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Design, Print & Packaging Skillnet

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Design, Print & Packaging Skillnet

The Irish PACKAGING SOCIETY Affiliated with IOM3

The Functions of Packaging 1B & 1C

Presenter
David Little

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Learning Outcomes

- Learning Outcome (What you need to know/understand)
  - **Understand the functions of packaging**
- Assessment Criteria (What you need to do)
  - Explain in detail the functions of packaging
  - Assess the role of packaging in terms of its functions
  - Assess the success of particular packs in meeting differing functions
  - Describe the factors which cause packaging deterioration

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Unit 1 Functions of Packaging Indicative Content

- Major functions which packaging is required to fulfill and the ability to evaluate each function for a given use.
- How packaging is used as a means of containing, protecting and preserving the product, and how spoilage can be reduced by appropriate choice of process and packaging.
- Packaging in its role of providing convenience in the safe handling and use of the product throughout the supply chain.
- Packaging as a way of providing information about the product.
- Consideration of the different types of information required and the needs of readers both people and electronic.

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Unit 1 Functions of Packaging Indicative Content (contd.)

- Packaging as a means of selling the product.
- Using a range of examples, show how particular packs meet different packaging functions
- Discuss how deterioration can affect pack performance
- Investigate instances of where and how this might occur

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Levels of Packaging

- Primary
- Secondary
- Tertiary

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Levels of Packaging

- **Sales packaging or Primary packaging**
  Packaging conceived so as to constitute a sales unit to the final user or consumer at the point of purchase;
- **Grouped packaging or Secondary packaging**
  Packaging conceived so as to constitute at the point of purchase a grouping of a certain number of sales units whether the latter is sold as such to the final user or consumer or whether it serves only as a means to replenish the shelves at the point of sale; it can be removed from the product without affecting its characteristics;
- **Transport packaging or Tertiary packaging**
  Packaging conceived so as to facilitate handling and transport of a number of sales units or grouped packaging in order to prevent physical handling and transport damage.

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What category packaging have we left out up to now?

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Industrial Packaging

Packaging used to deliver goods (raw materials & packaging) to your manufacturing sites,

e.g.
Drums, corrugated board cases, intermediate bulk containers, pallets, roll cages etc.

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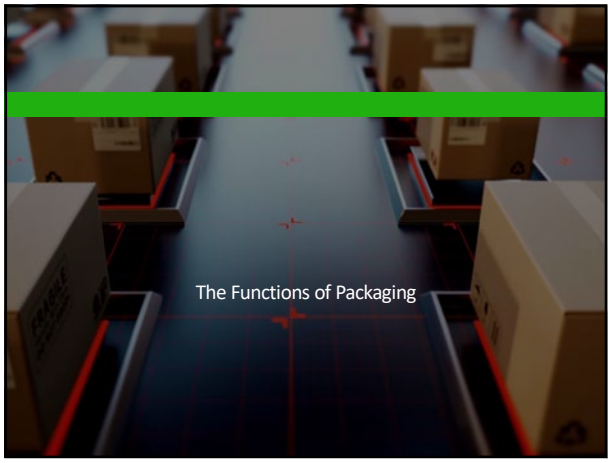

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The Functions of Packaging

- All products are packaged at some stage in their life cycle
- Food and drink account for 70% of all packaging used
- Consider primary, secondary and tertiary packaging

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Break out room

Break into Teams.
Examine three of the sample packs you have and make a list of what functions the packaging is meeting
(In other words, why did they choose that material, style, strength etc.)

10 minutes

- Functions

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The Functions of Packaging

- Packaging must meet the product needs
  - No product, no need for the pack!
  - No buyer deliberately buys unnecessary packaging.
  - Why do we need the packaging?

(from a Sustainability point of view is all the packaging currently used needed and should we change the format, spec or material?)

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Functions of Packaging

- Contains
- Protects/preserves
- Provides convenience
- Informs and sells
- Provides brand identity

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Functions of Packaging

and at the same time is…..

- Cost effective throughout the life of the product and the disposal of the pack.
- Environmentally responsible - creates minimal disturbance to the environment
- Complies with legal requirements

(These functions are crucial to know, to answer all exam questions and to understand and analyse or develop new packaging structures or brands, in your career)

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Aide memoir / acronym
Definition of Packaging

('EPPIC FUCSEL')

An Economic means to provide the product with Protection, Preservation, Information and Containment, during… Filling, Use, Carriage and Sale with consideration for Environmental and Legal matters.

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Benefits of Packaging?

What are the benefits of packaging?

- Containment
- Protection / Preservation
- Convenience
- Information
- Selling
- Economics
- Environmental Impact
- Legal Matters

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Containment

- No leakage
- No loss of product
  - no missing parts
- No product/pack damage
  - pack stays intact until opened
  - pack keeps product intact

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Contain

Question

- What if the packaging fails?
- What's the impact?

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Contain

Product damage
Surrounding product damage?
Loss of revenue
Replacement costs
Consequential loss
Production raw material loss
Production time lost
Distribution cost loss
Recall costs?
Brand Equity loss / Future sales / Customer loyalty

- How can you avoid this?

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Protect

- Protect the product
- Protect the pack…against physical damage

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Protect - Physical Damage

- Most damage occurs during warehousing and distribution
- Damage is linked to handling

Discussion

- What are the typical causes of damage?

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Protect - Mechanical Hazards

- Shock
- Vibration
- Compression
  - Static
  - Dynamic
- Puncture

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Protect - Physical Damage

Would you buy this pack?

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Protect - Climatic / Environmental Hazards

- Humidity
- Temperature
- Pressure
- Pests, dust, dirt
- Humans - tampering and pilferage




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Summary……Protect Products from….

Shock
Vibration
Compression
Puncture
Temperature - too high/low
Humidity level - too high/low
Pressure
Birds, insects, rodents, dust, dirt
Humans

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PRESERVE

- Stop or slow down spoilage
- Extend shelf life

Applies to food, drink, pharmaceutical, cosmetics, toiletries, engineering products and some furniture, textiles etc.

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The Preservation Function

- What is product spoilage?
- What causes it?
- How can packaging help to counteract it and extend shelf life?

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Product Spoilage

- Abiotic spoilage (external forces or fails)
- Biotic (microbiological) spoilage

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Abiotic Spoilage

- Chemical or physical changes due to external factors:

  Exposure to air (oxygen = rancidity in fats)

  Loss of moisture

  Gain of moisture

  UV light

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Abiotic Spoilage contd.

- Chemical or physical changes due to external factors (continued):

  Excessive heat

  Excessive cold

  Loss of volatiles

  Gain of volatiles

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Biotic Spoilage

- Biotic (microbiological) spoilage

  Internal - due to natural processes such as respiration and enzyme activity

  External - due to micro organisms

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Biotic Spoilage

- Due to micro organisms causing:

  Unpleasant appearance

  Unpleasant taste

  Unpleasant smell

  Unpleasant feel

  Poisoning causing sickness / death, due to toxicity (pathogens)

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Micro organisms (Microbes)

- Feed on the product on which they live
- Cause changes in the product
- Various types of micro organisms, but those which normally contaminate, and spoil products are bacteria, along with some moulds and yeasts.

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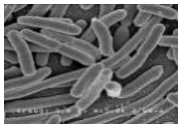
Types of micro organisms

- Bacteria



  Single cell – unicellular

  About 1 micron in diameter (some larger)

  Cannot be seen with the naked eye

  Reproduce by splitting in two - binary fission

  Can double every 20 minutes

  Thus food spoilage can be rapid

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Types of micro organisms

- Moulds (fungi)
  - Unicellular and multicellular
  - Much larger than bacteria, but spores are still not visible without magnification.
  - Reproduce and spread by spores
- Yeasts
  - Unicellular
  - Vary in size
  - Reproduce by budding, fission or spores

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Effect of Temperature

- Micro organism growth depends on temperature
- Bacteria are classified according to temperature at which they grow:

Thermophiles	40-65ºC
Mesophiles	20-45 ºC
Psychrophiles	0-20 ºC

Note: these temperature ranges are approximate

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Effect of Oxygen

- Bacteria:

Some are aerobic - require oxygen for growth

Others grow best at low oxygen levels

Others will not grow in the presence of oxygen – anaerobic

In general, moulds require oxygen and yeasts grow better in oxygen

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Effect of Moisture

- Micro organisms only grow in aqueous solutions
- The key measure is the water activity:

The degree of availability of water in a food product
(water activity is designated Aw)

Pure distilled water has a water activity of exactly one. As temperature increases, aw typically increases, (except in some products with crystalline salt or sugar). Higher aw substances tend to support more microorganisms.
Water migrates from areas of high aw to areas of low aw. For example, if honey (aw ≈ 0.6) is exposed to humid air (aw ≈ 0.7), the honey absorbs water from the air. If salami (aw ≈ 0.87) is exposed to dry air (aw ≈ 0.5), the salami dries out, which could preserve it or spoil it. (Wikipedia)

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Water Activity

- Aw = erh/100
- erh:
  Equilibrium Relative Humidity

  The humidity level at which a product will neither absorb water from the atmosphere, nor lose water into the atmosphere

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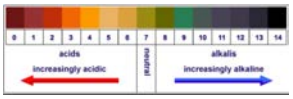
Effect of PH



- Generally:

Bacteria grow best at neutral or slightl alkaline conditions

Moulds and yeasts grow best in slightly acidic conditions

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Summary – Conditions supporting micro organism growth

- Favoured temperature
- Presence of oxygen (except anaerobes)

(a microorganism that is able to, or can only, live in the absence of oxygen.)

- Humidity > 60%
- Favoured pH
- Nutrient source

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Preserving the Product

- Manipulating the conditions supporting abiotic and biotic changes in the product
- Using packaging to help extend shelf life supports preservation, *but it is rarely the only factor in preventing spoilage.*

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Contamination / Sickness / Injury

- May also result from chemical and physical hazards, e.g:

  Cleaning chemicals

  Chemical reactions with containers

  Foreign bodies - glass, metal

Need for correct controls in place *throughout the supply chain (e.g maintain the cold chain)*

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Extending Shelf Life

- What is meant by 'shelf life?'

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Shelf Life

- Defined as the time during which the product will:
  - Remain safe
  - Be certain to retain desired sensory, chemical, physical and microbiological characteristics
  - Comply with any label declaration when stored under the recommended conditions

Kilcast D. Subramaniam P. The Stability and Shelf Life of Food. 2000 Woodhead Publishing Ltd Page 2

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Extending Shelf Life

- Preventing Abiotic Spoilage:

  What barriers does the packaging need to have?

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Abiotic Spoilage

Spoilage Mechanism	Packaging Properties
Oxygen	• Appropriate gas barrier • Appropriate light barrier
Loss of moisture	• Appropriate moisture barrier, related to ERH of the product
Gain of moisture	• Appropriate moisture barrier, related to ERH of the product. • May require moisture permeable pack
Light	• Appropriate light barrier
Heat/Cold	• Insulation • Importance of control of storage and handling conditions
Loss of volatiles	• Appropriate gas barrier • Appropriate chemical resistance
Gain of volatiles	• Free from taint and odour

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Extending Shelf Life

- Preventing / delaying micro-organism growth by:
  - Reducing temperature
  - Raising temperature
  - Reducing humidity
  - Changing pH / using chemical preservatives
  - Changing atmosphere
  - Irradiation
- Need to consider packaging implications in each method

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Reducing Temperature

- Helps slow down chemical activity and development of micro-organisms
- Chilling or freezing?
- Resistance to low temperature – all packaging components
- Moisture barrier
- Temperature control throughout supply chain

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Increasing Temperatures

- Destroying micro-organisms
- Canning / retorting
- Pasteurisation, hot filling
- Resistance to temperatures
- Seal integrity
- Effect of pack geometry and product type

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Reducing Humidity

- Removing free water
- Moisture barrier - and pack seals

Calcium Chloride Desiccant

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Changing PH / Chemical Preservatives

- Creating an acidic environment
- Pickling, salting
- Oxygen scavengers
- Resistance to chemicals used

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Changing the Oxygen

- Vacuum Packaging

  Consider material barrier and effect of vacuum on product

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MAP

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Changing the Oxygen

- Modified Atmosphere Packaging (MAP)

  Fastest growing method of food preservation

  Widely used for raw, cooked, wet, dry foods

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Modified Atmosphere Packaging

- Replacing oxygen with carbon dioxide and/or nitrogen (+ argon)
- Exception of red meat
- Gas flushing
- Vacuum packaging - limitations?

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Break out Session 2

- What packaging properties are needed for products packed in a modified atmosphere?
  e.g. Rasher or Bacon or cold meat type pack.
- Consider the advantages and disadvantages of MAP

10mins

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Modified Atmosphere Packaging

- Packaging properties:

  Gas barrier

  Moisture barrier

  Seal strength

  Puncture resistance - from product and exterior

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Modified Atmosphere Packaging

- Advantages:
  - Increases shelf life
  - Hence reduces product loss
  - Allows distribution over long distances
  - Gives a high consistent product quality
  - Limits need for chemical preservatives

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Modified Atmosphere Packaging

- Disadvantages:
  - Added cost for packaging materials with required barrier
  - Added cost for process
  - Special processing equipment needed - and training
  - Increases pack volume – increasing cost of warehousing and distribution
  - High emphasis on seal integrity

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Typical Modified Food Atmospheres for Selected Food Products

Product	Oxygen O_2	Carbon Dioxide CO_2	Nitrogen N_2
Red Meat	75%	25%	-
White Meats / Pasta	-	50%	50%
Fish	20%	40%	40%
Produce	5%	_	95%
Baked Goods	1%	60%	39%

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Irradiation

- Destroying micro organisms using short wavelength radiation
- Radiation sources – Cobalt 60, Caesium 137
- Resistance to radiation, especially polymers
- Health and safety aspect

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Irradiation

google

Why is irradiation of food bad?

free radicals kill some bacteria, but they also bounce around in the **food**, damage vitamins and enzymes, and combine with existing chemicals (like pesticides) in the **food** to form new chemicals, called unique radiolytic products (URPs).

why we don't like food irradiation - Organic Consumers Association
https://www.organicconsumers.org/.../what%27s%20wrong%20with%20food%20irradia...

Search for: Why is irradiation of food bad?

Is the irradiation of food safe?

Yes, **irradiated foods** are **safe**. **Irradiation** makes meat and poultry safer by reducing the numbers of harmful bacteria and parasites. **Food irradiation** does not make **foods** radioactive. ... Public health agencies worldwide have evaluated the **safety** of **food irradiation** over the last fifty years and found it to be **safe**.
Dec 20, 2016

Irradiation and Food Safety Answers to Frequently Asked Questions

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Preserving the Product Corrosion Damage

- Applies to metal products and metal packaging
- Need to consider conditions that might favour corrosion
- Need to manipulate conditions to prevent or delay corrosion

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Corrosion

Surface attack on metal, usually resulting in rusting or pitting.

Can penetrate the metal and cause leakage

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Corrosion

- Caused by:

  Atmospheric oxidation

  Chemical attack

  Galvanic action

  It **occurs** when two (or more) dissimilar metals are brought into electrical contact under water.

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Corrosion

- Influencing factors:

  Humidity
  Temperature
  Air / oxygen
  Abrasion
  Stress

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Corrosion

- Prevented / reduced by:

Reducing moisture, e.g. use a desiccant or VPI paper wrap

Vapor Corrosion Inhibitors work by diffusing corrosion inhibiting molecules from a source (packaging film or **paper** for example) to metal surfaces.

Removing surface oxygen:

- Oxygen scavenging
- Coatings - grease, oil, paint, lacquer

Very important in metal cans

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The Preservation Function

- Summary so far:

  What causes spoilage?

How to prevent or reduce spoilage:

Product treatments

Packaging materials

Packing processes

Storage conditions

Handling conditions

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The Preservation Function

Testing to get it right?

Estimating shelf life…

Accelerated aging and shelf life tests can help determine how environmental conditions including, temperature, humidity and light will affect the lifespan and integrity of your product.

Accelerated aging test methods use environmental chambers to determine the effects of temperature, humidity, UV exposure (UVA or UVB), and Cool White UV (indoor lighting cranked at a higher intensity) in compressed time and in a laboratory environment. The most common accelerated aging test we perform is ASTM F1980.

Large storage capacity test centres can accommodate a multitude of products under several conditions, including frozen, refrigerated, ambient, intermediate, tropical and accelerated shelf-life studies.
(www.element.com)

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Shelf Life of Packed Product

TEAM TASK

What affects the Shelf Life of a packed product?

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Shelf Life of Packed Product

- Is affected by:
  - Nature of the product and how it spoils
  - Size of the pack - surface area
  - Temperature and humidity levels likely to be encountered
  - Barrier of the packaging to moisture, gases and odours
  - Handling

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Barrier of the Pack

- Depends on:

  Resistance of the packaging material to the passage of moisture etc.

  Integrity of the pack seals - throughout the life of the packed product

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Barrier Properties

- Absolute barrier materials:
  - Glass bottles and jars
  - Metal cans
  - Aluminium foil above 17 microns

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Barrier Properties

- Barrier properties of other packaging materials are defined by:
- MVTR (WVTR) moisture vapour transmission rate or permeability
- OTR oxygen transmission rate or permeability

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Barrier Properties

- The lower the MVTR / OTR the better the barrier
- Barrier is directly related to thickness of Material
- Test results vary depending on test conditions

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Barrier of the Pack

Table 10.7 Properties of some flexible packaging materials

Material	MVTR G/SQ M/DAY for 25 micron film @90%RH/38°C	Oxygen Permeability CC/SQ M/DAY/ATM for 25 micron film	Tensile Strength MN/SQ Metre	Elongation %	Impact Strength Kg/cm
LDPE	15-20	6500-8500	6.9-15.8	200-600	4-6
HDPE	7-10	1600-2000	21.4-37.9	10-500	1-3
LLDPE	15-20	6500-8500	22-30	500-700	8-13
PP Cast OPP	10-12 5-7	3500-4500 2000-2500	30-120 *	50-600 50-100	5-15 *
PET	15-20	100-150	150-200	120-140	25-30
UPVC	30-40	150-350	40-60	2-40	12-20
PVdC	0.6-1.0	2-4	35-45	40-100	10-15
PA	300-400	50-75	40-50	250-500	4-6
PS	70-150	4500-6000	35-84	1-3	1-5

* Dependent upon degree of orientation

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Shelf Life and Storage Testing

- Actual product samples
- Actual packaging samples
- Actual processing
- Simulated storage conditions:

  Ambient e.g. 25ºC 75% Relative Humidity

  Accelerated e.g. 38ºC 90% Relative Humidity

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Shelf Life and Storage Testing

- What can be evaluated?

  Weight gain/loss, due to moisture

  Micro organism count

  Appearance

  Changes in performance

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The Convenience Function

- Making the product easy and safe to handle:

  On the filling line

  In storage and distribution

  In use by the consumer

- TEAM TASK

  Discuss and note down what points you need to consider to ensure that packaging is easy and safe to handle in the above situations

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Filling Line

- Ease of running on the filling line directly affects line efficiency and total cost
- Packaging line trials are ESSENTIAL when developing new packaging or making specification changes
- Different requirements depending on level of automation, and line speed

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Filling Line

- Think about: (just some ideas!)

  Component weight and centre of gravity

  Component contact points and potential for scuffing or breakage

  Component shape and potential for 'shingling'

  Ease of applying a cap - number of turns of thread

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Storage and Distribution

- Again, ease of handling will affect total cost
- Think about:
  - Weight - Manual Handling Regulations
  - Ease of picking up
  - How to recognise
  - Collating for ease of movement

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Use by the Customer

- Think about:
  - Opening
  - Tamper evidence
  - Child resistance
  - Dispensing
  - Holding - under likely conditions
  - Closing - can the pack be properly closed to maintain the expected storage life?
  - Storing - can it be stacked, does it fit?
  - Intended consumer?
  - What are their needs?

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Convenience

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Convenience

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Convenience

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The Information Function

TEAM TASK

Why is Packaging important for the information function?

What information is usually found the different levels of packaging?

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The Information Function

- Packaging is usually the only means of giving information about the product
- On all levels of packaging
- Must always be legible - by human and by electronic means

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The Information Function

Identity

Usage

Storage and handling

Promotion

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The Information Function

- On the primary (sales unit), secondary and tertiary packs

  Legal information - need to know requirements of each market

  Marketing information needed to promote and sell product

  Important consumer information

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The Information Function

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The Information Function

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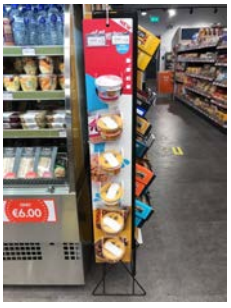
The Information Function



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The Information Function

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The Information Function

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The Selling Function

- Present and sell:

Stand out from the competition
Differentiating the product

Attract the buyer
Appealing to the consumer

Brand identity
Enhancing the Brand

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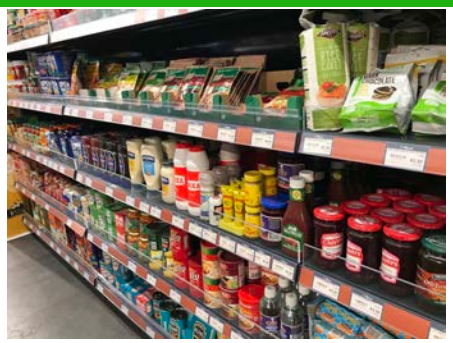
Selling / Differentiation / Brand



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Marketing & Sales

Must meet marketing needs

Identify the brand and helps sell the product in good condition and in a form that the consumer requires

A guarantee of quality

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Selling by use of

Colour

Shape

Graphics

Size

Texture

103

Selling – Pack formats or brand extension or flavour formats

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Selling - Recognisability

105

Selling - Band Equity

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Commercial

The packaging must meet all these functions and……

still be technically & economically feasible to make, fill, transport, display, sell, use and dispose of

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Delivering Cost Effective Solutions

- Moving goods from production to final user.
- Total pack cost in relation to product value and market position.
- Demands and expectations of the supply chain and the consumer.

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Disposal

Risk – Contamination

Reduce

Reuse

Recycle

Recover

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Environmental Impact

- Packaging provides protection and reduces product wastage
- Good environmental packaging uses 'minimum adequate amount' to protect and present the product

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Environmental Impact

- The European Packaging and Packaging Waste Directive 94/62/EC
- Directive 94/62/EC is implemented via:

  Producer Responsibility Obligations (Packaging Waste) Regulations 2012
  Packaging Regulations 2015 (as amended)

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Legally Compliant

- Food Safety Legislation
- Comply with Cosmetics Directive
- Packaging Waste Directive
- Pollution prevention and control
- Health and Safety
- Honesty in presentation
- Quantity control

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Thank you for your time.

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