The Kitchen of the Future

Pratt Institute • The LG Studio Process Guide:
Chapter Two, Food Preparation & Chapter Three,
Refrigerator, Kitchen Units & Contents of Interiors

The Kitchen of the Future

Pratt Institute • The LG Studio Process Guide:
Chapter Two, Contemporary & Historical Methods
of Food Preservation and Preparation

Chapter 2

Contemporary and Historical Methods of Food Preservation and Preparation

- Methods of Food Preservation
- Food Preservation Duration
- Timeline of Early Food Preservation Technologies
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- How Refrigeration Works
- The Refrigerator and Its Parts
- Automatic Ice Makers
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Methods of Food Preservation

Food preservation has been a challenge for human culture for thousands of years. Earliest evidence has been dated back to 12000 BCE, when man began to transition from a nomadic lifestyle to a more sedentary agrarian lifestyle.

Inevitably, food begins to spoil soon after it is harvested. Food spoilage is caused by micro-organisms. Humankind has found a variety of ways to slow down the metabolism of these micro-organisms, thus allowing food to keep longer.

Methods of food preservation are diverse. Examples include canning, fermenting, curing, freezing, cooling, drying, pickling and smoking.

The key factors determining which preservation process is used are local climate, indigenous food types, and available resources. As a result, different cultures have their own unique preservation processes.

There is a correlation between climate and food preservation method. In hot, wet, tropical climates, cultures traditionally use fermentation and smoking. Hot, dry climates are best suited for air drying and sun drying meats, vegetables, and fruits. Temperate climates allow for more versatility in food preservation, relying on a combination of canning, drying, and smoking.

Heat is used as a catalyst for fermenting fruits and vegetables; indigenous woods and spices are used to smoke and flavor meats. The northern Arctic areas tended to be heavily forested, and as a result peoples of this region would mostly smoke their food, using their available natural resources for heat and food preservation.

IMAGE 1

arid
temperate
tropical
arctic

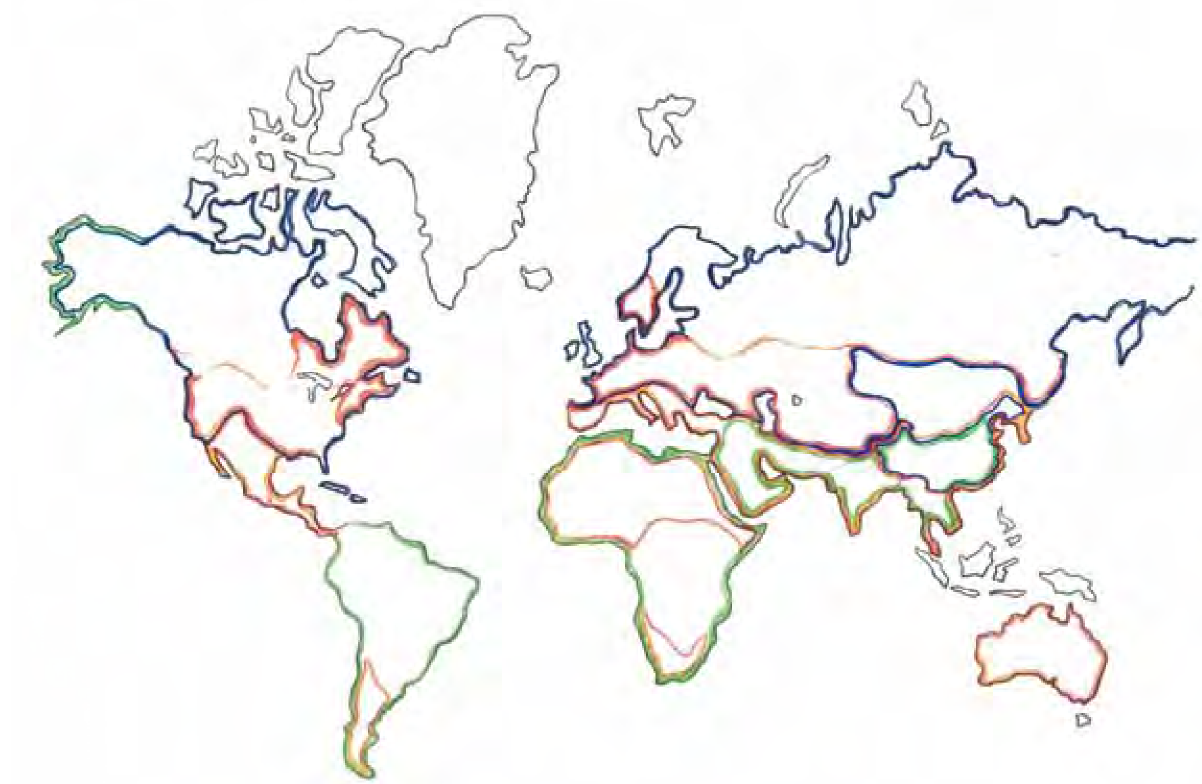


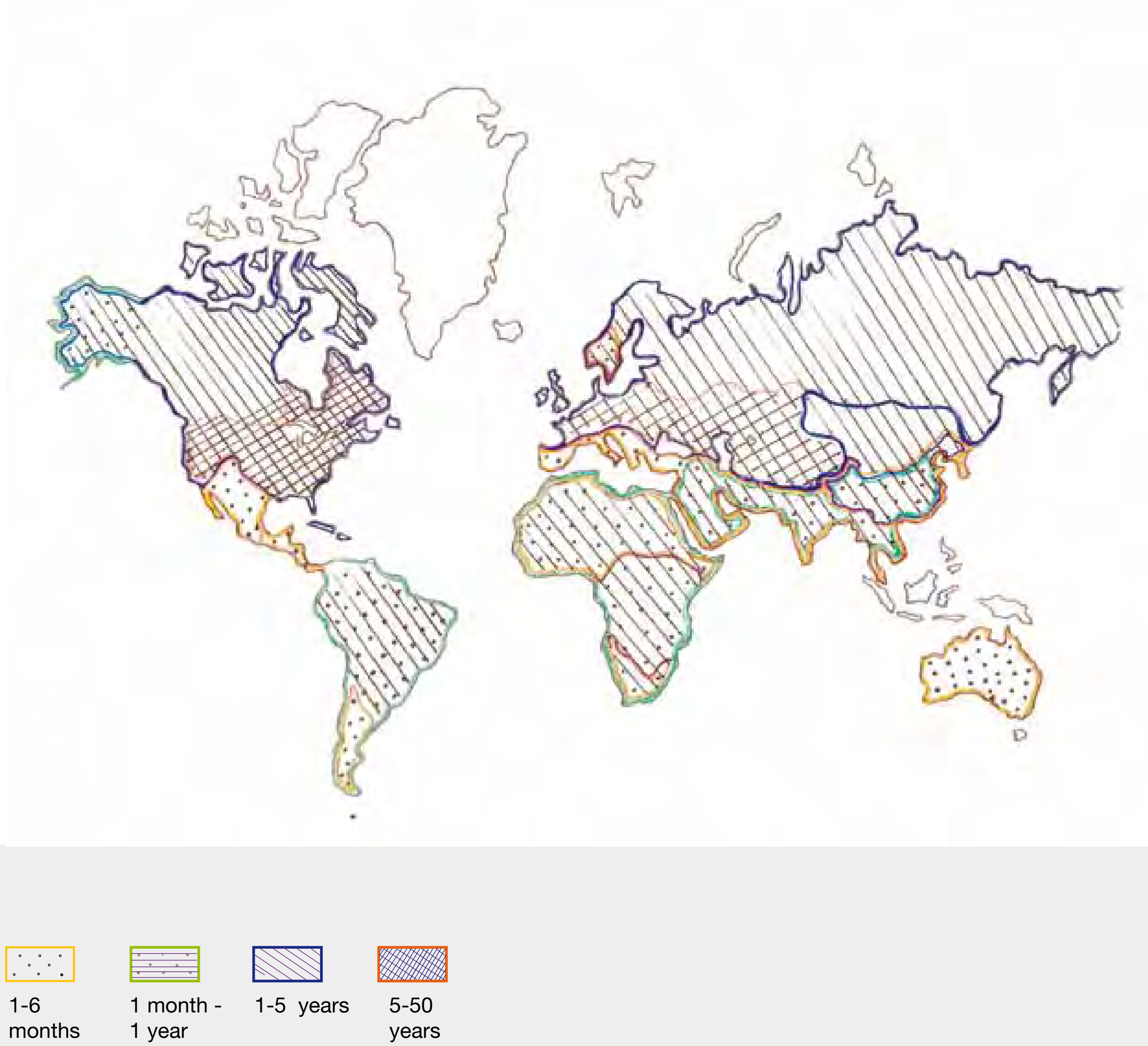
IMAGE 2 Distribution of food preservation methods

drying
canning
fermenting
smoking

Food Preservation Duration

Spoilage time varies depending on food type and the preservation method used.

IMAGE 3 These shelf-life estimates are obtained by accounting for both spoilage time and nutrition loss time. Dried foods tend to last 1 to 6 months, fermented foods can last from 1 month to 1 year (dairy products last for less time vs. canned fermented foods), smoked meats can last 1 to 5 years, and airtight canned goods can last for up to 50 years without spoilage and loss of nutritional content.



Timeline of Early Food Preservation Technologies

This timeline traces the emergence of food preservation techniques with their countries of origin.

First documentation of sun drying and salting foods (Egypt)	12000 BCE
First documentation of fermentation use in alcoholic beverages (China)	10000 BCE
First evidence of spices being used in food (Middle East)	5000 BCE
First documentation of pickling (India)	2500 BCE
First documentation of freezing food (Peru)	1000 BCE
First documentation of Vikings using smoking methods (Scandinavia)	800 BCE
Appert invents the modern process of canning (France)	1795
Louis Pasteur invents the process of pasteurization (France)	1826
Freeze drying of food is commercialized	1913
Process of food irradiation is developed	1940
First household refrigerator invented	1950

Traditional Methods of Preservation

Food preparation rituals are an integral expression of culture. Even with the introduction of modern refrigeration, cultures around the world have held on to these traditional means of food preservation.

Scandinavia

Traditional Scandinavian diets heavily consist of seafood, especially herring, and salmon. The fish would be preserved by means of smoking, typically using birchwood.

Smoking Process

- Debone, gut, and remove head of fish.
- Soak in brine for approximately 30 minutes.
- Rinse, then air dry.
- Smoke until inner fish temperatures reach 160° F for 30 minutes; total smoking time takes typically 8 hours.

IMAGE 4 Scandinavia is mostly an Arctic climate. It includes Sweden, Finland, Norway, Iceland, and Denmark.

Nigeria

Nigeria is located in a semi-desert scrubland. Using natural laws of thermodynamics and techniques used by the ancient Egyptians and Indians, Mohammed Bah Abba developed a system known as "Pot in Pot." This system is very efficient, providing cooling temperatures of up to 14° F using very little water.

Two clay pots of different diameters are fitted within each other. Moist sand is packed in between the two pots. Food is placed inside the smaller pot, and the pots are then covered with a damp cloth. The water contained in the sand evaporates towards the outer surface of the larger pot. The drier outside air circulates through the pots, causing an inner drop in temperature.

IMAGE 6 Nigeria is Africa's most populous country with approximately 130 million people. Many inhabitants live without electricity, and Bah Abba received the Rolex design award for his "Pot in Pot" system.

Lebanon

The Lebanese still use many of their traditional food preservation methods. Lebanese dry many of their foods in the sun, including meats, figs, apricots, peas, and beans.

IMAGE 8 Effective sun drying of food requires an average temperature of 85° F, humidity below 65%, and frequent breezes.

Sun drying

- Lebanese homes are built with flat topped roofs. These roofs serve as sorting and drying areas for food.
- Wood or straw drying racks are constructed for the food to lie on. Raised pallettes allow for better air circulation, quickening the drying process.
- The dried food is either bagged or canned for storage.

Africa, Asia, Latin America

Fermentation is a common method of food preservation in tropical climates, including parts of Africa, Asia, and Latin America.

Fermentation can be applied to a wide variety of foods such as sweet bread, beverages such as sorghum beer and palm wine, and pickles such as lime pickle, mango pickle, vegetable pickle, and also yogurt. Techniques and recipes are often passed down from mother to daughter, thus establishing deep, cultural roots.

Fermentation Process

- In jars, food is soaked in brine.
- The food is covered with a lid of a smaller diameter, allowing for air circulation.
- The lid is weighed down, typically by rocks, keeping the food submerged in brine.
- After 3 to 4 weeks, the food is fully fermented, and sealed in jars for storage.

IMAGE 11 Hotter, more humid climates are optimal for fermentation. Fermentation requires consistent temperatures of over 75° F.

Contemporary Methods of Preservation

Modern technology has brought about new ways to preserve food. These modern methods tend to be internationally used, and do not carry as deep of cultural sentiments as traditional methods of food preservation do.

Canning

Canning was invented in 1795 by French scientist Appert. Appert found that food, especially fruit and vegetables, could be preserved by heating it up until boiling point, and then sealing in air tight jars.

IMAGE 23

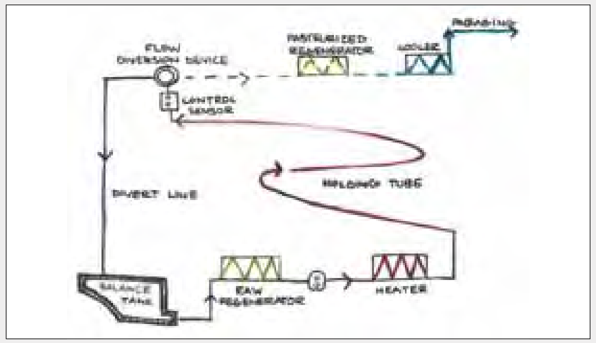


IMAGE 22 Bellis, Mary: freeze drying and freeze dried food

Pasteurization

Pasteurization was invented in 1862 by Frenchman Louis Pasteur. Pasteurization is based upon fermentation. Pasteurization is used in milk and dairy products, to eliminate harmful bacteria, molds, and yeasts.

Pasteurization Process

- Raw milk is passed through the heater section, at temperatures of approximately 72° C for 16 seconds.
- Treated milk is cooled to 4° C, and is stored in a tank for packaging

Freeze Drying

Freeze drying was commercially developed during World War II. Freeze drying is used primarily in camping and space food.

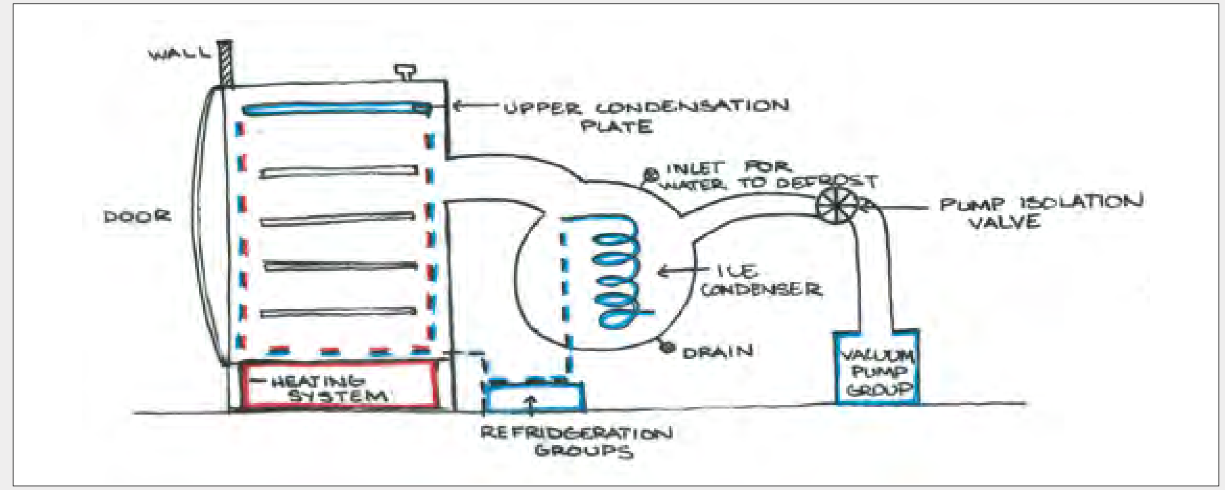


IMAGE 24

Freeze Drying Process

- Food product is completely frozen
- Vacuum: sublimation of frozen solvent
- Heat is applied to accelerate the sublimation process
- Low temperature condenser plates remove the vaporized solvent from the vacuum chamber, converting it back to a solid.

Food Irradiation

Food radiation began to be used in the1950s. Foods are exposed to either
gamma rays or electrons. Radiation kills harmful bacteria, and reduces
spoilage bacteria.

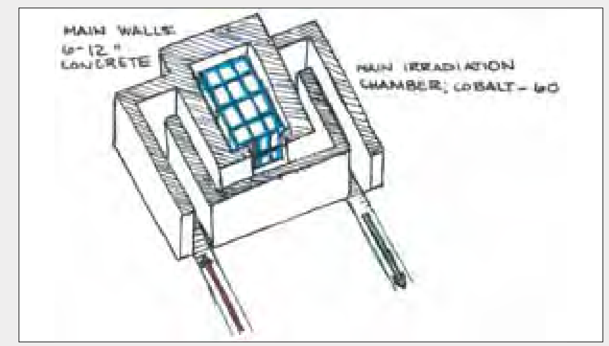


IMAGE 25 Radiation Technology IWC

Timeline of Modern Innovations in Refrigeration

1700s Icehouses used to preserve food. Natural ice was collected in the winter. The ice was packed in salt and wrapped in strips of flannel, and stored underground too keep it from melting.

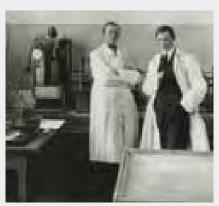
1850s Ice boxes were introduced into the home and business. It was wood box lined with tin or zinc and insulated with cork, sawdust, or seaweed. Ice was distributed and stored in the boxes to refrigerate and preserve food. The ice melted into a pan underneath the box and was emptied daily.

1889–1890 Mechanical refrigeration and freezing increases in the US because of a severe ice shortage due to warm winters.

1913 The first functional household refrigerator was produced in Chicago, Illinois.

1918 Kelvinator introduced the first refrigerator with automatic controls. It was made of two parts: an insulated casing cooled by brine coils and powered by belts attached to a motor located in the basement.

1920 Carl Munter and Baltzar von Platen filed their patent on a silent and functional refrigerator powered by electricity, kerosene or gas.



1927 General Electric introduced "Monitor-Top." It was a completely sealed refrigerator where the compressor placed on the top because it gave off a substantial amount of heat. The compressor was often covered with a decorative ring.

1930s Freon replaced sulfur dioxide which expanded the home refrigerator market.

1939 G.E. introduced the first dual temperature refrigerator with the freezer separate from the refrigeration compartment.

1950s–1960s Automatic defrosting and automatic ice making was introduced.

1970s–1980s New innovations were directed towards the environment: CFC's were eliminated from refrigeration sealed units and more energy efficient refrigerators were developed.

How a Refrigerator Works

The basic concept of refrigeration is the evaporation of a liquid to absorb heat. The refrigerant (liquid) evaporates at an extremely low temperature, creating freezing temperatures inside the refrigerator.

1. The compressor presses the refrigerant gas and raises the refrigerant's pressure and temperature.

2. The heat exchanging coils outside the refrigerator cools the refrigerant after the pressurization.

3. The refrigerant condenses into a liquid as it cools and flows through the expansion valve.

4. The liquid refrigerant moves from a zone of high pressure to a zone low pressure, causing it to expand and evaporate.

5. The refrigerant absorbs heat in the heat-exchanging pipes inside the refrigerator, making it cold.

6. It repeats the same circulation process, reusing the same refrigerant over and over again.

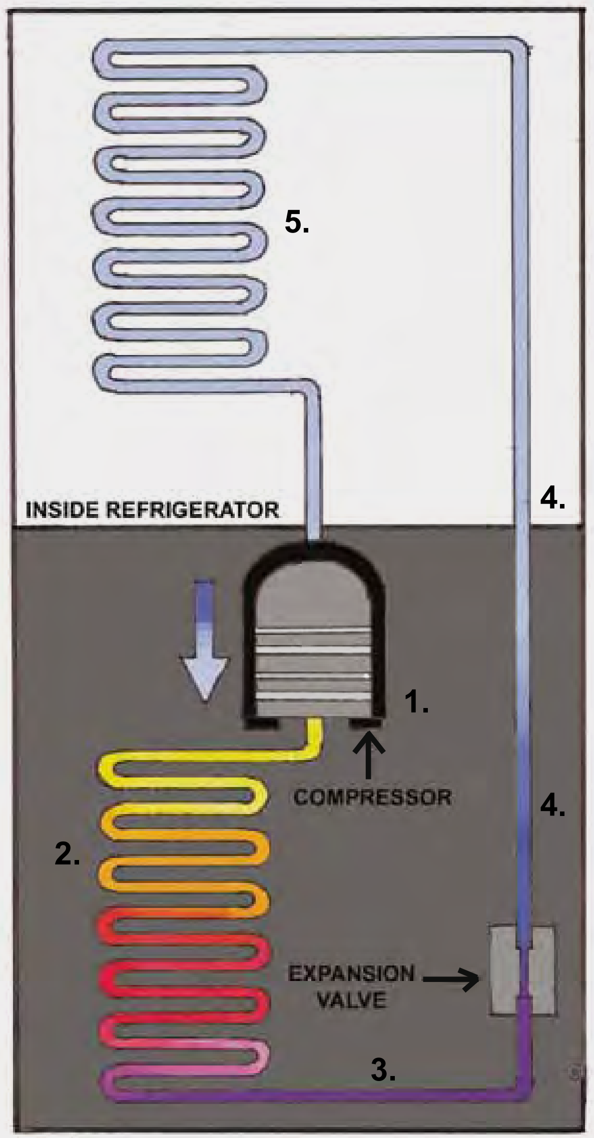
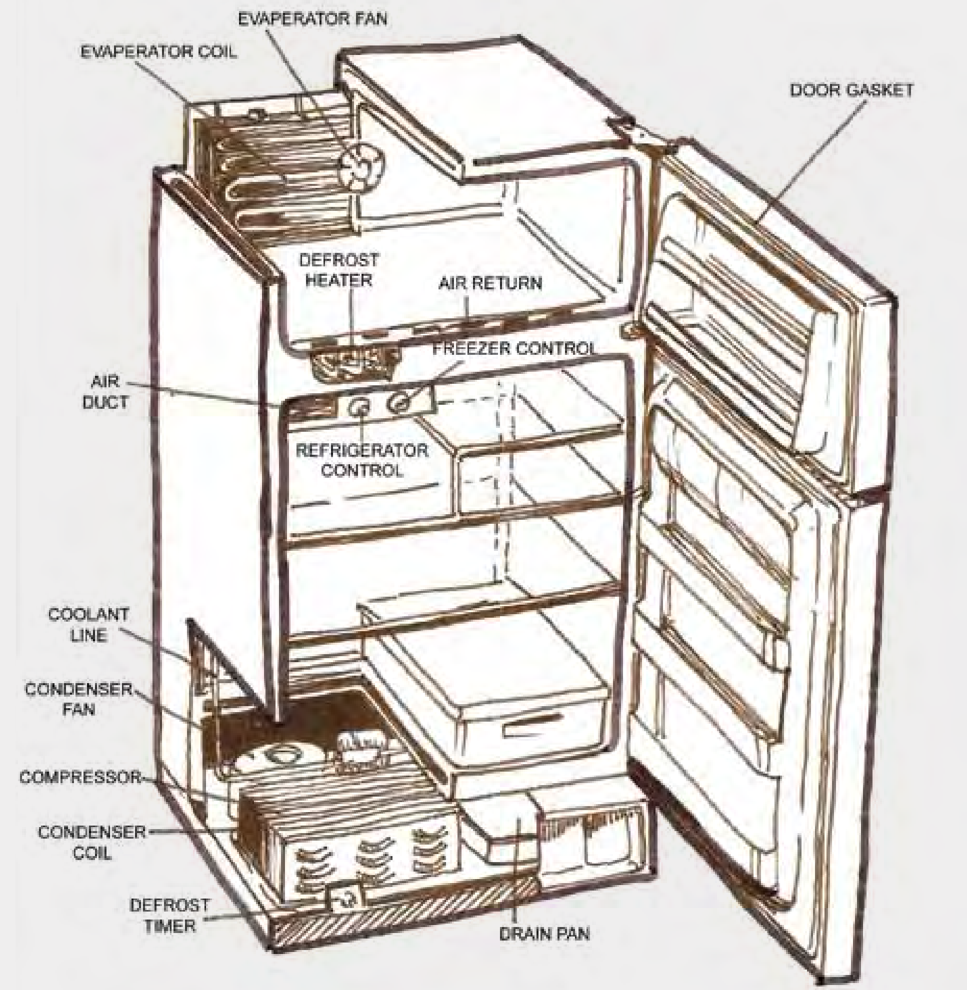


IMAGE 17

The Refrigerator and Its Parts

- There are two fans inside the refrigerator to help cool and circulate the air throughout. One is inside and circulates air around the heat-exchanging coils and it evens the cooling throughout the unit and the other aids in the defrost process for automatic defrost refrigerators.



- The ideal temperature for your refrigerator is between 35–38 degrees Fahrenheit. Anything colder will freeze the food, and anything warmer speeds the growth of bacteria causing food to rot.
- All modern refrigerators have a thermostat that controls the temperatures in the refrigerator separate from the freezer. When the refrigerator reaches a set temperature, the thermostat stops the electricity flow to the compressor, which stops cooling.

Automatic Ice Makers

Introduced in the 1960s, icemakers are independent of the other systems of the refrigerator. Icemakers use an electric motor, an electrically operated water valve and an electrical heating unit. The operation of the icemaker cycle is as follows:

1. The icemaker sends a signal to the water fill valve to open and let water into the icemaker tray.

2. The water valve is open for about seven seconds, letting just enough water in to fill the ice mold.

3. The icemaker waits until the water is frozen. The refrigerator unit does the actual freezing work, not the icemaker itself.

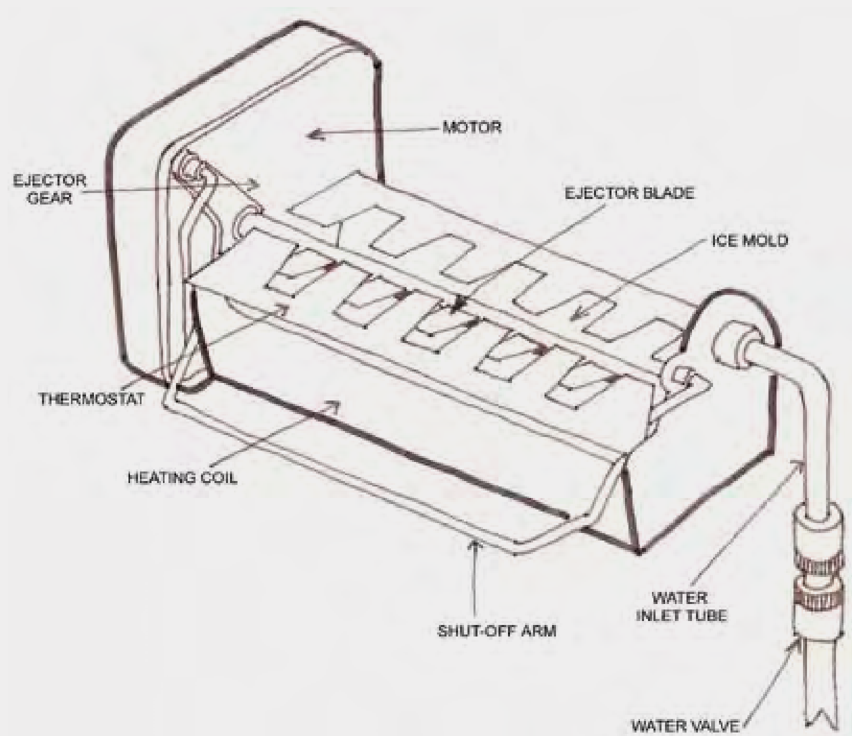
4. The icemaker's built-in thermostat senses the temperature when it drops to about 10–15 degrees Fahrenheit and stops the flow of electricity.

5. The electrical current warms the heating coils, loosening the ice cubes from the mold.

6. A motor is activated, spinning a gear, rotating a shaft with ejecting blades. The blades push the cubes up and out of the tray.

7. The shut-off arm raises up to let the cubes drop. The wire comes back down after the cubes have been dumped into the bin, activating the water valve to begin another cycle.

8. If the wire is not lowered all the way down, it automatically stops the flow to produce more.



Energy Efficiency

The refrigerator is America's most used appliance, and it uses the most amount of energy of all our household appliances (over 1,000 kWh per year).

All refrigerators are heat-transfer machines; they transfer the heat from the inside to the outside of the fridge. The compressor will operate more efficiently, and use less power if there is proper ventilation. The ventilation of a refrigerator is very important.

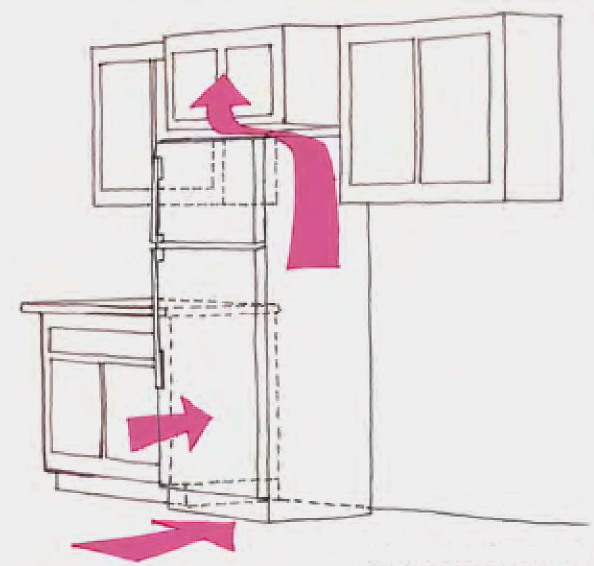


IMAGE 20

To properly ventilate a refrigerator, move it away from the stove, dishwasher, direct sunlight or any other heat sources so it doesn't have to work as hard. Design cabinets to allow several inches of space around and above the refrigerator so there is enough air flow around the coils in the back of the unit.

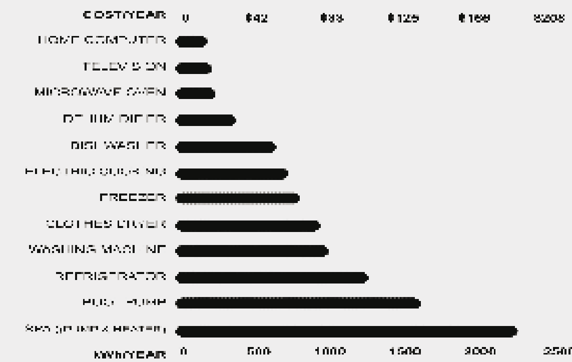


IMAGE 21

Restricting the ventilation of a refrigerator can add 15% or more to energy bill/consumption.

The arrangement of the refrigerator compartments is significant. Side-by-side refrigerators use about 12% more energy than units with the freezer on top. Bottom freezer units fall between the two.

Automatic icemakers increase the amount of energy use by 14% to 20%.

Traditional Methods of Food Preparation

The exact origin of cooking food is very obscure, although some evidence has been traced back to the Paleolithic Period.

Cooking is used for a variety of reasons. Heating foods, especially meat, to higher temperatures kills off harmful bacteria. Cooking also makes foods softer, more palatable, and easier to digest.

Human kind has devised a variety of methods to cook food. There are many different designs of ovens, stoves, and other ways of utilizing heat and fire.

Thermal Conductivity of Materials

Historically, different materials have been used to fabricate stoves and ovens. Some are more energy efficient (less energy and heat escapes into the environment) than others. Thermal conductivity refers to a material's ability to conduct heat. Thermal conductivity is expressed in W/m-K.

Conductivity Measurements at 25° C

Iron	55.0
Clay	3.00
Mortar	1.73
Ceramics	1.06

Chula

The chula is a type of stove that originated in India. It is built of clay, and runs primarily off of biofuels. The chula gives the options of either cooking with a pan on top, or cooking items over an open flame. Heat transfer efficiency ranges from approximately 10 to 40%.

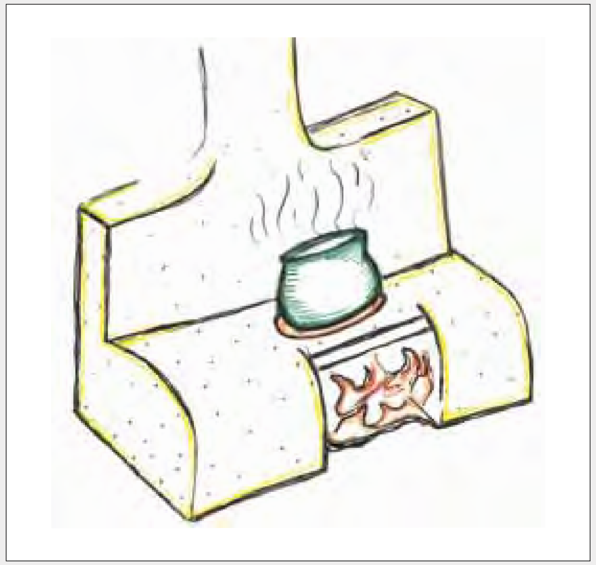


IMAGE 26

IMAGE 27

Ceramic Jiko

The jiko is a popular type of stove used in Africa, especially in Kenya. The stove is made of metal casting with an inner ceramic lining for insulation. The jiko runs primarily off of biofuels. Heat transfer efficiency is 25 to 40%.

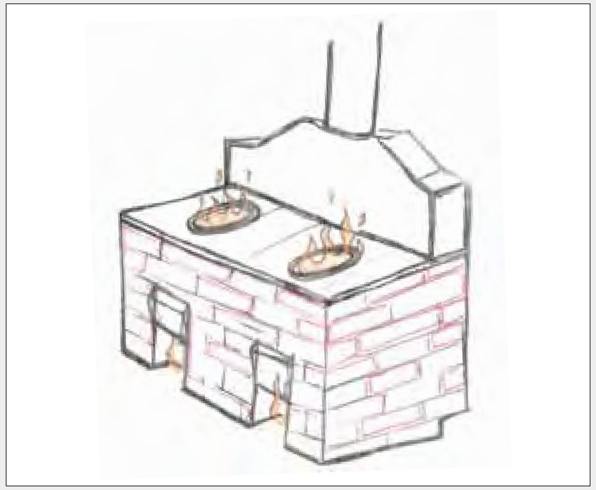
IMAGE 28

IMAGE 29

Brick Cook Stove

The brick cooking stove has been used by many culture, but their earliest use is attributed to the Chinese. These stoves are made out of brick and mortar. Traditionally, they run off of biofuels, and filter the soot out of chimneys attached to the back of the stove. Heat transfer efficiency ranges from 20 to 40%.

IMAGE 30



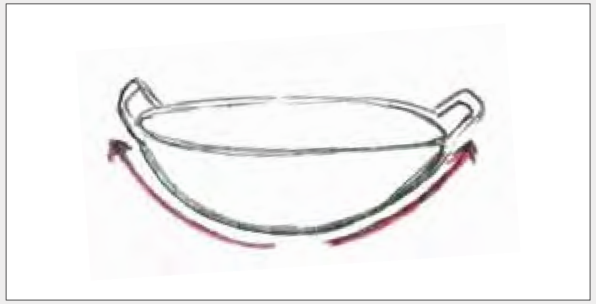


IMAGE 31 Chinese cuisine uses a specific cooking dish called the wok. Woks have rounded bottoms, allowing for a more even heat distribution to food.

Open Flame Cooking

The simplest method of cooking is to use an open flame. The food is usually put in cast- iron pots and set on hot coals to cook.

IMAGE 32

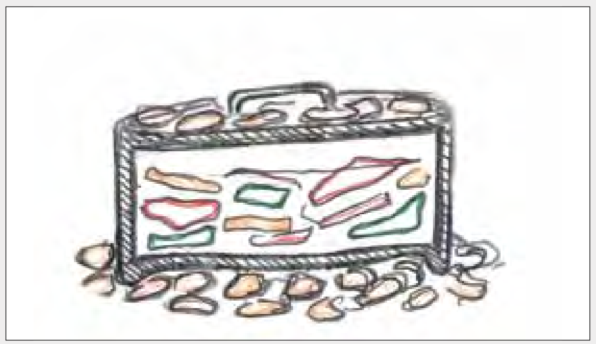


IMAGE 33

Clay Pot Cooking

Clay pot cooking has been used in many cultures, in countries including Morocco, India, and China.

IMAGE 34

Clay Pot Process

- Saturate clay pot and top in water for approximately 15 minutes.
- When heated, the food inside the pot begins to steam within its own juices and from the water held within the porous clay walls.
- Remove pot from heat, and cool on a wet rag as to avoid cracking.

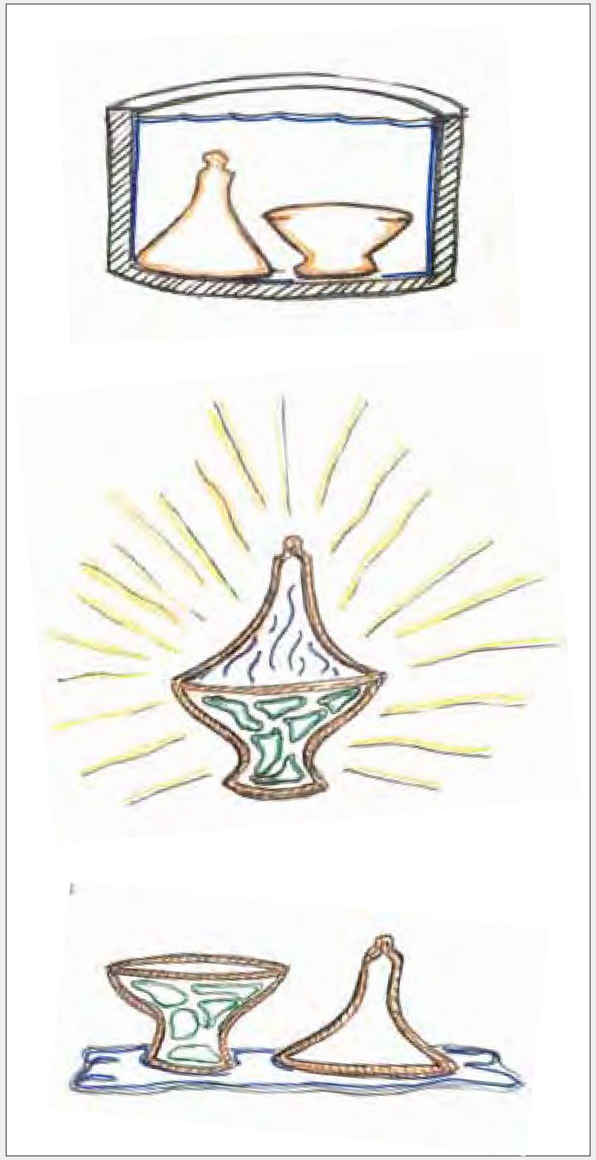


IMAGE 35

Pompeii Oven

Pompeii stoves were developed in Italy. They are constructed using terra cotta floor tiles, brick walls, a domed roof, and a mortar shell. A flue in the back provides proper air circulation. Pompeii Oven

IMAGE 36

IMAGE 37

Smokehouse

Smokehouses are typical in Scandinavia, parts of Western Europe, and parts of North America. Smoke-houses are used to cook meats and fish. Different tastes and aromas may be smoked into the meats, de-pending on what type of wood is burned.

IMAGE 38

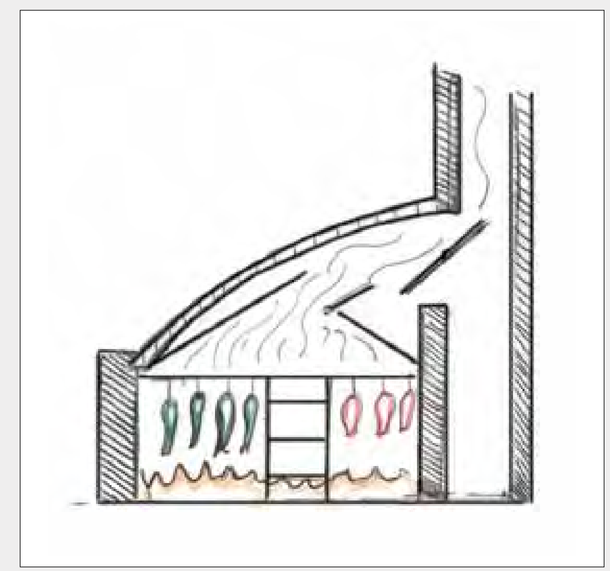


IMAGE 39

Modern Methods of Food Preparation

The Range

The range, also referred to as a stove, is a kitchen appliance that provides heat for cooking. A range has a cooktop with several heating areas, and including one or two ovens. There are two different kinds of ranges, the electric range and the gas range.

The Gas Range

The gas range was patented by James Sharp in 1826. Gas ranges were commonly used in the home by the1880s, having been adapted from commercial businesses. Soon after, the oven was integrated into the base of the range. The combination unit was smaller, more compact and functional. It also fit well and looked better in the residential kitchen. In 1910, producers started to enamel their gas stoves for easier cleaning and aesthetics.

IMAGE 41 1920s gas range

The Electric Range

The electric cooking range was invented by Thomas Ahearn in 1892, and was then showcased in 1893 at the World's Fair in Chicago, Illinois. The electric stove had a slow heat-up start compared to the gas stove that heated automatically. During the1930s, electric range technology advanced. The electric range slowly started to replace the gas stove.

The first technology used resistor heating coils which heated iron hot- plates on the top. Glass-ceramic cook- tops started to appear in the 1970's. The glass-ceramic cooktops were heated by electrical heating coils. Because of its physical characteristics, the smooth surface is easier to clean and heats quicker. Only the plate heats up while the rest of the surface remains relatively cool. Coil ranges still provide the best durability out of all electric cooktops.

IMAGE 40 Early electric stove

Induction Stoves

Induction stoves are a fairly new technology. These stoves heat the cookware directly through electromagnetic induction and thus require pots and pans with ferromagnetic (iron) bottoms. Anything that is not made of iron that touches the glass-ceramic surface will not heat up. Even touching the stove with your hand, you will not get burned.

Today gas or electric ranges are chosen by preference. Chefs prefer gas cooktops to cook more finely and quicker, and electric convection ovens for more even cooking and they're self-cleaning. Today's major brands sell gas cooktops combined with electric ovens.

IMAGE 54 Kitchen hot spots

Technological Integration in the Kitchen

In practical application, one has to understand the possibilities of dealing with the problem before trying to work out the application of the various technologies into the home. The first step to this understanding is an examination of the thermodynamics of the kitchen. Understanding the hot-points within the kitchen system is critical to future development of heat-recovering technology for the home. The relation-ship between heat cast off from the refrigerator and its possible harvesting for use within the range becomes paramount.

IMAGE 55 Kitchen heat loss

IMAGE 56 Kitchen thermodynamics

The central aspect of this relationship is the possibility of harvesting direct heat from the refrigerator's waste pump and turning it into usable energy for cooking and food preparation as well as potentially a thermostat system for warming up the domicile's air currents.

The applications of sustainable/renewable power technologies are very promising. However, their integration into the home industry seems to have several restrictions. The primary issue is local climate, which has a great influence on which sustainable technology is the most practical. Certain regions, such as the African desert plains for example, are not well equipped to rely on water power, while they are well suited for other technologies based on wind and solar power.

The success of incorporating sustainable power into the home is largely dependant on the utilization of site-appropriate technologies to gain a maximum amount of energy in any given region. For instance in Sub-Saharan Africa, the use of solar power as the chief sustainable way of importing energy is more logical than the use of biofuels due to greater abundance of that resource. Conversely, coastal regions would benefit from the utilization of wave farming or wind technology. In short, there cannot develop a technological reliance on simply one source of power, or humanity end up in the same predicament we are facing now.

IMAGE 57 Potential recovered heat use

The power used for refrigeration is part of the overarching electrical generation system that drives the larger network of home appliances. It is difficult to consider methods of sustainable power for refrigeration independent of the network of electrical power for the whole home. So far, there have been some promising instances of "stand-alone sustainability," however, such as the SunDazer solar powered refrigerator and mechanical powered electrical appliances.

Nonetheless, the current market retains plenty of room for further innovation. There have been major developments in large-scale sustainability while small power has so far been left largely unexplored. Some possible fields of exploration might include wind-powered refrigeration and water-integrated stand-alone technologies, with the topic of biofuels seeming to be better fit for large-scale industrial production. Overall, there is a tremendous amount of possibility in the area of sustainable kitchen design. All that is lacking is someone to "step up to the plate."

IMAGE 58

The Kitchen of the Future

Pratt Institute • The LG Studio Process Guide:
Chapter Three, Refrigerator & Kitchen Unit Dimensions, Fabrication & Contents of Interiors

Chapter 3

Refrigerator and Kitchen Unit Dimensions Fabrication and Contents of Interiors

- Fabrication and Manufacture
- Refrigerator Contents and Statistics
- Refrigerator Layout
- Refrigerator Dimensions

Fabrication and Manufacture

Materials and Fabrication of Refrigerators

Today's refrigerators are made of a few main components: the outer shell or exterior cabinet, the inner cabinet or liner, the insulation between the two, cooling systems, cooling agent, and the fixtures. The outer shells are typically made of aluminum and sheet metal, which are sometimes pre painted and held together by welding or clinching the materials together. Some makers may also use sheet metal for the inner cabinet, or may use a plastic liner.

IMAGE 204 Stainless steel door after vacuum molding

Clinching is a process, much like stapling in, where two pieces are crimped together under pressure. The raw materials for this process come from either aluminum or stainless steel rolls, which is then fed directly into a machine.

IMAGE 205 LG Manufacturing plant Monterrey, Mexico

The process for producing these inner cabinets is known as vacuum forming. This is done with a larger piece of plastic that is held on its edges and then heated up. Once warm enough the plastic is pulled into a mold by vacuum pressure and then left to cool.

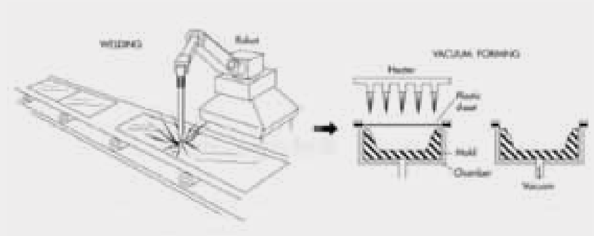


IMAGE 206

Once the two components are snapped together they are then filled with a fiberglass or polyform insulation, which is then heated in order for it to expand and become rigid and completely insulate the gap. Screws then attach the refrigeration components to the shell. The other fittings like tubing are then soldered together and sprayed with a protective coating. The door seal is made by means of a magnetic laden gasket that is then attached to the door by screws. Next handles and hinges are attached to the door and screwed to the cabinet. After full assembly the system is pressure tested for leaks. Once passed these tests the unit is packaged and shipped.

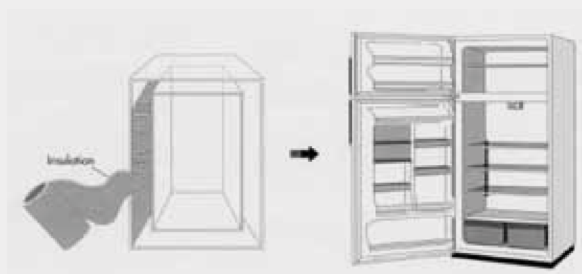


IMAGE 208 Adding insulation

To protect the environment, refrigerant or Freon is now being heavily monitored in order to prevent leakage into the atmosphere. Today's refrigerators have reduced usage and have installed leak detection systems to ensure the safety of the systems. There is research now going on to find a long-term replacement for Freon. As of now HCFC-22 is considered to be a good replacement, which would reduce the molecules ozone depletion by 95%.

IMAGE 207 LG production line

Materials and Fabrication of Kitchen Units

When it comes to kitchen units the possibilities for materials and fabrication are infinite. A basic cabinet can be made of MDF, which can then be covered by a High Pressure Laminate. Cabinet doors styles can be slab, recessed panel, raised panel, routed, or vacuum wrapped. They can also be made of stainless steel, glass, resins, and solid wood. Counter tops can be made of the same materials as the cabinets including ceramic tile, engineered stone, and natural stone.

IMAGE 210 Multi-surface counter

At LG's Mexico plant they have developed a production line that can be easily changed to produce multiple model types. This allows them to meet the demands of the consumer markets and cut back on over manufacturing. The plant also receives 50% of its raw materials from local distributors. Their goal is to "work smarter not harder" and to cut down on energy and waste materials.

IMAGE 209 Eye-catching designs

Today's cooking appliances may have very different styles from modern and sleek to sturdy and traditional, but they all have one thing in common, which is that they are employing technologies to allow us to cook food faster.

IMAGE 211 LG Microwave/Toaster combo

When considering the combination of cabinetry and appliances and fixtures, there has to be some sort of flow of materials. The material of choice for today's fabricated work surfaces is natural stone, mostly granite or other hard stones that can be polished and become stain and chemical resistant. These materials come in a large range of colors and patterns making it easy to adapt to any condition. As for sinks, they are generally made out of materials that are easily formed into deep containers. Sinks have been made of cast iron with an enamel coating, stainless steel, ceramic, glass, and stone.

IMAGE 212 Project Luna feature a twist on gas that raises and lowers from the cook top

IMAGE 213 Stainless steel sink counter

Other elements that can be built into kitchen units are ovens, refrigerators, freezers, windows, TVs, wine coolers, range hoods, and islands, among others elements. The kitchen of the future is in our hands, and it is up to us to make it happen.

IMAGE 214

Materials and Fabrication of Refrigerators

Most of the LG Electronics products entering the US and Latin America come from a manufacturing plant in Monterrey, Mexico. This plant was established in April of 2000. It has grown to over one million square feet and produces more than 40% of the refrigerator models in the US.

The plant currently has two production lines that are able to produce multiple model styles. This allows for strategic planning on the supply and demand of its model types.

Outside the US there are other competitors that share in the refrigerator market. Many of these companies are based in China. Below is a list of companies and the percentage of the market they hold.

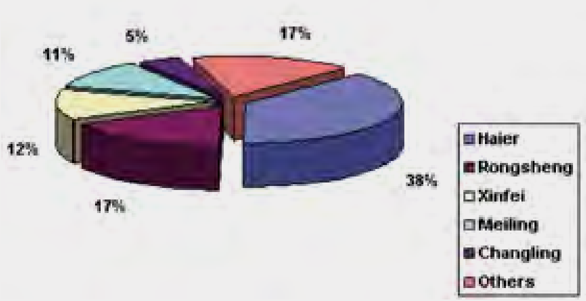


IMAGE 215

Combined 1960 - 2000 Results

	Material Use	Energy Use	Solid Residues	Liquid Residues	Gas Residues	Total
Pre-manufacture	1	2	2	3	1	9/20
	3	2	3	3	3	14/20
Product	3	2	2	3	1	11/20
Manufacture	3	2	3	4	2	14/20
Product Delivery	1	1	2	3	1	8/20
	1	2	2	3	2	10/20
Product Use	0	0	3	3	2	8/20
	3	3	4	4	3	17/20
Refurbishment,	1	3	0	2	1	7/20
Recycle, Disposal	3	2	2	3	4	14/20
Total	6/20	8/20	9/20	14/20	6/20	43/100
	13/20	11/20	14/20	17/20	14/20	69/100

IMAGE 216

At present, development of refrigerator products tends to be varied. In addition to innovations in energy saving and noise reduction, which are currently in high demand, refrigerator manufacturers must also consider designs for other requirements such as both extremely large and extremely small capacities, diversified partition of refrigerator cabins, and they are increasingly taking into account the need for the use of environment friendly substances as refrigerants.

Company	Place of production	Brand used	Annual output
Whirlpool, US	Beijing (Snow Flake)	Whirlpool	1 million
LIDO, Sweden	Changsha, Hunan (Zhongyi)	Electrolux	1 million
BOXIWEI, Germany	Chuzhou, Anhui (Yangzi)	BOXIYANG (transliteration)	1 million
Matsushita, Japan	Wuxi, Jiangsu (Little Swan)	National	1 million
Sharp, Japan	Pudong, Shanghai	Sharp	1 million
Samsung, Korea	Suzhou, Jiangsu (Xiangxuehai)	Samsung	1 million
Meitaike (transliteration), USA	Hefei, Anhui (Rongshida)	Meitaike	1 million
LG, ROK	Taizhou, Jiangsu (Chunlan)	LG	1 million

IMAGE 217

ITEM	JUICES	MILK	SMALL DRINKS	WATER	LARGE SODA	6 PACK CANS
AVERAGE QUANTITY	2.76	1.38	2.42	1.25	1.52	.64
% of USAGE	100%					90%

ITEM	KETCHUP/MUSTARD	TAKE OUT FOOD	FRUITS AND VEGGY	SALAD DRESSING	EGG CARTON
AVERAGE QUANTITY	3.12	2.21	3.5	2.92	1.2
% of USAGE	75%				

ITEM	BREAD	SANDWICH MEAT	CHEESE AND BUTTER
AVERAGE QUANTITY	.78	1.32	1.84
% of USAGE	85%	70%	45-50 %

ITEM	JARS	MEAT AND POULTRY	WINE AND LIQUOR
AVERAGE QUANTITY	2.8	2.36	.96
% of USAGE	50%	30%	40%

Refrigerator Layout

Standard Models

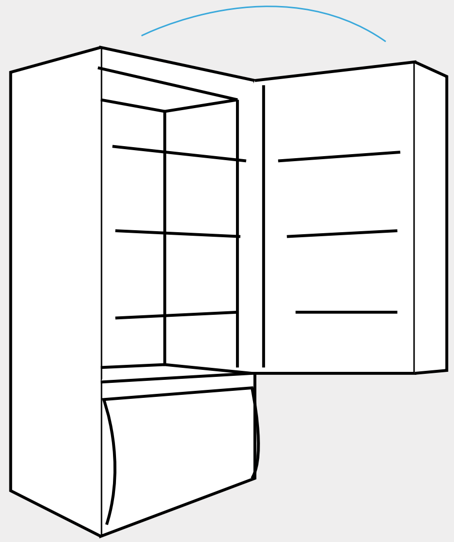
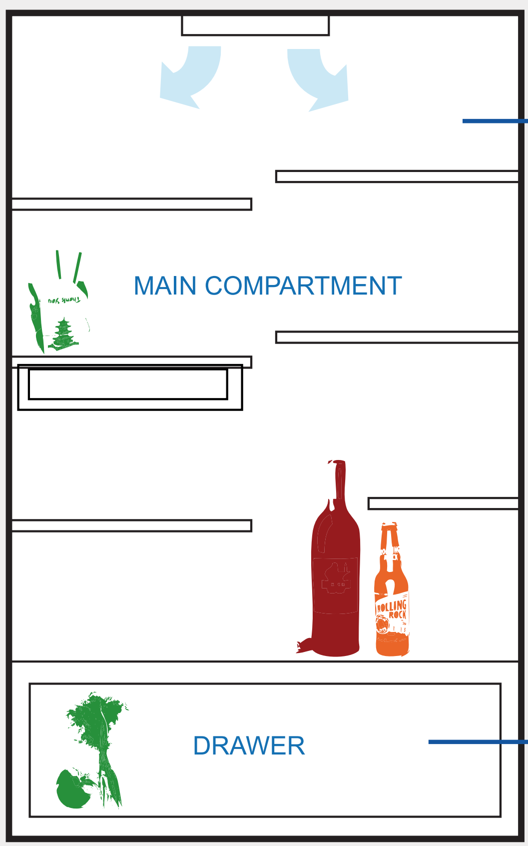


IMAGE 220

COOLING FLOW



MAIN COMPARTMENT
SLIDE OUT
TEMPERED GLASS SHELVES
EASY ACCESS AND EASY CLEANING

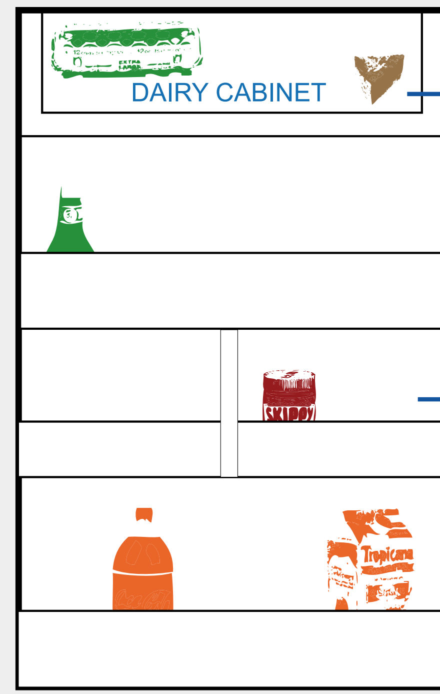
CONTENTS
- SMALL DRINKS
- CANS
- BREAD
- TAKE OUT / LEFT OVERS
- MEAT
- WINE / LIQUOR

MINI DRAWER CONTENTS
- SANDWICH MEAT
- CHEESE
- SMALL MISC. ITEMS

HUMIDITY CONTROL
DRAWERS FOR PRODUCE
(VEGETABLES & FRUITS)

IMAGE 221

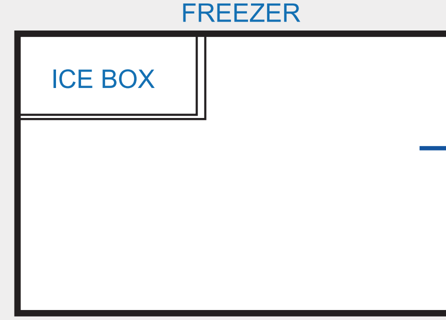
REFRIGERATOR DOOR



DAIRY CABINET
CONTENTS
- CHEESE
- BUTTER
- MARGARINE
- EGGS

CONTENTS
- MILK
- JUICES
- WATER
- JARS (PRESERVES,PEANUTBUTTER)
- KETCHUP
- MUSTARD

FREEZER



CONTENTS
- ICE
- TV DINNER
- MEAT
- ICE CREAM
- VEGETABLES
ETC.

IMAGE 222

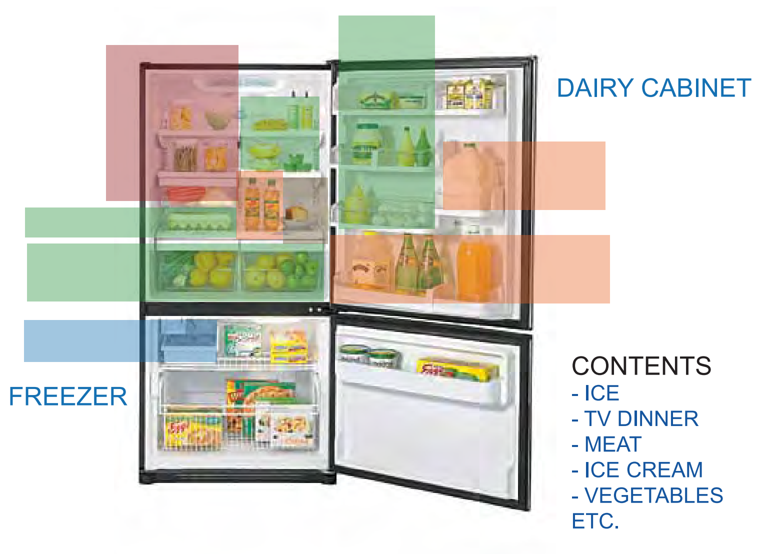


IMAGE 223

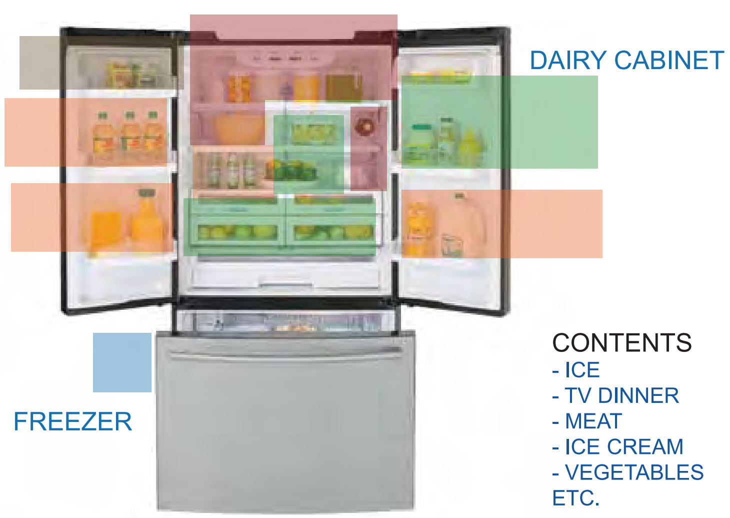


IMAGE 224

IMAGE 225

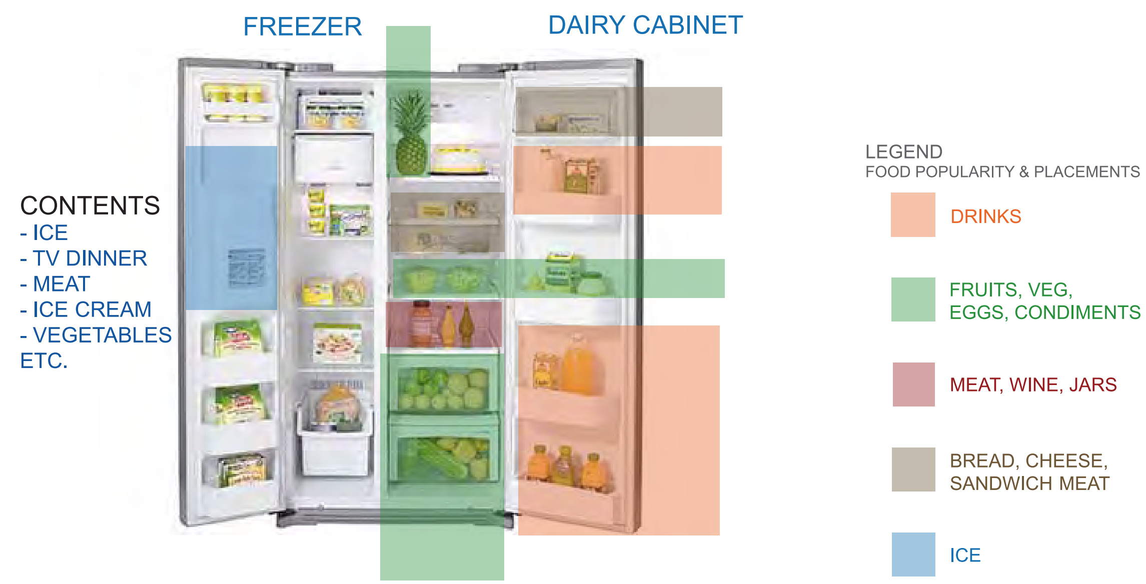


IMAGE 226

Refrigerator Dimensions

Stand Alone Systems

Width of standard systems range from 31 – 35 ¼ inches. The industry standard depicts a depth of 25 – 28 inches. Typical heights range from 62 – 68 inches, and more recent innovations provide a 15 inche LCD monitor on the front panels of refrigerators.

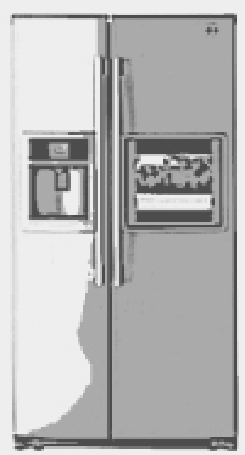


IMAGE 227

IMAGE 228

IMAGE 229

Built-in Units

Typical compartmentalized refrigerators have a large range of dimensions. Depth ranges from 24 – 28 inches. Height ranges from 68 – 84 inches. Width ranges from 36 – 48 inches. Front venting allows units to be completely built in and serviced from the front. Built-in units feature specific humidified compartments for better food keeping. The advantage of built-in refrigerators is that it fits perfectly in the kitchen interior. The refrigerator is covered by a door, only its temperature detectors are left outside so you can control your built-in refrigerator without opening it. Space under the refrigerator can be used for shelves or dishwasher. As for disadvantages, built-in refrigerator cost more. Besides, its useful capacity is two times smaller then its size.

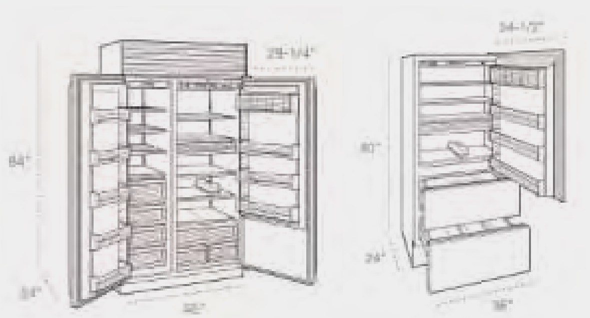


IMAGE 242

Mini Systems

Mini refrigeration systems range in size and use. From college dorm rooms to medical labs these little coolers span a height of 33 ½ inches, a width: 19 – 24 inches and a Depth of 19 – 34 inches. These systems surveyed are not built in systems.

IMAGE 230

Narrow Units

These new stand alone units allow users to either have their units stand together to appear as a single unit or separate. For example, the refrigerator can be located closer to the food preparation area and the freezer out of the way. Dimensions for refrigerators in this category range from 24 – 30 inches in width, with 84 inches in height, and a depth of 24 inches. Freezers that accompany this design have the same height and depth but vary in width from 18 – 24 inches.

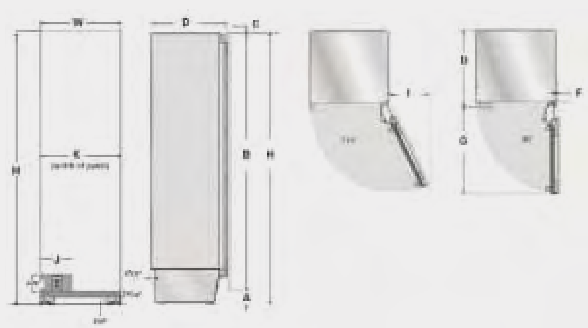


IMAGE 236

IMAGE 237

Drawer Units

Drawer units are at the forefront of refrigeration design. They can feature under-counter refrigeration, and they can eliminate the need for over counter cabinets. Various manufacturers are now producing these styles. Dimensions range from a height of 30 – 34 inches, width of 23 – 27 inches and depths of 24 – 30 inches.

IMAGE 238

IMAGE 239

Modular Configurations

Built to configure to ones personal preferences, these separate units are combined in various configurations to suit the user. They range from
24 – 48 inches in width, 34 – 79 inches in height and 25 inches in
depth.

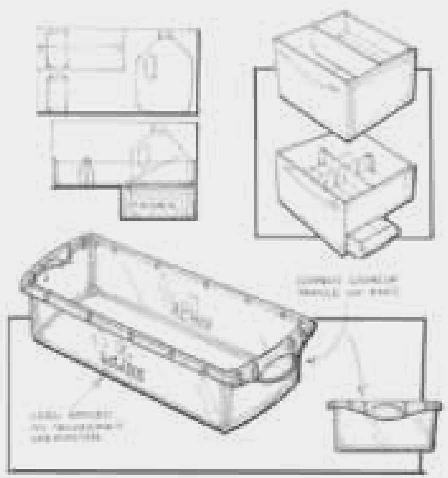


IMAGE 240

IMAGE 241

Range Dimensions

Combination Systems

The average American household contains the combo all in one stove top range with oven. The standard dimensions for these units, whether they are electric or gas, run from a cooking height of 33 – 36 inches with a back height of (if included) 40 – 47 inches. The newer dual oven models run at around 47 inches. Width can vary from 20 inches for smaller models up to 50” for larger. Most common widths run at either 30 or 40 inches. Depths for these units run around 26 – 30 inches.

MAGE 233

IMAGE 234

IMAGE 235

Cooktops

Cooktops range from 12 inches wide to 60 inches wide. Most drop in cooktops range from 30 – 60 inches wide, run 3 – 7 inches deep (3 inches for electric and 7 inches for heftier gas). Depth levels out at 25 – 30 inches. Some designs feature flip up gas cooktops the dimensions for these flip up burners are 3 inches in height, 14 inches wide, and 24 inches deep.

IMAGE 246

IMAGE 247

IMAGE 248

IMAGE 249

IMAGE 250

Built-in Systems

Built-in ovens are becoming more and more popular. There are many options and sizes available. Gas or electric ovens group into size ranges by either double or single ovens. The smaller ovens researched measure 16 inches in height, 35 inches in width and 22 inches in depth. Some manufacturers produce a 27 inch wide version. More moderate-sized built-in ovens range in sizes from 30 – 36 inches wide, 30 inches in height, and 30 inches deep. Double ovens run around 47 – 54 inches in height, 30 – 40 inches wide, and 30 inches deep.

IMAGE 243

IMAGE 244

IMAGE 245