss the actions which need to be taken. In Japan, the plan set out an action program for reform for the three years 1997-1999 which was noted to be a critical time that would determine the direction of Japan's future. Striking about the plan is the employers' acceptance that the relationship between labour and management is an imperative "stabilizing force in society". Thus it reaches beyond the tenets of TQM.

3.9 GENERAL OCCUPATIONAL HEALTH PROBLEMS

Industry contributes not only to physical hazards to workers like unguarded machines, poor housekeeping, falling of objects, flying particles which may cause injury. But certain processes, environment of conditions may affect the workers health as well. Let us have a look at what these hazards could be in relation to public health in general.

3.9.1 Public Health (General)

Some hazards encountered are discussed below:

1) **Tobacco:** It is widely used by workers. The forms include smoking, chewing, snuffing. This may cause lung and oral cancer, lung ailments etc.

2) **Drinking water:** The main source of water for industry is from river or from the ground. Leather industries and chemical industries let their effluent flow into a river or be absorbed in the ground thus polluting the soil and water (causing water pollution and soil pollution). The polluted water may cause lot of health problems like jaundice, liver and kidney failure, gastro-enteritis.

3) **Cancer:** Workers in chemical industries are exposed to chemicals like benzene, asbestos, nitrogen oxides, polyvinyl chlorides etc. These chemicals classified as carcinogens may cause cancer to the workers.

4) **Radiation:** Workers engaged in X-ray units and mines which contain radioactive materials may be affected due to radiation. This may cause cancer to the public.

5) **Drug abuse and alcoholism:** Drugs and alcoholism are very common public health hazards. They impair the sensory organs and due to inadequate judgment of the workers may cause accident.

6) **Unhygienic food:** Inadvertently supplied through canteen in the industry may cause diarrhoea, typhoid food poisoning, hepatitis etc. to the workers.

3.9.2 Cause of Health Hazards (Particular to Industry)

The general occupation health hazards may be due to:

(i) Heat (ii) Cold (iii) Light (iv) Noise (v) Chemicals (vii) Occupational Diseases.

i) **Heat:** Most of India is in the equator region and it is hot in summer months. Unlike western countries the employees get exhausted due to heat. Heat stroke is a common feature due to exhaustion during summer.

ii) **Cold:** Due to cold during winter the fingers may lose their sensation which may cause finger injuries. Loose items like mufflers/scarves may get entangled into running machines and cause injuries.

iii) **Light:** Adequate light is to be arranged in the work place. Vision is disturbed due to inadequate lighting, leading to the possibility of an accident.

iv) **Noise:** This creates a stressful situation, causing irritation, loss of hearing, rise in the blood pressure and increase in the heart beat.

v) **Radiation:** Workers engaged in NDT operation, X-ray laboratories and in atomic power industries are vulnerable to radiation which may cause cancer in the long run.

vi) **Chemicals:** Silica dust can enter the lungs and may cause silicosis. Asbestos may cause asbestosis. These are all lung ailments. Dye stuffs are used in dye industries mixed with water, any person drinking such water may suffer from liver/kidney disorders in course of time. Chemicals such as acids and corrosive alkalis may cause burns if they fall on the skin.

In the construction industry, metal surface finishing work is done by sand blasting. This is due course of time causes silicosis. Chemicals such as paints, thinners, binders, fasteners may cause many health hazards to workers.

3.9.3 Control of Health Risk

Health risk may be controlled through the following measures:

i) **Engineering measures:** By devising good and safe engineering processes the risk to the health of workers can be reduced.

ii) **Legal Measures:** Government by notification asks the employers / industries to modify the process or control the hazard.

iii) **Medical Measures:** Medical measures include:

   a) **Medical Examinations:** All workers in the industry to be screened for occupational diseases.

   b) **Periodical Examination:** All workers working in highly hazardous chemicals must be periodically examined.

   c) **Health Care:** Health care to all employees be provided in chemical industry.

   d) **Health Education:** Workers should be educated for good and hygienic way of living.

e) **Records:** Records of all medical examination to be kept and maintained for review and prevention.

3.9.4 Maintaining of Healthy Environment

Managing a healthy environment involves the following activities:

i) Pre-employment medical examination

ii) Continuous education on health and hygiene

iii) Periodical inspection of the site

iv) Provision of proper personal protection equipment provided to employees

v) A good medical / clinic facility

3.9.5 Substance Abuse Prevention (Screening for Alcohol and Drugs)

Alcohol and drug use by workers may:

i) increase the accident rate;

ii) increase the medical expenses;

iii) increase absenteeism; and

iv) cause absenteeism and reduce the income to the family.

As per the Factories Act possession and use of alcohol and narcotics is not permitted inside the work premises.

Alcoholism and drugs abuse by workers can be dealt with by:

i) counselling to workers;

ii) strict vigil at workplace;

iii) surprise inspection at work place;

iv) medical test; and

v) termination from service (disciplinary action).

Personal Protection

Elimination of unsafe conditions should be the first priority. For additional protection to individuals, Personal Protection Equipment (PPE) should be provided. Depending on the nature of the job the PPE has to be selected and given.

3.9.6 Why is the PPE needed?

Statistics on accident investigation reveal that 60% of workers at the site sustaining head injuries do not wear helmets, and nearly 99% of workers suffering face injuries do not wear face protection. 77% of workers suffering from foot injuries do not wear safety shoes, and 60% of workers with eye injuries do not wear eye protection.

3.10 SAFETY AND HEALTH MANAGEMENT SYSTEM

You are all aware of the international system of Quality Management covered under the ISO 9000 series of standards. The International Organisation for Standardisation attempts to ensure consistency in the management approach. Though ISO 9000 Quality

System Standards are quite common in almost all countries, the safety system standardization is not yet complete. Efforts are on to develop an international standard for safety management (ISO 18000 series). At the moment various countries have their own practices of safety management based on their local legislation.

The most important of these legislation are:

i) OSHA (Occupation Safety and Health Administration) standards followed in the USA.

ii) HASAWA 74 (Health and Safety and Work Act) in UK.

iii) In India we have

- The Factories Act
- The Workmen Compensation Act
- The Indian Electricity Rules
- The Gas Cylinder Rules

and many more depending upon the nature of job.

The salient features of the above legislations are dealt with in Appendix 1.

3.11 CASE STUDIES

The following case studies illustrate the occurrence of accidents and remedial measured adopted to prevent their recurrence.

Case Study 1

3.11.1 Description of the Accident (Case Study 1)

Rahul was a worker associated with M/s XYZ construction company engaged in the civil works for a building project. He was doing chipping work on the concrete slabs. He was provided with a safety glass for eye protection and was wearing it in the morning. He wanted to finish his work quickly after lunch. He, therefore, finished his lunch early and started his work keeping his safety glass aside. All on a sudden a tiny piece hit his left eye. The piece directly hit the pupil and tore it. As it was lunch time the supervisor and safety steward both had gone for lunch and were not available at the spot.

The accident was immediately reported to the Safety supervisor by Rahul's colleague. The Safety Supervisor swung into action and the worker was taken to the First Aid centre. He was given first aid and thereafter he was referred to an eye hospital for surgery. In spite of timely and best treatment given, his left eye could not be saved. He lost his left eye sight.

a) Accident investigation

As per company's Safety manual the investigation was carried out by a team consisting of

- Safety Manager,
- Construction Supervisor, and
- Site In-charge (Contractors).

The following facts were observed during investigation by the team:

– The accident happened during lunch time.

– The same worker was wearing the safety glasses in the morning but not during the post lunch session.

– The supervisor and the safety steward were not present during the accident.

– The supervisor and safety steward had gone for lunch when the accident took place and were not available at site.

– The worker wanted to finish the work quickly.

– He was chipping the slab during lunch break without wearing the safety glass.

– There was no safety coverage during lunch time.

b) Root Cause of the Accident

The worker did the chipping work during the lunch break without wearing the safety glasses (Non adherence to safety procedure and an unsafe act)

c) Observations related to Safety Management at site prior to the Accident

– The particular contractor's worker were instructed about the safety requirements.

– All workers were given safety orientation.

– One trained supervisor was arranged at the work site.

– One safety steward was arranged by the contractor to look after safety implementation.

– Toolbox talks were conducted regularly.

– All tools and equipment were inspected periodically.

– Safety Incentives were given to the workers to adhere to safety procedures.

d) Corrective Action taken after the accident

– The contractor was called for a meeting to review the adequacy of the safety procedure.

– Training classes were organized for all the employees involved in this job and they were briefed as to what happened to their co-worker and why it happened to him and how to avoid such incidents in future.

– Special training was given to the supervisor and to the safety steward.

– The subject was discussed in the safety committee monthly meeting and superintendent's meeting.

e) Lesson learned

i) Management and control of work need better attention for safety of workers.

ii) Adherence to basic safety practices is must.

iii) Creating awareness on the part of workers through proper orientation and training is very important.

iv) Proper follow up is required for effective implementation of safety culture.

3.11.2 Description of the Accident (Case Study 2)

This accident happened at a site around Delhi on 25th January, 97 and this was a last time accident. Many female workers were engaged on the site to carry soil from one place to another with the head pan. There was a 2.5 feet wide × 3 feet deep trench excavated to lay down drain pipes. There was a crossover and mostly all of the workers were using the crossover to move from one side to the other. Some of the workers used to cross the trench by jumping from one side to the other. Ganga Devi (a worker engaged by M/s AZ Construction Co.) also wanted to jump across the trench. While jumping across the trench, she was unable to stretch her leg as she was wearing a saree, and fell into the trench and fractured her right forearm.

She was taken out of the trench and her hand was tied and kept straight with the help of a piece of wood and towel. She was taken to the site clinic for first aid and then referred to the hospital for further treatment.

a) Accident investigation

As per company's standard procedure the investigation was carried out by a team consisting of the:

- Safety Manager,
- Construction Superintendent, and
- Contractor's Site Manager.

The following facts were observed during investigation by the team:

- The accident happened in the morning around 9 a.m.
- There was a crossover on the trench.
- Some workers did not use the crossover. Instead they jumped to cross the trench.
- Ganga Devi tried to jump the trench and accidentally fell into it.
- She was unable to stretch her legs as she was wearing a saree.
- The supervisor in-charge was on the rounds there and he was informed about the accident. He informed the safety person on the site who immediately arranged for an ambulance to carry the person to the site clinic.
- She was given first aid in the clinic and then taken to the hospital for further treatment.
- In the hospital after preliminary investigation it was decided to perform an operation.
- She underwent an operation in the hospital and was in the hospital for approximately 23 days before being released.

b) Root Cause of the accident

- The female worker did not use the crossover. (did not follow the safety procedure, i.e. indulged in an unsafe act)
- She jumped the trench out of curiosity and her saree was an obstacle which did not allow her to stretch her legs.

c) Observations related to safety management at site prior to the accident

– The particular contractor was briefed about the safety requirements.

– All workers were not given safety orientation.

– One supervisor was arranged at the work site.

– One safety steward was arranged by the contractor to look after safety implementation.

– Toolbox talks were not conducted regularly.

d) Corrective Action taken after the accident

– The contractor was called for a meeting and it was insisted that strict safety procedures be implemented.

– Training classes were organized for all the employees and they were educated about the importance of safety. This accident victim was mentioned as an example to explain why it had happened to her, and how such incidents in future could be avoided.

– The contractor's safety officer and the supervisor were asked to conduct tool box meetings regularly.

– Since the severity of the accident was more the matter was discussed with the top executive of the contractor, in the safety committee meeting and in the superintendent's meeting to ensure better safety implementation.

e) Lesson learned

i) Contractors' half-hearted approach towards implementation of safety is apparent from the fact that orientation was not given to all workers and toolbox talks were not held regularly.

ii) Safety rules are required to be followed 24 hours a day, 7 days a week and 365 days a year.

Check Your Progress Exercise 1

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of the unit.

1) What is Total Quality Management (TQM)?

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2) List the benefits of TQM?

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3) Define food quality?

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4) Why is quality and safety management needed in industries?

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3.12 LET US SUM UP

The Total Quality Management ensured avoidance of accidents in industries. It also improves the bottom line by reducing direct and indirect costs of accidents. The three distinctive management styles can be observed in regard to how safety is managed, *viz.* Safety Without Any Management Process, (SWAMP), Naturally Occurring Reactive Management (NORM), and World Class Management (WCM).

Implicit in the Quality Management is the belief that "accidents do not happen, they are caused". Accidents are caused by unsafe acts attributable to people and unsafe conditions attributable to management. The management of safety and quality therefore lies in the prevention of unsafe acts and in the provision of safe working conditions. This is the fundamental principle of safety and quality management.

To identify the risk involved, a powerful tool called Job Hazard Analysis or Job Safety Analysis (JSA) is used. This helps in unearthing the root causes. Necessary action can then be taken.

The three basic elements are vital parts of a good safety management. They are (i) good engineering standards, (ii) education, and (iii) enforcement. Based on these three elements safety is implemented in five steps.

Industries contribute to physical hazards and health problems. The nature of such problems depends upon the occupation, duration of work and hazards involved. The health problems in industries may be caused by the use of tobacco, carcinogens, heat, cold, light, noise, radiation, chemicals and substance abuse.

Personal protection is the last act to protect a worker (when all other control measures cannot ensure safety of a person at work). The right personal protection and standard equipment is to be selected and provided.

The important questions in safety management relate to finding the root cause of the safety/health problems, ways of correcting it and how we can save workers from health/physical hazards.

3.13 KEY WORDS

Job Safety Analysis (JSA)	:	A tool to assess the various types of risks associated with a job.
Norm	:	Naturally Occurring Reactive Management.
Safety	:	Freedom from risk, harm and danger.
Safety Task Assignment (STA)	:	Instructions related to the hazards minimization/ elimination involved in a job, e.g. the procedures to be followed and Personal Protective Equipment (PPE) to be used to perform the job safely.
SWAMP	:	Safety Without Any Management Process.
Standardization	:	Activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of the optimum degree of order in a given context

3.14 ANSWERS TO CHECK YOUR PROGRESS EXERCISE

Your answer should include the following points:

Check Your Progress Exercise 1

1) i) Characteristics differentiating individual units.

   ii) Degree of acceptability.

2) • Improvements in leadership qualities and more visible leadership from executives and senior managers.
   • Involving personnel in decision making process.
   • Increased confidence of personnel in their ability to carry out their work and to achieve targets.
   • Reduction of mistakes, increased pride in work, sense of achievement for workers.
   • Opportunity for self-development and self-improvement of personnel through a pro-active involvement in work.
   • Opportunity to engage in creative thinking to improve product quality and work environment.
   • Increased co-operation, quality and work environment.
   • Increased co-operation, improved teamwork and reduced conflict.

3) Quality of foods may be defined as the composite of those characteristics that differentiate individual units of product, these characteristics should have significance in determining the degree of acceptability of that unit by the buyer.

4) The first and foremost concern for safety is employee health. Good health is a pre-requisite for commitment to quality work and growth. We need to earn our livelihood on a continuous basis which again depends on maintenance of good health. *Job security* is influenced by ill-health, be it due to occupational hazards

or otherwise. Efforts are required to maintain general health and keep off occupational hazards so that we do not fall ill and are thus unable to attend to our jobs. Poor performance on safety may lead to adverse opinion in the publicity **"Media"** which ultimately may affect market share. Accidents sometimes cause downtime of machinery and loss of available man-days which in turn affect *production* and profitability of an organisation. Poor working conditions and unsafe acts are also the contributing factors for '*Poor Quality*' Frequent accidents in an industrial plant lead to more spending on worker compensation. Insurance company may tend to increase the premium for such industries. Accidents/fatalities also call for investigation by "*regulatory agencies*" like the police, factories inspector, Pollution Control Board representative etc. This causes avoidable wastage of man-hours. The urge to prevent loss of people, property and process leads to the implementation of Safety and Health Management in industry.

3.15 SUGGESTED READING

ISO 9001:2008 *Quality Managements Systems – Requirements,* International Organization for Stndardization ,Geneva.

Pascal Dennis; *Quality, Safety and Environment* – **Synergy in the 21st Century**, ASQC Quality Press, Milwaukee, Wisconsin, 1997.

Rao Killuru, Steven Barteu, Robin Pritblado, Scott stricoff; *Risk Assessment and Management Handbook for Environmental, Health and Safety Professionals*, McGraw Hill, 1996.

Features of Legislative Provision of Different Countries

A) Osha Standards – General Duty Safety Clause

Section 5 (a) requires each Employer:

i) Shall furnish to each of their employees – a place of employment which is free from recognized hazards that are causing or are likely to cause serious physical harm to their employees.

ii) Shall comply with occupational health standards promulgated under this act. Section : 5 (b) (1) requires each employee:

iii) Shall comply with Occupational Safety and Health Standards and all rules, regulations, and order issued pursuant to this Act which are applicable to their own actions or conduct.

For detailed requirements of various Occupational Safety aspects one may refer to (the "OSHA" standards).

B) Health and Safety at Work Act '74 (Haswa '74) – applicable in UK74

The purpose of this act is to provide the legislative framework to *promote, stimulate and encourage* high standards for Health and Safety at work.

The aim of the act is create safety awareness and provide the effective safety organisation and performance

The act is an enabling measure which replaces the existing HSE (Health and Safety Executive) Legislation.

The Act consists of four parts detailing out the various provisions as noted below.

Part I – Relating to Health, Safety and Welfare of employees at work place;

Part II – The employees Medical Advisory Service;

Part III – Amendments to Building Regulations; and

Part IV – To control emission of obnoxious gases or offensive substances to the atmosphere.

In addition, the HSE (Health and Safety Executive) Regulations, known as Six Pack Regulation guide the Safety and Health Management System in UK. These regulations include:

– Management of Health and Safety at Work Regulations.

– Work place Health and Safety Regulations.

– Provision and use of work regulations.

– Personnel Protective Equipment at work regulation.

– Manual Handling Operation regulations.

– Display Screen Equipment regulations.

C) The Position of India

i) The Factories Act, 1948

These Act forms the basis of the Safety & Health Management System required to be developed for industries.

In general safety aspects, specific to industries or usage of various materials are separately covered under diversified acts like:

– The Petroleum Act
– The Gas Cylinder Rules
– Indian Boiler Regulations
– Indian Electricity Act
– Indian Electricity Rules, etc.

The Factories Act specifies the general duties of the occupier (means the person who has ultimate control over the affairs of the factory) as:

1) Every occupier shall ensure, so far as is reasonably practicable, the health, safety and welfare of all workers while they are at work in the factory.

2) Without prejudice to the generality of the provisions of Sub-section (1) the matters to which such duty extends shall include:

   a) The provisions and maintenance of the plant and system of work in the factory that are safe and without risk to health;

   b) The arrangements in the factory for ensuring safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances;

   c) The provisions of such information, instructions, training and supervisions as are necessary to ensure the health and safety of all workers at work;

   d) The maintenance of all places of work in the factory, in a condition that is safe and without risk to the health and the provisions and maintenance of such means of access to, and egress from, such places as are safe and without such risks; and

   e) The provisions, maintenance and monitoring of such working environment in the factory for the workers, that is safe, without risk to health and adequate as regards facilities and arrangements for their welfare at work.

3) Except in such cases as may be prescribed, every occupier shall prepare, and, as often as may be appropriate, revise, a written statement of the general policy with respect to the health and safety of the workers at work and the organisations and arrangements for the time being in force for carrying out that policy, and to bring the statement and any revision thereof to the notice of all workers in such manner as may be prescribed."

The Factories Act has three major sections *viz.* Health, Safety and Welfare

Some of the important features described about Health are:

- Every factory shall be kept **clean** and free from effluvia arising from any drain and effective arrangements shall be made in every factory for the treatment of waste and effluents.

- Effective and suitable provision shall be made in every factory for securing and maintaining in every work room:

a) **Adequate ventilation** by circulation of fresh air.

b) Such a **temperature** as will secure to workers therein reasonable condition of comfort and prevent injury to health.

- In manufacturing processes where **dust or fume** or other impurity of such a nature and extent is given off, as is likely to be injurious to workers, effective measures shall be taken regarding its inhalation, and accumulation in any work room.
- In every part of a factory where workers are working or passing there shall be provided and maintained sufficient and suitable **lighting, natural** or **artificial** or **both**.
- In every factory effective arrangements shall be made to provide a sufficient supply of wholesome **drinking water** at suitable points conveniently situated for all workers.
- In every factory sufficient latrine and urinal accommodation of prescribed types shall be provided conveniently situated and accessible to workers at all times while they are at the factory.

The important features described about safety are:

- Every part of an electric generator, a motor or a rotary converter, transmission machinery and dangerous parts of any machinery shall be securely fenced by safeguards of a substantial construction (which shall be constantly maintained and kept in position) while the part of the machinery they are fencing in motion or in use.
- Women or young person shall not be allowed to clean, lubricate or adjust any part of a prime mover or of any transmission machinery while the prime mover or transmission machinery is in motion.
- Safety from – hoists and lifts:
  a) every hoist and lift shall be –
     i) of good mechanical construction, sound material and adequate strength; and
     ii) properly maintained, and shall be thoroughly examined by a competent person at least once in every six months, and a register shall be kept containing the prescribed particulars of every such examination.
- In every factory all floors, steps, stairs, passages and gangways shall be of sound construction, properly maintained and kept free from obstruction and substance likely to cause a person to slip, and where it is necessary to ensure safety, steps, stairs, passages and gangways shall be provided with substantial handrails.
- Every vessel, pump, tank, pit or opening in floor shall be securely covered or securely fenced.
- No person shall be employed in any factory to lift, carry or move any load so heavy as to be likely to cause him injury.
- In any manufacturing process which involves risk of injury to eyes, effective screen or suitable goggles shall be provided for protection.

- While working inside a chamber, tanks, vat, pipe, or other confined space, voltage of any electric lamp or other electric appliance, should not exceed twenty-four volts.
- All practicable measures shall be taken to prevent fire and to provide the necessary equipment for extinguishing fire.
- If a factory employs one thousand or more workers, if any risk injury or hazard to health is involved, the occupier shall, employ safety officers as applicable as per govt. notification.

For further details regarding legal requirements of Health and Safety you may please refer to the Acts/Regulation as applicable.

UNIT 4 PROJECT MANAGEMENT

Structure

4.0 OBJECTIVES

After reading this unit, we shall be able to:

- know the definition of project management and related activities;
- understand the different phases and framework of project management;
- describe the relationship between project management and line management;
- explain the role of strategy in project management;
- know the importance of time planning and role of teams in project management; and
- understand the different control systems, constraints and corrective actions required for effective project management.

4.1 INTRODUCTION

A project can be defined by ISO 10006:2003 as "unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources". It is a 'non-repetitive activity'. This needs to be augmented by other characteristics:

- It is goal oriented – it is being pursued with a particular end or goal in mind;

- It has a particular set of constraints – usually centred around time and resources;
- The output of the project is measurable; and
- Something has been changed through the project being carried out.

Project management includes planning, organising, directing and controlling activities in addition to motivating what is usually the most expensive resource on the project – the people. Planning involves deciding what has to be done, when and by whom. The resources then need to be organised through activities such as procurement and recruitment. Directing their activities towards a coherent objective is a major management role. The activities also need controlling to ensure that they fit within the limits (e.g. financial) set for them.

'PRINCE' (Projects in Controlled Environments) – the standard project management methodology for government information technology departments – defines a project in terms of its products. These are categorised as:

- management - the planning, documentation and control actions of management;
- technical – the planning, documentation and review of technical aspects of the project; and
- quality – the planning, documentation and review of the quality control of the project system.

'PRINCE' is a project management shell or structure within which plans can be formulated and actions controlled throughout the project life-cycle. Its major benefit is providing a degree of methodology standardisation between projects. This allows managers to concentrate on details of their specific project, confident in a recognised and proven method.

Having defined a project and outlined the role of management in this environment, we can now examine more closely what a project involves. This will be done through breaking the project down into three phases.

4.2 THE THREE PHASES OF PROJECT MANAGEMENT

One of the leaders of the change in management thinking to concentrate on quality rather than quantity of output was Dr. W. Edwards Deming. His original work was centred on the operational aspects of quality management – in particular the use of statistical data in controlling processes. This work was adopted with far greater vigour in Japan than in his native America, but latterly has been given more prominence in Western management study. He is famous for producing his 14 management points. The fifth of these points is:

'Improve constantly and forever every activity in the company, to improve quality and productivity and thus constantly decrease costs'.

The means by which this constant improvement is achieved is by the approach shown in Fig. 4.1. The *planning* stage involves the formulation and revision of statements of intended activity, whether formalised or otherwise. The doing is the time when the project is carried out (the direct value-adding phase). The *check/study* phase involves a critical appraisal of both the project output (was a good result achieved?) as well as the process (was it carried out as well as it could have been?) the *act* stage is that

phase when the project process is considered to see how the lessons learned and gleaned from the review could be channelled back to the people involved in the process.

Applied to the project environment, the three Ds of project management describe the three phases. These are:

- *Design it* – identify the need that the project will serve, construct models to show how the needs will be developed, evaluate these to determine the optimum process for the task and minimise risk;
- *Do it* – carry out the project in line with the models or plans generated above;
- *Develop it* – improve the models and processes in the light of the experience gained from the project, incorporating the check/study and act parts of the Deming cycle.

There is no 'most important phase' – they represent a chain of activities. Like a chain, the project performance will only be as good as the weakest part of the process. The last phase has a significant input to the performance of subsequent projects, in addition to elements of it determining the performance of the current project.

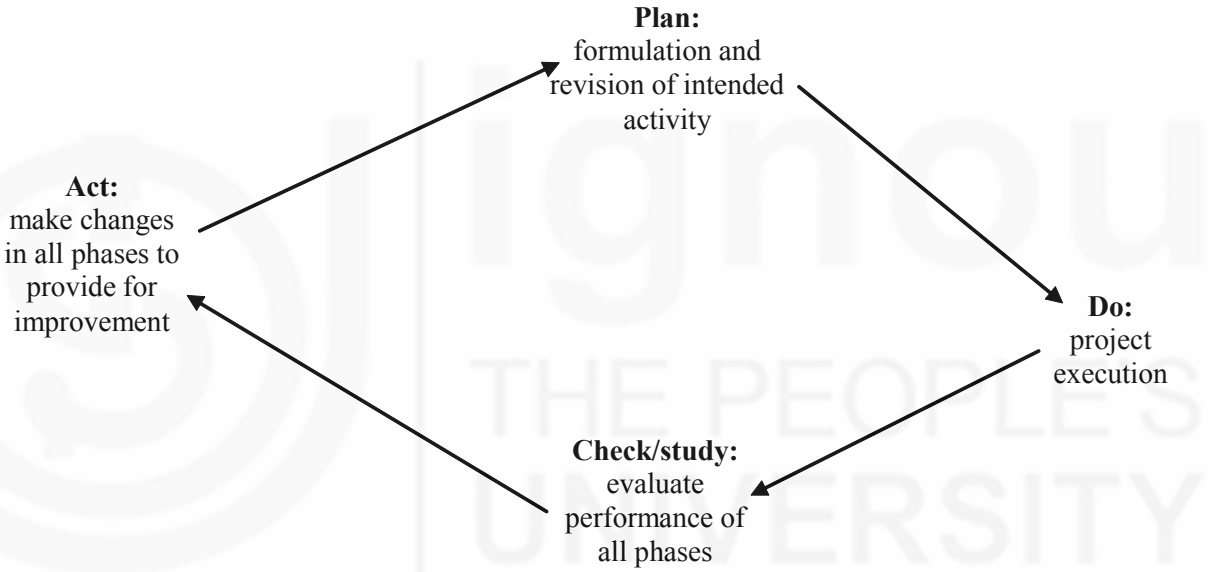

Fig. 4.1: Deming cycle for project management (PDCA)

The three phases provide the three sections of this text. Their application is summarised in Table 4.1.

Table 4.1: The Three Phases of Project Management

Phase	Key Issues	Fundamental Questions
Design it	Project and organisational strategy, goal definition, modelling and planning, estimating, resource analysis, conflict resolution and justification.	What is to be done? Why is it to be done? How will it be done? Who will be involved in each part? When can it start and finish?
Do it	Organisation, control, leadership, decision-making and problem-solving.	How should the project be managed on a day-to-day basis?
Develop it	Assessment of process and outcomes of the project, evaluation, changes for the future.	How can the 'management process' be continually improved?

There are a number of tasks and issue to be addressed in each phase. This provides a degree of complexity for the project manager and is one reason that there are few truly excellent examples of project management available. Taking the analogy of the project as a *chain*, it is important that there is general competence across the phases. This is preferable to there being excellence in one area, with other areas falling down.

The generic life-cycle for a project involves consideration of how the level of activity varies with time. This is illustrated in Fig. 4.2 and shows how the level of activity is relatively low during the design phase, increases through the doing phase, and decreases through the development phase.

This pattern is reflected in the graph of cumulative expenditure against time (Fig. 4.3). Outgoing are generally low in the early stages, but grow rapidly during the execution phase. The graph also demonstrates why the 'develop it phase' is so vital – by the time the majority of the doing phase is completed, the probability is that in excess of 98% of the total project expenditure will have been incurred. The last phase is the time when the project team themselves can benefit from the process and ensure that lessons (good and bad) are applied in the future.

The life-cycle may be further broken down as shown in Table. 4.2

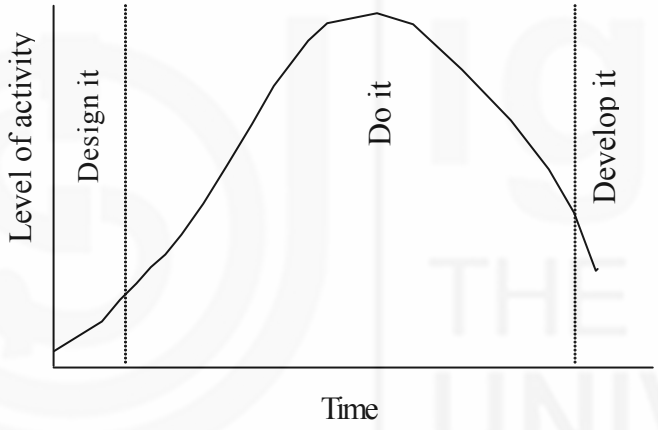

Fig. 4.2: Graph showing how level of activity varies with time

Table 4.2: Development of the project life-cycle

Stage in project life-cycle	Activity	Description
Design it	Conceptualisation	Generate explicit statement of needs.
	Analysis	Identify what has to be provided to meet those needs.
	Proposal	Show how those needs will be met through the project activities.
	Justification	Prepare and evaluate financial costs and benefits from the project.
	Agreement	Point at which go-ahead is agreed by project sponsor.
Do it	Start-up	Gathering of resources, assemble project teams.
	Execution	Carry out defined activities.

	Completion	Time/money constraint reached or activity series completed.
	Handover	Output of project passes to client/user.
Develop it	Review	Identify the outcomes for all share-holders.
	Feedback	Put in place improvements to procedures, fill gaps in knowledge, document lessons for the future.

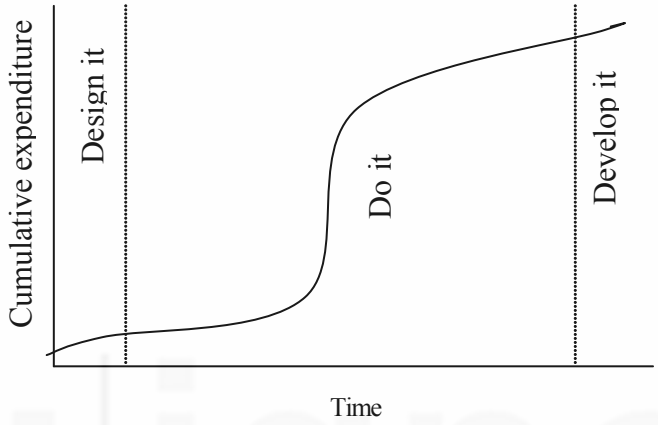

Fig. 4.3: Graph of cumulative expenditure against time

4.3 THE 7-S OF PROJECT MANAGEMENT

The 7-S framework of management issues was promoted by McKinsey and Co., management consultants. Their original 7-S is amended for the project environment, with a description of each of the elements, as shown in Table 4.1.

Table 4.3: The 7-S of Project Management

Element	Description
Strategy	The high-level requirements of the project and the means to achieve them.
Structure	The organisational arrangement that will be used to carry out the project.
Systems	The methods for work to be designed, monitored and controlled.
Staff	The selection, recruitment, management and leadership of those working on the project.
Skills	The managerial and technical tools available to the project manager and the staff.
Style/culture	The underlying way of working and inter-relating within the work team or organisation.
Stakeholders	Individuals and groups who have an interest in the project process or outcome.

Rather than being simply an outcome or a statement, *strategy* is a process. It involves a high-level consideration of objectives, which can be seen as points of principle, rather than activity-level details. Success starts with a rational strategy process, which then guides and informs the decisions made in all areas of the project.

Structure is the arrangement of human resources relative to lines of command and control. A key question for the project manager concerns the nature of this structure.

For example, should the project team be a dedicated, full-time team, or one where staff are 'borrowed' from other parts of the organisation or other organisations, only as and when needed?

Systems are 'the way we work'. Both formal and informal systems will need to be designed or at least recognised for key tasks, including communication and quality assurance. Formal systems can be demonstrated through statements of procedure – simply put, 'under these conditions, we carry out this action'. Informal systems, particularly for information transfer, are far less easy to describe and control. It is normal, however, for these to be the main mode of communication within groups. A theme within the systems element is the focus of the systems on 'process'. That is, ensuring that all activities carried out are contributing to the end objective of the project in a constructive manner. Systems are a recurring theme throughout this text.

Staff need to be selected, recruited and then managed. How they respond to their treatment will have a large impact on the success or otherwise of the project. Yet this element has traditionally been neglected by texts on project management.

Style/culture is part of the 'soft' side of management. Indeed, it cannot be managed in the short term in the same way that the finances of a project, for example, can be managed.

Stakeholders are an important consideration for project managers. Their importance has only recently been realised and methods for the management of expectations and perceptions developed.

The 7-S framework provides a comprehensive set of issues that need to be considered. It also allows classification of tasks within the remit of the project manager, which reduces the complexity of the role. In addition, classifying issues in this manner ensures that the project manager will know where to look to find sources of help if novel situations arise. Knowing that interpersonal problems in a team are aggravated by the style/culture that a project manager promotes provides a means for finding solutions to the problems.

Having considered the framework for consideration of issues by managers, some current issues for project managers are now discussed.

4.4 THE PROEJCT AS A CONVERSION PROCESS

The approach that will be considered in this book is a systems approach. The project is viewed as a conversion or transformation of some form of input into an output. As Fig. 4.4 shows, the inputs are some form of want or need which is satisfied through the process. The project will take place under a set of controls or constraints – those elements generally from outside the project which either provide the basis for any assumptions, or limit the project. The mechanisms are those resources that make the transformation process possible.

Inputs

For project of even moderate complexity there will be some form of project brief - a document which provides a statement of the want or need that is to be transformed by the project. There will be both explicitly stated requirements (original needs) and those which emerge during the course of the project due to the customer's changing needs or perceptions (emergent needs).

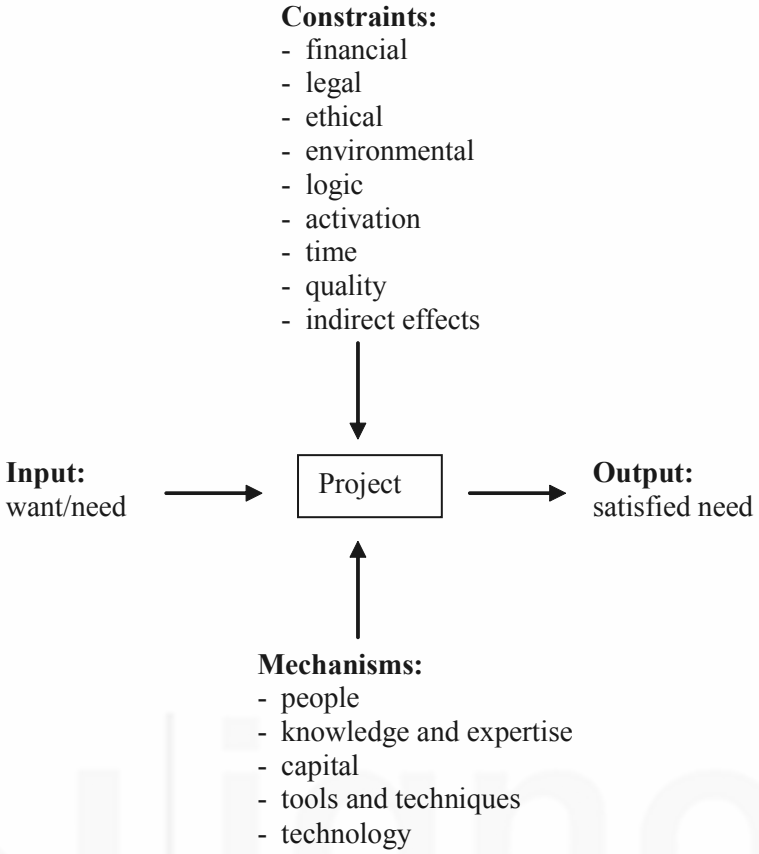

Fig. 4.4: The Project as a conversion process

It is tempting to think of a project brief as an unequivocal statement from the customer. In practice this is rarely the case and there will always be a degree of interpretation required from the project team. Where there is a large creative element required of the project, the brief will need to provide guidance as to what the nature of the desire is, without putting unnecessary limits on the way it is achieved.

Constraints

The brief will also set out the constraints, which may take the form of:

- financial – the amount and timing of release of capital to the project, and the revenue or other benefit it should generate;
- legal – this may not be explicitly stated but there will be legal constraints, e.g a building may not be constructed unless the planning permission for it has been obtained;
- ethical – a survey has shown that the consumers are becoming as concerned about the ethical behaviour of the companies they buy from as they are about the environmental friendliness of the products they buy. While this is at present limited to certain sectors of the community, the need to behave in an ethical manner as well as being seen to behave ethically is a factor in the way that projects are managed;
- environmental – the deluge of environmental legislation that has been generated by the European Union has changed the role of environmental control from a subsidiary issue to one which is at the forefront of management thinking;
- logic constraints – the need for certain activities to have been completed before a project can start;

- activation – actions to show when a project or activity can start;
- time – the biggest constraint for most projects (see current environment);
- quality – the standards by which both the product (the output of the process) and the process itself will be judged; and
- indirect effects – it is practically impossible for any change to take place in isolation. There will be ripple effects which will need to be taken into account at the outset. The output of the project will be in the form of:
  - converted information, e.g. a set of specifications for a new product.
  - a tangible product, e.g. a building.
  - changed people, e.g. through a training project, the participants have received new knowledge and so are part of the transformation process as well as being a product of it.

Outputs

Fig. 4.4 describes the output as a 'satisfied need'. This is a very wide interpretation of the possible outputs of a project and includes, for example, a new building as an output from a construction project; processed information, e.g. in the form of engineering drawings or a report; and people with the necessary skills for a task (the output of a project involving training). The outputs may be tangible or intangible.

Mechanisms

The means or mechanisms by which the output is achieved are as follows:

- people – those involved both directly and indirectly in the project;
- knowledge and expertise – brought to the project by the participants and outside recruited help (e.g. consultants);
- capital – the money that provides the resources;
- tools and techniques – the methods for organising the potential work with the available resources; and
- technology – the available physical assets that will be performing part or all of the conversion process.

This consideration provides the most basic model of the project. The nature of the transformation process will be determined by the environment in which it is taking place. This is the subject of the following section.

4.5 THE RELATIONSHIP BETWEEN PROJECT MANAGEMENT AND LINE MANAGEMENT

Fig. 4.5 shows a conventional management hierarchy with the lines on the diagram representing lines of reporting or responsibility. At the head of each of the major functions within an organisation there will be functional or line managers. These managers have the responsibility for the people who work under them in their departments.

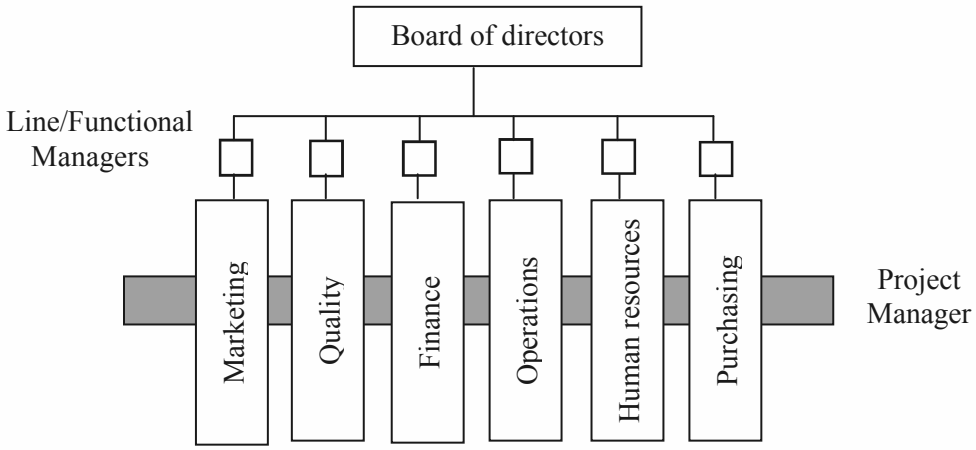

Fig. 4.5: Project organisational structure (for project of medium complexity)

The project manager may have a line management role as well, but is responsible for projects that may run across several functions. The figure shows the project manager being responsible for people drawn from every function in their activities in relation to that project.

The project manager's role differs from that of the line manager in the nature of the task being carried out. Table 4.2 gives the major differences.

Table 4.4: Project Versus Line Management

Line Management	*Project Management*
• responsible for managing the status quo.	• responsible for overseeing change.
• authority defined by management structure.	• lines of authority 'fuzzy'.
• consistent set of tasks.	• ever-changing set of tasks.
• responsibility limited to their own function.	• responsibility for cross-functional activities.
• works in 'permanent' organisational structures.	• operates within structures which exist for the life of the project.
• tasks described as 'maintenance'.	• predominantly concerned with innovation.
• main task is optimisation.	• main task is the resolution of conflict.
• success determined by achievement of interim targets.	• success determined by achievement of stated end-goals.
• limited set of variables.	• contains intrinsic uncertainties.

As Fig. 4.6 shows, the split between tasks that can be considered as maintenance (maintaining the status quo) and innovation is changing. On the figure, the trend is for the line AB to move downwards – increasing the degree of innovation activities required from line managers. The result of this is change in the role of line managers and a reduction in the difference in the roles of line and project managers.

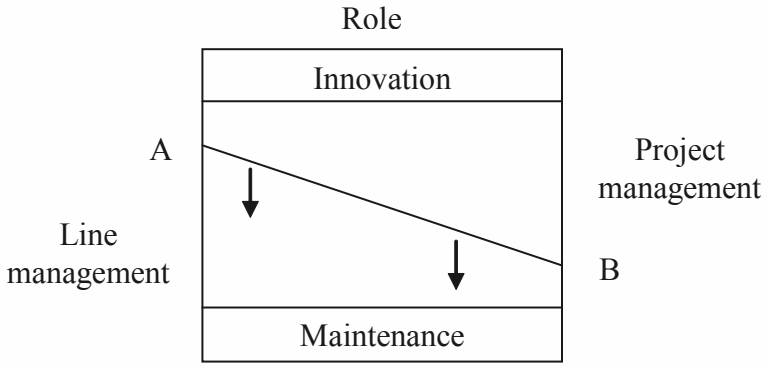

Fig. 4.6: Innovation/maintenance activities in line and project management

The major change in the practice of project management has been its emergence as a management specialism in its own right – just as financial management, operations and marketing have done. For many strategic projects, the function of project management will involve many elements, including:

- financial management – through the preparation of a financial case to meet the needs set out in the project brief;
- personnel management – the identification of skills required, the selection of staff, their motivation and welfare;
- operations management – there are often parts of a project that are repetitive in nature and so can be treated as individual operations;
- purchasing and logistics – the identification of material and service needs, suppliers, their selection and the management of the logistics (location and transport of materials);
- technical specialisms – e.g. new product development, engineering, programming, quality management; and
- marketing – projects generated for both internal and external customers will need to have explicit statements of needs drawn up and then be 'sold' to the customer.

Three project managers with distinctly different roles

1) The site manager of a housing construction project

I am incharge of the construction of the buildings you see around you (he gestured with his hand to the mixture of partially and fully completed properties) and of making sure they go from this stage (he indicates a pile of drawings and building schedules) to the point where we can hand them over to the sales people to sell. Most of the work is supervisory, ensuring that orders are placed and materials arrive on time, people turn up, do the job properly and get paid for it at the end of the week. There are always arguments between the various trades people to resolve and problems just get dumped on the desk. Some of the toughest problems come with the people you have to work with. Some of them will do anything to try to get one over on you – they'll tell you a job is finished when you can see it is only half done. Unless you go and check it yourself you're in trouble. Also, they don't give a damn for my schedule. How do you get a roofer, at four o'clock in the afternoon when it is raining rather heavily (not the words actually used) when you know he has a long drive home, to get back on the roof and finish the job he is doing so that other jobs which rely on this being completed can start at eight o'clock the following morning? It wouldn't be the first time we had to block his car in with a pallet of bricks to stop him leaving'.

2) The quality director (Implementing Total Quality Management)

'The quality director was appointed with the brief to introduce Total Quality Management (TQM) to the company. It was his responsibility to put the proposal as to how it could be done, and then to carry it out. As he described at the outset of the project "(this) is one of the most complex projects that we could undertake at this time". The complexity came because the project would hopefully change the way that everyone in the company thought and worked (i.e. both attitude and procedures). This would have to be done through consultation, training and the demonstration through piloting small-scale improvement activities, that the move towards TQM was worthwhile. The initial phase as part of the proposal process was to carry out a company-wide quality audit to determine attitudes, knowledge and current practice. The results paved the way for the carrying out of targeted efforts where needed most. The first phase of execution was to take the board of directors of the company on awareness training-showing them how working under a TQM environment would benefit them, and what changes would be needed. The next level of management were then trained and so on down the hierarchy until the middle management level. These managers then trained their own people – a process known as "cascading". The project to introduce the new philosophy to the company took several years, and has now moved on to become an accepted way of working. The quality director was initially involved in the management of the introduction process, where the employees and suppliers needed to be convinced that this was a good route for the company to take. His role then became one of project sponsor of a variety of improvement projects, which may be considered as sub-projects of the main one'.

3) Project manager in financial management system implementation

The main roles of the job include:

- organisation – from the design of the system to determining support issues and providing training;
- anticipation of future requirements of the system;
- monitoring of progress of the implementation;
- communication and information – providing progress reports to local team members and national common-interest groups; and
- audit – ensuring the housekeeping, procedures and system security are in order.

The initial system design work involved coordinating with external system designers, the providers of the software and the in-house IT group. Our local area network (LAN) needed upgrading to run the new system. Other organisational issues were the role that consultants would play in the system design and training of users and the allocation of the budget between activities.

Anticipation was required as the requirements of the system would change over its life. For example, higher level monthly indicators of financial performance would need to be provided where they had not been needed before. In addition, a management accounting system would be needed to provide budgetary controls.

The monitoring system we used for the project was PRINCE. This provided a basic set of planning tools, and we filled in the blanks on the planning sheets. A team was set up to monitor progress against the plan.

4.6 THE ROLE OF STRATEGY IN PROJECT MANAGEMENT

There are three levels at which the project manager can have an influence. These are the strategic, tactical and operational levels. For too long, the subject of project management has focused on the tactical and operational levels, ignoring its role in the development and deployment of strategy. This has resulted in:

- projects being carried out in a reactive mode with project managers having little or no input to the strategy process;
- a lack of definable objectives for projects; and
- inevitable conflicts with line managers over resources.

Having project managers who understand the strategy process and who can make an input to it is the first stage in achieving success. The strategy is like a set of principles that guide and inform the actions and decisions of managers. Without this, there is unnecessary chaos – people go in their own direction, to the detriment of the organisation in which they are working.

The term *strategy* needs to be defined. It is about setting objectives for an organisation and providing a path for it to progress towards those objectives. Good strategy is considered as central to success in any organisation, but its definition cannot be universally agreed. The major classifications of strategy are either in terms of:

- the environment in which an organisation exists (relative to competitions, for example through achieving cost advantage); or
- in an absolute sense, as a statement of the *vision* for the organisation (e.g. to have a market presence in every country in the world). Both of these approaches have relevance in the context of the project management.

Strategy in the context of project management is the outcome of a *strategy process.* It is through the consideration of the process that the outcome will be assured. This process includes two key elements: assessment of the present and anticipation of the future.

Furthermore, this process is conducted at two levels – the organisational and project levels. At the organisational level, the aspects of interest are external to the project but those *policies* will affect its objectives. At the project level, these are internal aspects that are generated by the project manager and refer to the project specifics. As a minimum requirement, the project strategy must be in line with the organisational strategy; not in conflict with it. Ensuring that this is achieved in a theme that is expanded in the following section.

Project strategy

The conventional approach to strategy in projects requires the manager to consider three key elements – time, cost and quality. If these can be objectively defined, this provides the goals for the project. This will be considered first. We then need to consider the further element of *flexibility*.

All three – time, cost and quality – can be considered as having two elements. The first is the element of *performance*, expressed as:

- What is the shortest possible project duration?
- What is the lowest cost?
- What is the highest level of quality that can be achieved?

The second element is *conformance*. This is a measure of the reliability required of the project system, expressed as:

- Can the project be guaranteed to be delivered on time?
- Will the project finish within budget?
- Will the project meet the specified level of quality?

The mechanisms by which the project manager assures conformance are different from those that ensure performance. For example, by selecting low-cost suppliers, the project manager may attempt to ensure that the project is delivered at minimum cost (performance). Whether it is in fact deliverable is determined by the actions of that manager to secure guarantees that the price (in addition to delivery and quality) will be achieved in practice (conformance).

Table 4.5: Conformance versus Performance Attributes of Time, Cost and Quality

	Time	Cost	Quality
Performance	Shortest possible	Cheapest possible	Highest level
Conformance	As planned	As budgeted	As specified

Time and cost criteria are relatively straightforward concepts. In practice, determining whether key objectives have been achieved can be a matter of some argument and commercial significance. However, one of the least understood concepts is *quality*. The key relationship that needs to be explored here is that between expectations and perceptions of customers (and other stakeholders) of both the project process and its outcomes.

The process of project planning – inputs, outputs and the process itself

The process of project planning takes place at two levels. At one level, it has to be decided 'what' happens. This, the tactical-level plan then needs to be converted into a statement of 'how' it is going to be carried out (or operationalised) at the operational level. Fig. 4.7 shows an activity model, as would be used to analyse systems of activity by considering the inputs, controls, outputs and mechanisms (ICOMs) for the activity. The inputs are the basis for what is going to be converted by the activity – in this case the project brief. The output is the project plan, or more specifically the project proposal. The controls provide the activation, the constraints and the quality standards for the planning process in addition to its outputs, and the mechanisms provide the means by which the process can happen.

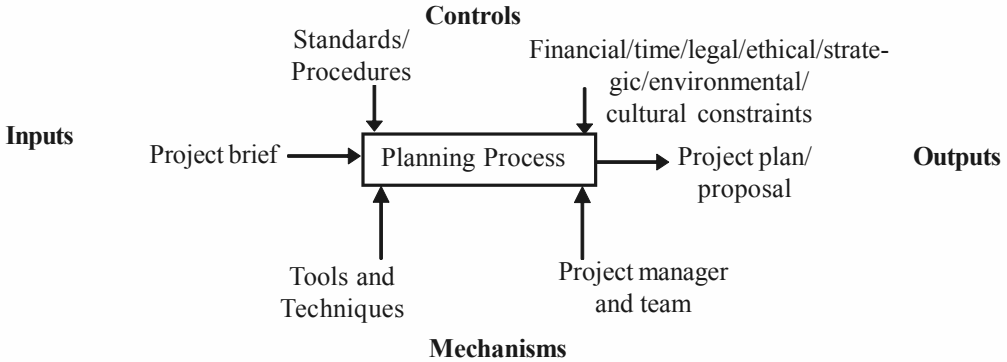

Fig. 4.7: Activity model using ICOMs

At the operational level, the way in which the proposal is generated should not be viewed as a one-off activity but should go through many cycles of suggestion and review before the 'final' document is produced. As Fig. 4.8 shows, the first cycles are to provide the major revisions, where significant changes are made. Once these have been done and the project team is happy with the basic format, the last stages are those of refinement, where small adjustments are made.

It is important for the overview to be verified first, before further effort is committed to planning at a detailed level – as discussed above. The life-cycle of planning in Fig. 4.8 shows the stages that the plan should go through. Cases such as the one given below are examples where the detail was considered before the major issues. As the example shows below, this is very wasteful of management time.

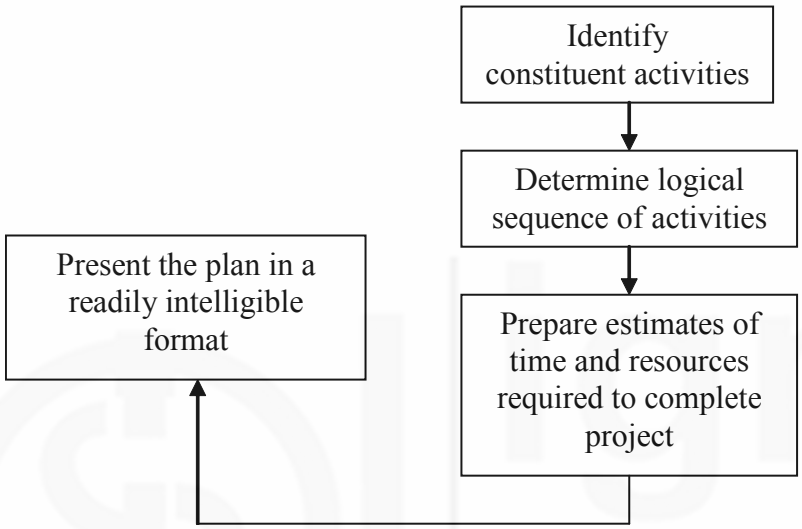

Fig. 4.8: The project planning process

Example – The upside down business plan

Business plan meetings were serious affairs – they always were. The concept was quite attractive – to set up an exclusive nursery school with an appealing teaching method in a smart area of the city. So far so good. This was however, where the rough planning stopped and the group succumbed to the virus that plagues so many projects at this point – detailitus. The discussions were then way laid by the need to have safety tyres on the school minibus and by the detailed wording of the liability insurance. No matter that the lag between the money being spent on the buildings and equipment and any income from fees received would create interest payments that the company could never hope to meet.

The revision/refinement process considers the necessary sub-projects (if any), the results of any numerical analysis (may be financial, resource, risk analysis or some form of mathematical simulation), the element of 'gut feel' (also referred to as the sub-conscious or back-of-the-mind element) as well as experience. The sponsor and other stakeholders will usually have some input to be considered in this process.

Managing the planning process

Most projects of low complexity will bias the ratio of planning: action heavily towards the action. As complexity increases, so does the necessity for a formalised plan. This is both a systematic analysis of the project (which provides its own set of benefits) and an opportunity to show that the project manager has been systematic in the planning

process (by showing the level of consideration that the project manager has given to issues). 'Traceability' has become a major issue in many companies – allowing products to be traced back to records of their constituent parts. The same is required of a project plan. In the event of an unsatisfactory result, for whatever reason, a good plan can show that the planner took every possible precaution to ensure that the result was positive. Conversely, should the project go particularly well, you will have an assignable cause for this – namely your planning.

The benefits of using a systematic methodology in planning include:

- breaking down complex activities into manageable chunks (see work breakdown structure);
- determining logical sequences of activities;
- providing an input to subsequent project management processes, including estimating the time and resources required for the project;
- providing a logical basis for making decisions;
- showing effects on other systems;
- filtering frivolous ideas and activities;
- providing a framework for the assessment of programmes (the post-project review process relies on comparing the achieved result with the original plan, particularly for the purpose of improving the planning process);
- being essential for the revision/refinement process;
- allowing lessons to be learned from practice; and
- facilitating communication of ideas in a logical form of others.

What follows shows how these benefits can be achieved through the application of tried and tested methods, within a systematic framework.

4.7 TIME PLANNING – TOOLS AND TECHNIQUES

The project planning process was described earlier as having four main stages – identify the constituent activities, determine their logical sequence, prepare estimates of time and resource and present the plan in a readily intelligible format. This last step allows the plan to be communicated to all parties involved with the project and analysis. The general approach to planning involves starting with a rough overview and conducting revisions of this through the process shown below. This is known as *iterative* – it involves going through the cycle several times, to test the effects of the changes you make on the outcomes. The objective is to make the major revisions early in the planning cycle and then make minor refinements to the plan. Following these, there should be a period of stability otherwise the plans lose credibility. The revision – refinement cycle is shown in Fig. 4.9.

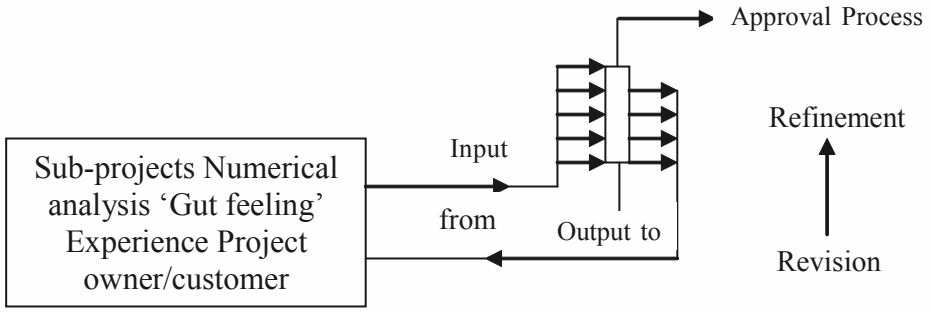

Fig. 4.9: Planning sequence

This section is concerned with developing detailed time plans. The techniques that follow are of increasing complexity. However, despite the diversity of projects being considered, one area of commonality between project managers is the use of various graphical techniques to:

- allow the construction of a comprehensive but comprehensible picture of the project activities; and
- communicate this with others.

The preference for graphical techniques is more than 'a picture telling a thousand words'. The whole revision/refinement process is built around people being able to understand what is going on. This is known as visibility, and is an essential feature of both the plan and the process.

The purpose of the graphical techniques is to illustrate the relationships between the activities and time. The simplest form is a horizontal bar chart, as in Fig. 4.10. This shows activity a represented by the bar starting at time 1 and finishing at time 3. Multiple activities can be built up on the same chart, using the same timescale.

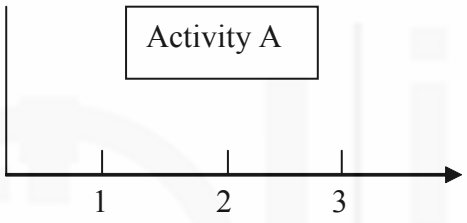

Fig. 4.10: Horizontal bar chart: activity A starts at time 1 and finishes at time 3

The following example involves a dissertation planning exercise. The student has a number of options as to how to present the information. The supervisor, being a busy person, has asked for the information to be presented in graphical form.

Time estimation – learning curve effects

Watching a skilled craftsperson at work shows how a highly intricate task can be learned and carried out so that it is made to look easy. Gaining such a level of skill requires years of training and practice (and many mistakes). A project rarely has such an opportunity to gain advantage through repetition. There will, however, be repetitive elements to any activity, particularly during the execution phase. Where this occurs, the time taken each time the task is carried out will decrease as the person becomes familiar with the methods. Subsequent improvements in speed are seen to become smaller over time. This can be quantified using the following formula:

$Y_x = Kx^n$

Where

x = the number of times the task has been carried out,

Y_x = time taken to carry out the task the xth time,

K = time taken to carry out the task the first time, and

n = $\log b / \log 2$ where b = learning rate.

Example

A team is set up to carry out a quality audit of ten departments. The first audit takes four days as the auditors are unfamiliar with the procedures. The second audit takes three. After a period of time, the minimum audit time is reached, and very little further improvement is seen. We can plot this progression as shown in Fig. 4.11.

If we wish to find out how long the eighth audit will take, we need to calculate the learning rate, *b*. The following values can be assigned from the above information:

x = the number of times the task has been carried out = 2

Y_x = time taken to carry out the task the xth time = 3

K = time taken to carry out the task the first time = 4

n can be calculated

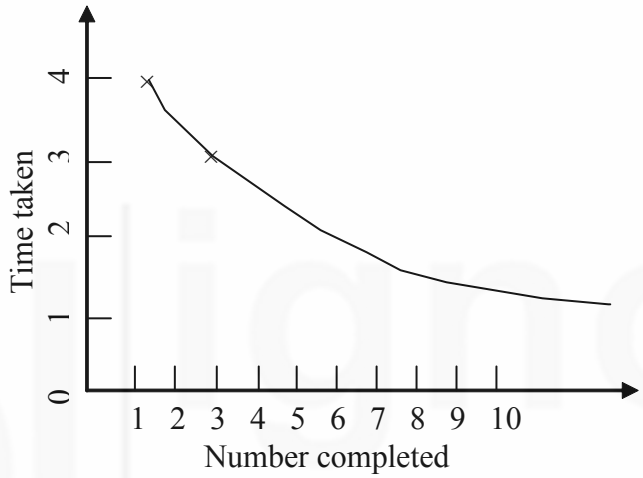

Fig. 4.11: Learning curve effect on time taken

Putting these valued in:

$$3 = 4(2)^n$$
$$2^n = ¾$$
$$n.\log 2 = \log(3/4)$$
$$n = -0.1249 / 0.4149$$
$$n = \log b / \log 2 = -0.4149$$
$$\log b = -0.1249$$
$$b = 0.75$$

From this we can say that the project has a 75 per cent learning curve.

This can also be seen intuitively, as another way of expressing the learning curve is to say that every time the total number of audits completed doubles, the time taken for the last audit will be the learning percentage multiplied by the original time. In this case as the number of audits doubled from 1 to 2, the time decreased from 4 to 3. The percentage is therefore ¾ = 75 per cent. As the number of times the audit is done increases, the times taken will decrease as shown in Table 4.4.

Table 4.6

Audit no.	Time taken (days)
1	4
2	3
3	2.54

4	2.25
5	2.05
6	1.90
7	1.78
8	1.69

4.8 PROJECT STRUCTURES – TEAMS AND ORGANISATION

The gathering together of individuals with the aim of making them a cohesive whole and ensuring the benefit of all stakeholders is a fundamental role of most project managers. This is at best likely to be a very hit-and-miss process (very few will naturally achieve both good social interaction and commercial success) and, at worst, financially disastrous. There have been many attempts to describe the best mixture of personalities that will ensure that the group dynamics are right and some of these will be discussed here. There are project issues. A strategic issue is how the project management structure fits in with the structure of the organisation as a whole. The ideas of the various forms of matrix are also discussed.

4.9 THE ROLE OF TEAMS

The organisation of people into *ad hoc* groups takes advantage of bringing together individuals from different specialisms (marketing, engineering, etc.) as needed for a project task. It is notable that as organisational size increases, the degree of specialism of individuals is increased. Since the days of Henry Ford, large organisations have been organised by functional specialism into 'chimneys'. The notion is that by grouping all the specialisms together, the arrangement is very efficient, as when you need that function to be performed, there is an obvious resource to draw on. Quite reasonably, from the point of view of the individual, career paths are well defined and basic administration systems are geared to this way of working. Give a group the task of setting up and running their own business and, 99 per cent of the time, the first task they set themselves is to allocate roles as heads of the various line functions. This is typically the case in many traditional industries, but has been shown to be detrimental to the creativity of individuals and the responsiveness of the organisation to changing market needs.

However, as discussed in, one single function will rarely provide a customer's entire need or want. To do this requires cross-functional activity, i.e. the linking of the activities of more than one functional area. Functional arrangements tend to lead individual managers to build their own empires by creating work for themselves – regardless of whether this is value-adding for the organisation as a whole. Departmental head-count is considered to be a measure of the status of the individual manager and the importance of their function.

The conventional management hierarchy or pyramid (see Fig. 4.13) has provided the basis on which the majority of organisations are ordered. The style is militaristic and there may be 11 or more layers in the chain of command (foot soldier to top-ranking general). Other structures include organisation by:

- Product group;
- Customer type (e.g military / civil);

- Geographical area (of their operations or the customers they serve); and
- The function they perform.

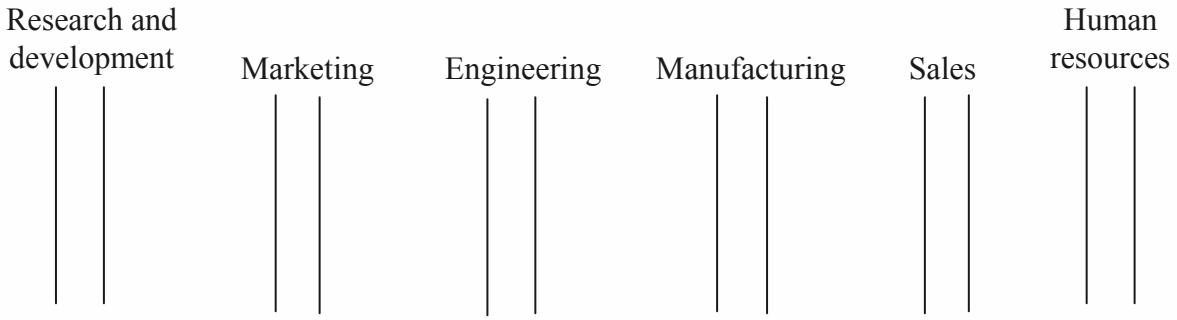

Fig. 4.12: Management chimneys

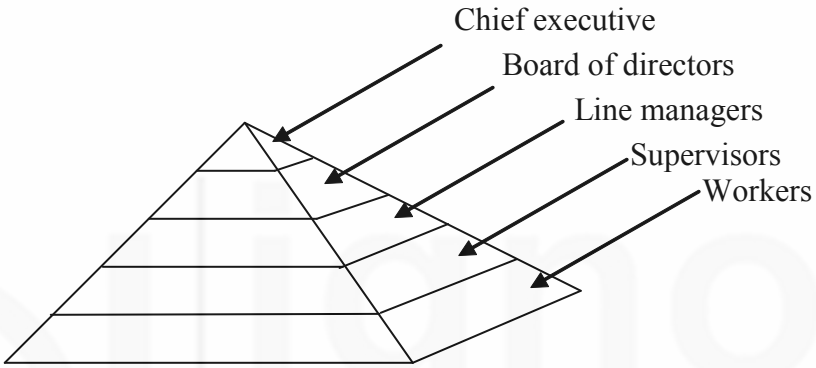

Fig. 4.13: Hierarchical pyramid

It is common to see a mixture of these forms of organisation being employed depending on the nature of the business and the degree of vertical integration in the supply stream (how many of the suppliers/customers are owned by the same organisation).

Where a project can be defined as having more than one function involved (which systems and strategy projects are almost bound to have) it is merging as one of the roles of the project management specialist to define possible organisational forms. Many authors note that project managers themselves rarely have a choice about how the project organisation is arranged and, consequently, have to use what are often inappropriate structures. The emerging strategic importance of the project manager means that they are likely to have more input in determining the structures within which they work in the future.

The nature of the work organisation is important as it:

- defines responsibility and authority;
- outlines reporting arrangements;
- determines the management overhead (costs);
- sets the structure behind the organisational culture; and
- determines one group of stakeholders in project activities.

As organisations have expanded, so the functions have often become less integrated by, for example, geographical separation. Walls, both literal and metaphorical, are

constructed around them. In order to try to enforce communication between departments, many organisations use 'dotted-line responsibility'. Here an individual may have a responsibility to one functional manager, with a dotted-line responsibility to another. This device has been used frequently to ensure that certain individuals do not engage in empire-building. In manufacturing industry, this was done by manufacturing directors who wanted to ensure that they retained responsibility for the running of the entire manufacturing operation. Consequently, when it became fashionable to employ a quality manager, they were not given any direct staff, but inspection and other quality staff would work for the manufacturing manager, while given a dotted-line responsibility to the quality manager (indicating that they were linked to the goals of this part of the operation). It did still leave power in the hands of the manufacturing people.

In addition to the dotted-line responsibility, detailed administrative procedures are introduced to ensure that some form of integration takes place. Often involving interminable meetings and mountains of bureaucracy, they are an attempt to make the organisation perform acts which it is not designed to do, i.e. integrate. Sloan's General Motors in the US in 1930's was run using considerable command-and-control structures – based on the premise that 'whoever holds the purse strings, commands'.

4.10 CONTROL SYSTEMS

The most basic model of a control system is shown in Fig.4.14. In this diagram, the output of a process is monitored by some means to determine the characteristics of the output. This data is interpreted and then fed back to the input to the process. On receipt of this information, adjustments are made to the process. By using this kind of 'feedback control system', the performance of the process can be guided by the application of corrective actions to keep it within certain limits (having defined 'acceptable deviation' from the desired performance).

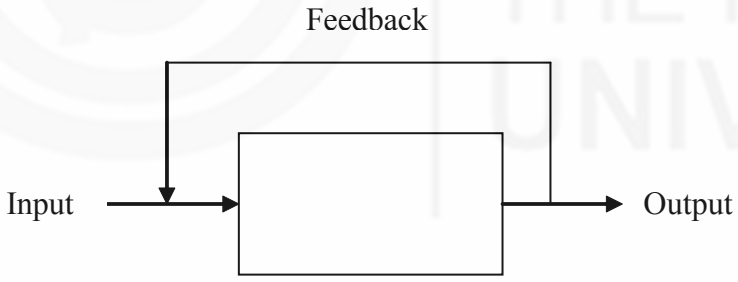

Fig. 4.14

The monitoring point should be set so as to take a representative measure of the characteristics in which you are interested. The nature of these will be discussed in the following sections. The action that is taken based on the feedback is the 'corrective' or 'control' action which seeks to remedy the deviation that has been noted. The intention is to keep the system stable through regular corrective action. The nature of the feedback itself is important.

Example of a control system – corrective actions and stability in a physical system

Try balancing a ball in the centre of a tray – start it moving and try to bring it to rest again ten centimetres away form the start point. Very quickly the movements of the tray get larger and the movement of the ball will generally become anything other than

diminishing as the ball passes over the point without stopping. The system rapidly becomes unstable as the movement of the ball has passed out of control and soon leaves the tray completely. This is the result of instability in the system – the brain cannot make the necessary corrective action to bring it back to rest and so the control actions get larger as the ball exhibits behaviour which is considerably different from that which is required.

4.11 CONTROL OF MAJOR CONSTRAINTS – COST AND TIME

The detailed systems for controlling quality are novel in many industries. The systems for controlling cost and time have been in use for far longer, but still require a considerable input from the project manager in their establishment and execution. The attributes of cost and time are interlinked as previously discussed. The need is for practical tools that will identify when corrective actions are required and what they should be. The role of the project manager in cost control may be stated as:

- setting up the cost control system in conjunction with the needs and recommendations of the financial function;
- allocating responsibilities for administration and analysis of financial data;
- ensuring costs are allocated properly (usually against project codes);
- ensuring costs are incurred in the genuine pursuit of project activities; and
- checking other projects are not using your budget.

The measurement that is often taken to consider progress using cost as a measure is 'sunk costs'. That is the measure of what has been spent to a particular point in time on activities. It is notoriously unreliable as a measure of how much has been achieved, as it is perfectly possible for a project to be 80 per cent complete but to have incurred 95 per cent of the budget allocated to it. Controlling cost overruns clearly needs more than just a raw figure such as expenditure incurred. The 'earned value' concept is one attempt to make the measure more meaningful.

'The earned value of a task is the approved budget allocated to perform the task. When the task is complete, the budget has been earned.'

4.12 MANAGING AND CONTROLLING SUPPLIERS AND CONTRACTORS

For many construction projects as much as 80 per cent of the revenue generated by a project is spent with suppliers and contractors. The design and control of the purchasing function is clearly a management specialism in its own right, but is a function in which the project manager has an input. Some of the purchasing responsibility is also typically devolved to the individual project, although it is more usual for the majority to be handled centrally. There are clear advantages to each form of purchasing, as shown in Table 4.7.

Table 4.7

	Centralised Purchasing	Localised Purchasing
Advantages	• purchasing power due to aggregation of orders. • better materials utilisation and stock management. • economies of staffing. • standardisation of purchasing procedures.	• local knowledge of suppliers. • low organisational inertia. • local management control. • enhanced supplier relationships.

The trade-offs will need to be optimised on a project-by-project basis. The objectives of the purchasing system are similar – to satisfy what are termed 'the five rights'. These are inter-dependent characteristics of a supplier or contractor depending on their ability to deliver:

- the right quantity;
- at right quality;
- at the right price;
- at the right time and place; and
- the right supplier.

The quantity of goods or services (contractors are generally assumed to deliver a service) is determined from the schedules drawn up with the plans. Where there have been changes these are built in and the quantity calculated. The quality of goods and services may be determined through:

- trial supply of goods or services;
- prior reputation; and
- certification or assessment of their quality systems.

Where contractors are hired on an individual basis, the recruiter may also seek membership of a particular professional body and possibly the contractor to provide their own legal indemnity insurance.

Achieving a purchasing decision at the right price is a difficult debate. In project organisations there is often the need for long-term relationship to be built up between buyers and supplier, though the relationship for that particular project may be fairly short. There are clear gains to be made by applying pressure on the price to obtain the cheapest supply. In the long term, however, the supplier may go out of business or may simply economise in ways that cost you money elsewhere.

'End the practice of awarding business on the basis of a price-tag. Purchasing must be combined with design of product, manufacturing and sales to work with the chosen supplier: the aim is to minimise total cost not merely initial cost.'

The best supplier may not then be the cheapest, as there is often a trade-off in other areas.

Achieving the right time and place is the basis of much literature and the predominant complaint that industrial purchasers have about suppliers. The rating of suppliers and

regular performance reviews can keep this as an issue for them. It is also one advantage that a degree of centralisation can have for the purchasing function – that of being able to track supplier performance on the basis of criteria such as late delivery if paperwork to place the order takes six weeks to be processed by the purchasing function. Giving suppliers the longest possible time in which to fulfil an order is going to be beneficial to both parties in the long term.

Being the right supplier clearly has dependence on the other four categories, but is included to start the discussion as to the way in which one selects suppliers. The choice base on price alone has been shown to provide possible short-term gains which can be more than countered in the longer term. There are several other factors which should be considered.

- Are choices made on the basis of a 'free lunch? The expansion of the corporate hospitality industry over the last ten years has been immense, for example. This has been paralleled by efforts by many companies to be seen to be behaving ethically and state publicly that their staff will not accept gifts, however small, from suppliers.
- How are orders conveyed, with what frequency and how do the suppliers really know what your requirements are? Also, they often have expertise in both the design of their products and their application, which, should be used as a source of knowledge and improvement.

4.13 PROJECT COMPLETION AND HANDOVER

The major elements that will require the attention of the project manager during this phase are:

- ensuring there is an incentive for the project to be finished and that activities are completed;
- ensuring documentation is provided;
- closing down the project systems, particularly the accounting systems;
- constructing the immediate review of activities – providing a starting point for all improvement activities;
- disposal of assets that are surplus to requirements;
- providing the best basis for future projects;
- ensuring that all stakeholders are satisfied; and
- providing the basis for future reviews of activities.

Documentation

The purpose of providing documentation is:

- to give the customer of the output of the project guidance on the operation and maintenance of the item provided;
- to provide evidence that the project has been completed in a proper manner;
- to provide the basis for one form of the assessment activity; and
- to allow any future work on the same system to be base on good information rather than assumptions.

The close-down activities should form part of the detailed planning and the derivation of checklists can provide an objective means of ensuring that the finishing tasks are carried out. Such a checklist is:

- an *Iaide-memoire* in addition to formal work allocation;
- evidence that the close-down tasks were planned; and
- evidence, when completed, that the tasks were carried out, by whom and when.

Check Your Progress Exercise 1

Note: a) Use the space below for your answers.

b) Compare your answers with those given at the end of the unit.

1) Define project and explain the key activities involved with project management.

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2) What are the different phases of project management?

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3) Explain the stages in development of project life cycle.

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4) What are the 7-S of project management?

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5) What is the relationship between project management and line management?

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6) What is the role of strategy in project management?

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7) Explain the role of teams in project management?

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8) Explain the process of controlling suppliers and contractors.

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4.14 LET US SUM UP

Project Management is no longer about managing the sequence of steps required to complete the project on time. It is about systematically incorporating the voice of the customer, creating a disciplined way of prioritising effort and resolving trade-offs, working concurrently on all aspects of the project in multi-functional teams, and much more. It involves much closer links between project teams and downstream activities, e.g. in new product development integration with manufacturing, logistics and after-sales support – in this case 80 per cent of costs are determined before they take over.

There are huge opportunities for eliminating wasted time and effort in almost every project. In manufacturing, Toyota estimate that only 5 per cent of activities actually

add value, 35 per cent are necessary but do not add value, while the remaining 60 per cent is pure waste – Muda in Japanese. By halving the effort in designing a new car, they show this Muda can be reduced by good project management. Every project manager in the future has not only to manage their own project but to seek new ways of eliminating the Muda in their systems so they can do more for less, and more quickly next time.

Projects make up around 50 per cent of all work carried out. They can therefore be termed 'an economically important' category of activities. That makes the subject of their management worth studying. However, it is not unusual to hear the question from students at the start of a course, *' It's just common sense, isn't it?* To some extent they are right. After all, there is nothing inherently difficult about the concepts which are discussed here (with the exception of some of the mathematical modelling). How is it that the majority of organisations are so poor at managing projects? The answer can be found in the definition of common sense as *'the obvious after it has been explained'*. It is observed that common sense is not so common, and many of these apparently obvious aspects of the subject are neglected.

4.15 KEY WORDS

Project	:	A goal oriented non-repetitive activity.
Project Management	:	Includes planning, organising, directing and controlling activities.
Three Phases of Project Management	:	Design it, do it and develop it.
Life Cycle of Project	:	Consideration of how the level of activity varies with time
Conversion Process	:	Conversion of some form of input into a output.
Strategy	:	Systematic analysis and planning out activities for a favourable outcome.
Performance Attributes	:	Time, Cost and Quality.
Management Hierarchy	:	Layers in the chain of command.
Constraints	:	Restrictions in implementation of actions.

4.16 ANSWERS TO CHECK YOUR PROGRESS EXERCISE

Check Your Progress Exercise 1

1) A project can be defined by ISO 10006:2003 as "unique process consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources". Project management includes planning, organising, directing and controlling activities in addition to motivating what is usually the most expensive resource on the project – the people. Planning involves deciding what has to be done, when and by whom. The resources then need to be organised through activities such as procurement and recruitment. Directing their activities towards a coherent objective is a major management role. The activities also need controlling to ensure that they fit within the limits (e.g. financial) set for them.

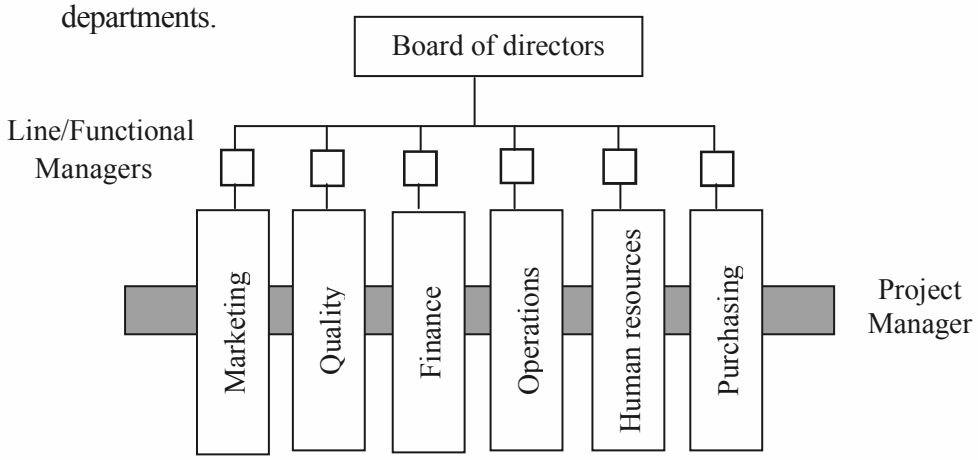
2)
- *Design it* – identify the need that the project will serve, construct models to show how the needs will be developed, evaluate these to determine the optimum process for the task and minimise risk;
- *Do it* – carry out the project in line with the models or plans generated above; and
- *Develop it* – improve the models and processes in the light of the experience gained from the project, incorporating the check/study and act parts of the Deming cycle.

3) The *planning* stage involves the formulation and revision of statements of intended activity, whether formalised or otherwise. The doing is the time when the project is carried out (the direct value-adding phase). The *check/study* phase involves a critical appraisal of both the project output (was a good result achieved?) as well as the process (was it carried out as well as it could have been?) the *act* stage is that phase when the project process is considered to see how the lessons learned and gleaned from the review could be channelled back to the people involved in the process.

4) **The three phases of project management**

Phase	Key Issues	Fundamental Questions
Design it	Project and organisational strategy, goal definition, modelling and planning, estimating, resource analysis, conflict resolution and justification.	What is to be done? Why is it to be done? How will it be done? Who will be involved in each part? When can it start and finish?
Do it	Organisation, control, leadership, decision-making and problem-solving	How should the project be managed on a day-to-day basis?
Develop it	Assessment of process and outcomes of the project, evaluation, changes for the future	How can the 'management process' be continually improved?

5) Figure shows a conventional management hierarchy with the lines on the diagram representing lines of reporting or responsibility. At the head of each of the major functions within an organisation there will be functional or line managers. These managers have the responsibility for the people who work under them in their departments.



Project organisational structure (for project of medium complexity)

6) The strategy is like a set of principles that guide and inform the actions and decisions of managers. Without this, there is unnecessary chaos – people go in their own direction, to the detriment of the organisation in which they are working. Good strategy is considered as central to success in any organisation, but its definition cannot be universally agreed.

Strategy in the context of project management is the outcome of a *strategy process*. It is through the consideration of the process that the outcome will be assured. This process includes two key elements: assessment of the present and anticipation of the future.

The conventional approach to strategy in projects requires the manager to consider three key elements – time, cost and quality. The first is the element of *performance*, the second element is *conformance*.

7) The organisation of people into *ad hoc* groups takes advantage of bringing together individuals from different specialisms (marketing, engineering, etc.) as needed for a project task. It is notable that as organisational size increases, the degree of specialism of individuals is increased. The notion is that by grouping all the specialisms together, the arrangement is very efficient, as when you need that function to be performed, there is an obvious resource to draw on.

8) The design and control of the purchasing function is clearly a management specialism in its own right, but is a function in which the project manager has an input.

Purchasing must be combined with design of product, manufacturing and sales to work with the chosen supplier: the aim is to minimise total cost not merely initial cost.' The best supplier may not then be the cheapest, as there is often a trade-off in other areas. Achieving the right time and place is the basis of much literature and the predominant complaint that industrial purchasers have about suppliers. The rating of suppliers and regular performance reviews can keep this as an issue for them. It is also one advantage that a degree of centralisation can have for the purchasing function – that of being able to track supplier performance on the basis of criteria such as late delivery if paperwork to place the order takes six weeks to be processed by the purchasing function. Giving suppliers the longest possible time in which to fulfil an order is going to be beneficial to both parties in the long term.

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- How are orders conveyed, with what frequency and how do the suppliers really know what your requirements are? Also, they often have expertise in both the design of their products and their application, which, should be used as a source of knowledge and improvement.

4.17 SUGGESTED READING

ISO 10005:2003 *Quality Management Systems-Guidelines for Quality Management in Projects*

Kerzner.H - *Project Management*

Obeng.E – *The Role of Project Management in Implementing Strategy*

Rosenau, M D (1991) *Successful Project Management*, Van Nostrand Reinhold, New York

Stewart, Dorothy M (ed) (1990) *Handbook of Management Skills*, Gower Publishing Co,London.

(Feedback Response Sheet)

Dear Student,

Welcome to the PG Diploma in Food Safety and Quality Management.

The School intends to upgrade and strengthen the study material continuously as the subject is dynamic in nature. Please arrange to give you inputs to improve the self learning study material. We wish to know your difficulties and suggestions in order to improve the contents. A response sheet for a block of the course has been enclosed for your kind persual and consideration please. Kindly fill in this response sheet pertaining to a block and send the inputs for various blocks of the programme to the school. If you find the space provided is insufficient, please use a separate sheet.

Enrolment No. ☐☐☐☐☐☐☐☐☐☐

Name of the Course and Block _____

1) How many hours did you need for studying the units of this block?

Unit No.	**1**	**2**	**3**	**4**
Number of Hours				

2) Please give your observations to the following on quality of contents after going through the block.

Items	**Yes**	**No**	**Requires Changes/Additions if any**
Contents are complete	☐	☐	
Factual mistakes in the contents	☐	☐	
Additional inputs required	☐	☐	

3) Please give your observations to the following items after reading the block.

Items	**Excellent**	**Very Good**	**Good**	**Poor**	**Give Specific Examples, if Poor**
Presentation Quality	☐	☐	☐	☐	
Language and Style	☐	☐	☐	☐	
Conceptual Clarity	☐	☐	☐	☐	

4) Any other comments:

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Please mail either through post or email to:

a) Programme Coordinator (PGDFSQM), School of Agriculture, Academic Complex, Block-G, Room No.2, Indira Gandhi National Open University (IGNOU), Maidan Garhi, New Delhi-110068 02

or

b) pgdfsqm@ignou.ac.in

or

c) Post your comments at SAFE (www.ignouonline.ac.in/ safe)

Indira Gandhi National Open University
School of Agriculture

MVP-003
Principles of Food Safety and Quality Management

Food Safety and Quality Management Systems

1