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ABC analysis

What is ABC analysis?

- ABC analysis is an ***inventory categorization method*** which consists in dividing items into three categories (A, B, C):
  - A being the most valuable items,
  - C being the least valuable ones.
- This method aims to draw managers' attention on the critical few (A-items) not on the trivial many (C-items).

The Pareto principle

VILFREDO PARETO (1848-1923)

- 20% of population owns 80% of nations wealth
- 20% of employees cause 80% of problems
- 20% of items accounts for 80% of firms expenditure

The ABC analysis

The ABC approach states that a company should rate items from A to C, basing its ratings on the following rules:

- ***A-items*** are goods which annual consumption value is the highest; the top 70-80% of the annual consumption value of the company typically accounts for only 10-20% of total inventory items.

The ABC analysis

The ABC approach states that a company should rate items from A to C, basing its ratings on the following rules:

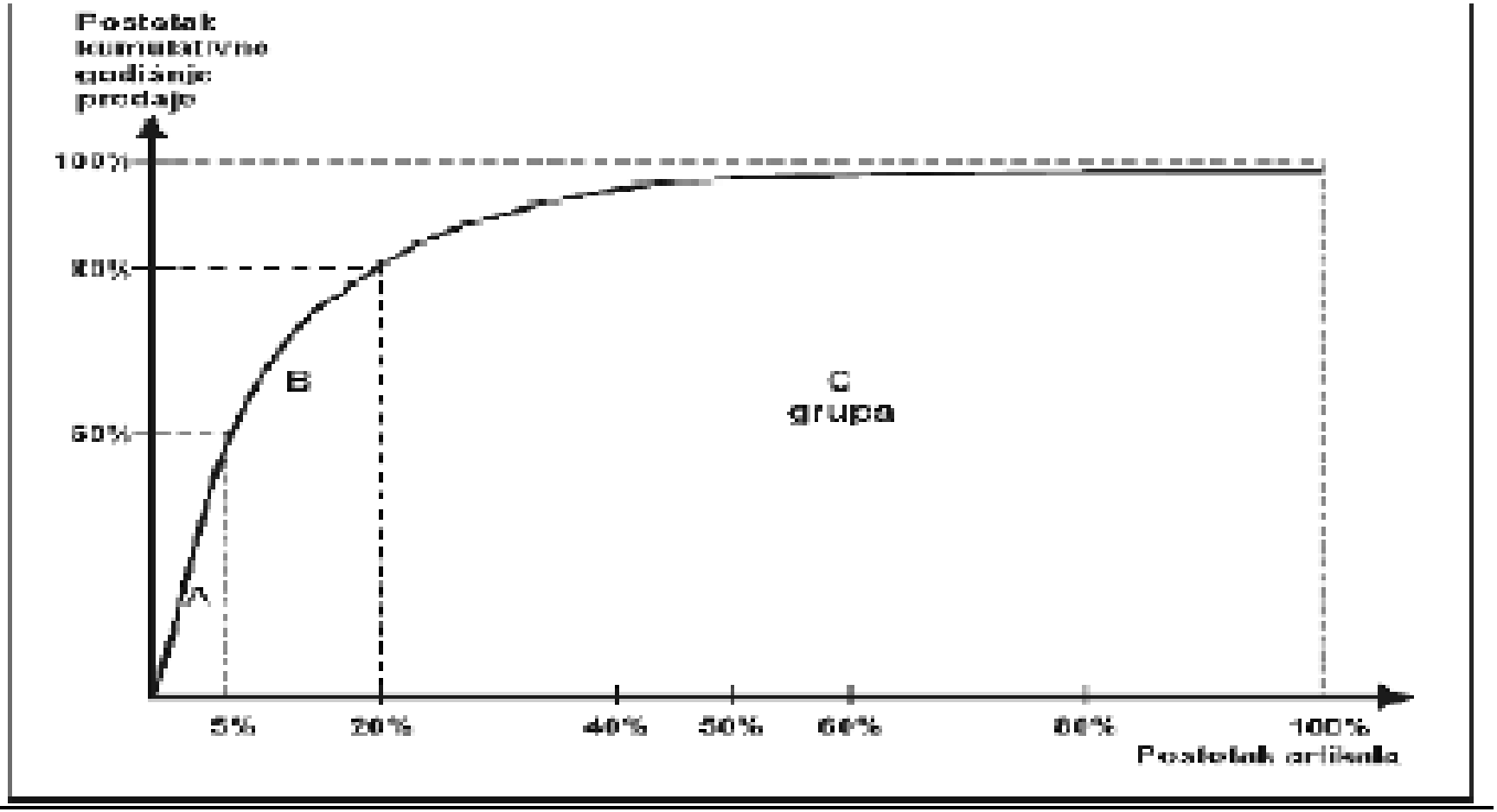
- ***B-items*** are the interclass items, with a medium consumption value; those 15-25% of annual consumption value typically accounts for 30% of total inventory items.

The ABC analysis

The ABC approach states that a company should rate items from A to C, basing its ratings on the following rules:

- ***C-items*** are, on the contrary, items with the lowest consumption value; the lower 5% of the annual consumption value typically accounts for 50% of total inventory items.

The ABC analysis



The ABC analysis

- The annual consumption value is calculated with the formula:

(Annual demand) x (item cost per unit)

- Through this categorization, the supply manager can identify inventory hot spots, and separate them from the rest of the items, especially those that are numerous but not that profitable.

The ABC analysis

Steps for the classification of items:

1. Find out the unit cost and and the usage of each material over a given period;
2. Multiply the unit cost by the estimated annual usage to obtain the net value;
3. List out all the items and arrange them in the descending value (Annual Value);

The ABC analysis

Steps for the classification of items:

4. Accumulate value and add up number of items and calculate percentage on total inventory in value and in number;
5. Draw a curve of percentage items and percentage value;
6. Mark off from the curve the rational limits of A, B and C categories.

ABC analysis

	Percentage of items	Percentage value of annual usage	
Class A items	About 20%	About 80%	Close day to day control
Class B items	About 30%	About 15%	Regular review
Class C items	About 50%	About 5%	Infrequent review

Example 1

Item number	101	102	103	104	105	106	107	108	109	110
Unit cost	5	11	15	8	7	16	20	4	9	12
Annual demand	48000	2000	300	800	4800	1200	18000	300	5000	500

	Percentage of items	**Percentage value of annual usage**	
Class A items	About 20%	About 80%	Close day to day control
Class B items	About 30%	About 15%	Regular review
Class C items	About 50%	About 5%	Infrequent review

Step 1

Calculate the total spending per year

Item number	Unit cost	Annual demand	Total cost per year
101	5	48,000	240,000
102	11	2,000	22,000
103	15	300	4,500
104	8	800	6,400
105	7	4,800	33,600
106	16	1,200	19,200
107	20	18,000	360,000
108	4	300	1,200
109	9	5,000	45,000
110	12	500	6,000
Total usage			737,900

Total cost per year: Unit cost * total cost per year

Step 2

Calculate the usage of item in total usage

Item number	Unit cost	Annual demand	Total cost per year	Usage as a % of total usage
101	5	48,000	240,000	32,5%
102	11	2,000	22,000	3%
103	15	300	4,500	0,6%
104	8	800	6,400	0,9%
105	7	4,800	33,600	4,6%
106	16	1,200	19,200	2,6%
107	20	18,000	360,000	48,8%
108	4	300	1,200	0,2%
109	9	5,000	45,000	6,1%
110	12	500	6,000	0,8%
Total usage			737,900	100%

Usage as a % of total usage = usage of item/total usage

Step 3

Sort the items by usage

Item number	Cumulative % of items	Unit cost	Annual demand	Total cost per year	Usage as a % of total usage	Cumulative % of total
107	10%	20	18,000	360,000	48,8%	48,8%
101	20%	5	48,000	240,000	32,5%	81,3%
109	30%	9	5,000	45,000	6,1%	87,4%
105	40%	7	4,800	33,600	4,6%	92%
102	50%	11	2,000	22,000	3,0%	94,9%
106	60%	16	1,200	19,200	2,6%	97,5%
104	70%	8	800	6,400	0,9%	98,4%
110	80%	12	500	6,000	0,8%	99,2%
103	90%	15	300	4,500	0,6%	99,8%
108	100%	4	300	1,200	0,2%	100%
Total usage				737,900	100%	

Step 4

Results of calculation

Cathegory	Items	Percentage of items	Percentage usage (%)	Action
Class A	107, 101	20%	81,6%	Close control
Class B	109, 105, 102, 106	40%	16,2%	Regular review
Class C	104, 110, 103, 108	40%	2,5%	Infrequent review

Additional rules for ABC analysis

Cathegory	Percentage of items	Percentage of usage
Class A items	5-25%	40-80%
Class B items	20–40%	15-40%
Class C items	40-75%	5-20%

A ≤ B ≤ C

Inventory management policies

Each item should receive a treatment corresponding to its class:

- ***A-items*** should have tight inventory control, more secured storage areas and better sales forecasts; reorders should be frequent, with weekly or even daily reorder; avoiding stock-outs on A-items is a priority.

Inventory management policies

Each item should receive a treatment corresponding to its class:

- ***B-items*** benefit from an intermediate status between A and C; an important aspect of class B is the monitoring of potential evolution toward class A or, in the contrary, toward the class C.

Inventory management policies

Each item should receive a treatment corresponding to its class:

- Reordering ***C-items*** is made less frequently; a typically inventory policy for C-items consist of having only 1 unit on hand, and of reordering only when an actual purchase is made; this approach leads to stock-out situation after each purchase which can be an acceptable situation, as the C-items present both low demand and higher risk of excessive inventory costs.

Procurement and Warehouse Applications

The results of an ABC Analysis extend into a number of other inventory control and management processes:

- ***Review of stocking levels:*** "A" items will generally have greater impact on projected investment and purchasing spend, and therefore should be managed more aggressively in terms of minimum and maximum inventory levels; inactive items will fall to the bottom of the prioritized list; the bottom of the "C" category is the best place to start when performing a periodic obsolescence review.

Procurement and Warehouse Applications

The results of an ABC Analysis extend into a number of other inventory control and management processes:

- ***Cycle counting:*** the higher the usage, the more activity an item is likely to have; to ensure accurate record balances, higher priority items are cycle counted more frequently; “A” items are counted once every quarter; “B” items once every 6 months; and “C” items once every 12 months.

Procurement and Warehouse Applications

The results of an ABC Analysis extend into a number of other inventory control and management processes:

- ***Identifying items for potential consignment or vendor stocking:*** since “A” items tend to have a greater impact on investment, these would be the best candidates to investigate the potential for alternative stocking arrangements that would reduce investment liability and associated carrying costs.

Procurement and Warehouse Applications

The results of an ABC Analysis extend into a number of other inventory control and management processes:

- ***Turnover ratios and associated inventory goals:*** "A" items will have greater usage than "B" or "C" items, and as a result should have greater turnover ratios; when establishing investment and turnover metrics, inventory data can be segregated by ABC classification, with different targets for each category.

Example 2

Item number	Annual quantity used	Unit value
1	75	80
2	150,000	0,9
3	500	3,0
4	18,000	0,20
5	3,000	0,30
6	20,000	0,10
7	10,000	2

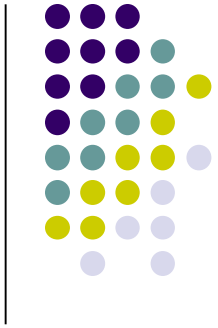
Step 1

Item number	Annual quantity used	Unit value	Usage per year
1	75	80	6,000
2	150,000	0,9	135,000
3	500	3,0	1,500
4	18,000	0,20	3,600
5	3,000	0,30	900
6	20,000	0,10	2,000
7	10,000	2	20,000
Total usage			169,000

Step 2

Item number	Annual quantity used	Unit value	Usage per year	Percentage in total usage (%)
1	75	80	6,000	3,51%
2	150,000	0,9	135,000	79,8%
3	500	3,0	1,500	0,87%
4	18,000	0,20	3,600	2,1%
5	3,000	0,30	900	0,53%
6	20,000	0,10	2,000	1,18%
7	10,000	2	20,000	11,8%
Total usage			169,000	

Step 3



Item number	Cumulative % of items	Annual quantity used	Unit value	Usage per year	Percentage in total usage (%)	Cumulative % of total
2	14%	150,000	0,9	135,000	79,8%	79,8%
7	29%	10,000	2	20,000	11,8%	91,6%
1	42%	75	80	6,000	3,51%	95,11%
4	56%	18,000	0,20	3,600	2,1%	97,21%
6	71%	20,000	0,10	2,000	1,18%	98,39%
3	84%	500	3,0	1,500	0,87%	99,46%
5	100%	3,000	0,30	900	0,53%	100%
Total usage				169,000		

Step 4

Cathegory	Items	Percentage of items	Percentage of usage (%)	Action
Class A items	2	15%	79,8%	Close control
Class B items	7, 1	30%	15,31%	Regular review
Class C items	3, 4, 5, 6	55%	4,89%	Infrequent review

Conclusion

- The boundary between class A and class B might not be as sharply defined;
- The purpose of this classification is to ensure that purchasing staff use resources to maximum efficiency by concentrating on those items that have the greatest potential savings → selective control will be more effective than an approach that treats all items identically.

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FINANCIAL DERIVATIVES

What are Derivatives?

- A derivative is a financial instrument whose value is **derived** from the value of another asset, which is known as the **underlying**.

- When the price of the underlying changes, the value of the derivative also changes.

- A Derivative is not a product. It is a contract that derives its value from changes in the price of the underlying.

Example :

The value of a gold futures contract is derived from the value of the underlying asset i.e. Gold.

Traders in Derivatives Market

There are 3 types of traders in the Derivatives Market :

- **HEDGER**

  A hedger is someone who faces risk associated with price movement of an asset and who uses derivatives as means of reducing risk.

  They provide economic balance to the market.

- **SPECULATOR**

  A trader who enters the futures market for pursuit of profits, accepting risk in the endeavor.

  They provide liquidity and depth to the market.

- **ARBITRAGEUR**

  A person who simultaneously enters into transactions in two or more markets to take advantage of the discrepancies between prices in these markets.

- Arbitrage involves making profits from relative mispricing.

- Arbitrageurs also help to make markets liquid, ensure accurate and uniform pricing, and enhance price stability

- They help in bringing about price uniformity and discovery.

- OTC and Exchange Traded Derivatives.

1. OTC

Over-the-counter (OTC) or off-exchange trading is to trade financial instruments such as stocks, bonds, commodities or derivatives directly between two parties without going through an exchange or other intermediary.

- The contract between the two parties are privately negotiated.
- The contract can be tailor-made to the two parties' liking.
- Over-the-counter markets are uncontrolled, unregulated and have very few laws. Its more like a freefall.

2. Exchange-traded Derivatives

- Exchange traded derivatives contract (ETD) are those derivatives instruments that are traded via specialized Derivatives exchange or other exchanges. A derivatives exchange is a market where individuals trade standardized contracts that have been defined by the exchange.

- The world's largest derivatives exchanges (by number of transactions) are the **Korea Exchange.**

- There is a very visible and transparent market price for the derivatives.

What is a Forward?

- A forward is a contract in which one party commits to buy and the other party commits to sell a specified quantity of an agreed upon asset for a pre-determined price at a specific date in the future.

- It is a customised contract, in the sense that the terms of the contract are agreed upon by the individual parties.

- Hence, it is traded OTC.

Economic benefits of derivatives

- Reduces risk
- Enhance liquidity of the underlying asset
- Lower transaction costs
- Enhances liquidity of the underlying asset
- Enhances the price discovery process.
- Portfolio Management
- Provides signals of market movements
- Facilitates financial markets integration

Forward Contract Example

3 months Later

Risks in Forward Contracts

- Credit Risk – Does the other party have the means to pay?

- Operational Risk – Will the other party make delivery? Will the other party accept delivery?

- Liquidity Risk – Incase either party wants to opt out of the contract, how to find another counter party?

Terminology

- Long position - Buyer
- Short position - seller
- Spot price – Price of the asset in the spot market.(market price)
- Delivery/forward price – Price of the asset at the delivery date.

What are Futures?

- A future is a standardised forward contract.
- It is traded on an organised exchange.
- Standardisations-
  - quantity of underlying
  - quality of underlying(not required in financial futures)
  - delivery dates and procedure
  - price quotes

Futures Contract Example

A

L $10
S $12
Profit $2

Market Price/Spot Price	
D1	$10
D2	$12
D3	$14

B

S $10
L $14
Loss $4

C

L $12
S $14
Profit $2

Types of Futures Contracts

- Stock Futures Trading (dealing with shares)
- Commodity Futures Trading (dealing with gold futures, crude oil futures)
- Index Futures Trading (dealing with stock market indices)

Terminology

- Contract size – The amount of the asset that has to be delivered under one contract. All futures are sold in multiples of lots which is decided by the exchange board.

Eg. If the lot size of Tata steel is 500 shares, then one futures contract is necessarily 500 shares.

- Contract cycle – The period for which a contract trades.

The futures on the NSE have one (near) month, two (next) months, three (far) months expiry cycles.

- Expiry date – usually last Thursday of every month or previous day if Thursday is public holiday.

Terminology

- Strike price – The agreed price of the deal is called the strike price.

- Cost of carry – Difference between strike price and current price.

Margins

- A **margin** is an amount of a money that must be deposited with the clearing house by both buyers and sellers in a margin account in order to open a futures contract.

- It ensures performance of the terms of the contract.

- Its aim is to minimise the risk of default by either counterparty.

Closing a Futures Position

- Most futures contracts are not held till expiry, but closed before that.

- If held till expiry, they are generally settled by delivery. (2-3%)

- By closing a futures contract before expiry, the net difference is settled between traders, without physical delivery of the underlying.

Marking to Market

- This is the practice of periodically adjusting the margin account by adding or subtracting funds based on changes in market value to reflect the investor's gain or loss.
- This leads to changes in margin amounts daily.
- This ensures that there are o defaults by the parties.

COMPARISON	FORWARD	FUTURES
• Trade on organized exchanges	No	Yes
• Use standardized contract terms	No	Yes
• Use associate clearinghouses to guarantee contract fulfillment	No	Yes
• Require margin payments and daily settlements	No	Yes
• Markets are transparent	No	Yes
• Marked to market daily	No	Yes
• Closed prior to delivery	No	Mostly
• Profits or losses realised daily	No	Yes

What are Options?

- Contracts that give the holder the option to buy/sell specified quantity of the underlying assets at a particular price on or before a specified time period.
- The word “option” means that the holder has the right but not the obligation to buy/sell underlying assets.

Types of Options

- Options are of two types – call and put.
- Call option give the buyer the right but not the obligation to buy a given quantity of the underlying asset, at a given price on or before a particular date by paying a premium.
- Puts give the buyer the right, but not obligation to sell a given quantity of the underlying asset at a given price on or before a particular date by paying a premium.

Call Option Example

CALL OPTION

Right to buy 100 Reliance shares at a price of Rs.300 per share after 3 months.

Premium = Rs.25/share

Amt to buy Call option = Rs.2500

Current Price = Rs.250

Strike Price

Expiry date

Suppose after a month, Market price is Rs.400, then the option is exercised i.e. the shares are bought.
Net gain = 40,000-30,000-2500 = Rs.7500

Suppose after a month, market price is Rs.200, then the option is not exercised.
Net Loss = Premium amt = Rs.2500

Put Option Example

PUT OPTION

Premium = Rs.25/share

Amt to buy Call option = Rs.2500

Right to sell 100 Reliance shares at a price of Rs.300 per share after 3 months.

Current Price = Rs.250

Strike Price

Expiry date

Suppose after a month, Market price is Rs.200, then the option is exercised i.e. the shares are sold.
Net gain = 30,000-20,000-2500 = Rs.7500

Suppose after a month, market price is Rs.300, then the option is not exercised.
Net Loss = Premium amt = Rs.2500

Features of Options

- A fixed maturity date on which they expire. (Expiry date)
- The price at which the option is exercised is called the exercise price or strike price.
- The person who writes the option and is the seller is referred as the “option writer”, and who holds the option and is the buyer is called “option holder”.
- The premium is the price paid for the option by the buyer to the seller.
- A clearing house is interposed between the writer and the buyer which guarantees performance of the contract.

Types of Options (cont.)

- The other two types are – European style options and American style options.
- European style options can be exercised only on the maturity date of the option, also known as the expiry date.
- American style options can be exercised at any time before and on the expiry date.

Options Terminology

- Underlying: Specific security or asset.
- Option premium: Price paid.
- Strike price: Pre-decided price.
- Expiration date: Date on which option expires.
- Exercise date: Option is exercised.
- Open interest: Total numbers of option contracts that have not yet been expired.
- Option holder: One who buys option.
- Option writer: One who sells option.

Options Terminology (cont.)

- Option class: All listed options of a type on a particular instrument.
- Option series: A series that consists of all the options of a given class with the same expiry date and strike price.
- Put-call ratio: The ratio of puts to the calls traded in the market.

Options Terminology (cont.)

- Moneyness: Concept that refers to the potential profit or loss from the exercise of the option. An option maybe in the money, out of the money, or at the money.

	Call Option	Put Option
In the money	Spot price > strike price	Spot price < strike price
At the money	Spot price = strike price	Spot price = strike price
Out of the money	Spot price < strike price	Spot price > strike price

What are SWAPS?

- In a swap, two counter parties agree to enter into a contractual agreement wherein they agree to exchange cash flows at periodic intervals.

- Most swaps are traded “Over The Counter”.

- Some are also traded on futures exchange market.

Types of Swaps

There are 2 main types of swaps:

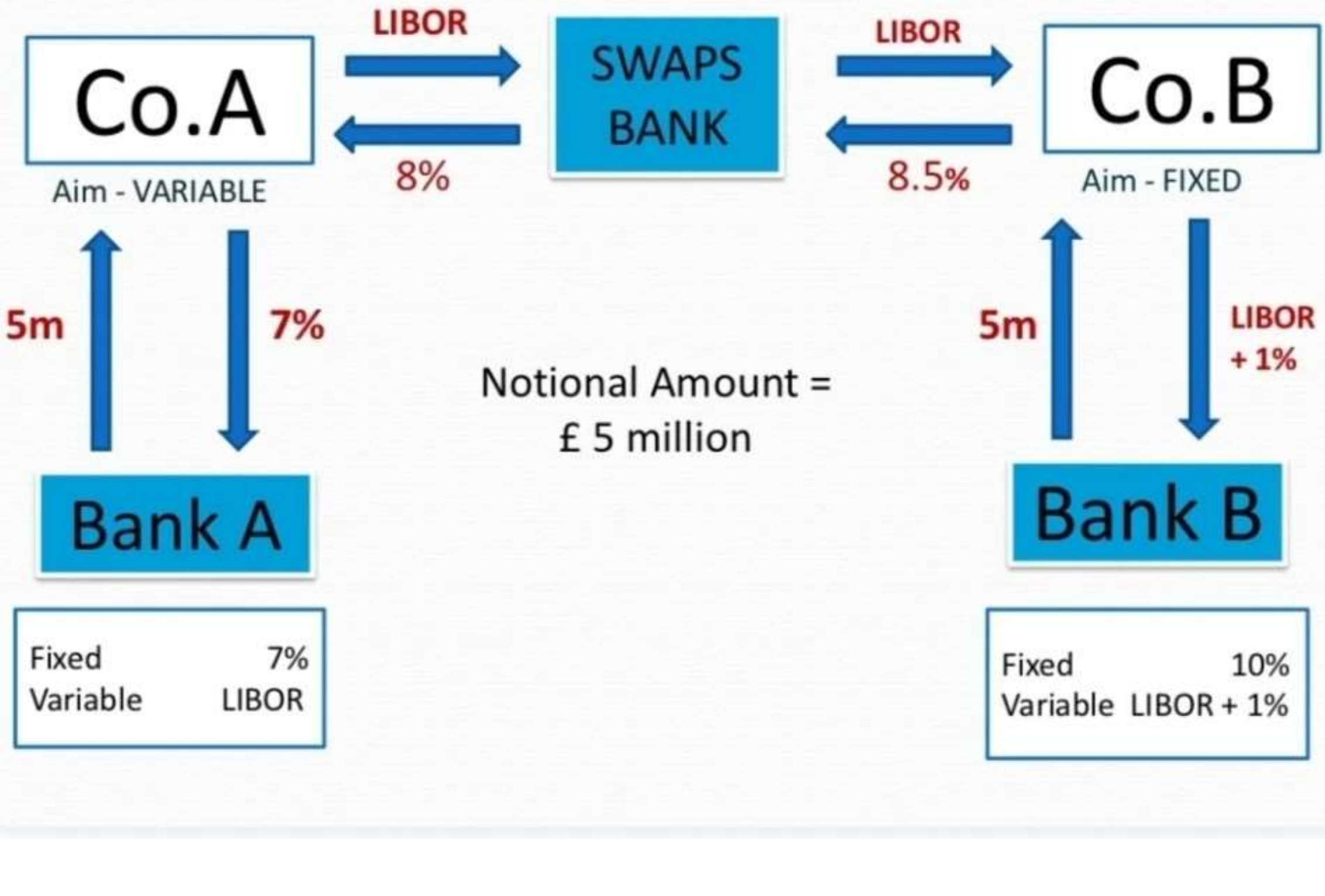
- Plain vanilla fixed for floating swaps
  or simply **interest rate swaps**.

- Fixed for fixed currency swaps
  or simply **currency swaps**.

Floating Interest Rate

- LIBOR – London Interbank Offered Rate
- It is the average interest rate estimated by leading banks in London.
- It is the primary benchmark for short term interest rates around the world.
- Similarly, we have MIBOR i.e. Mumbai Interbank Offered Rate.
- It is calculated by the NSE as a weighted average of lending rates of a group of banks.

Interest Rate Swap Example



Using a Swap to Transform a Liability

- Firm A has transformed a fixed rate liability into a floater.
  - A is borrowing at LIBOR – 1%
  - A savings of 1%

- Firm B has transformed a floating rate liability into a fixed rate liability.
  - B is borrowing at 9.5%
  - A savings of 0.5%.

- Swaps Bank Profits = 8.5%-8% = 0.5%

What is an Interest Rate Swap?

- A company agrees to **pay** a pre-determined **fixed interest rate** on a **notional principal** for a fixed number of years.

- In return, it **receives** interest at a **floating rate** on the same notional principal for the same period of time.

- The **principal** is **not exchanged**. Hence, it is called a notional amount.

What is a Currency Swap?

- It is a swap that includes exchange of principal and interest rates in one currency for the same in another currency.
- It is considered to be a foreign exchange transaction.
- It is not required by law to be shown in the balance sheets.
- The principal may be exchanged either at the beginning or at the end of the tenure.

- However, if it is exchanged at the end of the life of the swap, the principal value may be very different.

- It is generally used to hedge against exchange rate fluctuations.

Direct Currency Swap Example

- Firm A is an American company and wants to borrow €40,000 for 3 years.
- Firm B is a French company and wants to borrow $60,000 for 3 years.
- Suppose the current exchange rate is €1 = $1.50.

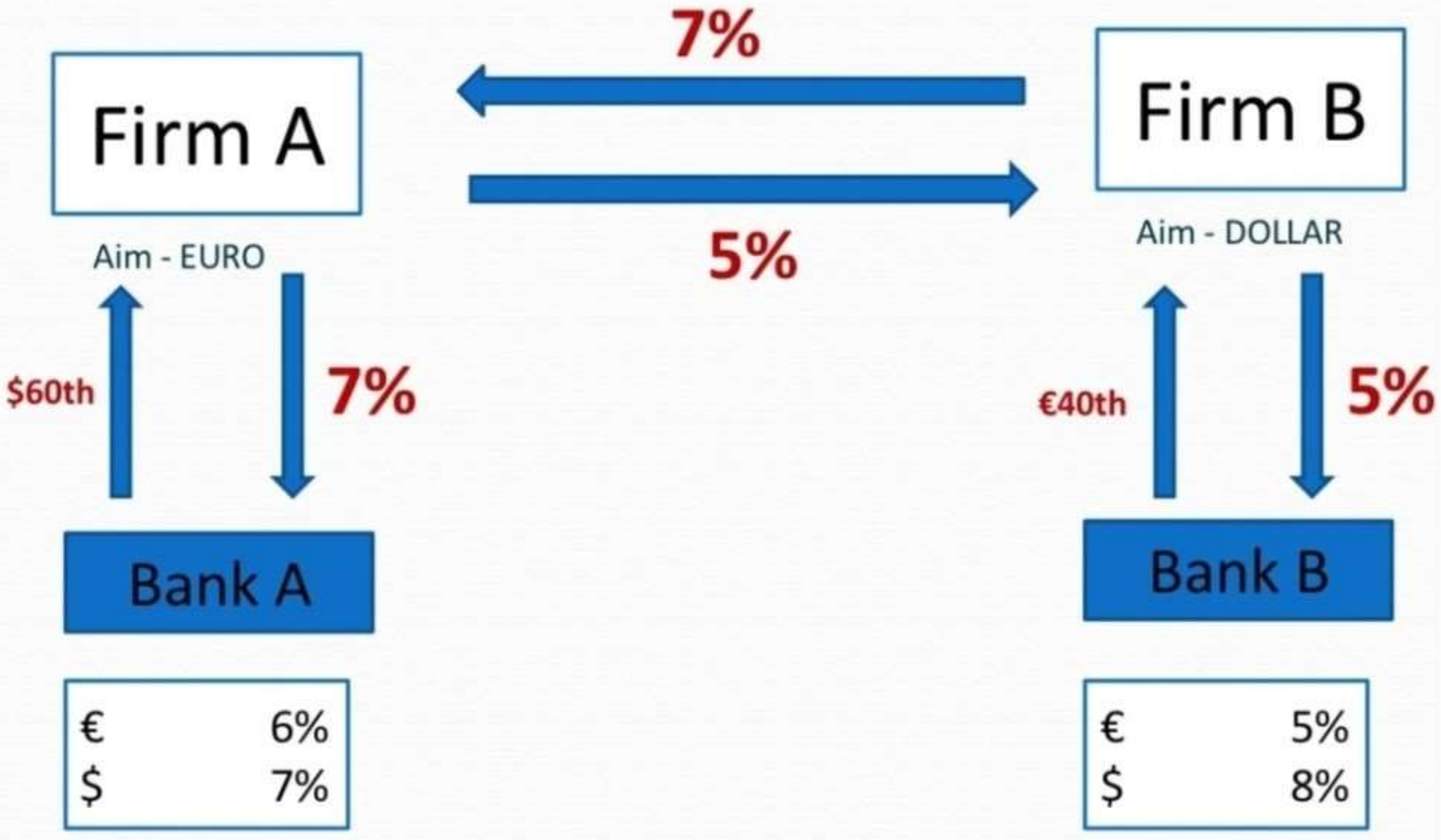
Comparative Advantage

- Firm A has a **comparative advantage** in borrowing Dollars.

- Firm B has a **comparative advantage** in borrowing Euros.

- This comparative advantage helps in reducing borrowing cost and hedging against exchange rate fluctuations.

Direct Currency Swap Example



Margins

- Initial Margin - Deposit that a trader must make before trading any futures. Usually, 10% of the contract size.

- Maintenance Margin - When margin reaches a minimum maintenance level, the trader is required to bring the margin back to its initial level. The maintenance margin is generally about 75% of the initial margin.

- Variation Margin - Additional margin required to bring an account up to the required level.

- Margin call – If amt in the margin A/C falls below the maintenance level, a margin call is made to fill the gap.

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SECURITY ANALYSIS & PORTFOLIO MANAGEMENT

The Role and Function of a Stock Exchange

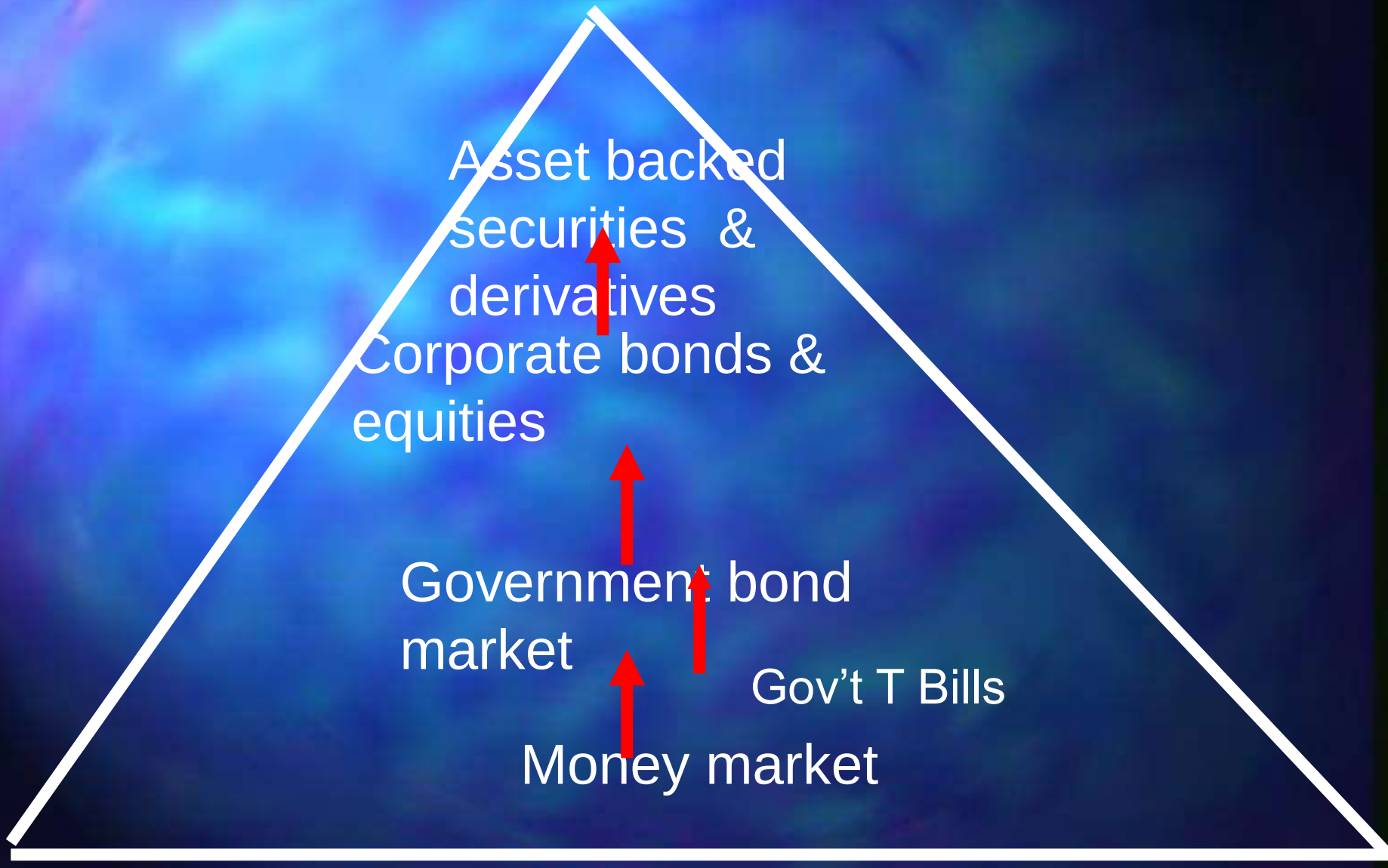
Outline

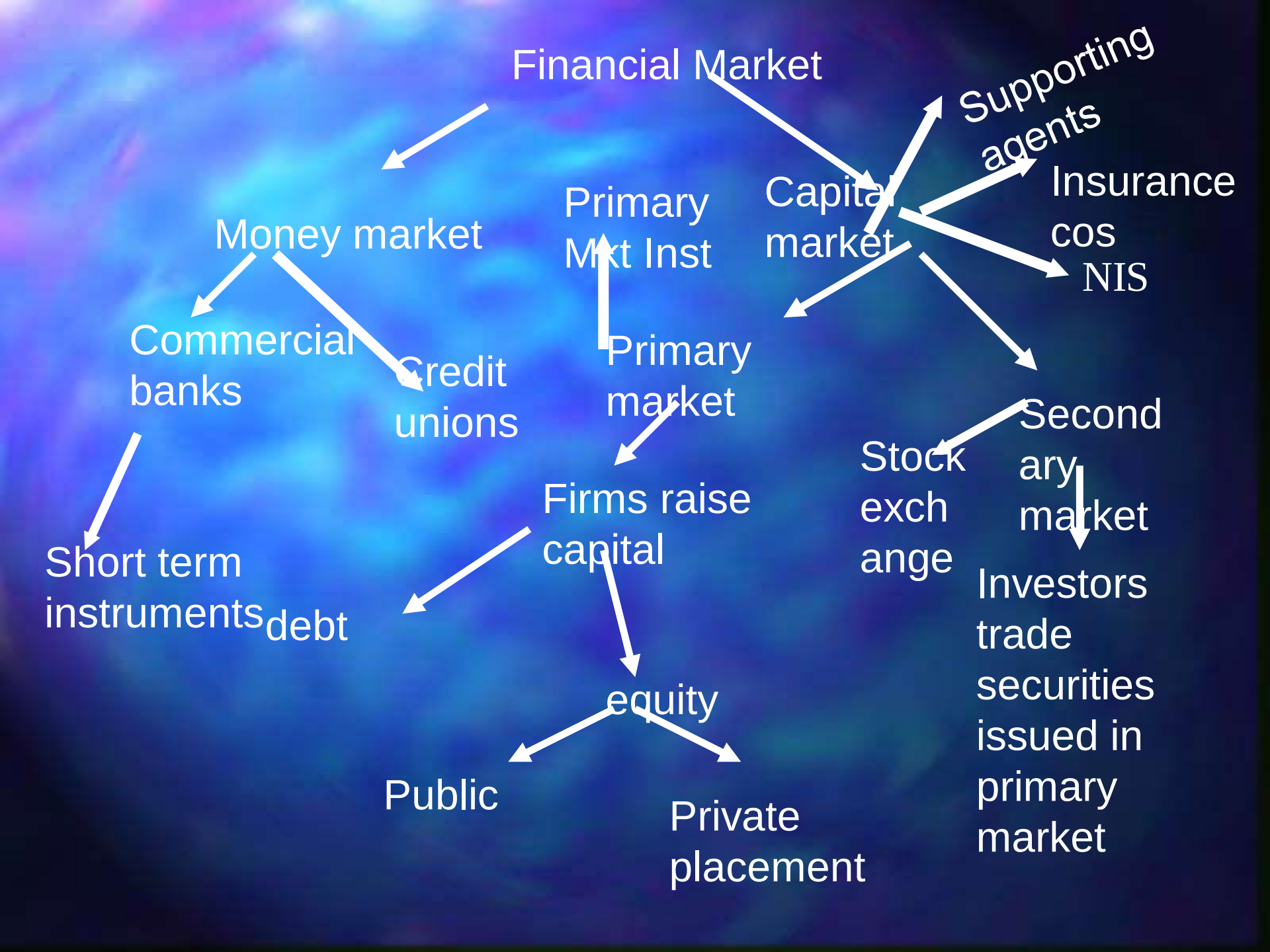
- Overview of financial markets
- Institutional infrastructure
- Role and functions of stock exchange

Overview of Financial Markets

- Two types of financial markets
- Money markets
- Capital markets
  - Primary market
  - Secondary market

The Hierarchy of Markets




Financial Market
Money market
Commercial banks
Credit unions
Short term instruments
Primary Mkt Inst
Primary market
Firms raise capital
debt
equity
Public
Private placement
Capital market
Supporting agents
Insurance cos
NIS
Stock exch ange
Second ary market
Investors trade securities issued in primary market

Market infrastructure

- Stock exchange
- Clearing and settlement
- Education and training
- Investors' protection
- Rating agency

Instruments

- Equities
  - Most popular investing instruments
  - Stocks and shares
  - Bonus issues
  - Rights issues
- Bonds
  - Corporate
  - Government

Intermediaries

- Brokerage houses

Hand in Hand
Beharry
stockbrokers
Trust company
GuyAmerica

- Stock brokers
- Advisors

Regulation & Supervision

A few questions

- Ever wondered how the capital markets work
- Who sets the rules
- What does the stock exchange do
- What is the role of the stock broker
- How to become a registered broker

The Regulator

- Foremost authority presiding over the capital markets
- With mission to promote and maintain Fair, efficient , secure and transparent market and to facilitate the orderly development of the stock exchange

Role and Functions of a stock exchange

Established for the purpose of assisting, regulating and controlling business of buying, selling and dealing in securities

Role and Functions of a stock exchange cont'd

- Provides a market for the trading of securities to individuals and organizations seeking to invest their saving or excess funds through the purchase of securities

Role and Functions of a stock exchange **cont'd**

Provides a physical location for buying and selling securities that have been listed for trading on that exchange

Role and Functions of a stock exchange **cont'd**

Establishes rules for fair trading practices and regulates the trading activities of its members according to those rules

Role and Functions of a stock exchange cont'd

The exchange itself does not buy or sell the securities, nor does it set prices for them

Fair

The exchange assures that no investor will have an undue advantage over other market participants

Efficient market

This means that orders are executed and transactions are settled in the fastest possible way

Transparency

Investor make informed and intelligent decision about the particular stock based on information

Transparency cont'd

Listed companies must disclose information in timely, complete and accurate manner to the Exchange and the public on a regular basis

Transparency cont'd

Required information include stock price, corporate conditions and developments dividend, mergers and joint ventures, and management changes etc

Doing business

People who buy or sell stock on an exchange do so through a broker

Doing business cont'd

The broker takes your order to the floor of the exchange looks for a broker representing someone wanting to buy/sell

- **If a mutually agreeable price is found the trade is made**

Some type of orders

- Limit order
- Market order
- Day order
- Open
- All or none
- Any part
- Good through

Price

At any point in time, the price of previously issued stock is determined by the ebb and flow of supply and demand

Listing requirements

There are specific requirements for allowing a public company to list its securities on the Stock Exchange these are set out in the legislation

Benefits of listing

- Visibility
- Market support
- Investors confidence
- Increased demand for products and services
- Overall increase in profitability

Once traded

- Aura of reliability
- Accuracy in reporting financial data
- Reputation
- Strength

Delisting

Stock exchange can delist companies for a number of reasons including :-

- Merger with another company
- Solvency problems
- Name change company asked to be removed
- Failure to comply with exchange rules

Desirable Characteristics of a stock market

Liquidity

Ability to sell an asset quickly at a fairly known price Low transactions costs

Desirable Characteristics of a stock market cont'd

- **Availability of information Market efficiency**
- **Prices react quickly to new information**
- Small price fluctuations
- Narrow price spread

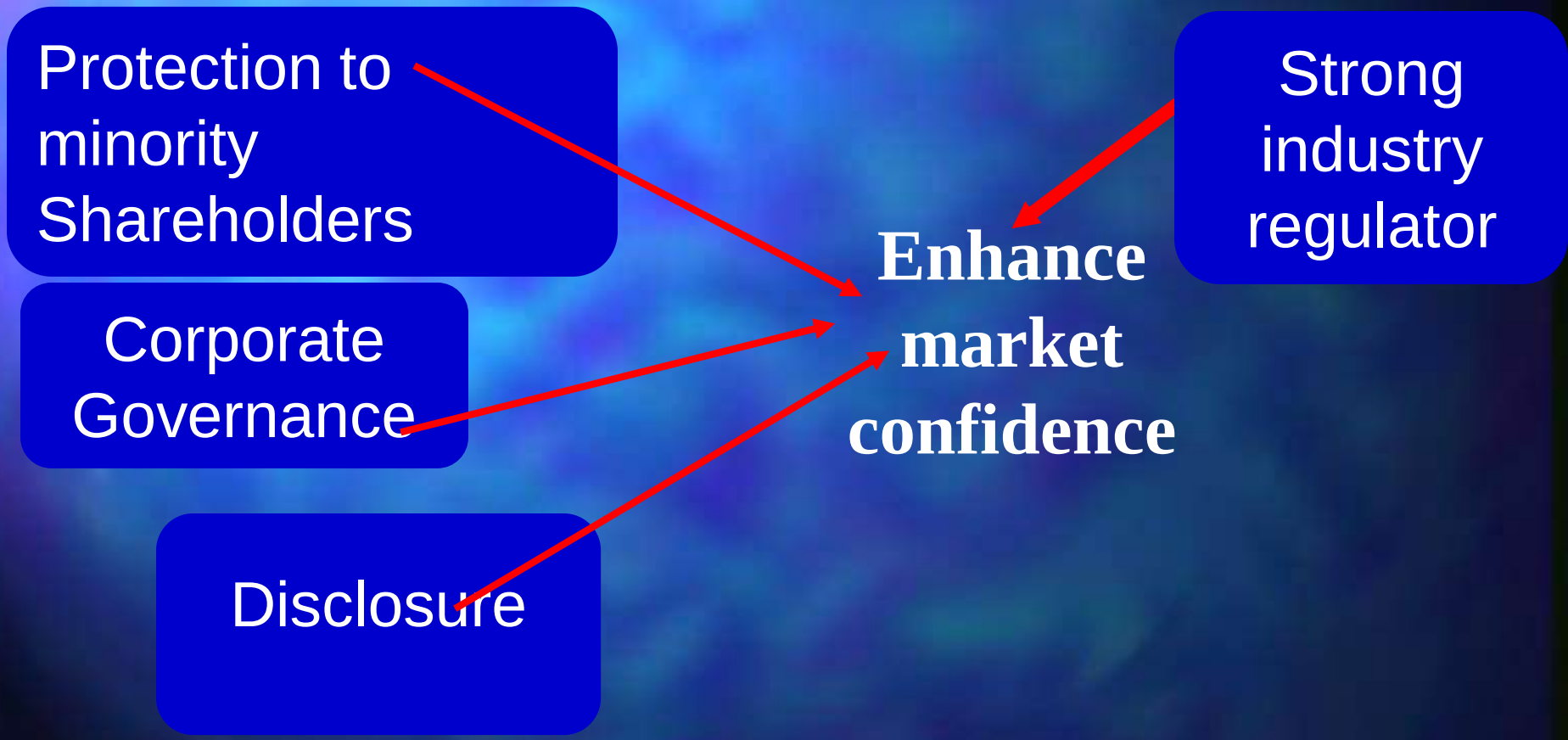
Financing the exchange

- Transaction fees paid by members for each order executed
- Fees paid by firms when their securities are originally listed
- Annual fees by firms
- Entrance fees from new members
- sale of historic trading and market information

Major challenges for the Exchanges

- **Cross border trading**
- **Issuers and investors are expanding their horizons beyond their home markets**
- **Investors becoming much more demanding**

- Regulatory improvement Transparency and Corporate Governance



Owners

Ownership of the company is by the public in the form of shares one share, one vote

Board of Directors

Board is elected by shareholders to represent the best interests of the owners

Managers

Board hires and fires the management of the company

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PRODUCT DESIGN

Lecture Outline

- Design Process
- Rapid Prototyping and Concurrent Design
- Technology in Design
- Design Quality Reviews
- Design for Environment
- Quality Function Deployment
- Design for Robustness

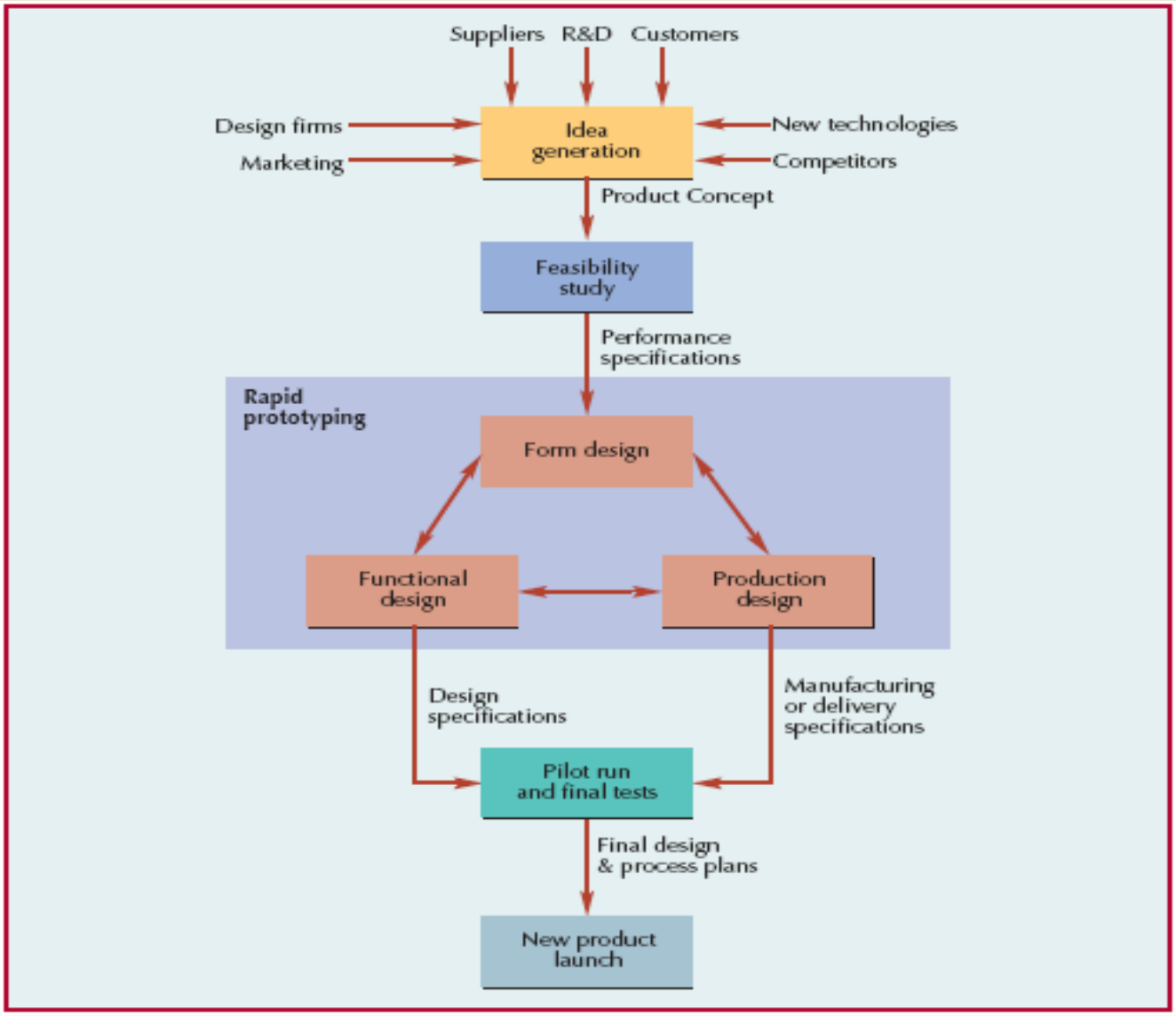
Design Process

- Effective design can provide a competitive edge
  - matches product or service characteristics with customer requirements
  - ensures that customer requirements are met in the simplest and least costly manner
  - reduces time required to design a new product or service
  - minimizes revisions necessary to make a design workable

Design Process

- Product design
  - defines appearance of product
  - sets standards for performance
  - specifies which materials are to be used
  - determines dimensions and tolerances

Design Process



Idea Generation

- Company's own R&D department
- Customer complaints or suggestions
- Marketing research
- Suppliers
- Salespersons in the field
- Factory workers
- New technological developments
- Competitors

Idea Generation

- Perceptual Maps
  - visual comparison of customer perceptions
- Benchmarking
  - comparing product/process against best-in-class
- Reverse engineering
  - dismantling competitor’s product to improve your own product

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Perceptual Map of Breakfast Cereals

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Feasibility Study

- Market analysis
- Economic analysis
- Technical/strategic analyses
- Performance specifications

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Rapid Prototyping and Concurrent Design

- Testing and revising a preliminary design model
- Build a prototype
  - form design
  - functional design
  - production design
- Test prototype
- Revise design
- Retest

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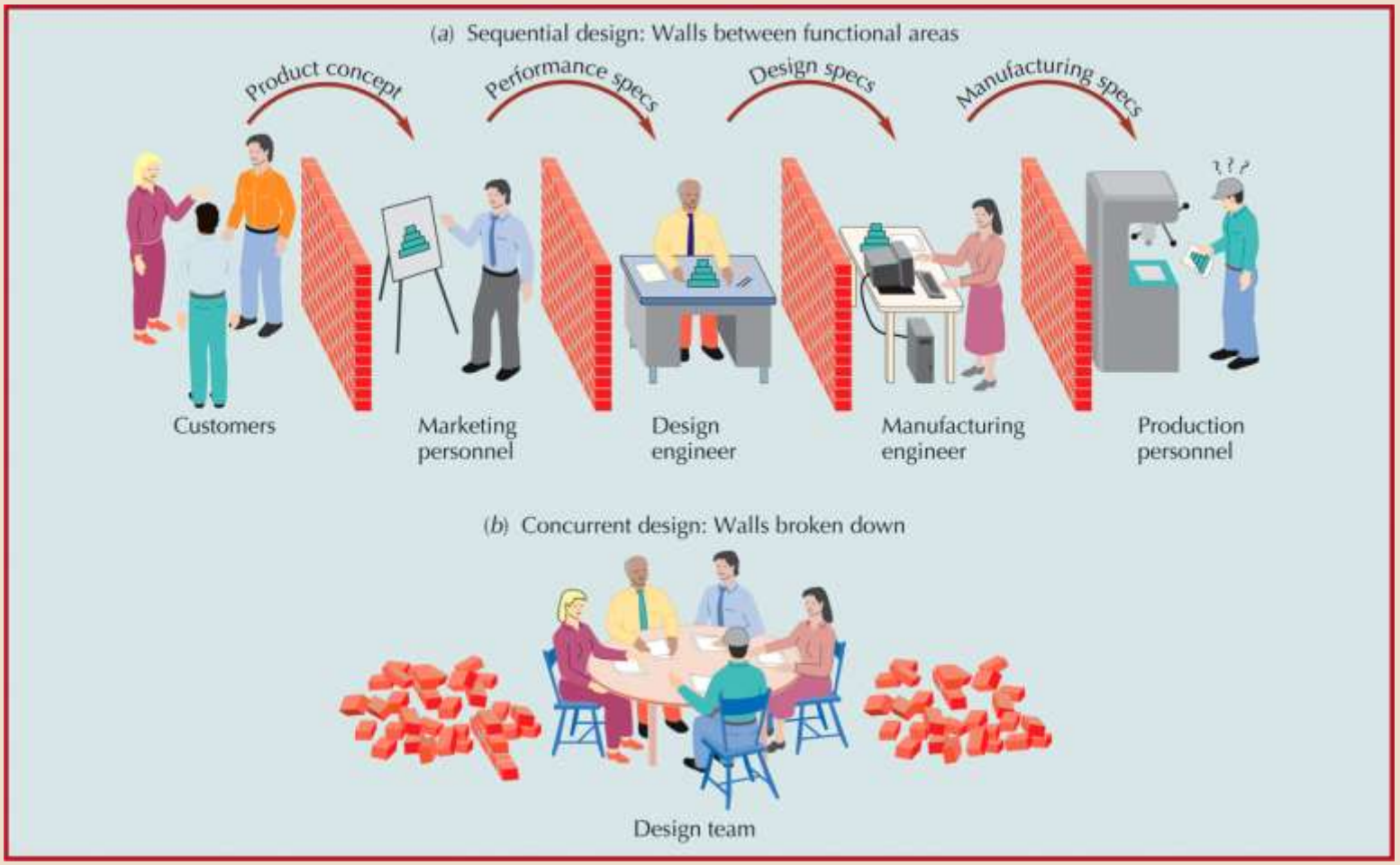
Concurrent Design



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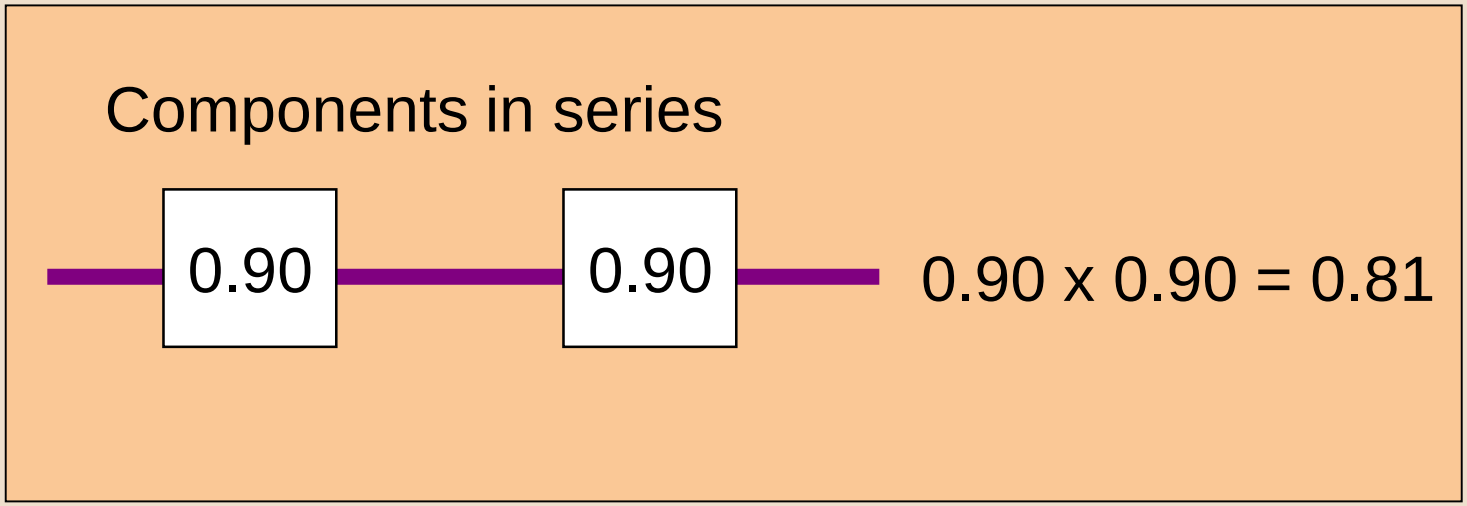
Form and Functional Design

- Form Design
  - how product will look?
- Functional Design
  - how product will perform?
    - reliability
    - maintainability
    - usability

Computing Reliability



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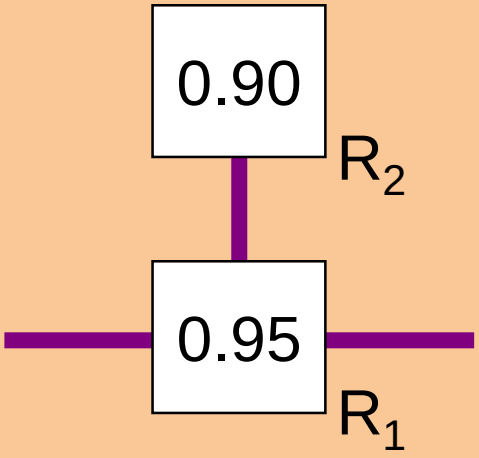
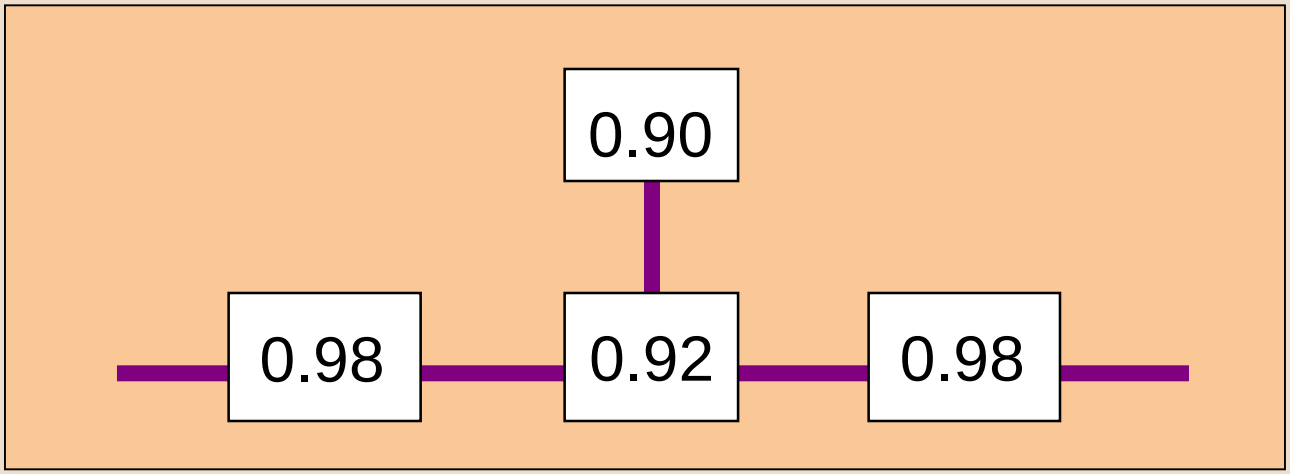
Computing Reliability

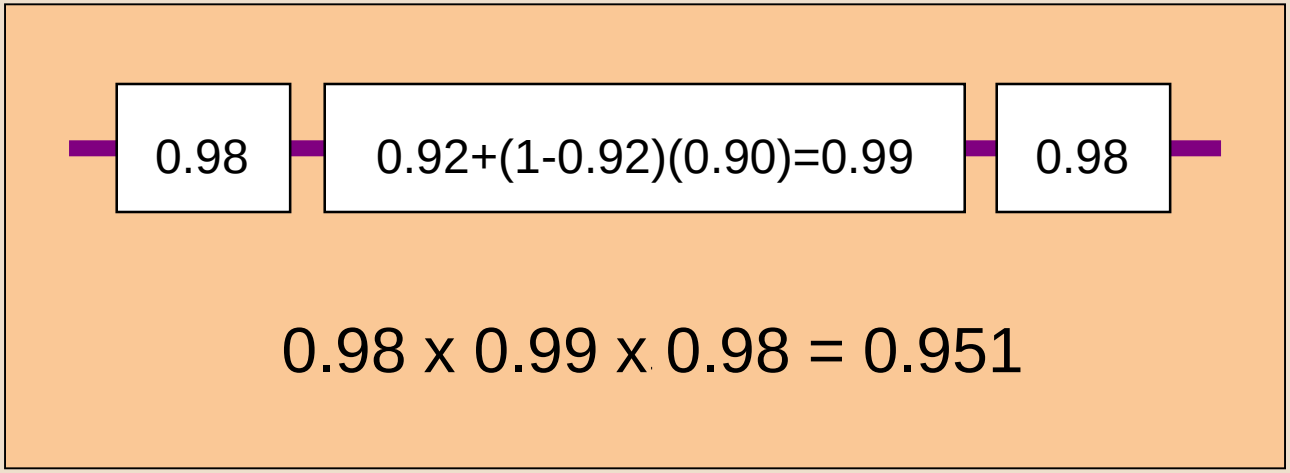
Components in parallel



$0.95 + 0.90(1-0.95) = 0.995$

System Reliability





0.98 x 0.99 x 0.98 = 0.951

System Availability (SA)

$$SA = \frac{MTBF}{MTBF + MTTR}$$

where:

MTBF = mean time between failures

MTTR = mean time to repair

System Availability

PROVIDER	MTBF (HR)	MTTR (HR)
A	60	4.0
B	36	2.0
C	24	1.0

$SA_A = 60 / (60 + 4) = .9375$ or 94%

$SA_B = 36 / (36 + 2) = .9473$ or 95%

$SA_C = 24 / (24 + 1) = .96$ or 96%

Usability

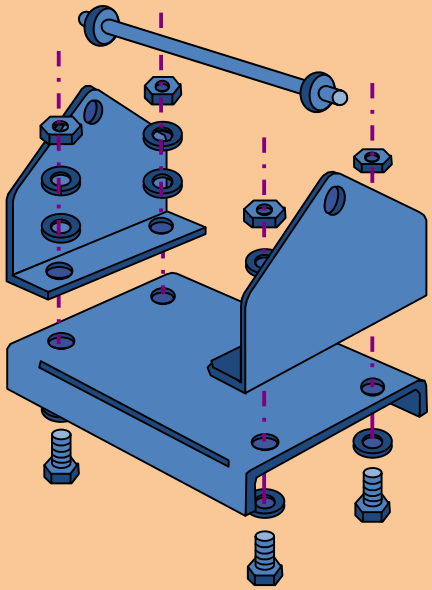
- Ease of use of a product or service
  - ease of learning
  - ease of use
  - ease of remembering how to use
  - frequency and severity of errors
  - user satisfaction with experience

Production Design

- How the product will be made
  - Simplification
    - reducing number of parts, assemblies, or options in a product
  - Standardization
    - using commonly available and interchangeable parts
  - Modular Design
    - combining standardized building blocks, or modules, to create unique finished products
  - Design for Manufacture (DFM)
    - Designing a product so that it can be produced easily and economically

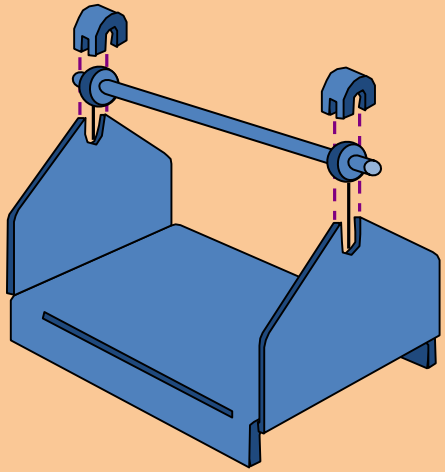
Design Simplification

(a) Original design



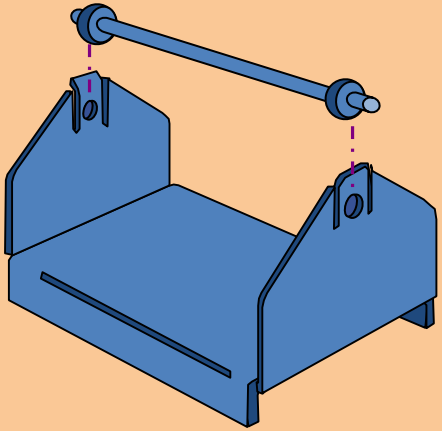
Assembly using common fasteners

(b) Revised design



One-piece base & elimination of fasteners

(c) Final design



Design for push-and-snap assembly

Final Design and Process Plans

- Final design
  - detailed drawings and specifications for new product or service
- Process plans
  - workable instructions
    - necessary equipment and tooling
    - component sourcing recommendations
    - job descriptions and procedures
    - computer programs for automated machines

Technology in Design

- Computer Aided Design (CAD)
  - assists in creation, modification, and analysis of a design
  - computer-aided engineering (CAE)
    - tests and analyzes designs on computer screen
  - computer-aided manufacturing (CAD/CAM)
    - ultimate design-to-manufacture connection
  - product life cycle management (PLM)
    - managing entire lifecycle of a product
  - collaborative product design (CPD)

Collaborative Product Design (CPD)

- A software system for collaborative design and development among trading partners
- With PML, manages product data, sets up project workspaces, and follows life cycle of the product
- Accelerates product development, helps to resolve product launch issues, and improves quality of design
- Designers can
  - conduct virtual review sessions
  - test “what if” scenarios
  - assign and track design issues
  - communicate with multiple tiers of suppliers
  - create, store, and manage project documents

Design Quality Review

- Review designs to prevent failures and ensure value
  - Failure mode and effects analysis (FMEA)
    - a systematic method of analyzing product failures
  - Fault tree analysis (FTA)
    - a visual method for analyzing interrelationships among failures
  - Value analysis (VA)
    - helps eliminate unnecessary features and functions

FMEA for Potato Chips

Failure Mode	Cause of Failure	Effect of Failure	Corrective Action
Stale	◆low moisture content ◆expired shelf life ◆poor packaging	◆tastes bad ◆won't crunch ◆thrown out ◆lost sales	◆add moisture ◆ cure longer ◆better package seal ◆shorter shelf life
Broken	◆too thin ◆too brittle ◆rough handling ◆rough use ◆poor packaging	◆can't dip ◆poor display ◆injures mouth ◆chocking ◆perceived as old ◆lost sales	◆change recipe ◆change process ◆change packaging
Too Salty	◆outdated receipt ◆process not in control ◆uneven distribution of salt	◆eat less ◆drink more ◆health hazard ◆lost sales	◆experiment with recipe ◆experiment with process ◆introduce low salt version

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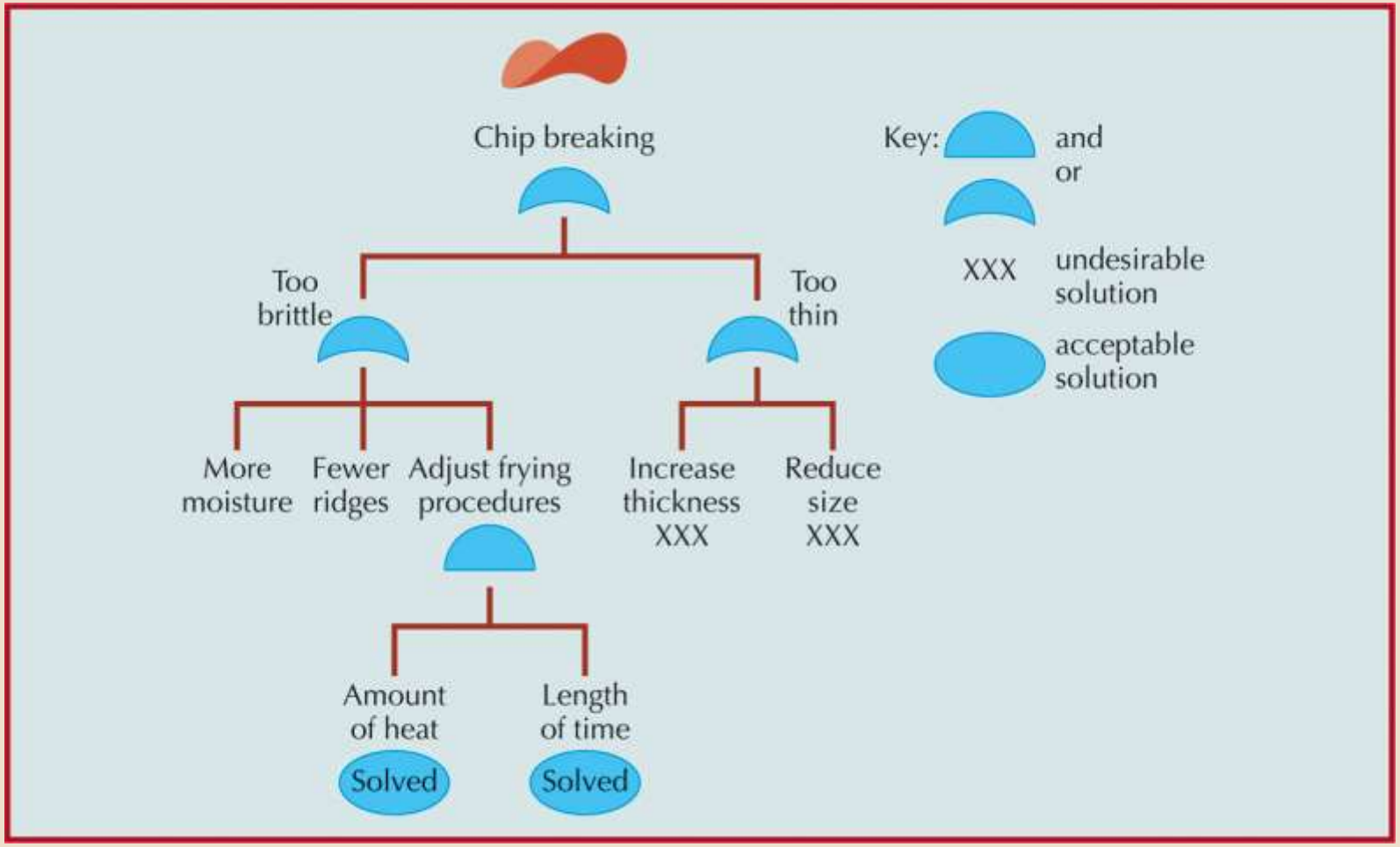
Fault Tree Analysis (FTA)



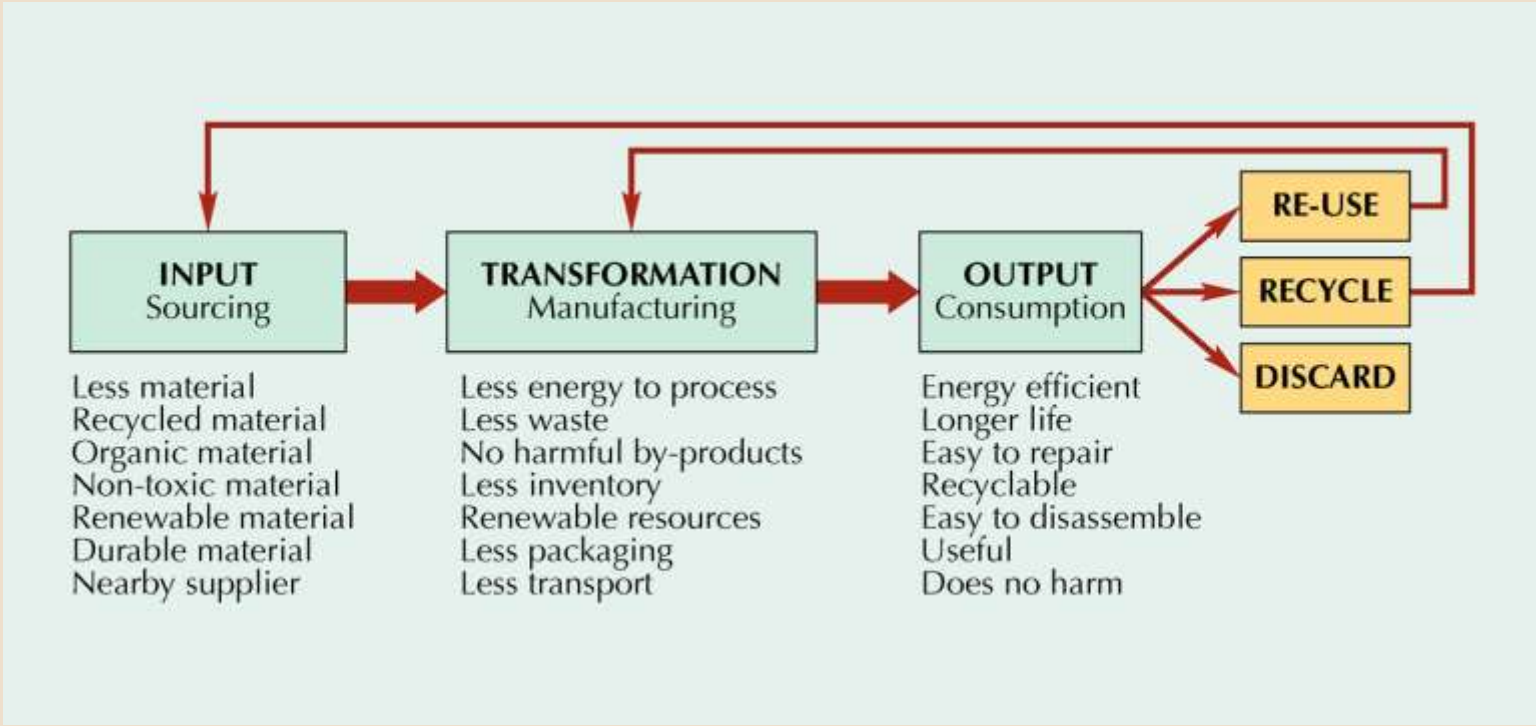
Value Analysis (VA)

- Eliminate unnecessary features and functions
- Used by multifunctional design teams
- Define essential functions of an item
- Determine the value of the functions
- Determine the cost of providing the functions
- Compute Value/Cost ratio
- Design team works to increase the ratio

Design for Environment and Extended Producer Responsibility

- Design for environment
  - designing a product from material that can be recycled
  - design from recycled material
  - design for ease of repair
  - minimize packaging
  - minimize material and energy used during manufacture, consumption and disposal
- Extended producer responsibility
  - holds companies responsible for their product even after its useful life

Design for Environment



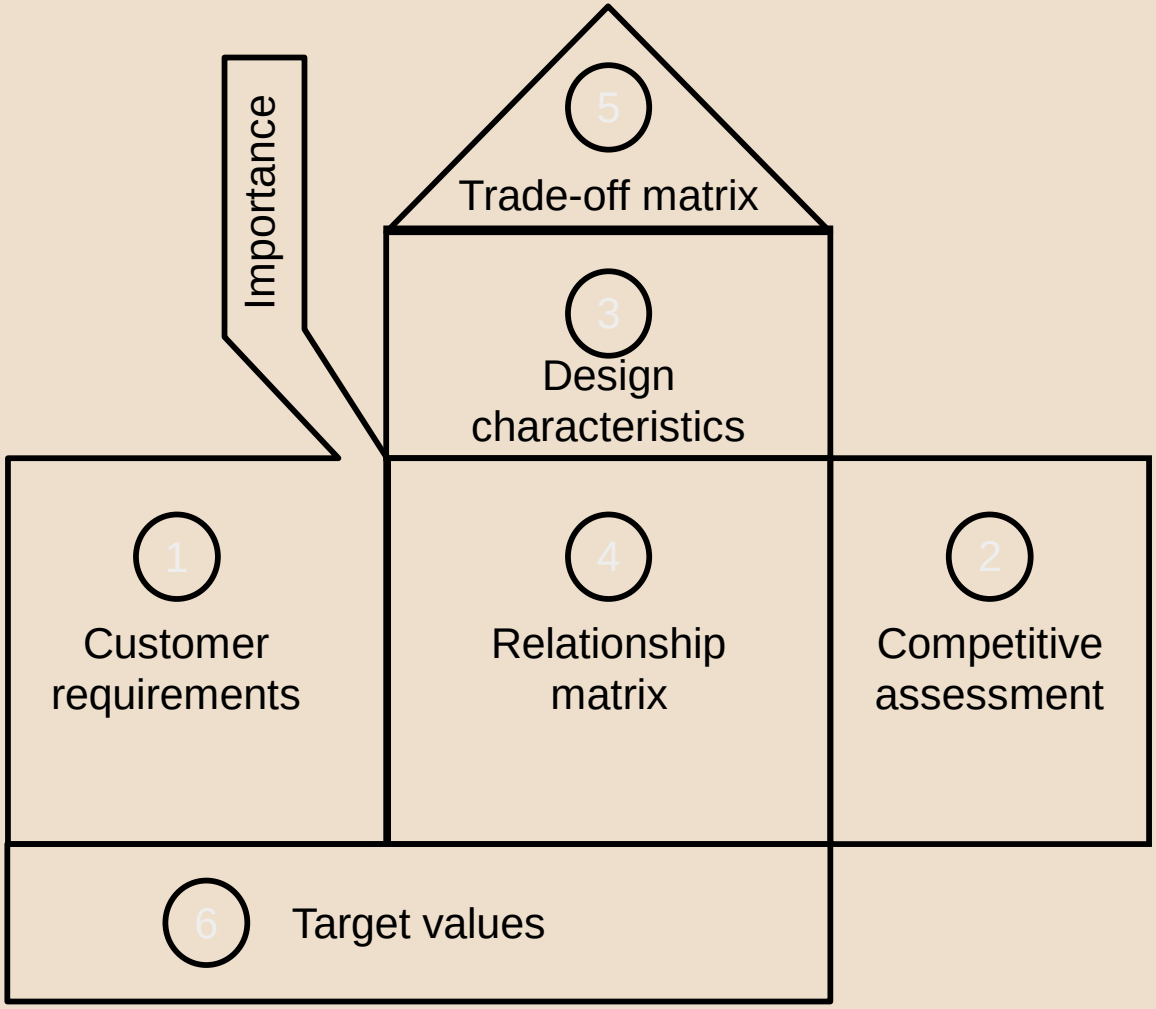
Green Areas

- Green Sourcing
  - use less material
  - use recycled if possible
- Green Manufacture
  - is energy from renewable sources
  - amount of waste produced
- Green Consumption
  - product’s use of energy
  - is product recyclable and maintainable
- Recycling and Re-Use
  - design products to be recycled or re-used
  - save energy and money

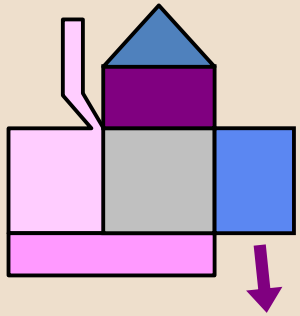
Quality Function Deployment (QFD)

- Translates voice of customer into technical design requirements
- Displays requirements in matrix diagrams
  - first matrix called “house of quality”
  - series of connected houses

House of Quality

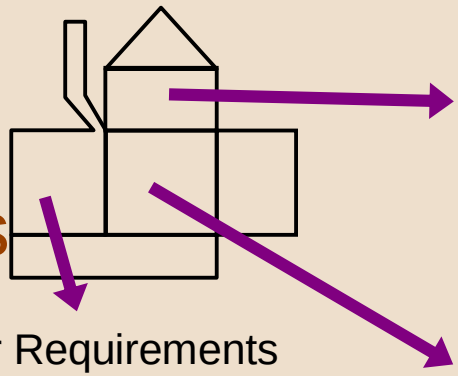


Competitive Assessment of Customer Requirements



	Customer Requirements		Competitive Assessment 1	2	3	4	5
Irons well	Presses quickly	9		B A		X	
	Removes wrinkles	8		AB		X	
	Doesn't stick to fabric	6		X		BA	
	Provides enough steam	8			AB		X
	Doesn't spot fabric	6			X AB		
	Doesn't scorch fabric	9			A XB		
Easy and safe to use	Heats quickly	6		X	B	A	
	Automatic shut-off	3					ABX
	Quick cool-down	3		X	A B		
	Doesn't break when dropped	5		AB		X	
	Doesn't burn when touched	5		AB X			
	Not too heavy	8		X		A	B

From Customer Requirements to Design Characteristics



	Customer Requirements	Energy needed to press	Weight of iron	Size of soleplate	Thickness of soleplate	Material used in soleplate	Number of holes	Size of holes	Flow of water from holes	Time required to reach 450° F	Time to go from 450° to 100°	Protective cover for soleplate	Automatic shutoff
Irons well	Presses quickly	-	⊖	+	+	+				-			
	Removes wrinkles		⊕		+		+	+	+				
	Doesn't stick to fabric		-			⊕			+		⊕	+	
	Provides enough steam			+			+	+	+				
	Doesn't spot fabric					+	-	-	⊖				
	Doesn't scorch fabric				+	⊕			+	-	⊕		
Easy and safe to use	Heats quickly			-	-					⊕		-	
	Automatic shut-off												⊕
	Quick cool-down			-	⊖	+					⊕		
	Doesn't break when dropped		+	+	⊕							+	
	Doesn't burn when touched				+						+	⊕	+
	Not too heavy	+	⊖	-	-	⊕						-	

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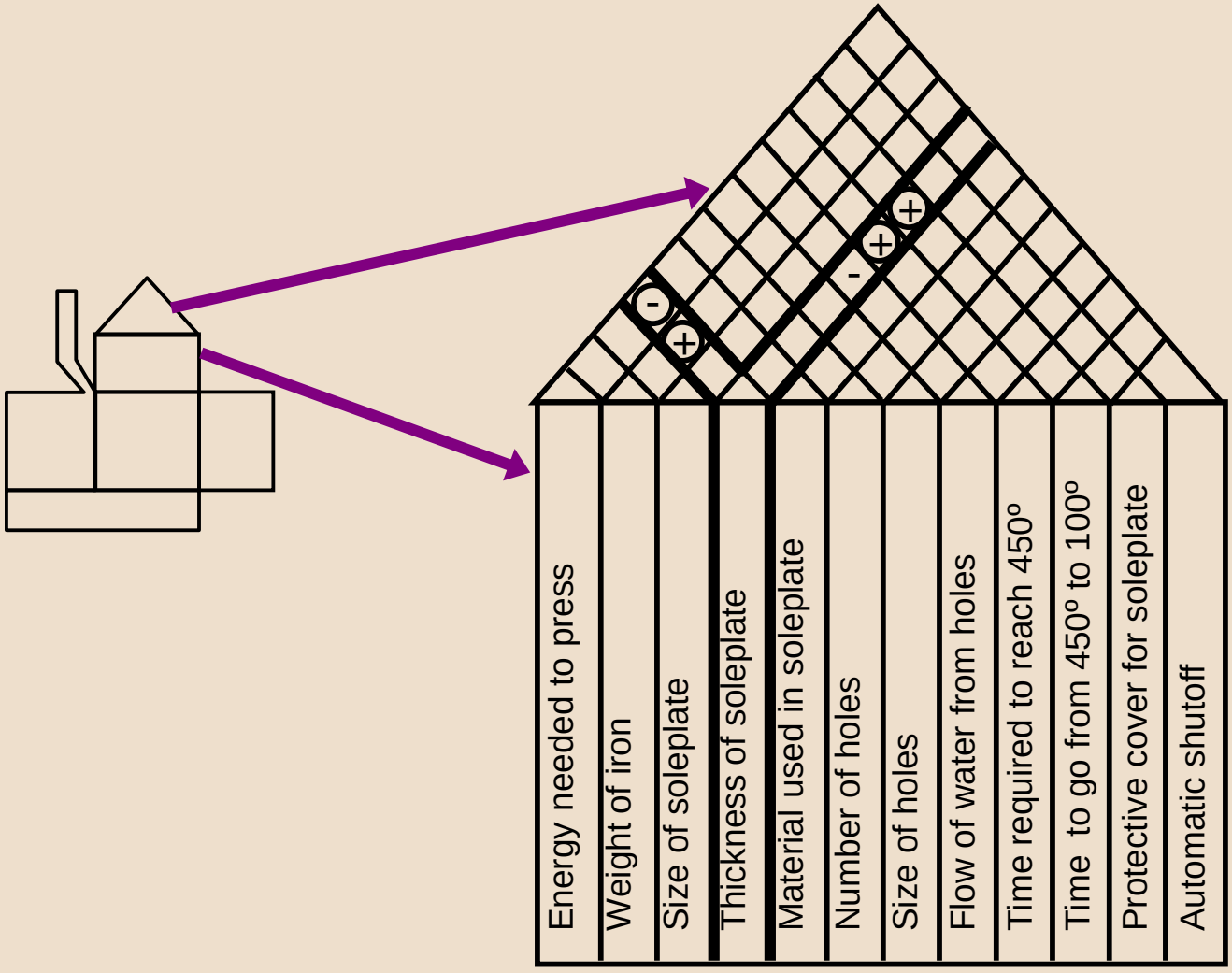
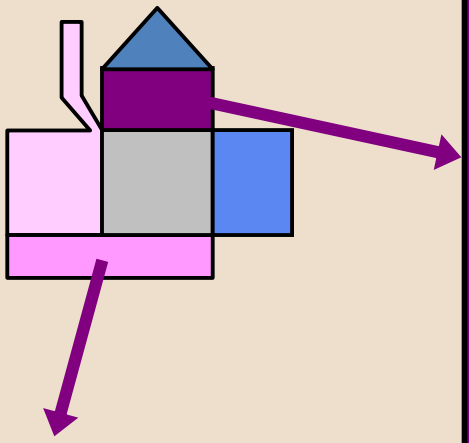
Tradeoff Matrix



Targeted Changes in Design



		Energy needed to press	Weight of iron	Size of soleplate	Thickness of soleplate	Material used in soleplate	Number of holes	Size of holes	Flow of water from holes	Time required to reach 450°	Time to go from 450° to 100°	Protective cover for soleplate	Automatic shutoff
Objective measures	Units of measure	ft-lb	lb	in.	cm	ty	ea	mm	oz/s	sec	sec	Y/N	Y/N
	Iron A	3	1.4	8x4	2	SS	27	15	0.5	45	500	N	Y
	Iron B	4	1.2	8x4	1	MG	27	15	0.3	35	350	N	Y
	Our Iron (X)	2	1.7	9x5	4	T	35	15	0.7	50	600	N	Y
Estimated impact		3	4	4	4	5	4	3	2	5	5	3	0
Estimated cost		3	3	3	3	4	3	3	3	4	4	5	2
Targets			1.2	8x5	3	SS	30			30	500		
Design changes			*	*	*	*	*			*	*		

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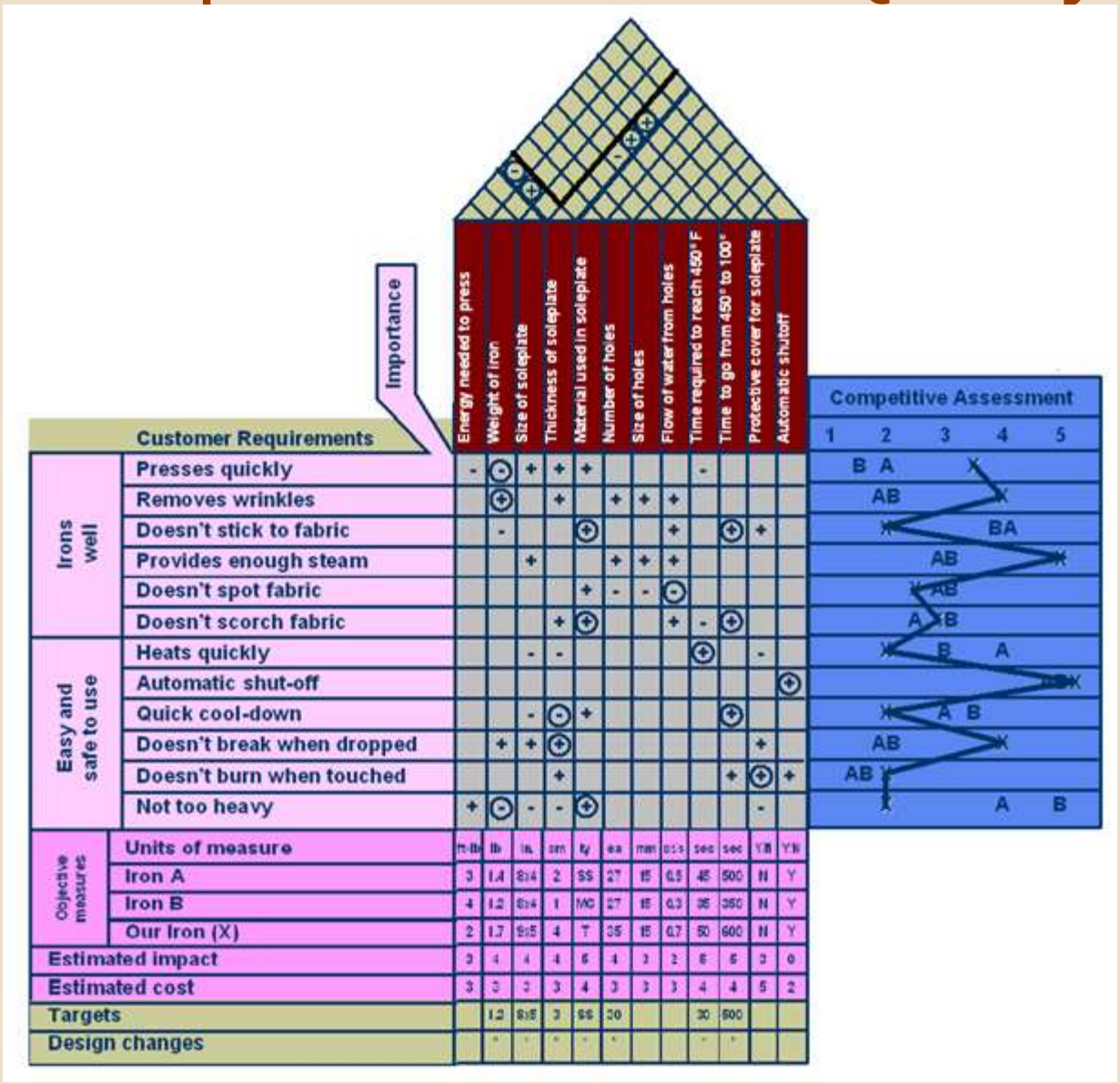
Completed House of Quality



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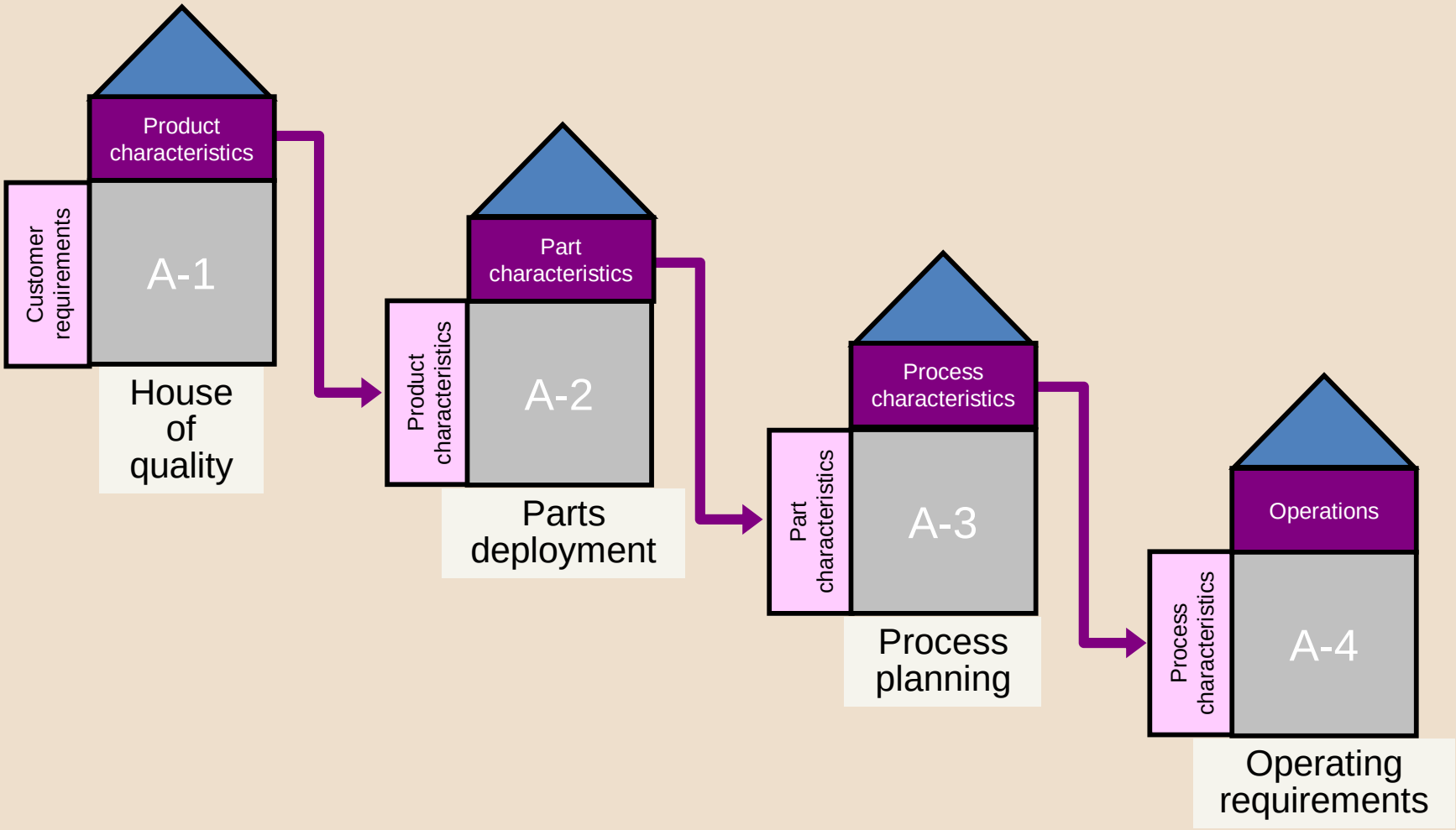
A Series of Connected QFD Houses



Benefits of QFD

- Promotes better understanding of customer demands
- Promotes better understanding of design interactions
- Involves manufacturing in design process
- Provides documentation of design process

Design for Robustness

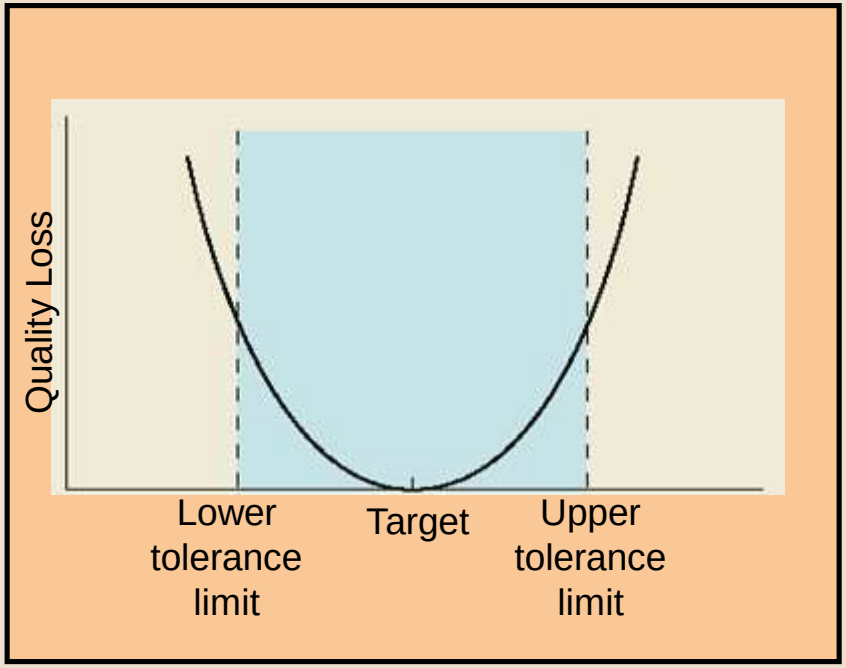
- Robust product
  - designed to withstand variations in environmental and operating conditions
- Robust design
  - yields a product or service designed to withstand variations
- Controllable factors
  - design parameters such as material used, dimensions, and form of processing
- Uncontrollable factors
  - user’s control (length of use, maintenance, settings, etc.)

Design for Robustness

- Tolerance
  - allowable ranges of variation in the dimension of a part
- Consistency
  - consistent errors are easier to correct than random errors
  - parts within tolerances may yield assemblies that are not within limits
  - consumers prefer product characteristics near their ideal values

Taguchi's Quality Loss Function

- Quantifies customer preferences toward quality
- Emphasizes that customer preferences are strongly oriented toward consistently
- Design for Six Sigma (DFSS)



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