Technology’s role in shaping warehouse design
Definition of warehouse

What is a warehouse?
Warehousing is the storage of goods for profit. A warehouse is a physical storage facility that receives goods and products for the eventual distribution to consumers or other businesses. A warehouse may also be referred to as a distribution center.

Definition of technology

What is technology?
The word technology comes from the Greek meaning ‘the study of something’. Technology is the usage and knowledge of tools, techniques, systems or methods of organization.
Brief History of the Warehouse

Key events
• Development of sea trade routes
• Industrialization & Mass Production
• Railway
• Car & Truck
• Forklift & Pallet
• Containerization
• e-commerce

1300 1700 1800 1885 1925 1956 1990

Sea Trade Routes  Industrialization  Railway  Automobile  Forklift & Pallet  Containerization  e-commerce
**Brief History of the Warehouse**

Warehousing has been in existence in some form for thousands of years. Originally used to store food, which was available for purchase during times of famine.

As explorers began to create land and sea trade routes, trade grew between nations and warehouses grew in importance. Ports became the major location for warehouses.
Brief History of the Warehouse

With industrialization, railroads began to expand travel and the role of transportation. The increased volumes of goods lead to the creation of rail depots for the storage of materials. Railroad companies' soon gained control over freight depots. It wasn’t until ‘the Hepburn Act in 1906’ when the US government placed more restrictions on railroads to open up competition that commercial warehousing began to grow. From this point on road based transport asserted its authority.
Warehouse history - How did technology affect the appearance and location of warehouses?

With the growth of railway, companies began to move their warehouses closer to the railway terminals that were usually located in the centre of the city and close to the wholesale districts. As the demand for storage space increased and land values rose, multi-storey buildings were erected.

Up until the 1920s and 1930s most material handling was manual. Stacking was by hand and a stack height of between 8-12 feet. This meant warehouse storage height was not an issue.
Warehouse history - How did technology affect the appearance and location of warehouses?

However in the 1940s the forklift truck and wooden pallet were introduced extensively allowing stacking to 30 feet (9m)! It was soon clear that a single storey warehouse had functional advantages at around 30ft and was cheaper and more efficient than a multi-storey warehouse on more expensive land.

From this time on, warehouses sought to be on cheaper land.

There was also a shift from privately owned warehouses to public ones, driven largely by mass consumerism and lead by the supermarkets using a 30 day contract.

Over the years the contract became longer as trust in public warehousing increased. The supermarkets and manufacturers reduced the need for their own warehouses which resulted in larger shared public or lease warehouses we see today.
Brief History of the Warehouse

As mass production grew to all parts of manufacturing sector and with the advent of World War II, warehouses needed to become more efficient. The result was an increase in the size of warehouses and the increased usage of mechanized methods for storing and retrieving products and materials.
Brief History of the Warehouse

The first container ship was a refitted tanker that left Newark in 1956 with 58 containers aboard. Prior to this shipping was expensive and inefficient.

Today, container ships are like ‘Floating Warehouses’ with standard size 20 or 40 feet containers which has radically transformed and grown global trade and with it the need for even more warehouses.
Warehouse history - How did technology affect the appearance and location of warehouses?

The world wide web was created in 1990. With the acceptance of on-line purchasing, the need for time critical delivery has grown. This, along with the need to track parcels and provide value added services ie label, pack, assemble etc has also transformed the appearance and location of warehouses.
Warehouse history - How did technology affect the appearance and location of warehouses?

Warehouses are capital intensive, so investment return for the developer has always been a driver of warehouse location and style. Hence the multistory warehouses of the 1900s which were located close to city markets on transport nodes when railway was king and demand was for facilities close to markets.

Today modern warehouses are increasingly single storey and located on the fringe of cities accessible by highway networks. Advances in building technology have resulted in warehouses being cheaper and faster to build, resulting in enhanced returns for developers.
Video: The impact of forklift & Pallet

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Key construction technology advances that shaped warehouses

- **Bronze age (100bc)**: Arch, Vault & Dome
- **1100**: Roman Concrete
- **1850**: Nail & Rivets
- **1851**: Safety elevator
- **1855**: Modern Sheet Glass
- **1885**: Iron ‘I’ Beam
- **1915**: Steel frame construction
- **1920**: Pre-Stressing Concrete
- **1941**: Modern Steel Production (Bessemer Process)
- **1970**: Long Span Steel
- **1980**: Computer design

Additional advancements:
- **1885**: Steel frame construction
- **1970**: Iron 'I' Beam
- **1980**: Pre-Fab buildings
- **1970**: High Strength Steel & Concrete

**Timeline**:
- 100bc: Arch, Vault & Dome
- 1100: Roman Concrete
- 1850: Nail & Rivets
- 1851: Safety elevator
- 1855: Modern Sheet Glass
- 1885: Iron ‘I’ Beam
- 1915: Steel frame construction
- 1920: Pre-Stressing Concrete
- 1941: Modern Steel Production (Bessemer Process)
- 1970: Long Span Steel
- 1980: Computer design
Tracking Warehouse Design  Salt Warehouse - Poland 1650s
Tracking Warehouse Design    Food Warehouse - Moscow 1830s
Tracking Warehouse Design  Warehouse - Finland 1840s
Tracking Warehouse Design  Warehouse - Japan 1850s
Tracking Warehouse Design  Warehouse – UK 1865
Tracking Warehouse Design  Warehouse – Japan 1893
Tracking Warehouse Design  Tobacco Warehouse – Germany 1896
Tracking Warehouse Design  Warehouse – Japan 1900
Tracking Warehouse Design  Warehouse – Australia 1900
Tracking Warehouse Design  Warehouse – USA 1900
Tracking Warehouse Design  Warehouse – Denmark 1900 (Note Dock)
Tracking Warehouse Design  Warehouse – Japan 1903
Tracking Warehouse Design  Warehouse – USA 1905
Tracking Warehouse Design

Warehouse – USA 1906
Tracking Warehouse Design  Warehouse – Japan 1911
Tracking Warehouse Design  Warehouse – Canada 1913
Tracking Warehouse Design  Warehouse – Japan 1920
Tracking Warehouse Design  Warehouse – USA 1922
Tracking Warehouse Design  Warehouse – UK 1930
Tracking Warehouse Design  Warehouse – USA 1931
Tracking Warehouse Design  Warehouse – Japan 1936
Tracking Warehouse Design  Warehouse – USA 1937
Tracking Warehouse Design  Warehouse – USA 1940
Tracking Warehouse Design  Warehouse – USA 1949
Tracking Warehouse Design  Warehouse – Canada 1950
Tracking Warehouse Design  Warehouse – Japan 1960s
Tracking Warehouse Design  Warehouse – USA 1964
Tracking Warehouse Design Warehouse – USA 1966
Tracking Warehouse Design  Warehouse – USA 1971
Tracking Warehouse Design  Warehouse – USA 1978
Tracking Warehouse Design  Warehouse – Japan 2008 (Slope Access)
Tracking Warehouse Design  Warehouse – Japan 2008 (Spiral ramp Access)
Construction Technology
Construction Process – USA 1930

Preparing Ground

Preparing Footings

Inserting piles

Frame

Frame finalization & Roof
Construction Process - Belgium

Preparing the site

Preparing the footings

Preparing the truss frame

Preparing the truss frame
Construction Process - Belgium

Inserting the fireproofing

Installing the roof

Inserting the fireproofing

Installing exterior cladding
Construction Process - Belgium

Completed Wall Structure

Loading Dock Preparation

Finishing of walls

Install the doors for docks
Construction Process - Belgium

Finishing of Office

Installation of Racking

Project Completion
Construction Process – Japan 2007

Stage 1 – 設計段階

Stage 2 – 工事準備

Stage 3 – 工事開始
Video: Constructing warehouse – UK 2008
Warehouse Spans & Heights
Tracking Warehouse Design – Racking & Pallet Height Trends

Standard Rack height In Japan

Rare rack height In Japan

Global Standard

Rack Supported & Auto Warehouse

Pre-forklift

Clear Height
- 20.0+m
- 9.0m
- 7.5m
- 5.5m
- 2.0m

Standard Rack height In Japan
Tracking Warehouse Design

Warehouse – Colum Grid

Japan
• was 7-8m
• now 9.5m-10.5m
• future 12-15m

Global
• 15m minimum.
• Many facilities are now virtually column free.
Tracking Warehouse Design – Internal Spans (JAPAN)

5.5m clear height – 3 pallet

7.5m clear height – 4 pallet
Tracking Warehouse Design – Internal Spans (GLOBAL)

9m+ clear height

Rack to 5 pallets
Tracking Warehouse Design – Internal Spans (Rack Supported)

Up to 30m clear height
Warehouses of the future
Warehouse of the future

Trends

• Blending of usage – Warehouse no longer just for goods storage. Integration of factory, office, data centre, call centre & service centre

• Special facilities – Splintering of usage as SKUs continue to grow and storage & handling laws become stricter. Increased separation & prioritization of sensitive & time critical items. Automation & Robots

• Eco – Integrated technology, smarter, green buildings with reduced running costs.

• Size – Larger as more companies outsource logistics operations to 3PLs. Increasingly larger truck size & cargo volumes also driving this. There may also be a trend back to smaller specialised, more centrally located centres

• Materials – Stronger, Lighter, Cheaper
Warehouse of the future

Trend – Blending of Usage

Integration/Co-location of warehouse, office, retail, data/call centre, service centre
Warehouse of the future

Trend – Transport & Automation

• Trucks bigger
• Robots
• Automation
Warehouse of the future - Eco

Future Design Trends

‘Eco-warehouse’ incorporating sustainable building features & integrated technology for reduced running costs & better worker amenity.
Warehouse of the future - Eco
Warehouse of the future - Eco
Video: Robots in the warehouse
Thank you!