Food Processing Operations and Requirements

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LEVELS OF PROCESSING

Categories of Agro Industries based on degree of transformation of raw materials

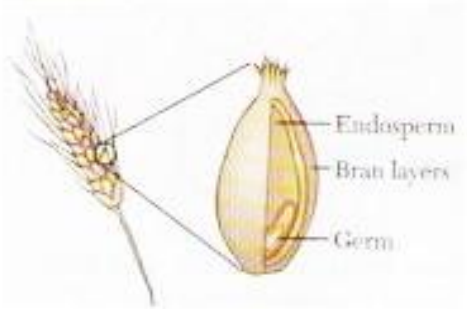
PRIMARY PROCESSING	• **Cleaning** • **Grading** • **Conditioning** • **Packaging** • **Storage** • **Weighing**	**No physical transformation of the commodity**

Make food safe to eat or manufacture other food product

Primary Processing

Aspire: To **describe**
treating milk and th
a range of foods.
Challenge: To **defin**
secondary processi

Flour is made by **milling wheat grains.**



Harvested & cleaned
- Wheat grains are harvested & cle
  dust.

Stored
- Grains are stored in dry conditions
  growing.

Crushed
- Grains are put into a hopper & ar
  to crack open the grain.

Sieved
- Flour is sieved to make different typ
  - Wholemeal – 100% grain is used
  - Brown flour – 85% grain is used, some bran and germ remo
  - White flour – 70% grain is used (only endosperm)

B vitamins added
- B vitamins are lost when making w
  back in.

Turn primary processed foods into other food products

SECONDARY PROCESSING	• Paddy to rice • Wheat to flour • Oilseed to Oil • Pulses to dal • Dal to basen	Physical transformation but product is not ready to eat

Value added food segment

TERITARY PROCESSING	• Cooking rice • Baking bread & biscuit • RTE foods • Pickles • Ketchup	RTE products Convenient

Major causes of food deterioration include:

- ❑ Growth and activities of micro-organisms, mainly bacteria, yeasts and moulds;
- ❑ Activities of natural food enzymes;
- ❑ Insects, parasites and rodents;
- ❑ Temperature, both heat and cold;
- ❑ Moisture and dryness;
- ❑ Air and in particular oxygen;
- ❑ Light;
- ❑ Time.

High temperature, moisture, and air all affect the multiplication and activities of bacteria, as well as the chemical and enzymatic activities of the food.

Food preservation principles

Two general principles are employed in food preservation.

(1). Inhibition priciple

(2). Killing principle

Inhibition Principle

Food preservation is achieved by inhibition of growth & multiplication of microorganisms (does not cause destruction of organisms)

The inhibition can be achieved by any of the following

(a). Reduction of water activity e.g. By drying and salting

(b). Reduction in pH e.g. by fermentation and addition of acids.

(c). Use of preservatives, e.g. sodium benzoate

(d). Use of low temperatures (chilling or freezing)

(e). Smoking – which has a drying and preservative effect

Food preservation by lowering pH

- Many food products can be preserved by lowering pH so that the growth of spoilage and pathogenic bacteria is prevented.
- The lowering of pH can be achieved by **addition of acids and fermentation**
- Fermentation is the breakdown of carbohydrates under anaerobic conditions into alcohol or lactic acid and carbon dioxide.

Food preservation by lowering water activity

Lowering of water activity can be achieved by:

- Addition of high content of salt: Sodium chloride and sometimes nitrats and nitrites
- Addition of high content of sugar
- Drying: sun/air drying; electrical drying or freeze drying.

Food preservation by use of low temperatures

Two methods are employed to arrest microbial growth and multiplication.

- These are chilling (cold storage) and freezing.
- Chilling is keeping food at temperatures between 0-15^{o}C. The commom chilling temperatures ranges between 4-5^{o}C.
- Freezing is keeping food at temperatures between 0^{o}C and -35^{o}C.

Effect of low temperatures

Retard chemical reactions and actions of food enzymes and to slow down the growth and activity of microorganisms.

A low enough temperature will prevent growth of any microorganisms.

Spores are not usually injured at all by freezing. However, most parasites are killed by freezing.

Killing principle

In this principle, spoilage microorganisms are destroyed (Killed) in the food, and the food protected against subsequent contamination by being enclosed in an air tight container.

Methods employed to achieve the killing principle

1. **Heat treatment:** through **pasteurization** or **sterilization**
2. **Irradiation** with either ionizing or electromagnetic radiation e.g gamma rays, cobalt 60 radioactive particles. Radiations kill microorganisms by destruction of DNA and by creating toxic reactive compounds in a medium and in microbial cells
3. **Use of gases:** by use of ethylene oxide or ozone. The gases destroy both vegetative cells and spores.

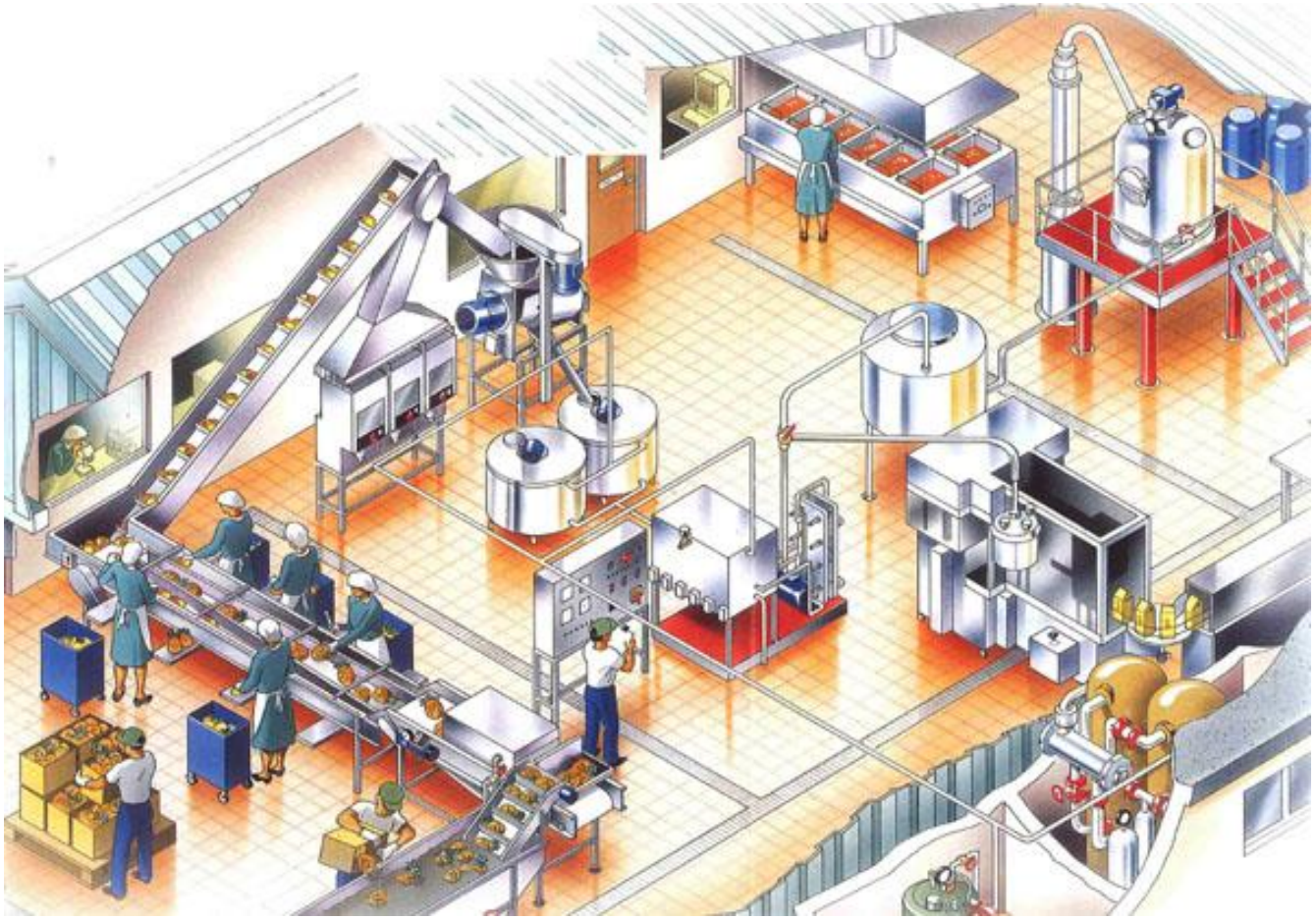
Applications

- In pracice, often a combination of inhibition and killing principles and the various methods are used depending on the food type. e.g.
  - use of pasteurization and chilling of milk,
  - lowering of water activity and low temperature storage,
  - use of preservatives and low temperature etc.

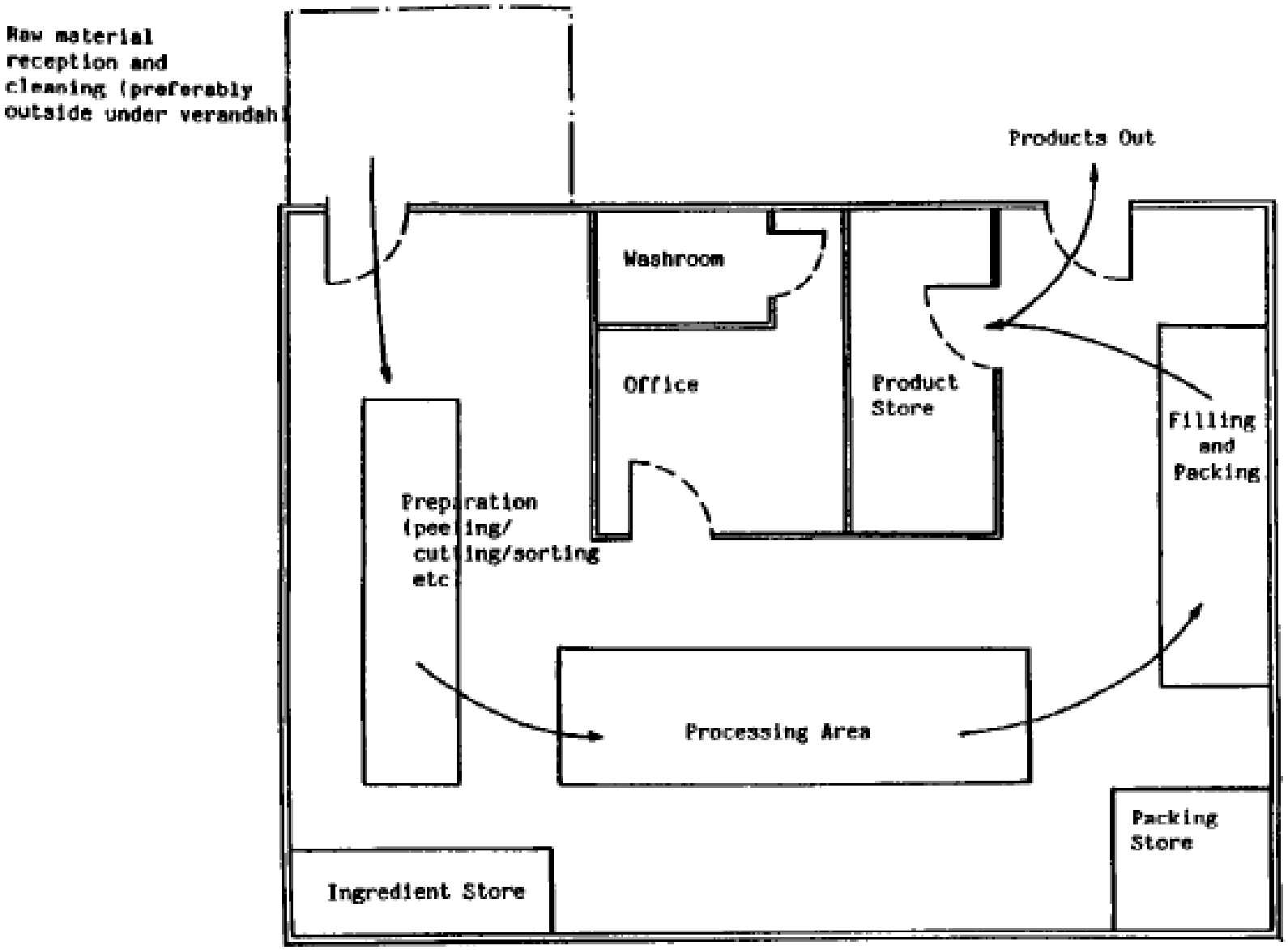
PLANT DESIGN

Design of food plant involves the application of a few basic principles to address the following critical issues

1. Minimization of capital and operating costs while satisfying food safety regulations and quality expectations
2. Performing the intended functions all within the agreed upon budget and schedule.



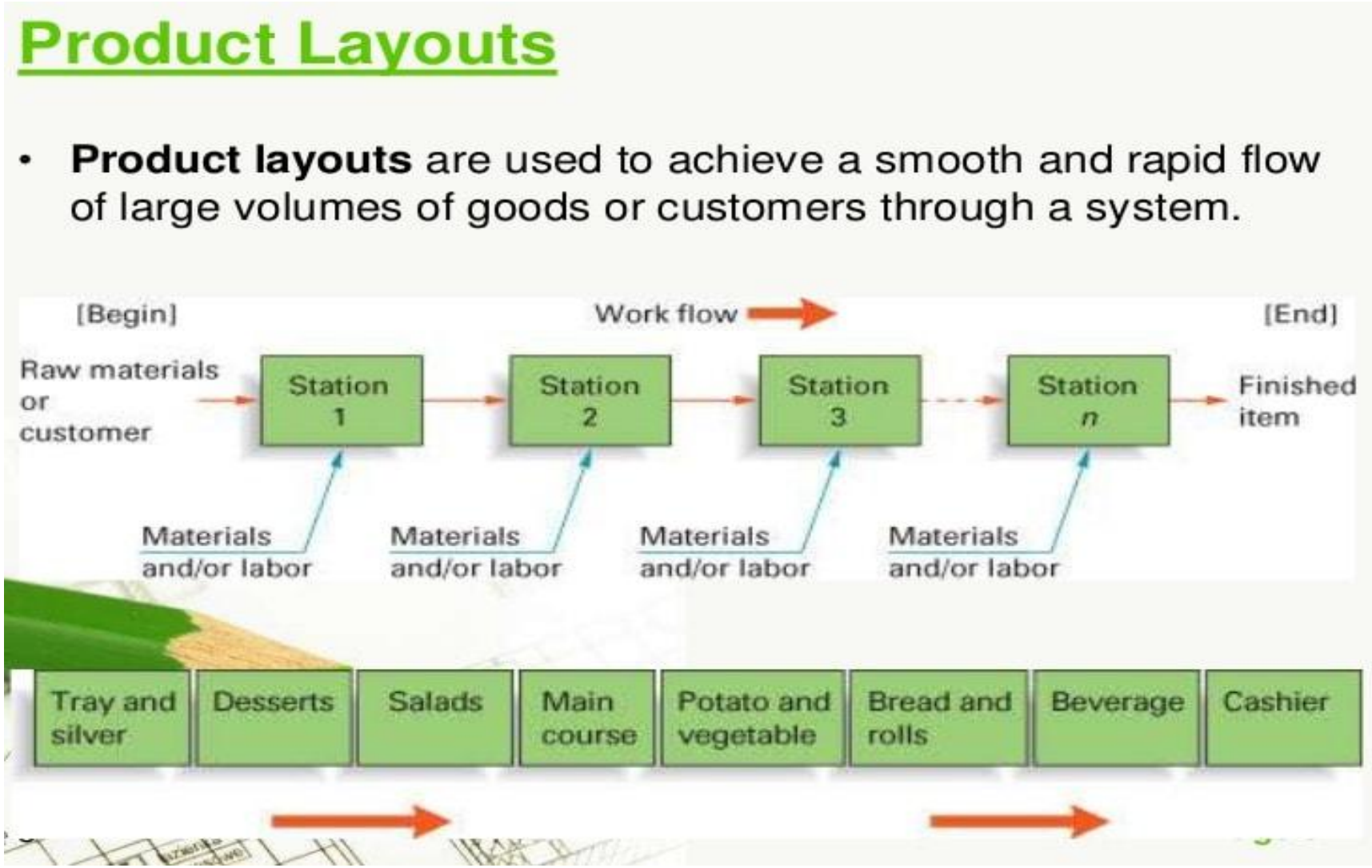
Plant design refers to the overall design of a manufacturing enterprise / facility and includes both the physical facility ie building and supporting utilities and process equipment.



General Layout of Food Processing Plant

Types of Layout

Product Layout: In this type of layout, only one product or one type of product is produced in a given area.



Process Layout

Process Layout: Similar equipment and similar operations are grouped together in the process or functional layout. It is particularly useful where low volume is required.

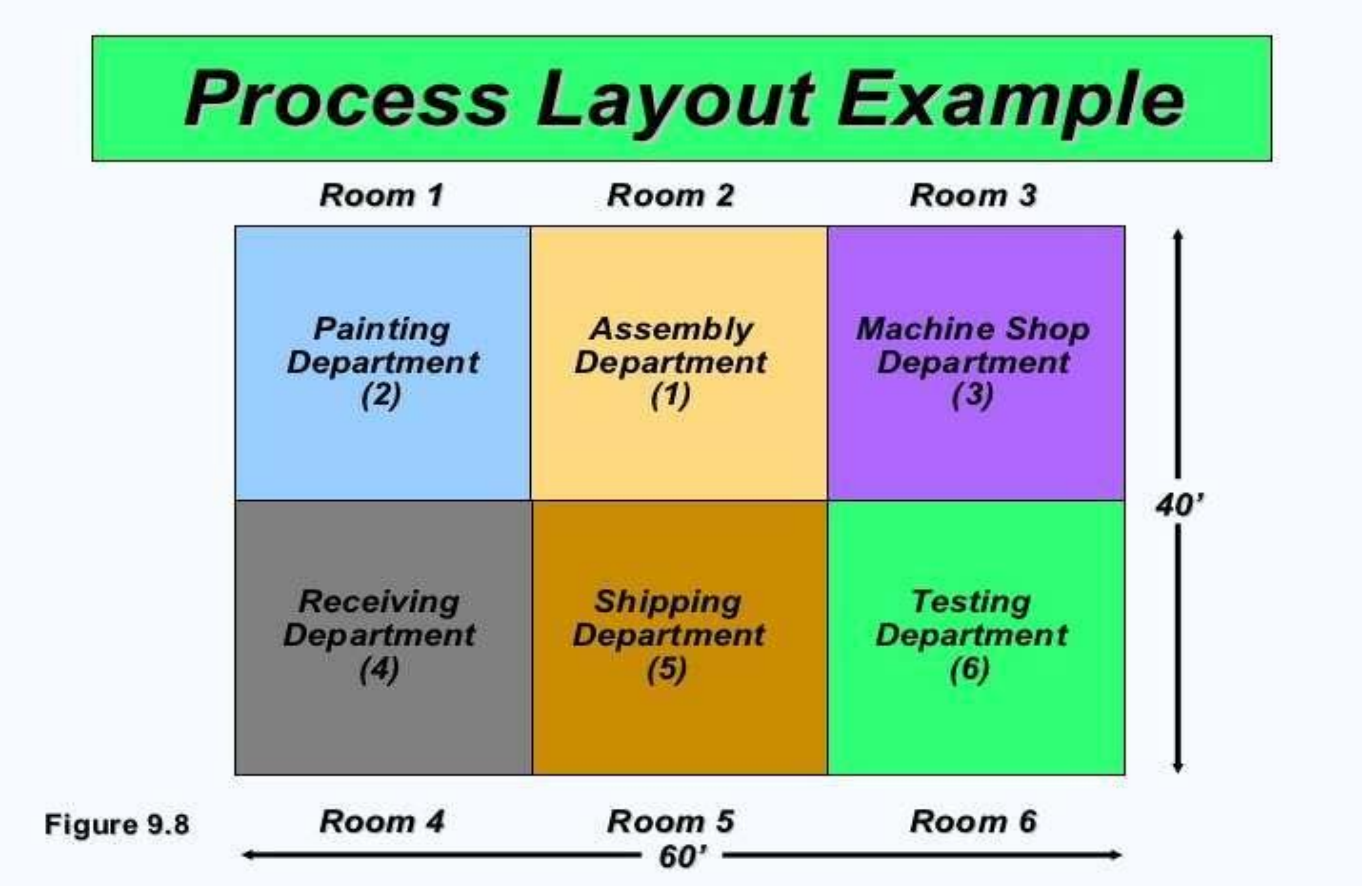
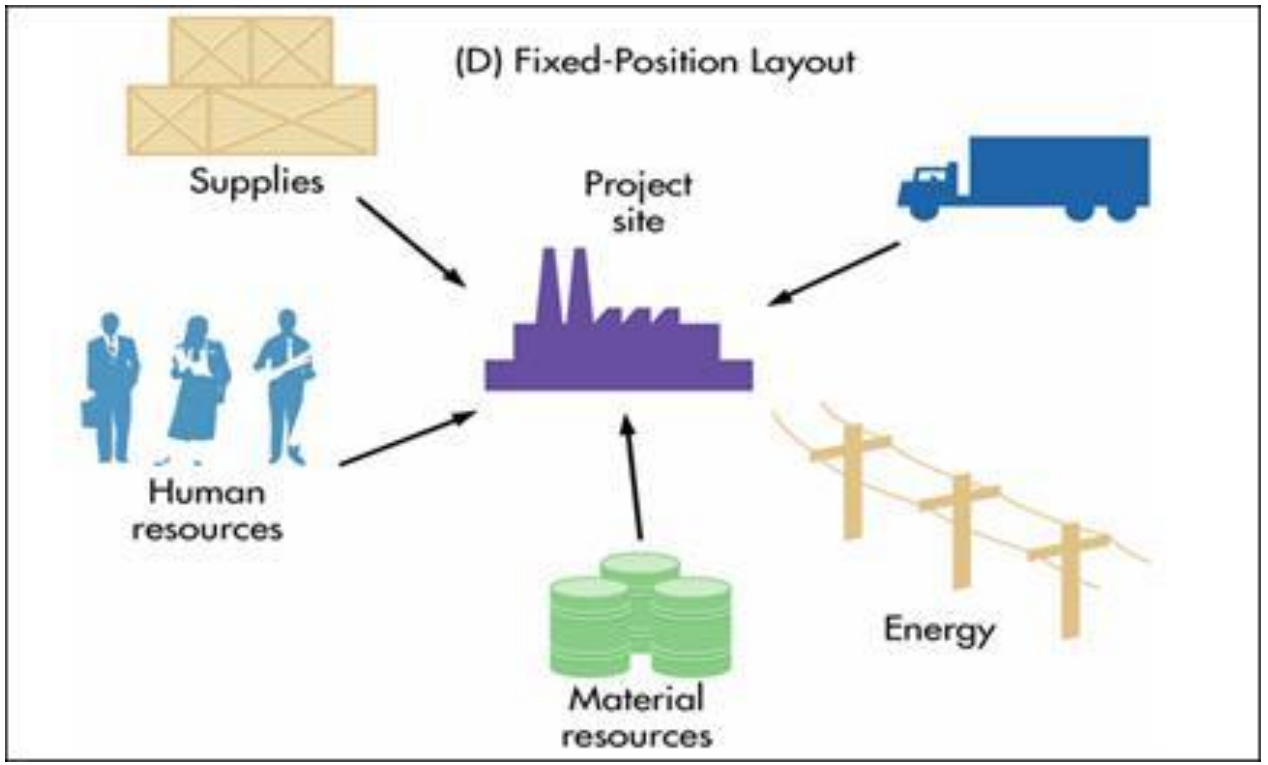


Figure 9.8

Fixed-Position Layout

Fixed-Position Layout: In this type of layout, the material or major component remains in a fixed location, and tools, machinery, men as well as other pieces of material are brought to this location..



BUSINESS OPPORTUNITY AND SELECTION

OPPORTUNITY ? →

Opportunity is a favorable set of circumstances that enables an entrepreneur to offer marketable products or services to interested buyers or end users

Product or service is still not in existence
Product or service is already in the market but failed to satisfy the customers – so need to be improved

TYPES OF SITUATIONAL FACTORS

When people decide they have certain needs & want to be satisfied,
when people discovered a problem of some kind that can be helped by a product or service.

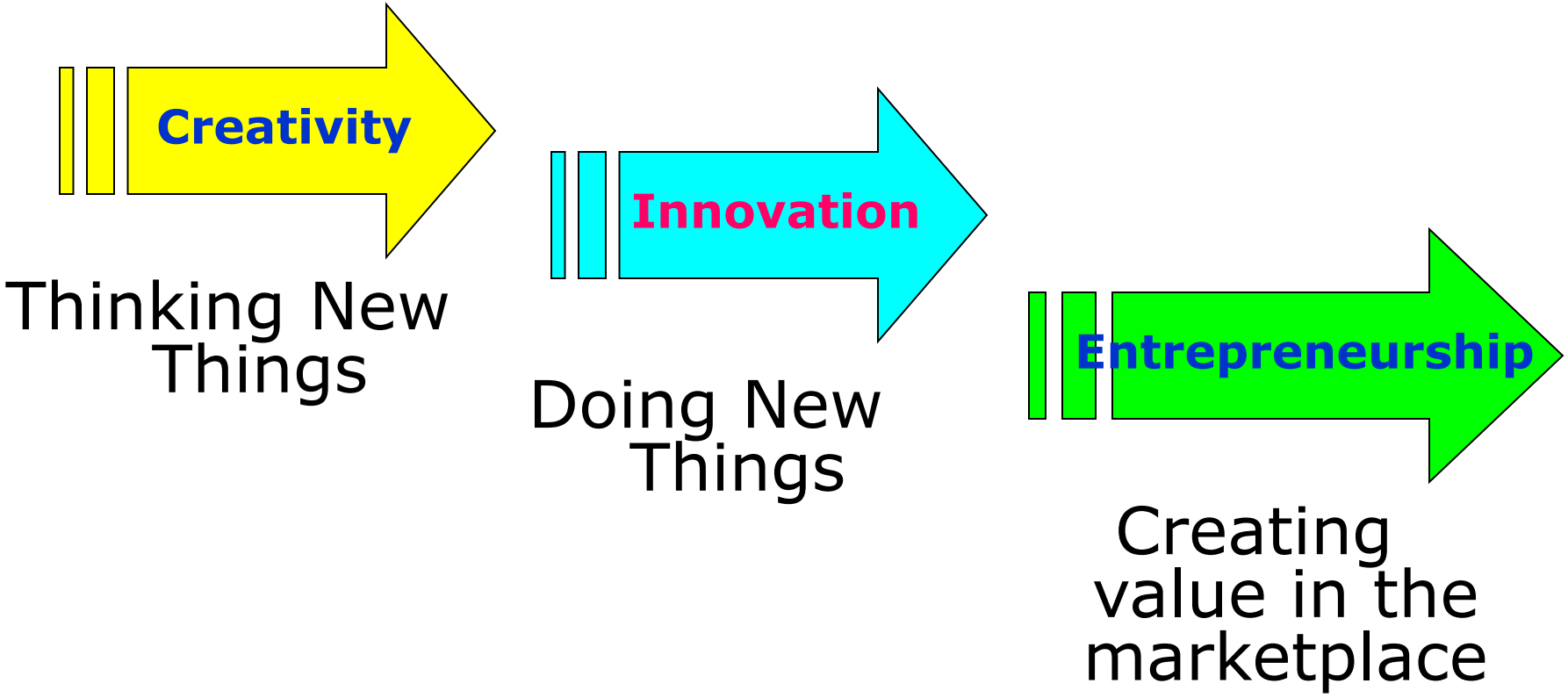
The presence of unfulfilled needs and want and/or problems alerts the entrepreneur to the potential opportunity.

The entrepreneur later creates a business that is able to fulfill the needs or want and/or solve the problem

The Entrepreneur always searches for change, responds to it and exploits it as an opportunity”

The chain of entrepreneurship

Creativity & innovation are the first stages of successful entrepreneurial initiatives



OBSERVING CHANGES IN THE ENVIRONMENT

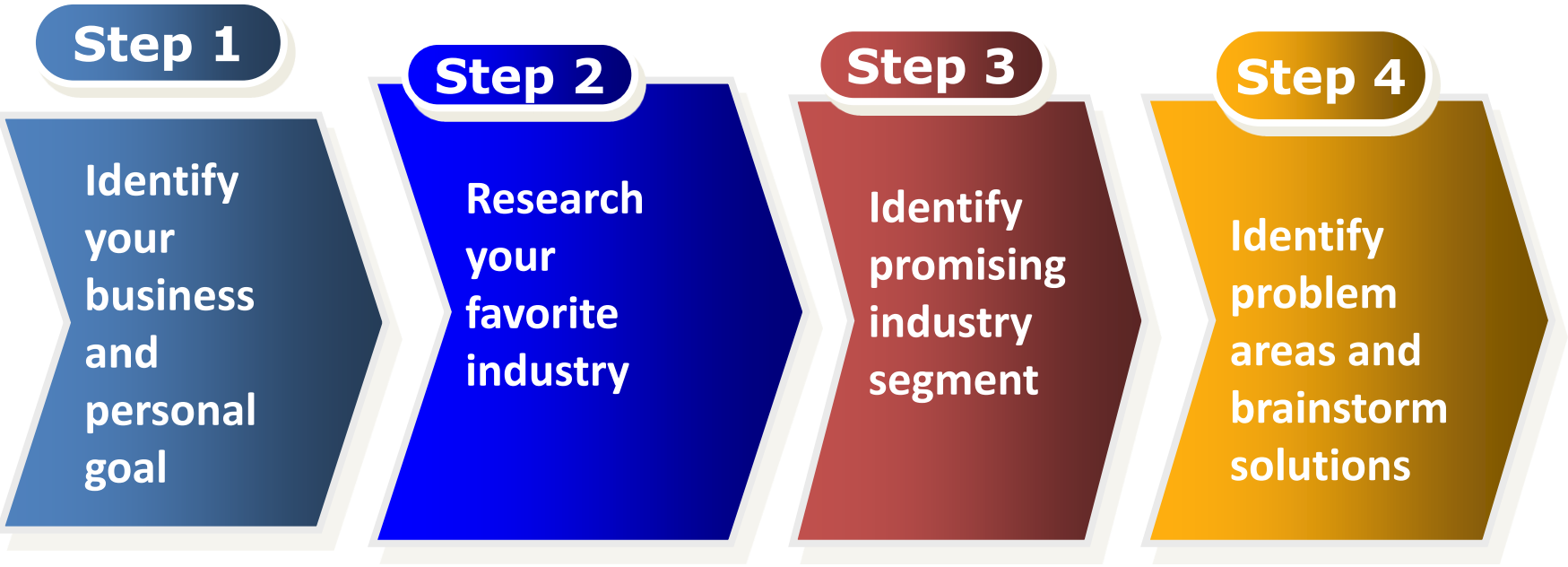
Changes in the environment give rise to needs and wants and/or problems, and an opportunity emerges

1. **Economic forces**
2. **Social forces**
3. **Technological advances**
4. **Political and regulatory statues**

Examples of How Changes in the Environment Provides Openings for New Product and Service Opportunities

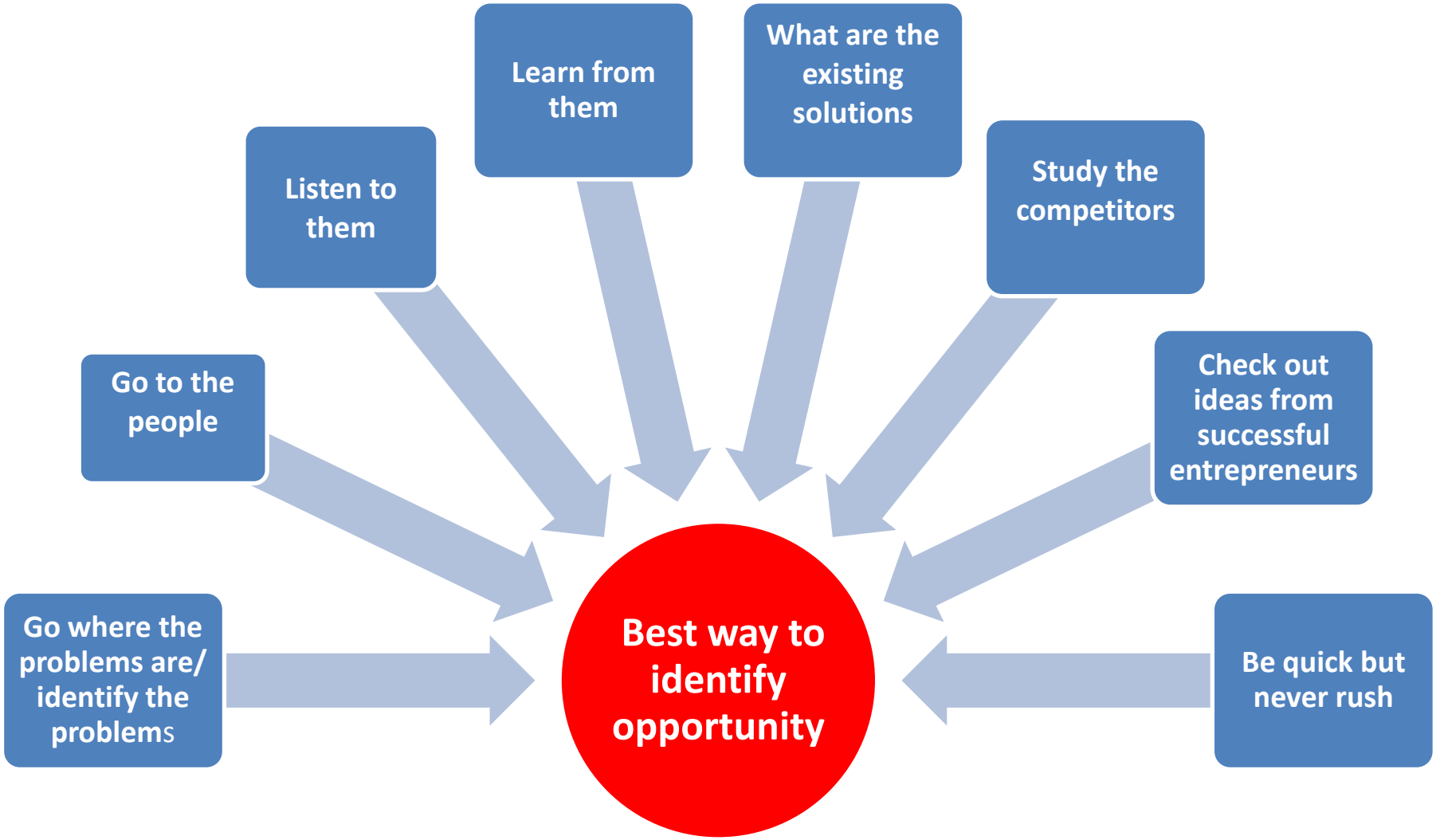
Structure of Population and Income	**Number of teenagers higher than number of elderly and children** **People have higher purchasing power**	**Cyber cafes, Cineplex's, recording studios** **Passenger cars, household furniture, DVD**
Social	Increase incident of housebreaking	Grills, alarm, sensor, security systems
	Increase interest in fitness	Fitness center, dancing class, in-house exercise equipment, health food store
	Increase mobility of population	Hand phone, laptop computers
	Increasing predominance of dual-income families leaves less time to cook at home	Restaurants, food delivery services

How to select the right opportunity?

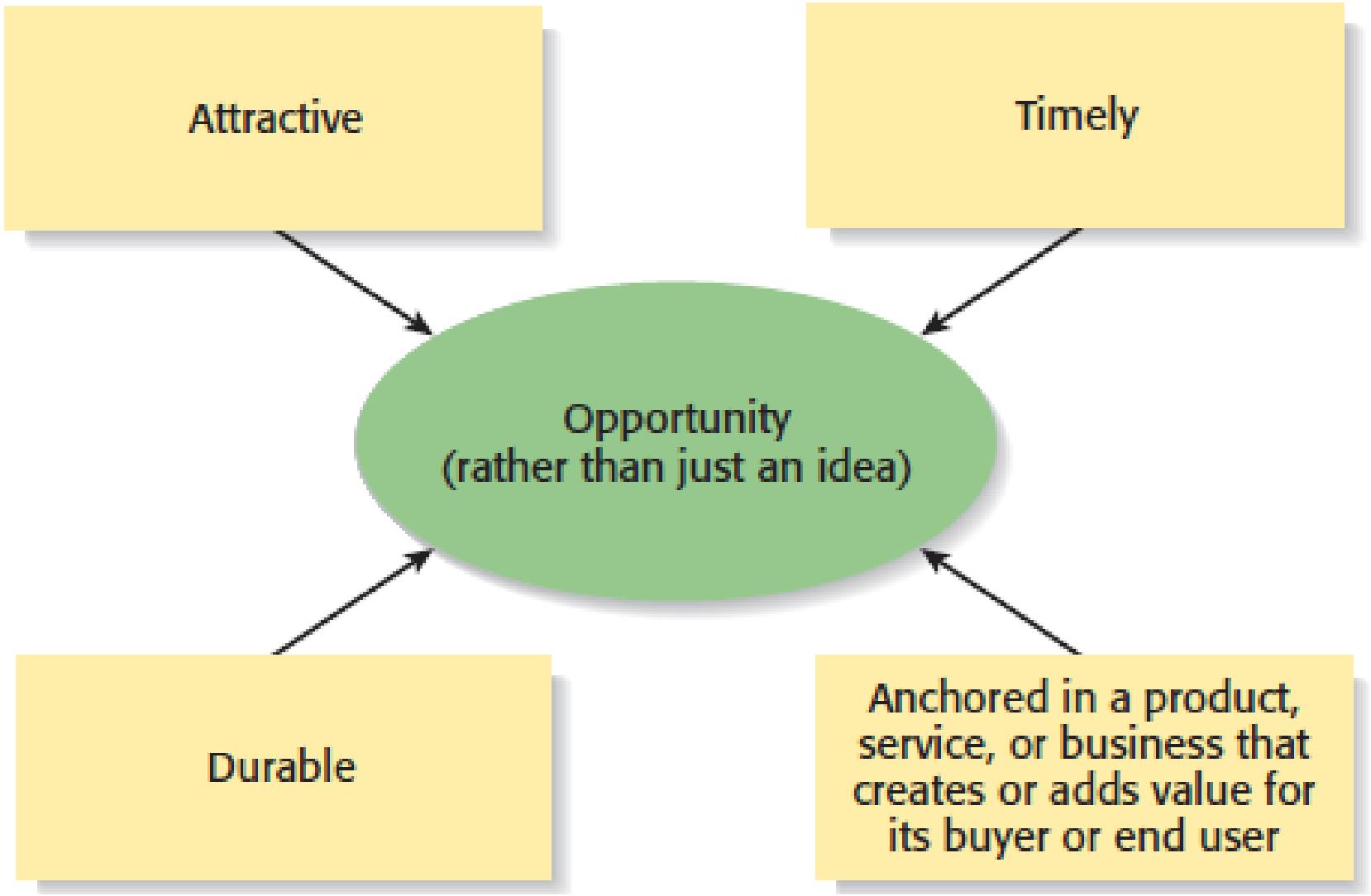


Compare possible solutions with your objectives and opportunities in the market place

Focus on the most promising opportunities


Learn from them
What are the existing solutions
Listen to them
Study the competitors
Go to the people
Check out ideas from successful entrepreneurs
Go where the problems are/ identify the problems
Best way to identify opportunity
Be quick but never rush

An opportunity has four essential qualities



NEEDS & WANTS of consumers

- **Need – is something basic in life such as food, drink, clothing and shelter.**
- **Want – is extension of need; craving for better than the basic need.**
  - ***Need for food*: Rice**
  - ***Want for food*: Chicken Rice (Chicken Rice Shop)**
  - ***Need for shelter*: Renting a flat with 10 housemates**
  - ***Want for shelter*: Renting a condo**
- **The better the economy of people, the more business opportunities available for the entrepreneurs.**

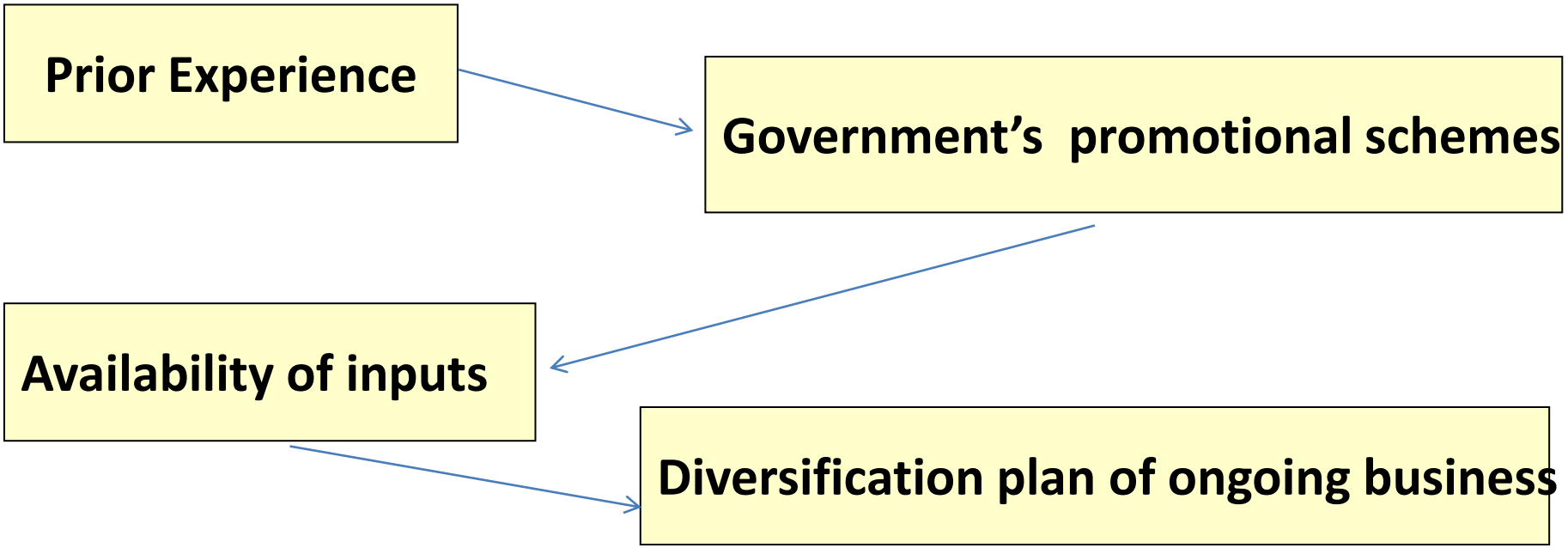
- **Human NEEDS and WANTS are unlimited.**

Translate the NEEDS and WANTS into PRODUCTS or SERVICES.

- **PRODUCTS – are physical forms e.g. car, handphone, books.**
- **SERVICES – non-physical form, intangible product e.g. cab service, telco network, training.**

Entrepreneurs select their products or projects based on

Characteristics that tend to make some people better at recognizing opportunities than others



FEASIBILITY STUDY

Pre- project planning tool

When a new processing business is being planned, it is often difficult to estimate how much product can be sold and many small processors simply make a guess.

Feasibility study is a logical tool to employ before any resources are invested in the new project

Feasibility studies are preliminary investigations into the potential benefits associated with undertaking a specific activity or project.

COMPONENTS OF FEASIBILITY STUDY

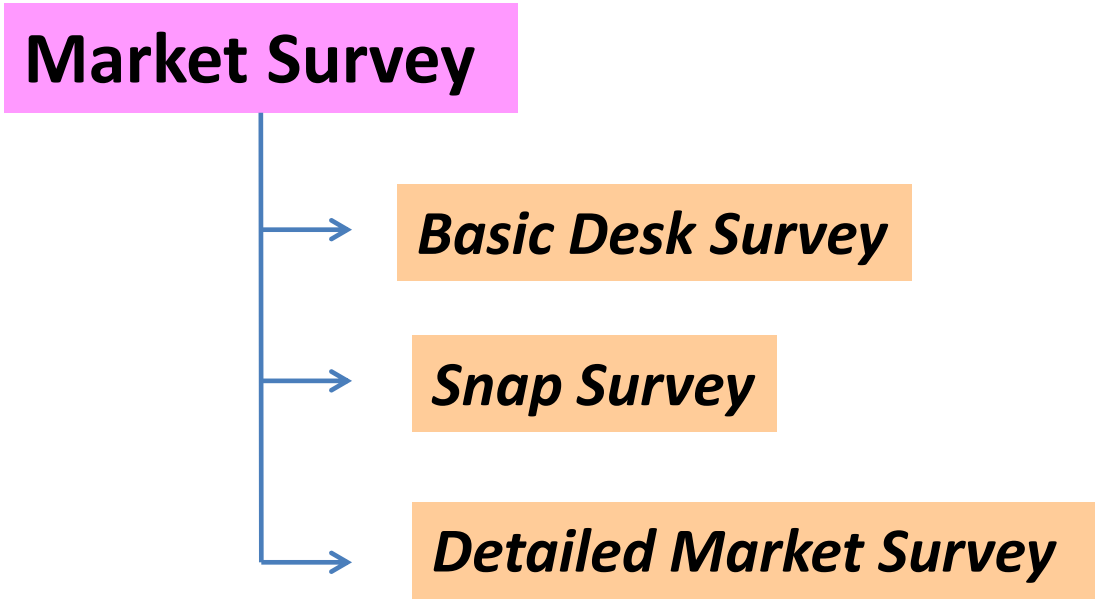
Market feasibility

Technical feasibility

Financial feasibility

Organizational feasibility

Market feasibility



Market feasibility

• is there a demand for the produce?	(Find out the characteristics required of the product and the size and value of the market)
• who else is producing similar products?	(Determine the number and type of competitors)
• what is needed to make the product?	(Find the availability and cost of staff, equipment, services, raw materials, ingredients and packaging)
• what is the cost of producing a product?	(Calculate the capital costs of getting started and the operating costs of production)
• what is the likely profit?	(Calculate the difference between the expected income from sales to an estimated share of the market and the costs of production)

When all the information has been gathered and analyzed, it should be possible to make a decision on whether the proposed investment in the business is worthwhile

Technical feasibility

The series of questions below is helpful in deciding the technical requirements of the business:

Are enough raw materials available of the correct quality for year-round production?

is the cost of the raw materials satisfactory?

is the correct size and type of equipment available for the expected production level at a reasonable cost?

can it be made by local workshops and are maintenance and repair costs affordable?

Technical feasibility

- is sufficient information and expertise available to ensure that the food is consistently made at the required quality?
- are suitable packaging materials available and affordable?
- are distribution procedures to retailers or other sellers established?
- is a suitable building available and what modifications are needed?
- are services (fuel, water, electricity etc.) available and affordable?
- are trained workers available and are their salaries affordable?

Financial feasibility

To assess profitability aspect of the business, financial feasibility analysis is done

It takes in to account the following issues

Start-up costs,

Operating costs,

Cash flow,

Return on investment

Profit potential and Loans

Start-up capital is the amount of money that is needed:

1. to buy the facilities and equipment,

2. to register and licence the business and

3. get the necessary hygiene certificates

Working Capital includes the costs of

1 Raw materials,
2. Packaging,
3. Staff training,
4. Product promotion etc.

that have to be made before the business begins to generate income from sales of the product

Operating costs

Fixed Costs: **those expenses that have to be paid even if no production takes place**

Variable Costs: **those that depend on the amount of food that is produced**

CASH FLOW

The statement of cash flows, or the cash flow statement, is a financial statement that summarizes the amount of cash and cash equivalents entering and leaving a company.

Income and profit

Income = Selling price per unit x number of units sold

Fixing a price for a product

Two approaches can be taken:

1. **Price can be based on production costs it ensure that income exceeds the total costs.**

2. **To be successful, the new product should be priced at or below the price of other similar products.**

Remember the profit that will be expected by retailers (10-25)%.

In addition, there are **distribution costs** and perhaps special **promotion costs** that should also be included.

The operation of the business should be above the ***breakeven Point*.**

$$\text{Break-Even Point (BEP)} = \frac{\text{Fixed Costs}}{\text{Selling Price - Variable Costs}}$$

Organizational Feasibility:

a) Management Prowess

Assessment of management team who is going to manage the business

b) Resource Sufficiency

Assessment of physical resources availability with the venture

Pre-production planning

- Equipment needed to achieve the planned production level
- Number of staff required and their different jobs
- Level of stock to be held such as raw materials ingredients, equipment spares, packaging and finished products.

Choosing Equipment

The main pre-project planning decisions in relation to buying equipment are:

- Which parts of a process require mechanization and which can be done manually;

- The correct size of the equipment (its capacity or throughput) for the intended scale of production to ensure that all equipment has a similar throughput;

- Whether to buy equipment from a local engineering company or to import it.

Mechanized versus Manual Processing

Processes, such as ***edible oil extraction from seeds and nuts***, or ***milling cereal grains*** are difficult and time-consuming to perform manually and ***product yields are low***. They are usually mechanized and these processes therefore require ***greater start-up capital*** than most other types of agro-processing.

The reliance on machinery also means that the management of maintenance and a spares inventory are important aspects of operating these types of business.

Staff numbers are smaller but training is required to correctly operate and adjust machines to achieve maximum yields and productivity.

There are stages that are time consuming and highly labour intensive, and introducing small machines can substantially increase throughputs for a relatively small investment.

Examples include slicing fruits or bread, separating cream from milk, filling packages, and mixing dough.

Calculating the correct size of equipment

Sales forecast

The first stage in deciding the size of equipment is to make an accurate assessment of likely sales. An existing business can collect these data by adding daily sales records to produce monthly totals.

Production rate

Sales information can be used to find the daily production rate

$$Production\ rate\ \left(\frac{Kg}{day}\right) == \frac{(\ Amount\ of\ product\ produced\ per\ month, kg)}{(No.\ of\ days\ of\ production\ per\ month)}$$

If feed sales are 24 tonnes per month and a feed mill works six days a week, then one tonne of feed has to be produced every day.

Product throughput

The average amount of production per hour is known as the 'product throughput' and is calculated to help finding the required size of equipment.

Calculation of throughput

Using the production rate data above, and assuming that 2 hours per day are available for the staff to mix the feed, then the average throughput of the mixer is:

= 1 tonne per day / 2 hours per day
= 0.5 tonne/hour

If the feed mixer takes 30 min to mix a batch of feed, then two batches per hour are possible.
A mixer with a capacity of 0.5/2 = 0.25 tonne is suitable (i.e. a capacity of 300 kg to avoid spillage).

Example

If 3 hours are available to boil 36 kg of jam per day,
the throughput for the boiling stage is: 36/3 = 12 kg per hour.

A batch of jam should be boiled within approximately 15 minutes to maintain the quality of the product, **and a maximum of three batches per hour are possible.**
The processor therefore has a number of choices:

1.) **To buy a single, large (e.g. 15-20 litre) stainless steel pan and a large burner to heat one 12 kg batch of product within 15 minutes.**

This is the most expensive option, but production is straightforward and requires the least organization.

2). **Process two batches of 6 kg using a smaller (e.g. 10 litre capacity) boiling pan and a smaller burner.**

3.) **Process three batches of 4 kg each using a smaller (e.g. 6 litre capacity) boiling pan and a smaller burner.**

This is the cheapest level of investment but requires more complex work organization, staff skills and production planning

MANPOWER REQUIREMENT

You will need manpower for:
Production (Workers)
Supervision (Technicians)
Administration, sales, miscellaneous work (Staff)

Estimating staff requirements

Numbers and types of workers needed to operate a processing business depend on the production rate and also on the degree of mechanization of the process.

Figure 3: Production process for making chutney*

Stage in process (50 kg per day)	Activities	Estimated time required (min)	Estimated numbers of staff required
Fruit ↓			
Wash ↓	By hand to remove stones, leaves or soil	20	1
Sort/grade ↓	By hand to select for similar colour	45	1
Peel ↓	By hand using knives	125	2
Cut/slice/core ↓	By hand using knives	90	2
Spices, Mix sugar vinegar ↓	Using an electric mixer	10	1
Heat ↓	Boil in boiling pan, with constant mixing by hand	20	1
Fill & Seal Jars/ ↓	Hot fill into pre-sterilized jars using filling machine and hand seal lids.	45	2
Cool, label & store	Use small labelling machine, pack into boxes by hand.	75	2

* assuming that two staff work for a total of 7.25 hours per day

Levels of Stocks to be held

Weights of raw materials and ingredients to be bought;
Amount of packaging to be ordered;
Numbers of extra or temporary staff to employ

Amounts of ingredients needed to make 50 kg are shown in the right column of the table, with the calculation in the centre.

Ingredients	Input needed (kg) per Kg of output	Calculation of ingredients	Quantity for 50 Kg
Tomatoes	**1.50**	**1.50 x 50**	**75 Kg**
Sugar	**0.30**	**0.30 x 50**	**15**
Chillies	**0.10**	**0.10 x 50**	**5**
Garlic	**0.05**	**0.05 x 50**	**2.5**
Salt	**0.01**	**0.01 x 50**	**0.5**

Typical material losses during food processing

Stages in a process	Typical losses (%)			
	Oil extraction	**Fruit & vegetable processing**	**Cereal milling**	**Meat & Dairy**
Sorting raw materials	5 - 30	5 – 50	5 – 30	5 – 30
Preparation	-	5 – 30	-	10 – 30
Processing	10 – 30	5 – 20	5 – 10	10 – 20
Rejected products	0 – 5	0 – 5	0 – 5	0 – 5
Packaging	0 – 5	5 – 10	5 – 10	0 – 5
Accidental spillage	0 – 5	0 – 5	5 – 10	0 – 5
Distribution	0 – 5	0 – 5	0 – 5	0 – 5

$$\text{Yield (\%)} = \frac{Weight\ of\ final\ produce\ x100}{Weight\ of\ raw\ material}$$

Losses (%) = 100 – Yield (%)

In juice processing, 60 kg of passion fruit are bought and used to produce 170 bottles of juice, each containing 200 ml.

The yield (%) = ((170 x 0.2)/60) x 100 = 56.7%,
and the % losses = 100 – 56.7 = 43.3% (Provided that 1 litre juice weighs 1 kg)

Ways of Improving Productivity are:

1. Reducing operating costs (e.g. reducing idle machine time and waste, increasing the amount of food produced by each operator per day);
2. Improving procedures for buying materials or changing suppliers of raw materials;
3. Changing the design or layout of the production facilities to reduce unnecessary movement of foods, staff, or equipment, and making as few journeys as possible to deliver products to wholesalers or retailers;
4. Finding buyers for waste or by-products;
5. Reducing energy use by switching off lights and electrical equipment when they are not being used or using solar water heating (e.g. for pre-heating process water or washing equipment).

FOR YOUR PRECIOUS ATTENTION