



Planning and Forecasting



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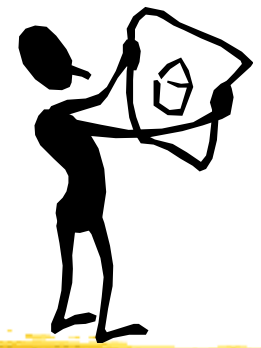
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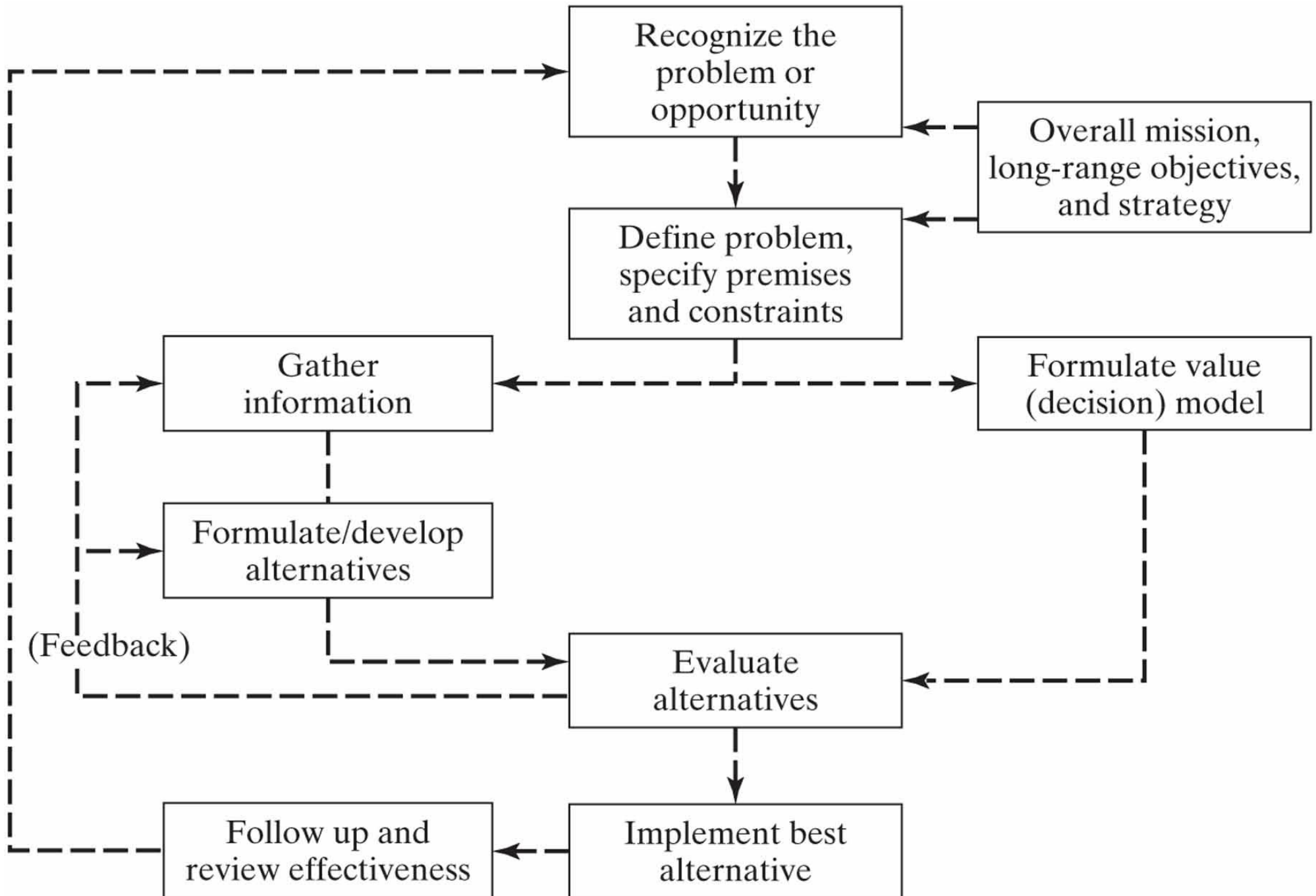
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- Strategic Planning
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- Planning Concepts
- Forecasting
- Forecasting Methods
- Good Forecast



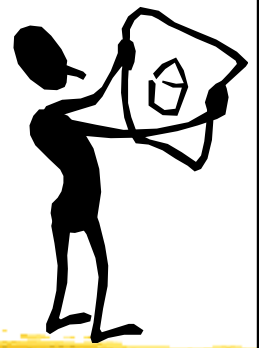
Nature of Planning

- Planning
 - Provides method for identifying objectives
 - Design sequence of programs and activities to achieve objectives
- Effective planning
 - “Plan to plan”
 - People implementing plan should be involved in preparing plan

The planning/decision making process

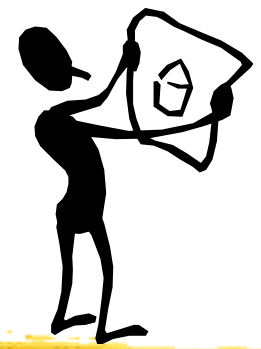


Nature of Planning



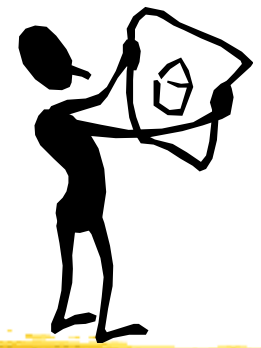
- Planning: leading questions
 - What must be done?
 - Who will do it?
 - How will it be done?
 - When must it be done?
 - How much will it cost?
 - What do we need to do it?
 - What is the problem/purpose?
 - How to establish goal/objectives?
 - What Client need is being satisfied by the project?
 - How to identify success criteria?





Nature of Planning

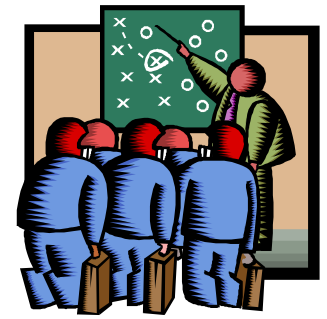
- Planning requirements
 - Defining goals
 - Get inputs from various departments
 - Goals are dived and subdivided to lower levels
 - Individual goals are targets
 - Strategy (used to reach goals) is made
 - Must consider “if-then-else”
 - Unforeseen and unexpected situation must be considered



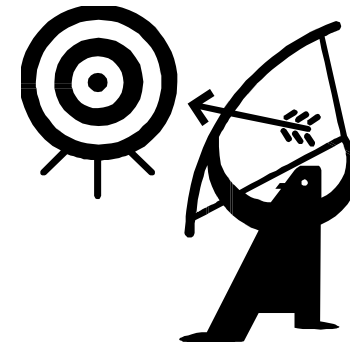
Nature of Planning

- Planning procedure
 - Short term strategy is prepared
 - Strength, weaknesses, opportunities and threats (SWOT) are considered
 - Translate into action plans
 - Establish processes and set standards
 - Consider budget, running expenditures, capital and human resources
 - Trainings are planned
 - Changes are planned and implemented

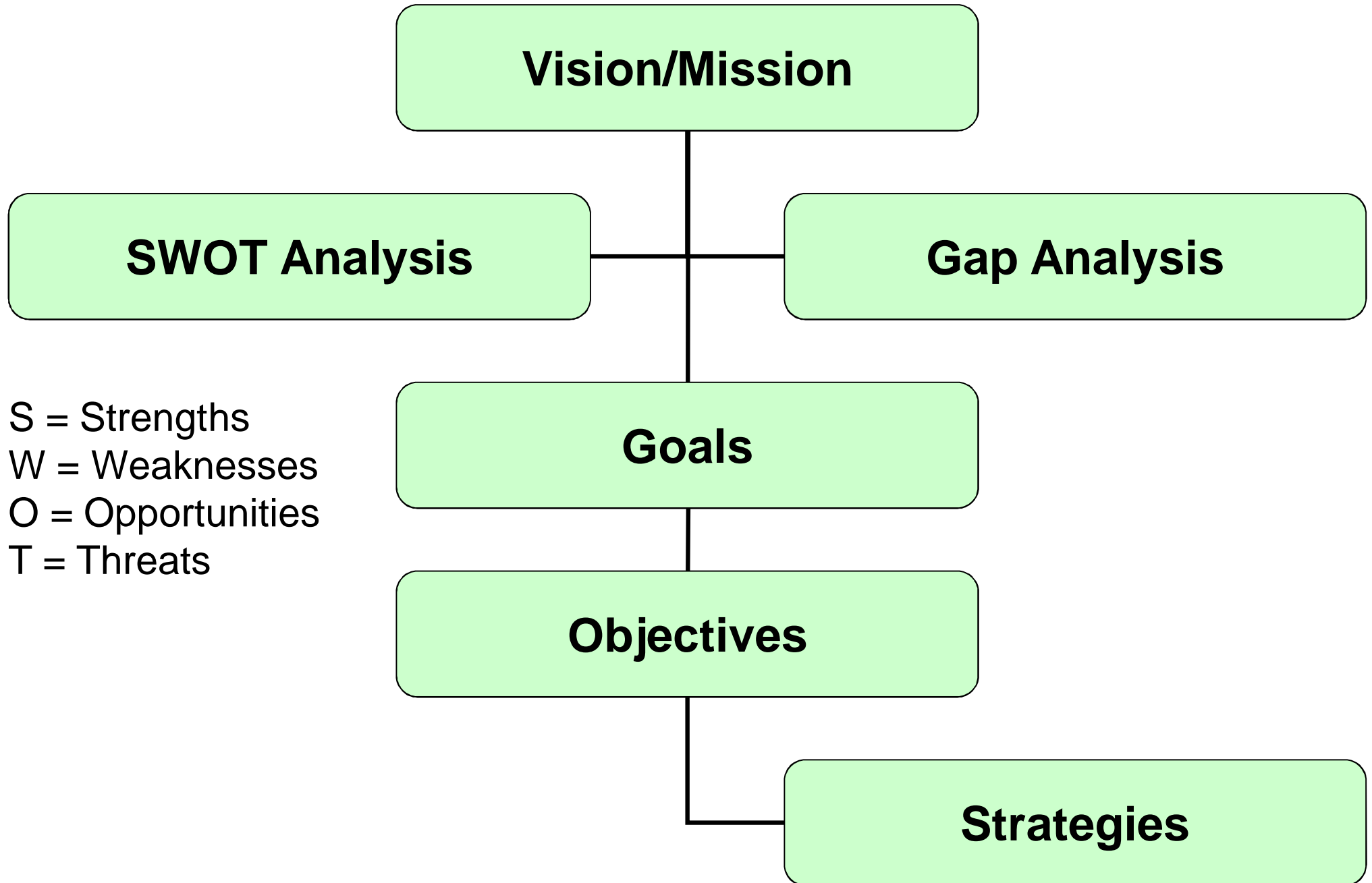
Strategic Planning



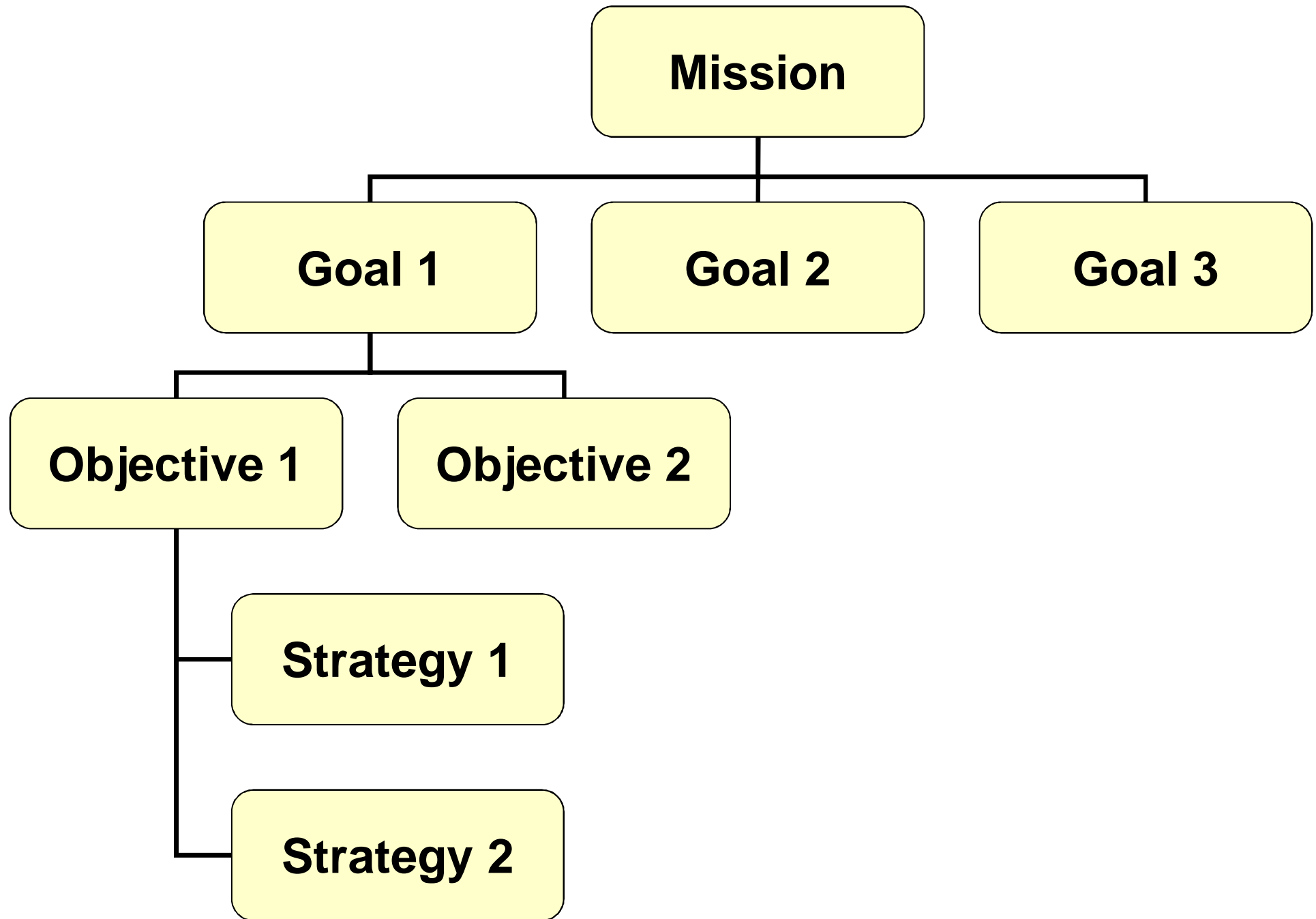
- Types of planning: (All customer driven)
 - Strategic
 - Tactical
 - Operational
 - Contingency
- The foundation for planning
 - 1. Mission
 - 2. Purpose or Goal
 - 3. Objectives
 - 4. Strategies



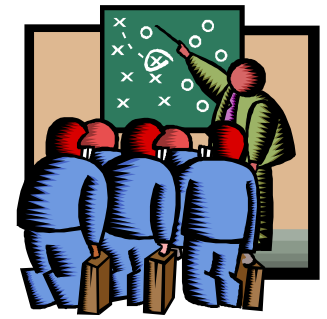
Strategic Planning



S = Strengths
W = Weaknesses
O = Opportunities
T = Threats

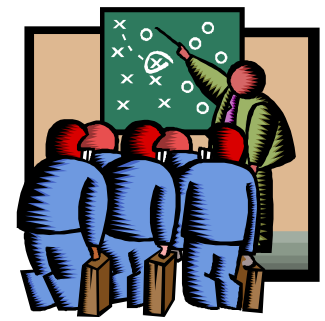


Strategic Planning



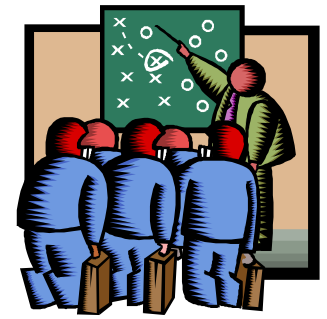
- Strategic plan
 - Suggests ways (strategies) to identify and to move toward desired future states
 - Consists of the process of developing and implementing plans to reach goals and objectives
 - Not a business plan
 - Not an operational plan

Strategic Planning



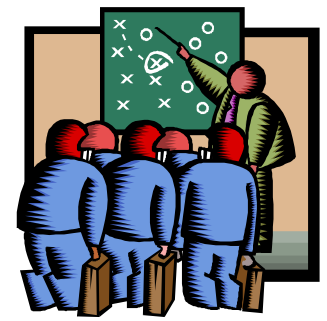
- Strategy is a road map or guide by which an organization moves from a current state of affairs to a future desired state
- It is not only a template by which daily decisions are made, but also a tool with which determines long-range future plans and courses of action
- Strategy allows a company to position itself effectively within its environment to reach its maximum potential, while constantly monitoring that environment for changes that can affect it so as to make changes in its strategic plan accordingly
- In short, strategy defines where you are, where you are going, and how you are going to get there

Strategic Planning



- Strategy: decision which is taken in advance to achieve the target/ missions i.e.
 - What to be produced
 - How is to be produced
 - When is to be produce
 - Who will be responsible to produce
 - What should be raw material
 - From where the raw material will be achieved
 - What will be its cost
 - What will be total production cost
 - What will be selling price
 - Where it will be sold

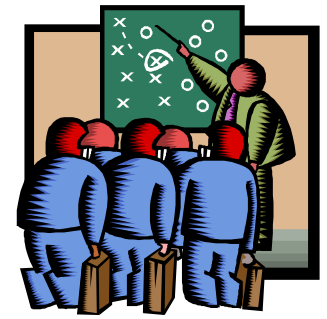
Strategic Planning



- Strategy:
 - Action plan to achieve mission
 - Shows how mission will be achieved
 - Company has a business strategy
 - Functional areas have strategies



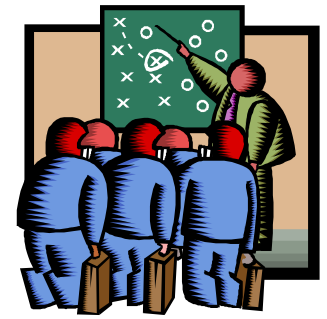
Strategic Planning



- Vision

- A vision statement describes in graphic terms where the goal-setters want to position themselves in the future.
- Examples:
 - Eastman Chemical Company: “To Be the World's Preferred Chemical Company”
 - Microsoft (1980’s): “A personal computer on every desk, and every computer running Microsoft software”

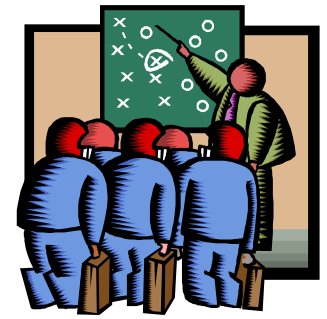
Strategic Planning



- Mission - where are you going?
 - Organization's purpose for being
 - Provides boundaries & focus
 - Answers 'How can we satisfy people's needs?'
 - Expressed in published statement
- Long term strategic plans
 - Are called as action plans



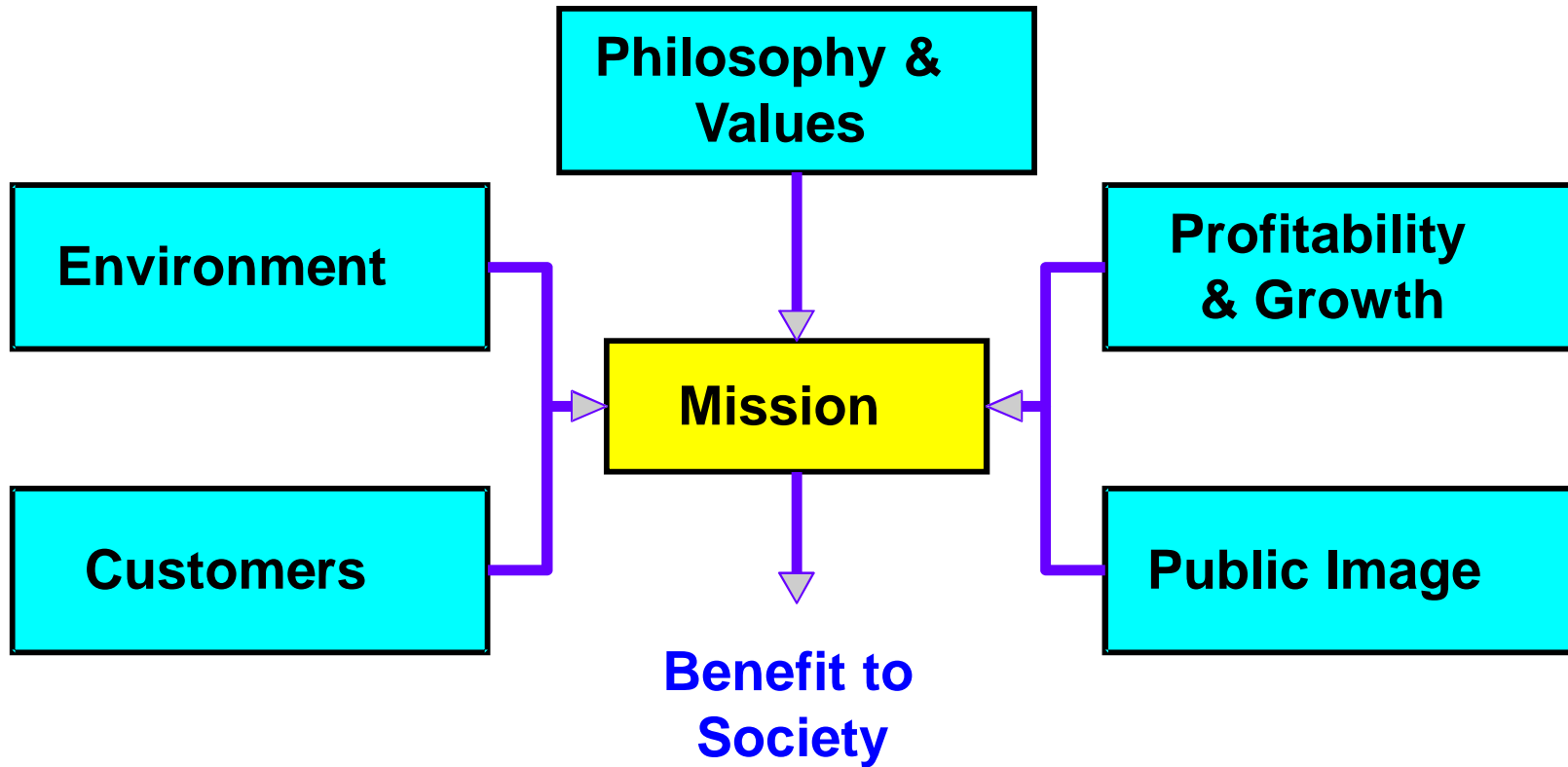
Strategic Planning



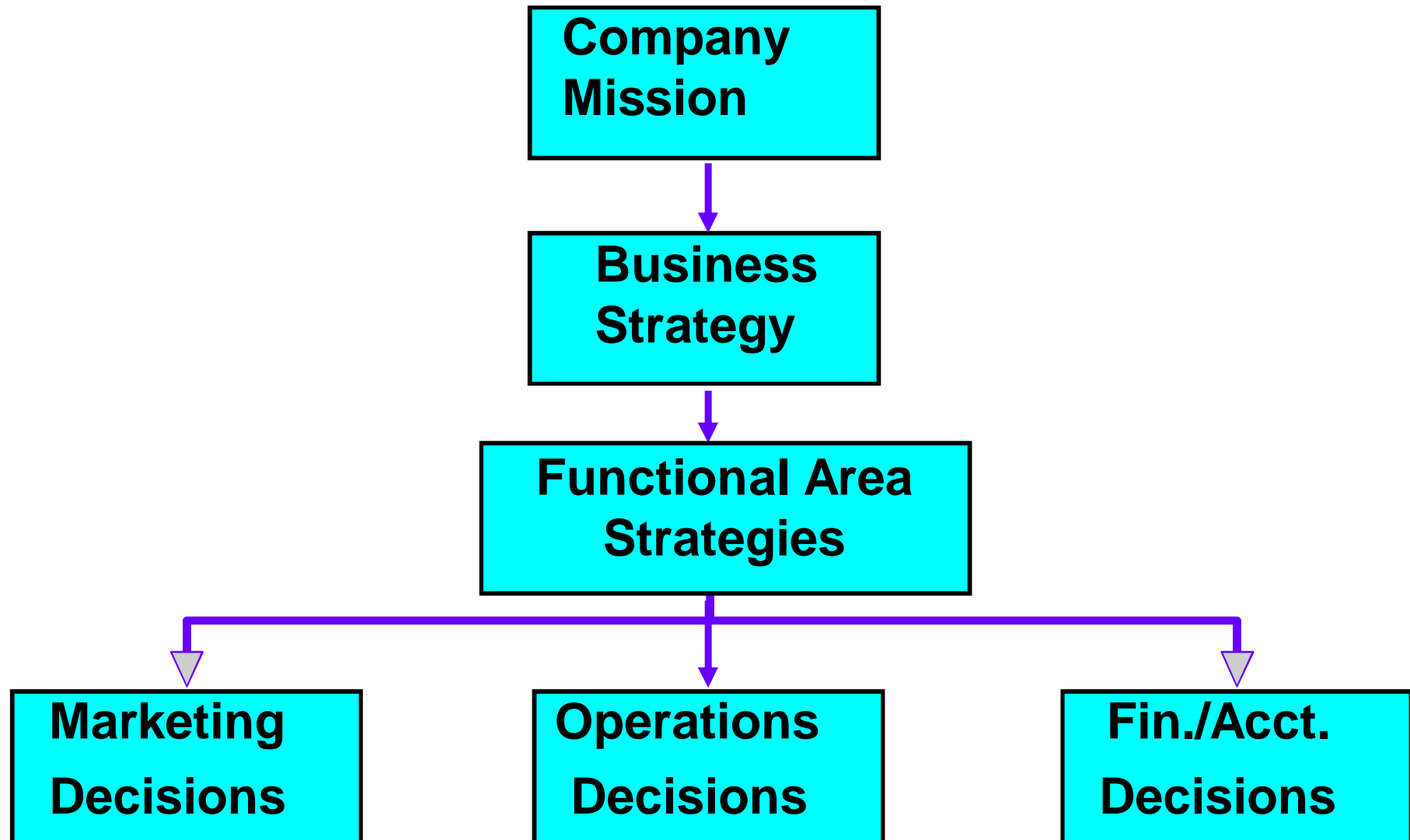
- Mission Example – Manufacturing Company
 - The mission of Merck is to provide society with superior products and services - innovations and solutions that improve the quality of life and satisfy customer needs - to provide employees with meaningful work and advancement opportunities and investors with a superior rate of return



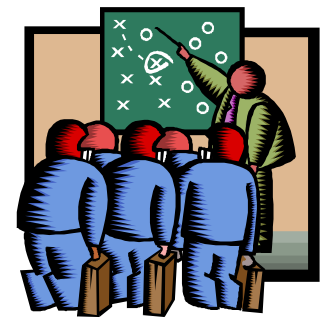
Factors affecting mission



Strategy process



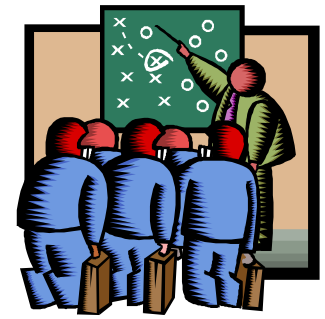
Strategic Planning



- Planning mission statement
 - First step in planning process
 - What do we want to do
- Mission statement
 - Resembles a vision statement
 - Has a more immediate business focus with a time horizon
 - Example:
 - Mission – Pal's: To deliver excellence in food service while providing a menu focused on exceptional quality



Strategic Planning



- Mission statement: Examples

- The mission of Southwest Airlines is dedication to the highest quality of Customer Service delivered with a sense of warmth, friendliness, individual pride, and Company Spirit. (<http://www.southwest.com> 9/9/05)



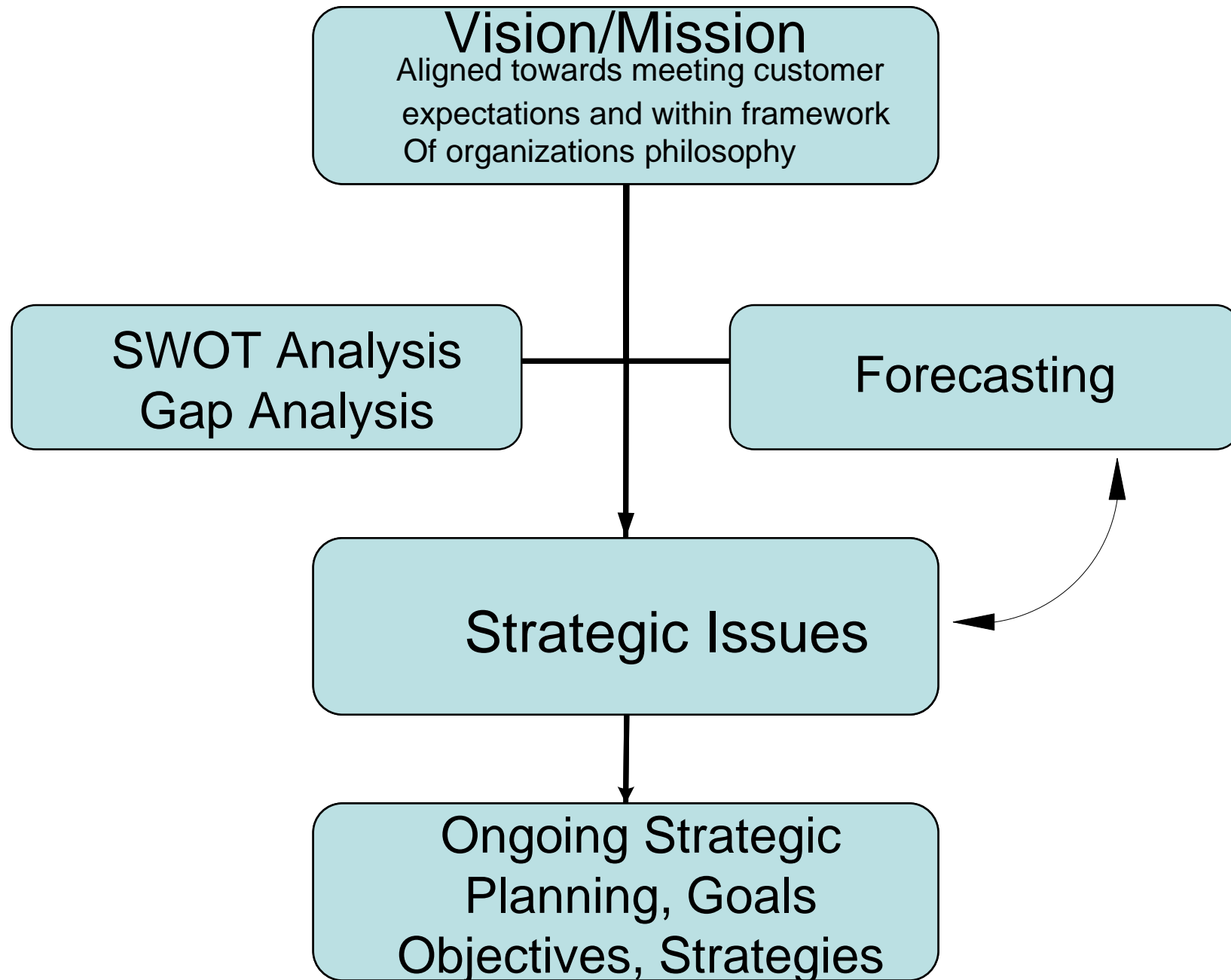
- Sample Mission - Circle K

- As a service company, our mission is to:

- Satisfy our customers' immediate needs and wants by providing them with a wide variety of goods and services at multiple locations.



Strategic Planning

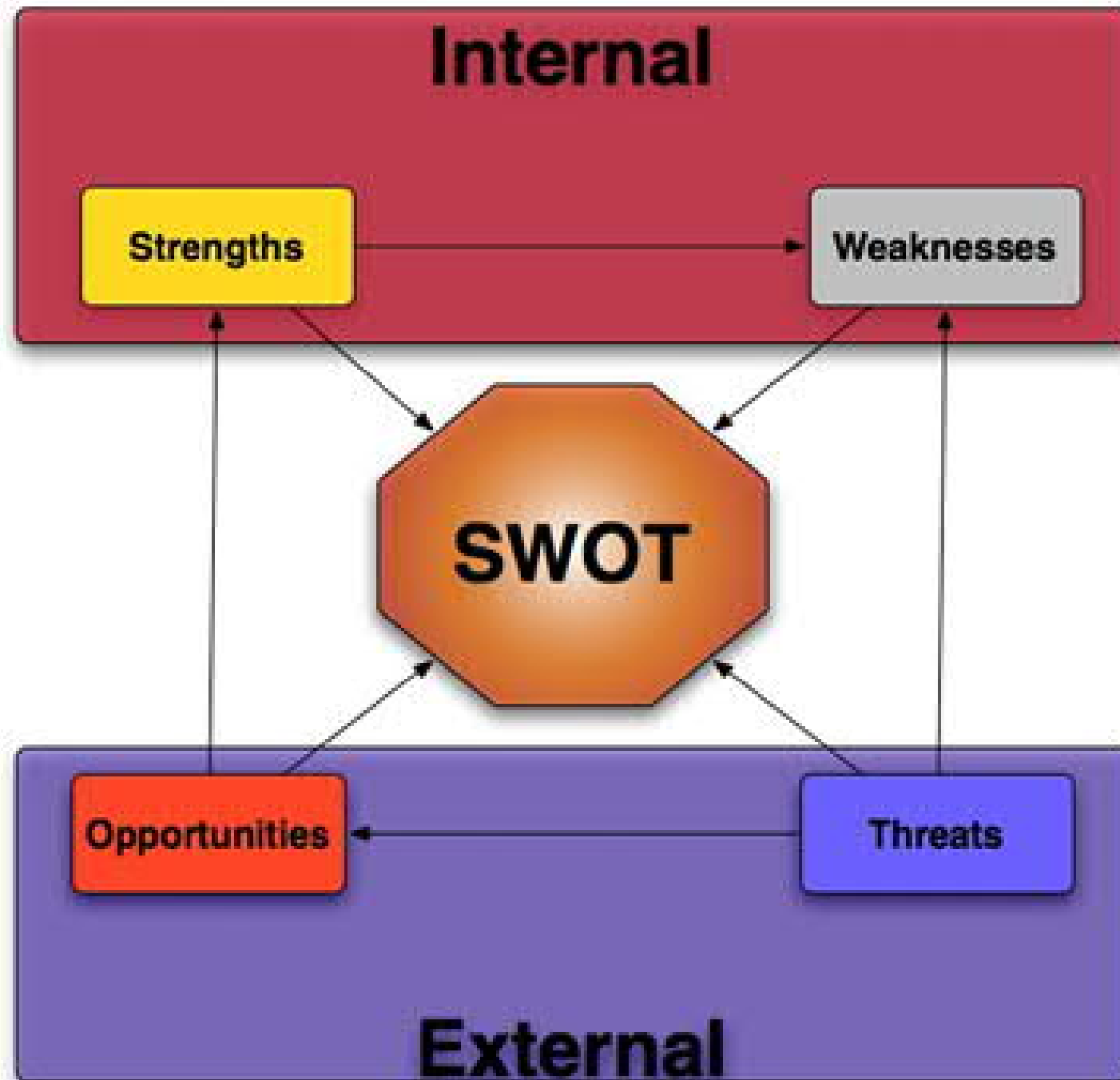


SWOT Analysis



- SWOT analysis (SWOT matrix, situation analysis)
 - A structured planning method used to evaluate the **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats involved in a project or in a business venture
 - Strengths: characteristics of the business or project that give it an advantage over others [*internal*]
 - Weaknesses: characteristics that place the team at a disadvantage relative to others [*internal*]
 - Opportunities: elements that the project could exploit to its advantage [*external*]
 - Threats: elements in the environment that could cause trouble for the business or project [*external*]

SWOT analysis



SWOT analysis (example)

Internal

Positive:

Strengths:

- Technological skills
- Leading brands
- Distribution channels
- Customer loyalty/relationship
- Production quality
- Scale
- Management

Negative:

Weaknesses:

- Absence of important skills
- Weak brands
- Poor access of distribution
- Low customer retention
- Unreliable product /service
- Sub-scale
- Management

SWOT analysis (example)

External

Positive:

Opportunities:

- Changing customer taste
- Liberalization of geographic market
- Technological advances
- Changes in government politics
- Lower personal taxes
- Change in population age structure
- New distribution channel

Negative:

Threats:

- Changing customer taste
- Closing of geographic market
- Technological advances
- Changes in government policies
- Tax increases
- Changes in population age structure
- New distribution channel

SWOT analysis (example): McDonald's restaurant

Internal

Strengths

- Rank very high on the Fortune Magazine's most admired list
- Community oriented
- Global operations all over the world
- Cultural diversity in the foods
- Excellent location
- Assembly line operations
- Use of top quality products

Weaknesses

- Failing pizza test market thus limiting the ability to compete with pizza providers
- High training costs due to high turnover
- Minimal concentration on organic foods
- Not much variation in seasonal products
- Quality concerns due to franchised operations
- Focus on burgers / fried foods not on healthier options for their customers

Opportunities

- Opening more joint ventures
- Being more responsive to healthier options
- Advertising wifi services in the branches
- Expanding on the advertising on being socially responsible
- Expansions of business into newly developed parts of the world
- Open products up to allergen free options such as peanut free

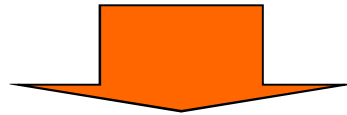
Threats

- Marketing strategies that entice people from small children to adults
- Lawsuits for offering unhealthy foods
- Contamination risks that include the threat of e-coli containments
- The vast amount of fast food restaurants that are open as competition
- Focus on healthier dieting by consumers
- Down turn in economy, people not eat that much

External

SWOT analysis process

- Environmental Analysis

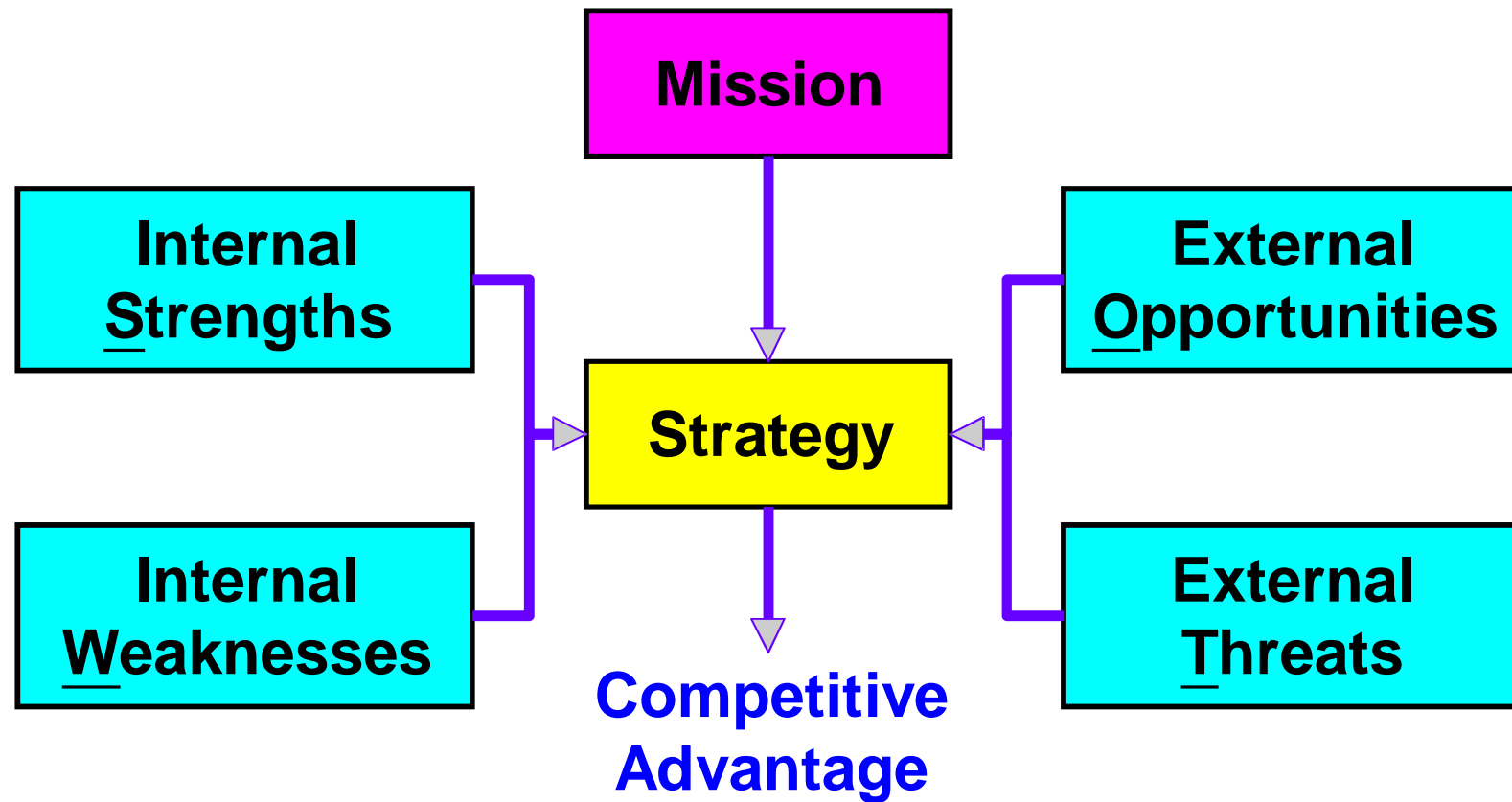


- ◆ Determine Corporate Mission



- ◆ Form a Strategy

SWOT analysis to strategy formulation



Identifying critical success factors

Marketing

Service
Distribution
Promotion
Channels of distribution
Product positioning
(image, functions)

Finance/Accounting

Leverage
Cost of capital
Working capital
Receivables
Payables
Financial control
Lines of credit

Production/Operations

Decisions

Product
Quality
Process
Location
Layout
Human resource
Supply chain
Inventory
Schedule
Maintenance

Sample Options

Customized, or standardized
Define customer expectations and how to achieve them
Facility size, technology
Near supplier or customer
Work cells or assembly line
Specialized or enriched jobs
Single or multiple source suppliers
When to reorder, how much to keep on hand
Stable or fluctuating productions rate
Repair as required or preventive maintenance

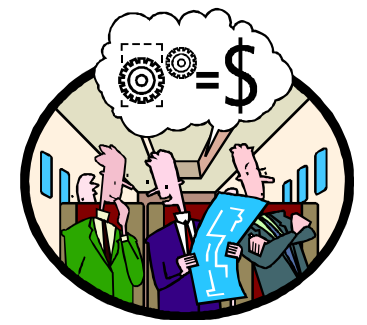


SWOT Analysis



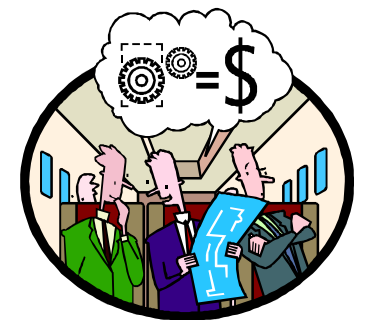
- Critical success factors: Microsoft & Compaq
 - They focus on one business
 - They are global
 - Their senior management is actively involved in defining and improving the product development process
 - They recruit and retain the top people in their fields
 - They understand that speed to market reinforces product quality

Planning Concepts



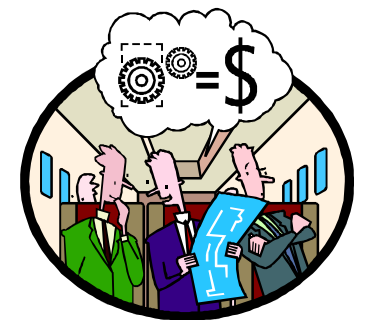
- Planning goal statement
 - Why?
 - What do we do?
 - For whom do we do it?
- Goal statement
 - Gives purpose and direction
 - Used as continual point of reference for questions regarding scope or purpose

Planning Concepts



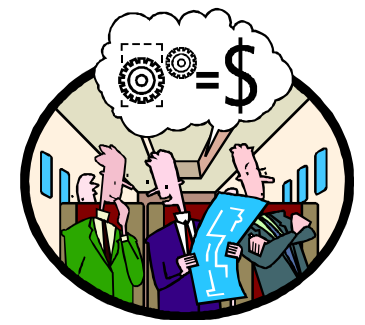
- Planning objectives
 - More detailed than goal statement
 - Clarifies goal
 - How do we go about it?
 - To (action verb)
 - Consistent with organization

Planning Concepts



- Develop objectives
 - Specific
 - Measurable
 - Attainable
 - Realistic
 - Time-limited
- Objectives characteristics
 - Outcome - what is to be accomplished
 - Time Frame - expected completion date
 - Measure - metrics for success
 - Action - how the objective will be met

Planning Concepts

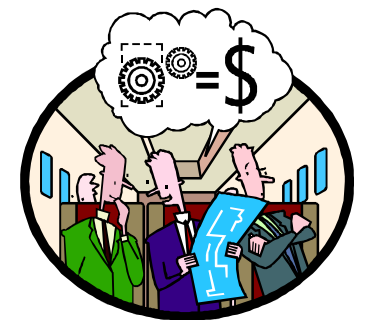


- Management By Objectives (MBO)*

- Also known as Management By Results (MBR)
- Corollary MBWA (Management by Walking Around)
- A process of defining objectives within an organization so that management and employees agree to the objectives and understand what they need to do in the organization in order to achieve them
 - Participative goal setting
 - Choosing course of actions
 - Decision making

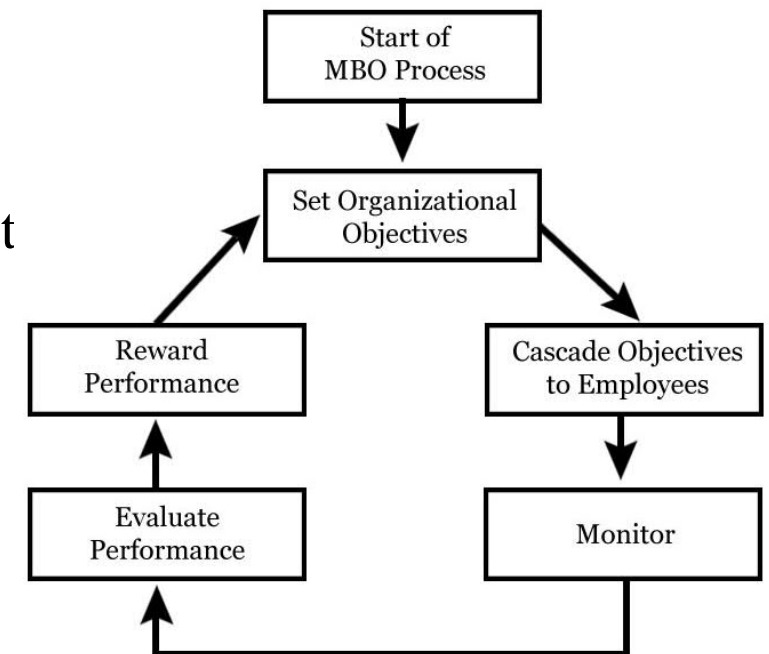
(* See also <http://communicationtheory.org/management-by-objectives-drucker/>)

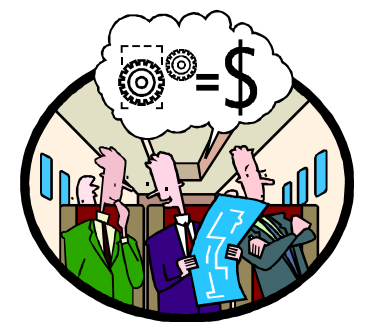
Planning Concepts



- Goals and objectives
 - Peter Drucker's Objectives for Organizational Survival (i.e. Management by Objectives, MBO)
 - Market share
 - Innovation
 - Productivity
 - Physical and financial resources
 - Manager performance and development
 - Worker performance and attitude
 - Profitability
 - Social responsibility

The Five-Step MBO Process





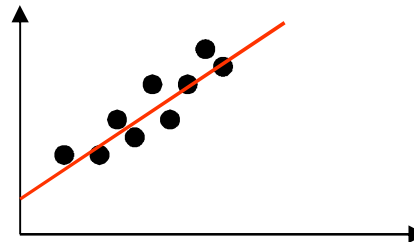
Planning Concepts

- Responsibility for planning
 - Mainly with top and middle management, lead to action
- Planning premises
 - Assumptions on which planning is based
- Planning horizon
 - How far into the future one should plan
- Systems of plans
 - Strategic plans (3-15 years), operating plans (annual)
- Policies and procedures
 - Guides for decision making; sequence of activities

Forecasting



- **Forecasting**: Process of predicting a future event based on historical data
- “Educated Guessing” (logical and rational)
- Underlying basis of all business decisions
 - Production
 - Inventory
 - Personnel
 - Facilities



Forecasting



- **Forecast**: a statement about the future value of a variable of interest such as demand
 - Essential preliminary to effective planning
 - Engineering manager must be concerned with both future markets and future technology
- Why Forecasting?
 - New facility planning
 - Production planning
 - Work force scheduling
- Forecasting is used to make informed decisions

Importance and uses of forecasts

Accounting	Cost/profit estimates
Finance	Cash flow and funding
Human Resources	Hiring/recruiting/training
Marketing	Pricing, promotion, strategy
Management Information System (MIS)	Information Technology (IT)/ Information Services (IS) systems, services
Operations	Schedules, Material requirements planning (MRP), workloads
Product/service design	New products and services

Forecasting



- **Short-range forecast**
 - Usually < 3 months
 - Job scheduling, worker assignments
- **Medium-range forecast**
 - 3 months to 2 years
 - Sales/production planning
- **Long-range forecast**
 - > 2 years
 - New product planning

Detailed
use of
system

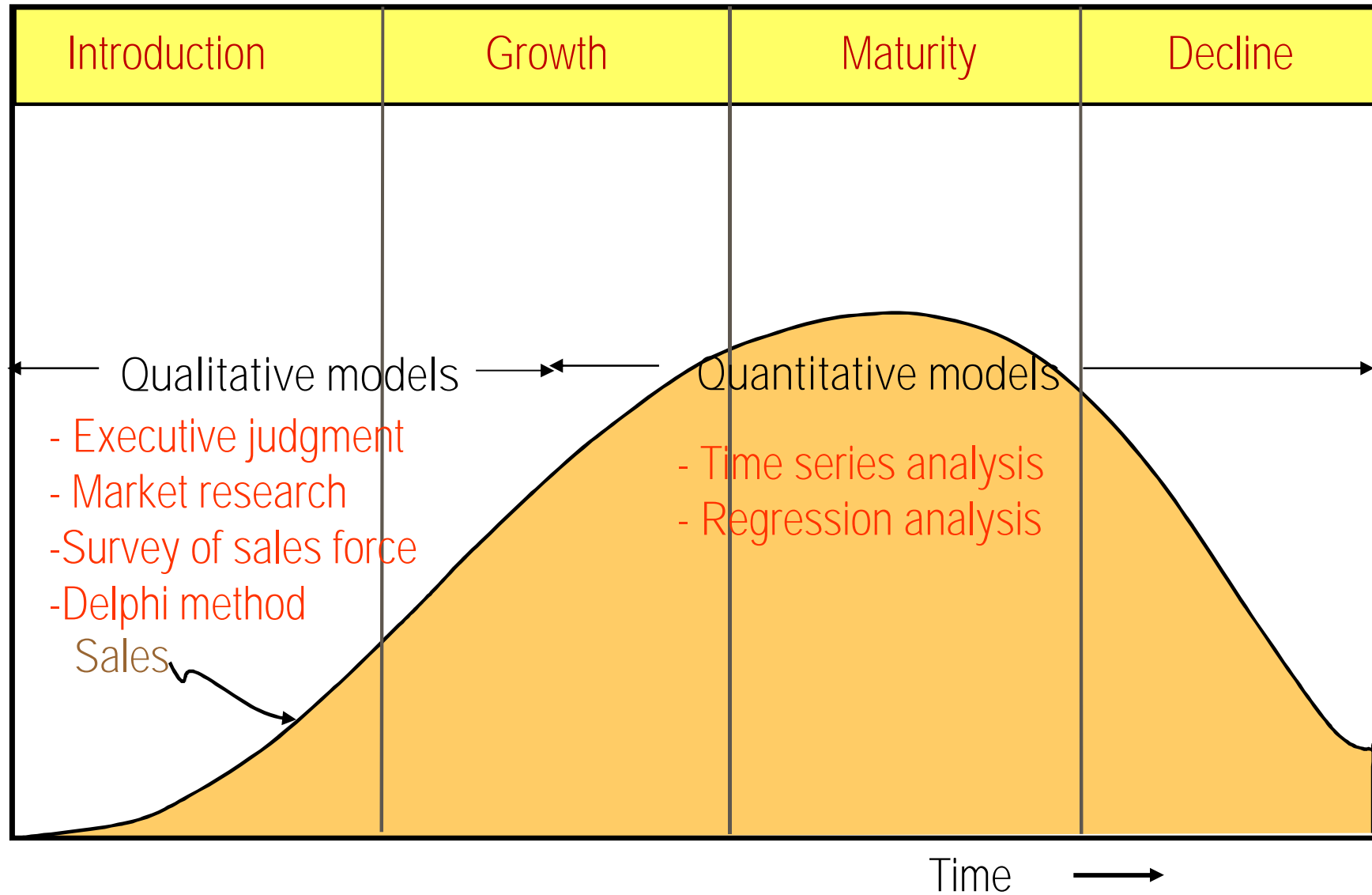
Design
of system

Quantitative
methods

Qualitative
Methods



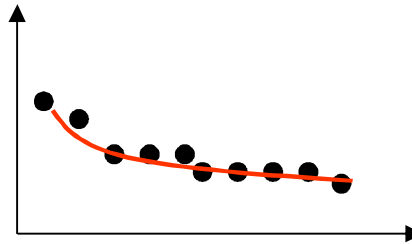
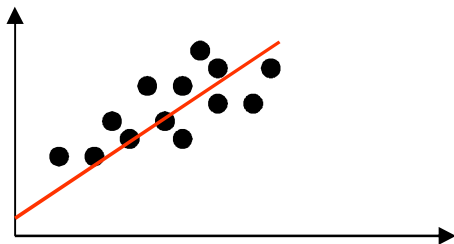
Forecasting during the (product or organization) life cycle



Forecasting



- Features of forecasts
 - Assumes causal system
 $\text{past} \implies \text{future}$
 - Forecasts rarely perfect because of randomness
 - Forecasts more accurate for groups vs. individuals
 - Forecast accuracy decreases as time horizon increases



Steps in the forecasting process



“The forecast”

Step 6 Monitor the forecast

Step 5 Make the forecast

Step 4 Obtain, clean and analyze data

Step 3 Select a forecasting technique

Step 2 Establish a time horizon

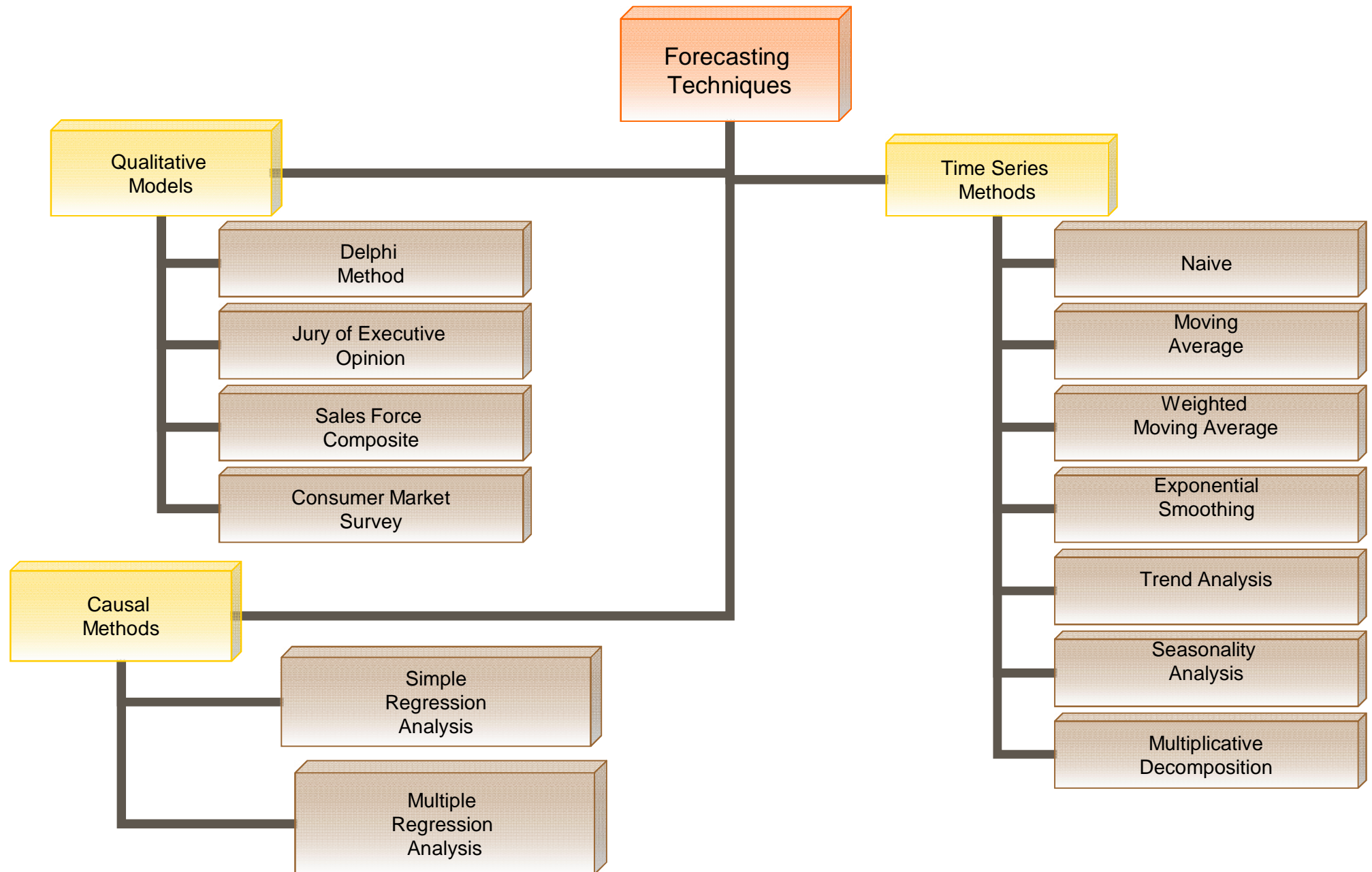
Step 1 Determine purpose of forecast



Forecasting Methods

- Qualitative – opinion-based; incorporates judgmental and subjective factors into forecast
- Quantitative – number-based; most frequently used
 - Time-Series – attempts to predict the future by using historical data over time
 - Causal – incorporates factors that may influence the quantity being forecasted into the model

Forecasting methods and models





Forecasting Methods

- Qualitative methods
 - Executive Judgment: Opinion of a group of high level experts or managers is pooled.
 - Sales Force Composite: Each regional salesperson provides his/her sales estimates. Those forecasts are then reviewed to make sure they are realistic. All regional forecasts are then pooled at the district and national levels to obtain an overall forecast.
 - Market Research/Survey: Solicits input from customers pertaining to their future purchasing plans. It involves the use of questionnaires, consumer panels and tests of new products and services.



Forecasting Methods

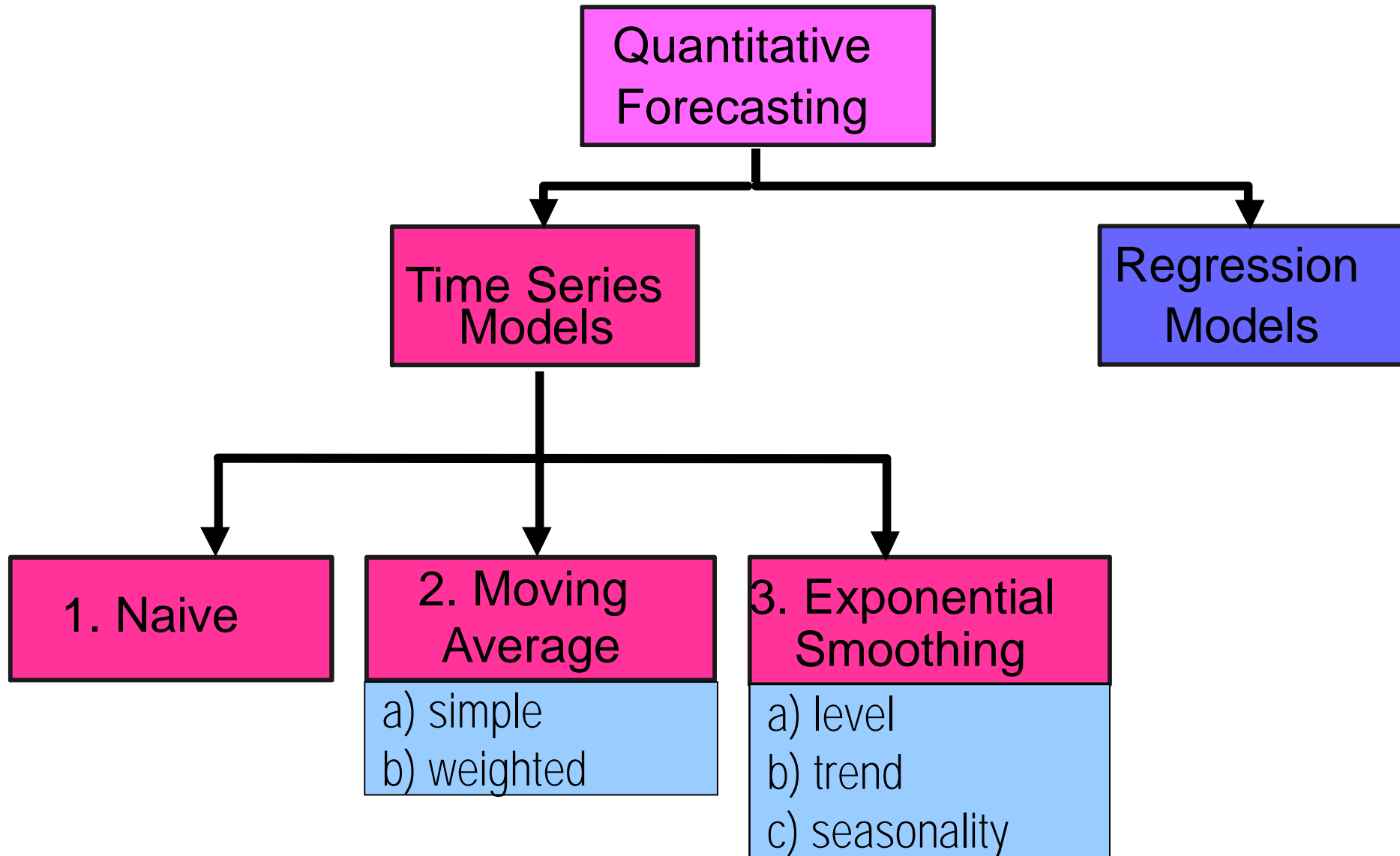
- Qualitative methods (cont'd)

- [Delphi Method](#):*

*See also http://en.wikipedia.org/wiki/Delphi_method

- Eliminates effects of interactions between members
 - Experts do not need to know who other experts are
 - Delphi coordinator asks for opinions, forecasts on subject
 - Develop objective of forecast
 - Determine number of participants, select and contact participants
 - Develop first questionnaire and submit
 - Coordinator analyzes responses
 - Develop second questionnaire based on results of first
 - Analyze responses
 - Rounds continue until consensus reached or experts' opinions cease to change

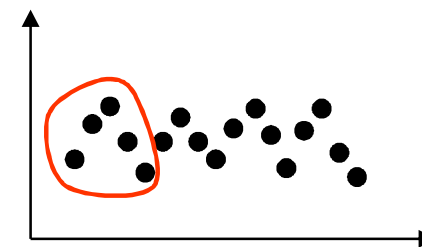
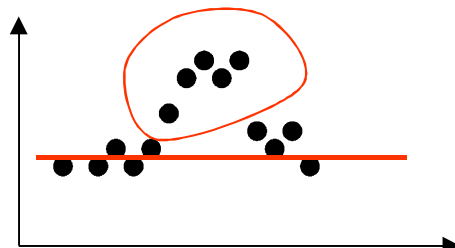
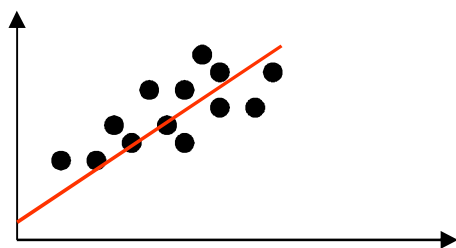
Quantitative forecasting methods



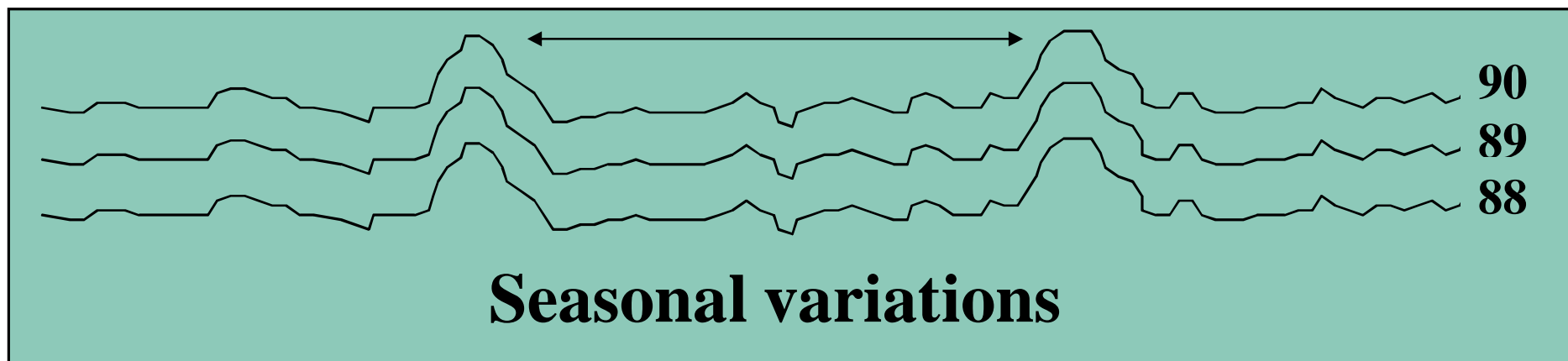
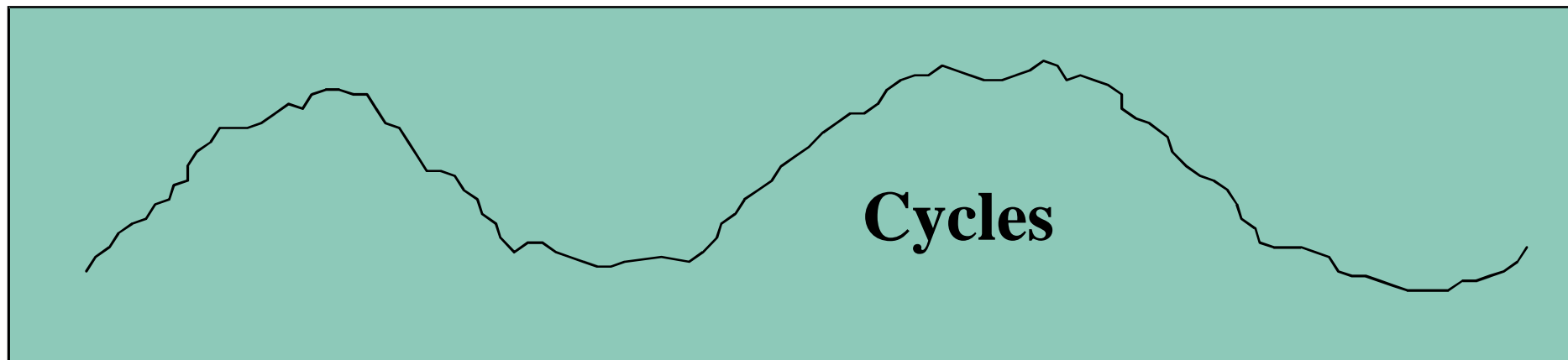
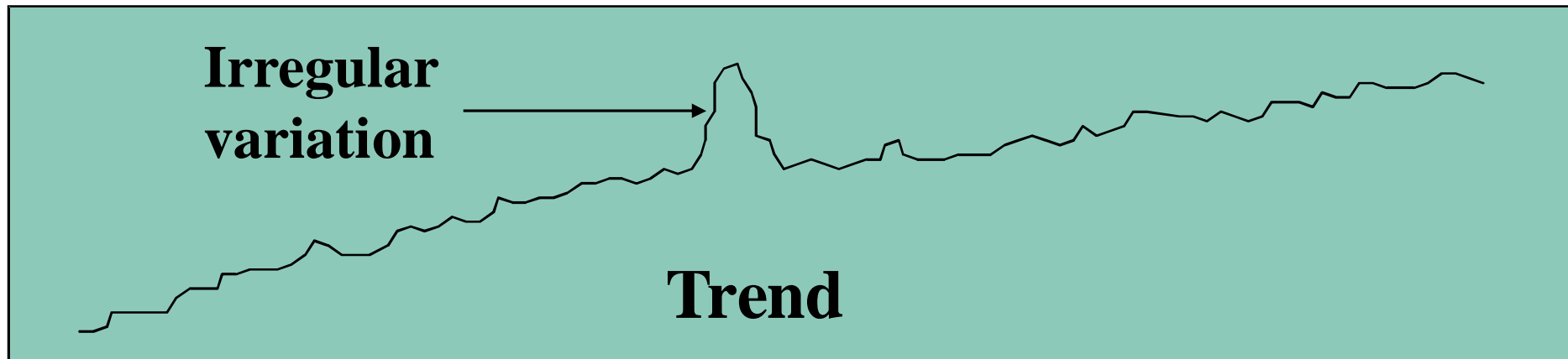


Forecasting Methods

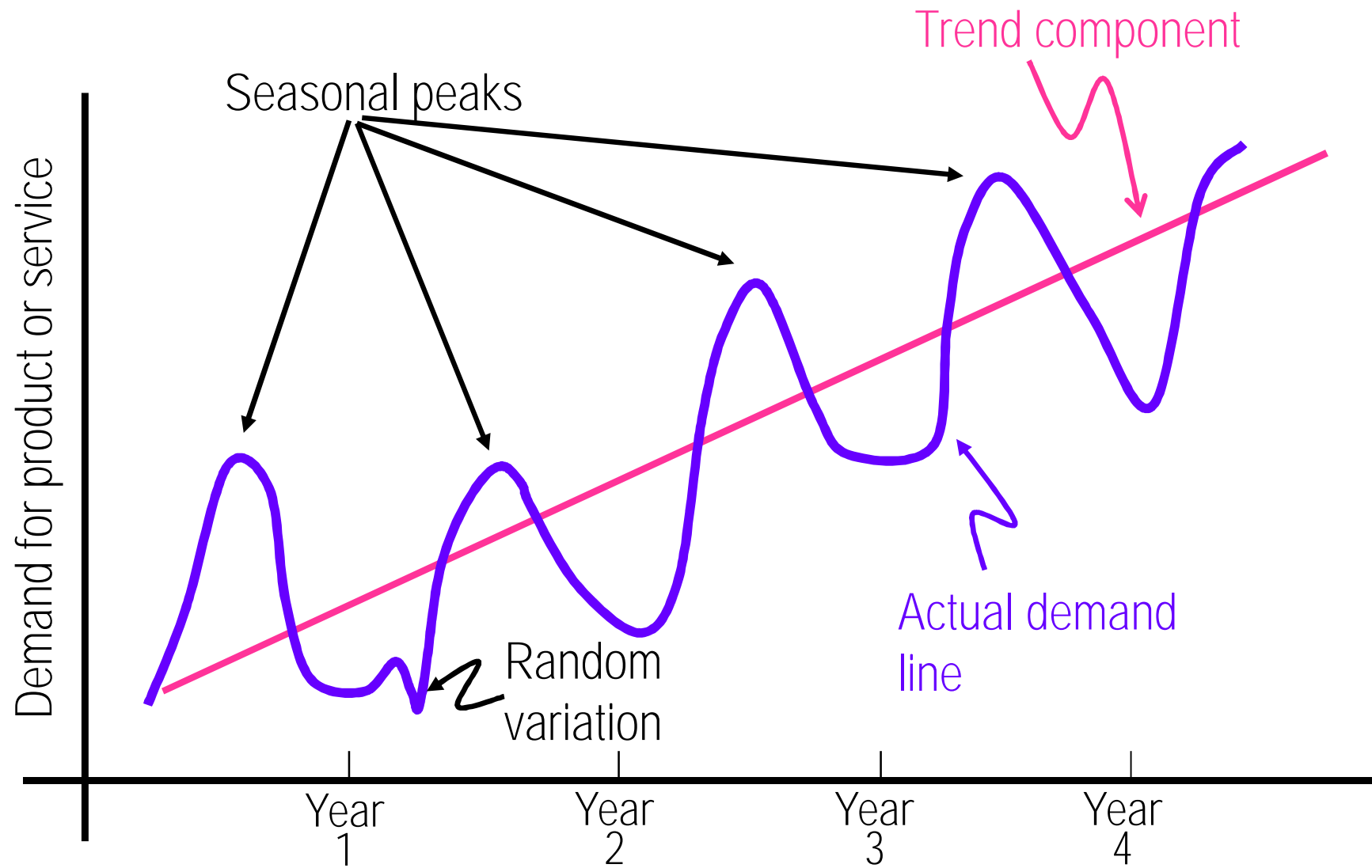
- Time series forecasts
 - Trend - long-term movement in data
 - Seasonality - short-term regular variations in data
 - Cycle – wavelike variations of more than one year's duration
 - Irregular variations - caused by unusual circumstances
 - Random variations - caused by chance



Forecast variations

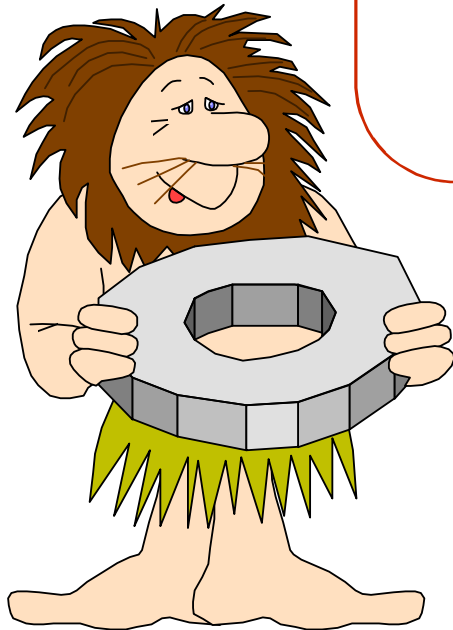


Example: Product demand over time



Naïve Forecasts

**Uh, give me a minute....
We sold 250 wheels last
week.... Now, next week
we should sell....**



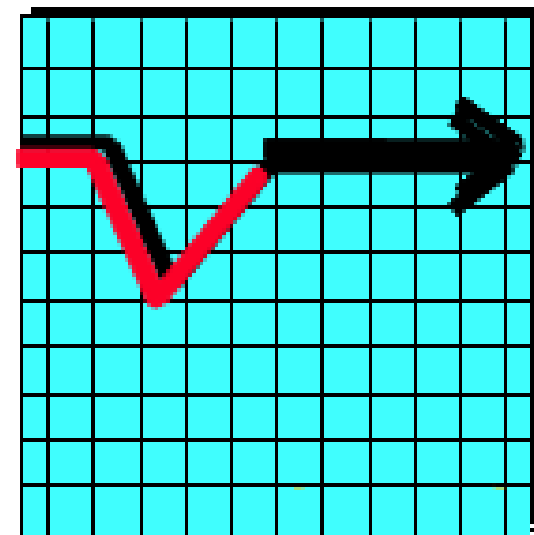
**The forecast for any period equals
the previous period's actual value.**

e.g. May sales = 48 → June forecast = 48



Forecasting Methods

- Naïve Forecasts
 - Simple to use
 - Virtually no cost
 - Quick and easy to prepare
 - Data analysis is nonexistent
 - Easily understandable
 - Cannot provide high accuracy
 - Can be a standard for accuracy





Forecasting Methods

- Uses for Naïve Forecasts
 - Stable time series data
 - $F(t) = A(t-1)$
 - Seasonal variations
 - $F(t) = A(t-n)$
 - Data with trends
 - $F(t) = A(t-1) + (A(t-1) - A(t-2))$
- Techniques for averaging
 - Simple moving average
 - Weighted moving average
 - Exponential smoothing



Forecasting Methods

- Simple moving average
 - Assumes an average is a good estimator of future behavior
 - Used if little or no trend
 - Used for smoothing

$$F_{t+1} = \frac{A_t + A_{t-1} + A_{t-2} + \dots + A_{t-n+1}}{n}$$

F_{t+1} = Forecast for the upcoming period, t+1


n = Number of periods to be averaged

A_t = Actual occurrence in period t



Forecasting Methods

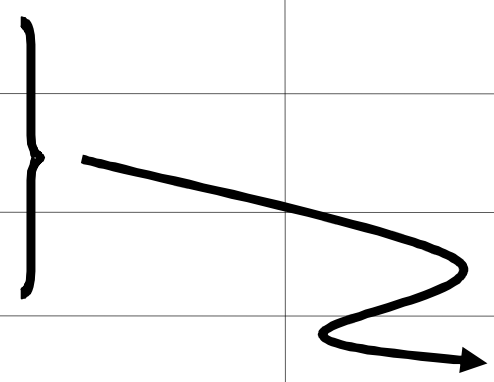
- Simple moving average (example)
 - You're manager in Amazon's electronics department. You want to forecast ipod sales for months 4-6 using a 3-period moving average.

Month	Sales (000)	
1	4	
2	6	
3	5	
4	?	
5	?	
6	?	

Simple moving average (example)

You're manager in Amazon's electronics department.
You want to forecast ipod sales for months 4-6 using
a 3-period moving average.

Month	Sales (000)	Moving Average (n=3)
1	4	NA
2	6	NA
3	5	NA
4	?	$(4+6+5)/3=5$
5	?	
6	?	



Simple moving average (example)


What if ipod sales were actually 3 in month 4?

Month	Sales (000)	Moving Average (n=3)
1	4	NA
2	6	NA
3	5	NA
4	3	5
5	?	
6	?	

Simple moving average (example)

Forecast for Month 5?

Month	Sales (000)	Moving Average (n=3)
1	4	NA
2	6	NA
3	5	NA
4	3	5
5	?	$(6+5+3)/3=4.667$
6	?	



Simple moving average (example)

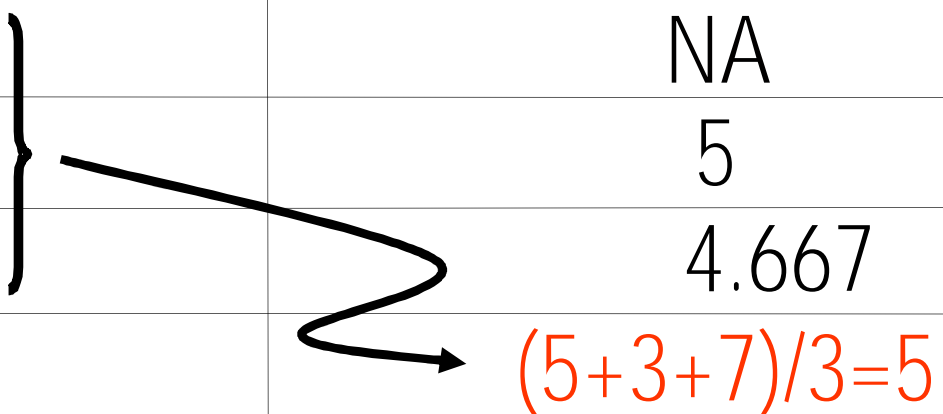
Actual Demand for Month 5 = 7

Month	Sales (000)	Moving Average (n=3)
1	4	NA
2	6	NA
3	5	NA
4	3	5
5	7	4.667
6	?	

Simple moving average (example)

Forecast for Month 6?

Month	Sales (000)	Moving Average (n=3)
1	4	NA
2	6	NA
3	5	NA
4	3	5
5	7	4.667
6	?	$(5+3+7)/3=5$



A black bracket groups the sales values for months 3, 4, and 5 (5, 3, and 7). A black arrow points from the right side of this bracket to the calculation $(5+3+7)/3=5$ in the moving average column for month 6.



Forecasting Methods

- Weighted moving average
 - Gives more emphasis to recent data

$$F_{t+1} = w_1 A_t + w_2 A_{t-1} + w_3 A_{t-2} + \dots + w_n A_{t-n+1}$$

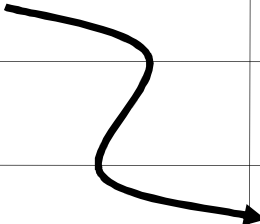
- Weights
 - Decrease for older data
 - Sum to 1.0

Simple moving average models weight all previous periods equally

Weighted moving average (example)

Weighted Moving Average: 3/6, 2/6, 1/6

Month	Sales (000)	Weighted Moving Average
1	4	NA
2	6	NA
3	5	NA
4	?	$31/6 = 5.167$
5	?	
6	?	



Weighted moving average (example)

Weighted Moving Average: 3/6, 2/6, 1/6

Month	Sales (000)	Weighted Moving Average
1	4	NA
2	6	NA
3	5	NA
4	3	$31/6 = 5.167$
5	7	$25/6 = 4.167$
6		$32/6 = 5.333$



Forecasting Methods

- Exponential smoothing

- Assumes the most recent observations have the highest predictive value: **Gives more weight to recent time periods**
 - Weighted averaging method based on previous forecast plus a percentage of the forecast error
 - (A - F) is the error term, α is the % feedback

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

F_{t+1} = Forecast value for time $t+1$

A_t = Actual value at time t

α = Smoothing constant

Need initial
forecast F_t
to start.

Exponential Smoothing – Example 1

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	Ai
Week	Demand
1	820
2	775
3	680
4	655
5	750
6	802
7	798
8	689
9	775
10	

Given the weekly demand data what are the exponential smoothing forecasts for periods 2-10 using $\alpha=0.10$?

Assume $F_1=D_1$

Exponential Smoothing – Example 1 (cont'd)

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	A _i	F _i
Week	Demand	$\alpha = 0.1$
1	820	820.00
2	775	
3	680	
4	655	
5	750	
6	802	
7	798	
8	689	
9	775	
10		

$$F_2 = F_1 + \alpha(A_1 - F_1) = 820 + .1(820 - 820) = 820$$

Exponential Smoothing – Example 1 (cont'd)

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	A _i	F _i
Week	Demand	$\alpha = 0.1$
1	820	820.00
2	775	820.00
3	680	
4	655	
5	750	
6	802	
7	798	
8	689	
9	775	
10		

$$F_3 = F_2 + \alpha(A_2 - F_2) = 820 + .1(775 - 820) = 815.5$$

Exponential Smoothing – Example 1 (cont'd)

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	A _i	F _i
Week	Demand	$\alpha = 0.1$
1	820	820.00
2	775	820.00
3	680	815.50
4	655	
5	750	
6	802	
7	798	
8	689	
9	775	
10		

This process
continues
through week 10

Exponential Smoothing – Example 1 (cont'd)

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	A _i	F _i	
Week	Demand	$\alpha = 0.1$	$\alpha = 0.6$
1	820	820.00	820.00
2	775	820.00	820.00
3	680	815.50	793.00
4	655	801.95	725.20
5	750	787.26	683.08
6	802	783.53	723.23
7	798	785.38	770.49
8	689	786.64	787.00
9	775	776.88	728.20
10		776.69	756.28

What if the
 α constant
equals 0.6

Exponential Smoothing – Example 2

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	A _i	F _i	
Month	Demand	$\alpha = 0.3$	$\alpha = 0.6$
January	120	100.00	100.00
February	90	106.00	112.00
March	101	101.20	98.80
April	91	101.14	100.12
May	115	98.10	94.65
June	83	103.17	106.86
July		97.12	92.54
August			
September			

What if the
a constant
equals 0.6

Exponential Smoothing – Example 3

Company A, a personal computer producer purchases generic parts and assembles them to final product. Even though most of the orders require customization, they have many common components. Thus, managers of Company A need a good forecast of demand so that they can purchase computer parts accordingly to minimize inventory cost while meeting acceptable service level. Demand data for its computers for the past 5 months is given in the following table.

Exponential Smoothing – Example 3

$$F_{t+1} = F_t + \alpha(A_t - F_t)$$

i	A _i	F _i	
Month	Demand	$\alpha = 0.3$	$\alpha = 0.5$
January	80	84.00	84.00
February	84	82.80	82.00
March	82	83.16	83.00
April	85	82.81	82.50
May	89	83.47	83.75
June		85.13	86.38
July		??	??

What if the
a constant
equals 0.5



Forecasting Methods

- Exponential smoothing
 - How to choose α
 - Depends on the emphasis you want to place on the most recent data
- Increasing α makes forecast more sensitive to recent data

Forecast effects of smoothing constant α

$$F_{t+1} = F_t + \alpha (A_t - F_t)$$

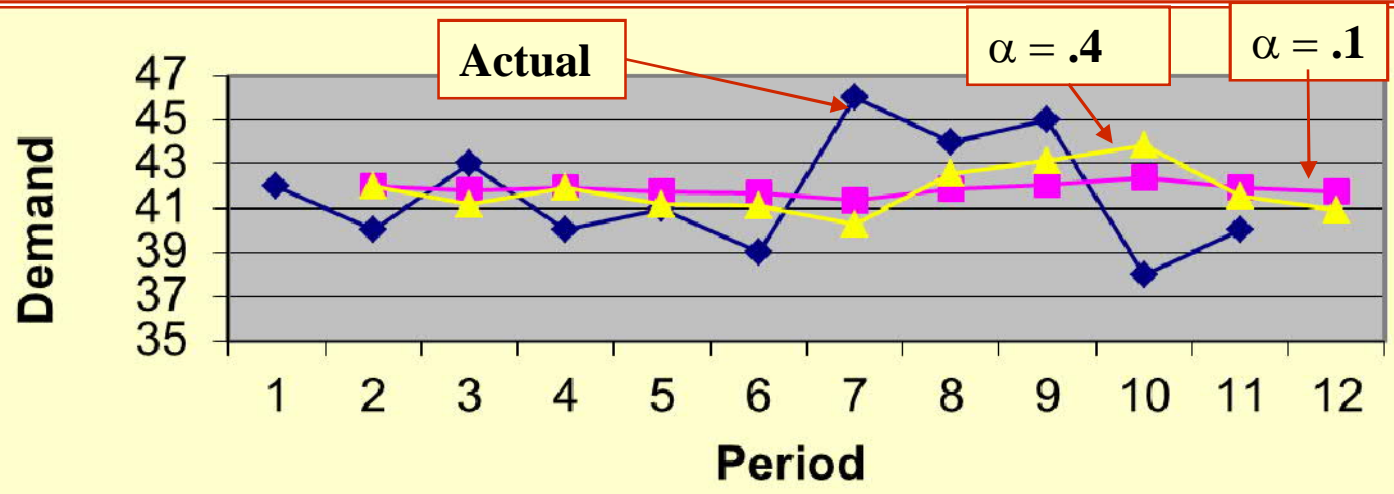
or

$$F_{t+1} = \underbrace{\alpha}_{W_1} A_t + \underbrace{\alpha(1-\alpha)}_{W_2} A_{t-1} + \underbrace{\alpha(1-\alpha)^2}_{W_3} A_{t-2} + \dots$$

$\alpha =$	Weights		
	Prior Period	2 periods ago	3 periods ago
	α	$\alpha(1-\alpha)$	$\alpha(1-\alpha)^2$
$\alpha = 0.10$	10%	9%	8.1%
$\alpha = 0.90$	90%	9%	0.9%

Exponential Smoothing: Example

Period	Actual	Alpha = 0.1	Error	Alpha = 0.4	Error
1	42				
2	40	42	-2.00	42	-2
3	43	41.8	1.20	41.2	1.8
4	40	41.92	-1.92	41.92	-1.92
5	41	41.73	-0.73	41.15	-0.15
6	39	41.66	-2.66	41.09	-2.09
7	46	41.39	4.61	40.25	5.75
8	44	41.85	2.15	42.55	1.45
9	45	42.07	2.93	43.13	1.87
10	38	42.36	-4.36	43.88	-5.88
11	40	41.92	-1.92	41.53	-1.53
12		41.73		40.92	



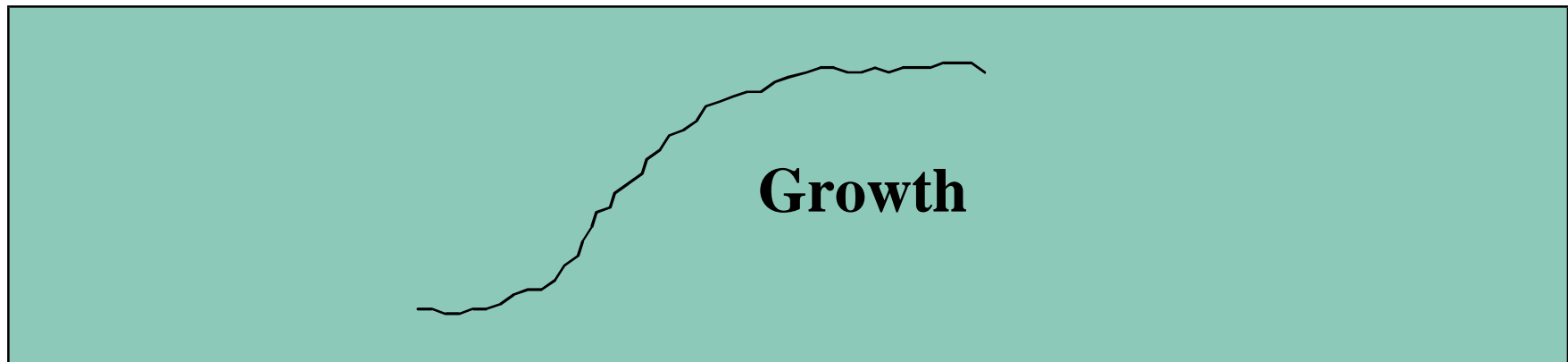
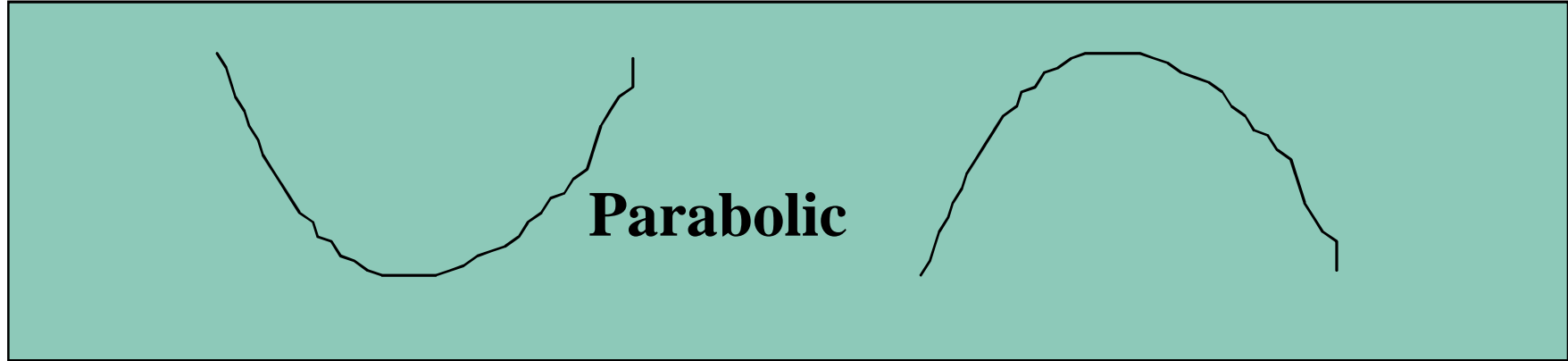
Picking a smoothing constant



Forecasting Methods

- To use a forecasting method
 - Collect historical data
 - Select a model
 - Moving average methods
 - Select n (number of periods)
 - For weighted moving average: select **weights**
 - Exponential smoothing
 - Select α
 - Selections should produce a good forecast
 - Has a small error: $\text{Error} = \text{Demand} - \text{Forecast}$

Common nonlinear trends





Forecasting Methods

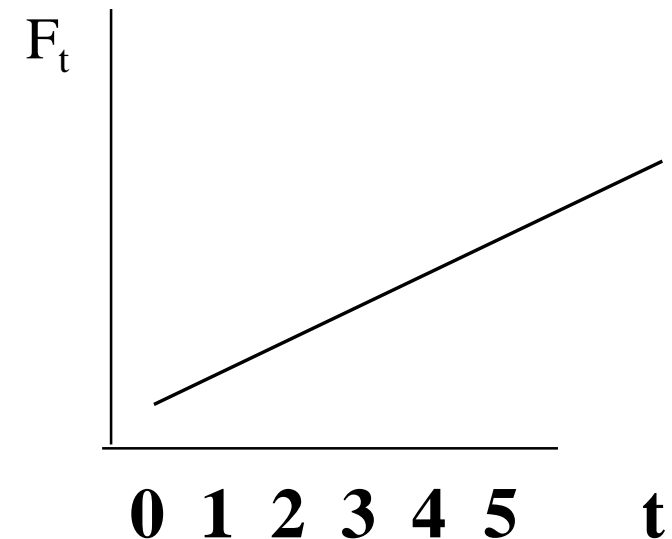
- Linear trend equation

$$F_t = a + bt$$

- F_t = Forecast for period t
- t = Specified number of time periods
- a = Value of F_t at $t = 0$
- b = Slope of the line
- Calculating a and b :

$$a = \frac{\sum y - b\sum t}{n}$$

$$b = \frac{n \sum (ty) - \sum t \sum y}{n \sum t^2 - (\sum t)^2}$$



Linear trend equation example

t Week	t ²	y Sales	ty
1	1	150	150
2	4	157	314
3	9	162	486
4	16	166	664
5	25	177	885
$\Sigma t = 15$ $(\Sigma t)^2 = 225$	$\Sigma t^2 = 55$	$\Sigma y = 812$	$\Sigma ty = 2499$

$$a = \frac{812 - 6.3(15)}{5} = \mathbf{143.5}$$

$$b = \frac{5(2499) - 15(812)}{5(55) - 225} = \frac{12495 - 12180}{275 - 225} = 6.3$$

$$y = 143.5 + 6.3t$$



Forecasting Methods

- Techniques for seasonality
 - Seasonal variations
 - Regularly repeating movements in series values that can be tied to recurring events
 - Seasonal relative
 - Percentage of average or trend
- Centered moving average
 - A moving average positioned at the center of the data that were used to compute it



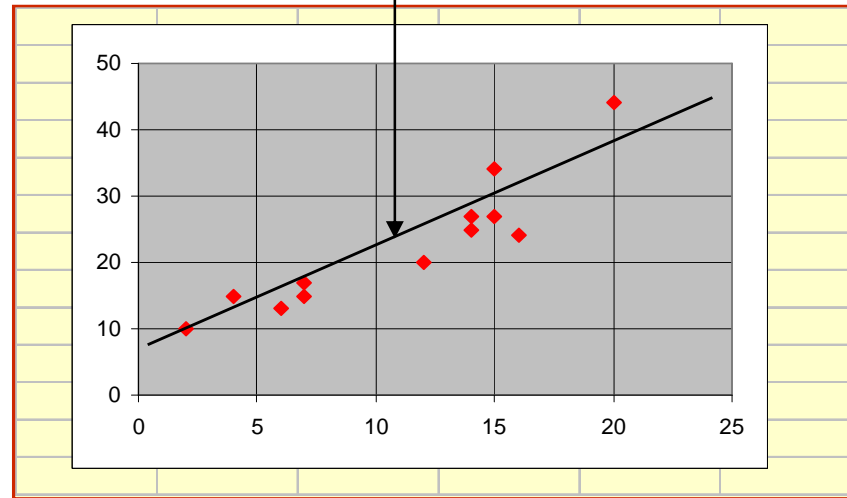
Forecasting Methods

- Associative forecasting
 - Predictor variables - used to predict values of variable interest
 - Regression - technique for fitting a line to a set of points
 - Least squares line - minimizes sum of squared deviations around the line

Linear model seems reasonable

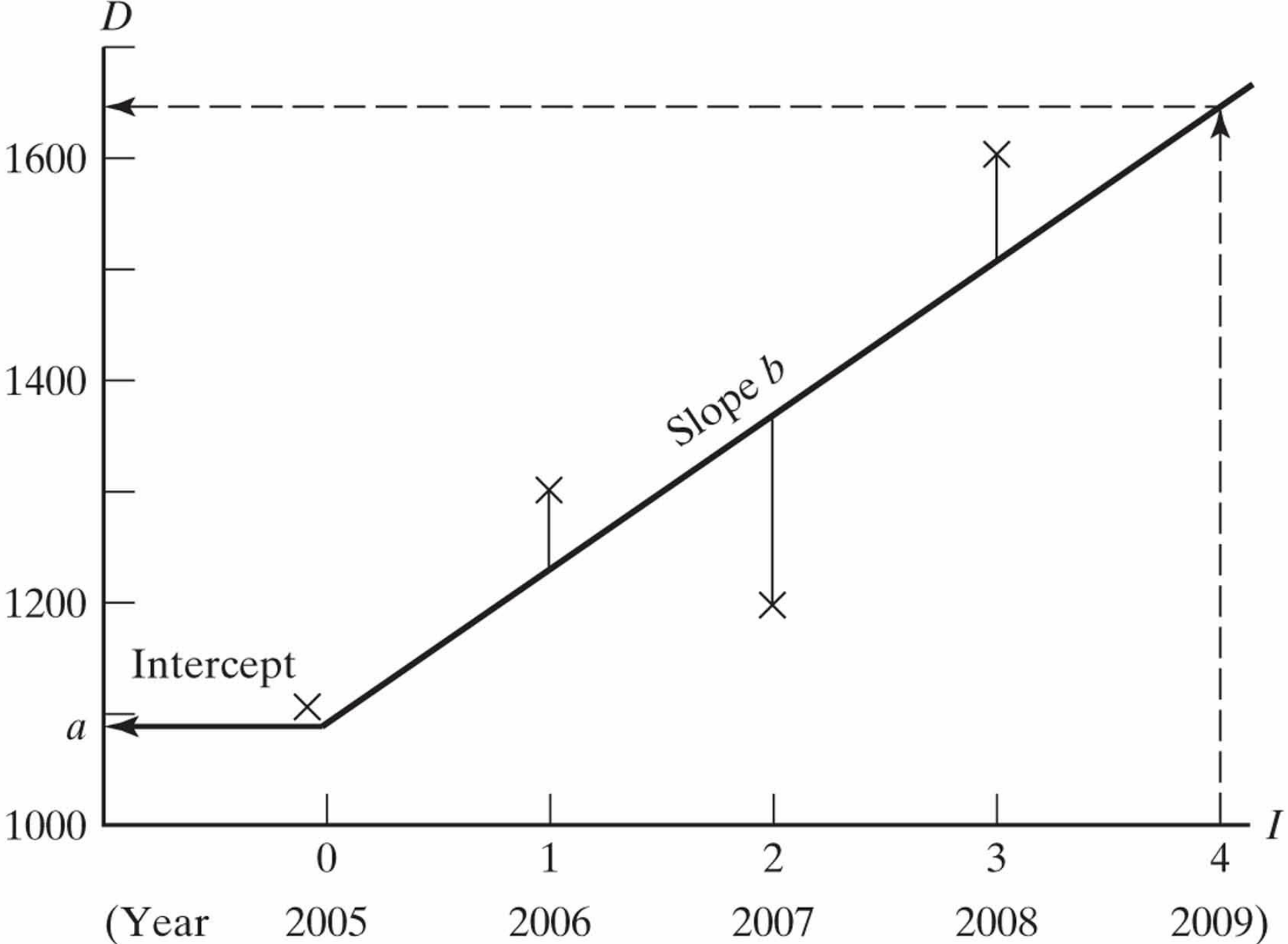
X	Y
7	15
2	10
6	13
4	15
14	25
15	27
16	24
12	20
14	27
20	44
15	34
7	17

Computed
relationship



A straight line is fitted to a set of sample points.

Simple regression model



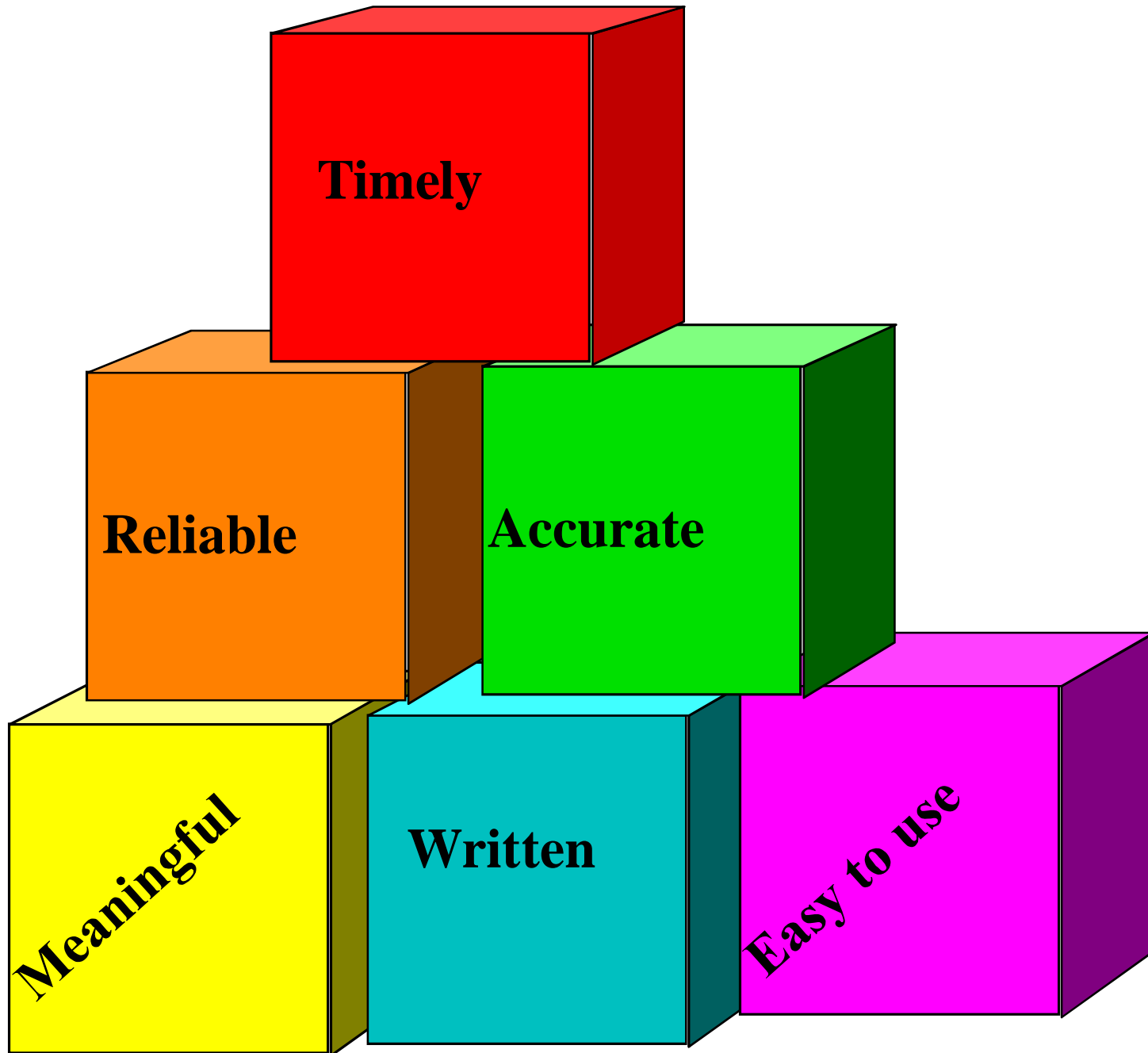
(Source: Morse, L. C. and Babcock, D. L., 2010. *Managing Engineering and Technology*, 5th ed.)



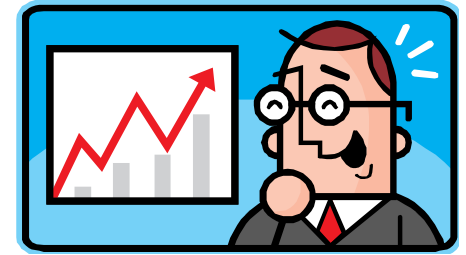
Forecasting Methods

- Linear regression assumptions
 - Variations around the line are random
 - Deviations around the line normally distributed
 - Predictions are being made only within the range of observed values
 - For best results:
 - Always plot the data to verify linearity
 - Check for data being time-dependent
 - Small correlation may imply that other variables are important

Elements of a good forecast



Good Forecast



- Forecast accuracy
 - Error - difference between actual value and predicted value

- Mean Absolute Deviation (MAD)

- Average absolute error
- Easy to compute
- Weights errors linearly

$$\text{MAD} = \frac{\sum |Actual - Forecast|}{n}$$

- Mean Squared Error (MSE)

- Average of squared error
- More weight to large errors

$$\text{MSE} = \frac{\sum (Actual - Forecast)^2}{n}$$

- Mean Absolute Percent Error (MAPE)

- Average absolute percent error
- Puts errors in perspective

$$\text{MAPE} = \frac{\sum \left[\left(\frac{Actual - Forecast}{Actual} \right) \times 100\% \right]}{n}$$

Example of forecast accuracy calculations

Period	Actual	Forecast	(A-F)	A-F	(A-F)^2	(A-F /Actual)*100
1	217	215	2	2	4	0.92
2	213	216	-3	3	9	1.41
3	216	215	1	1	1	0.46
4	210	214	-4	4	16	1.90
5	213	211	2	2	4	0.94
6	219	214	5	5	25	2.28
7	216	217	-1	1	1	0.46
8	212	216	-4	4	16	1.89
			-2	22	76	10.26
MAD=	2.75					
MSE=	10.86					
MAPE=	1.28					

A = Actual

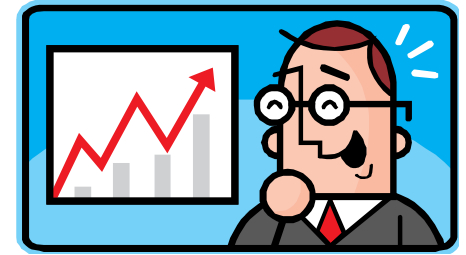
F = Forecast

MAD = Mean Absolute Deviation

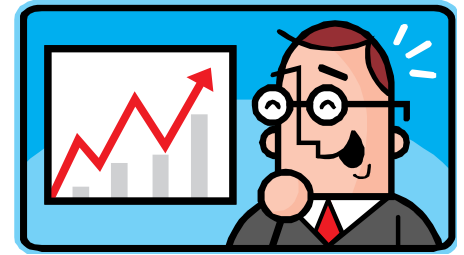
MSE = Mean Squared Error

MAPE = Mean Absolute Percent Error

Good Forecast



- Controlling the forecast
 - Control chart
 - A visual tool for monitoring forecast errors
 - Used to detect non-randomness in errors
 - Forecasting errors are in control if
 - All errors are within the control limits
 - No patterns, such as trends or cycles, are present
- Sources of forecast errors
 - Model may be inadequate
 - Irregular variations
 - Incorrect use of forecasting technique

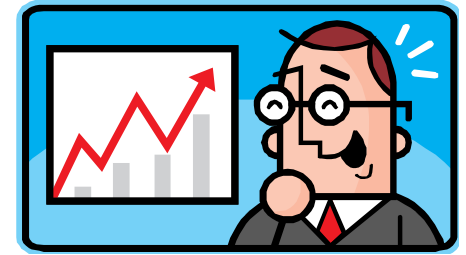


Good Forecast

- Bias – Persistent tendency for forecasts to be greater or less than actual values
 - How can we tell if a forecast has a positive or negative bias?
- Tracking signal (TS)
 - Ratio of cumulative error to Mean Absolute Deviation (MAD)
 - Good tracking signal has low values

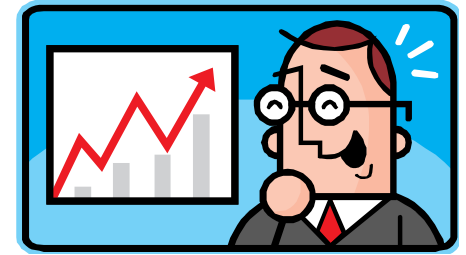
$$\text{Tracking signal} = \frac{\sum(\text{Actual-forecast})}{\text{MAD}}$$

Good Forecast

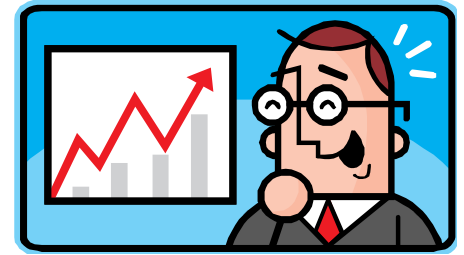


- Choosing a forecasting technique
 - No single technique works in every situation
 - Two most important factors
 - Cost
 - Accuracy
 - Other factors include the availability of:
 - Historical data
 - Computers
 - Time needed to gather and analyze the data
 - Forecast horizon

Good Forecast



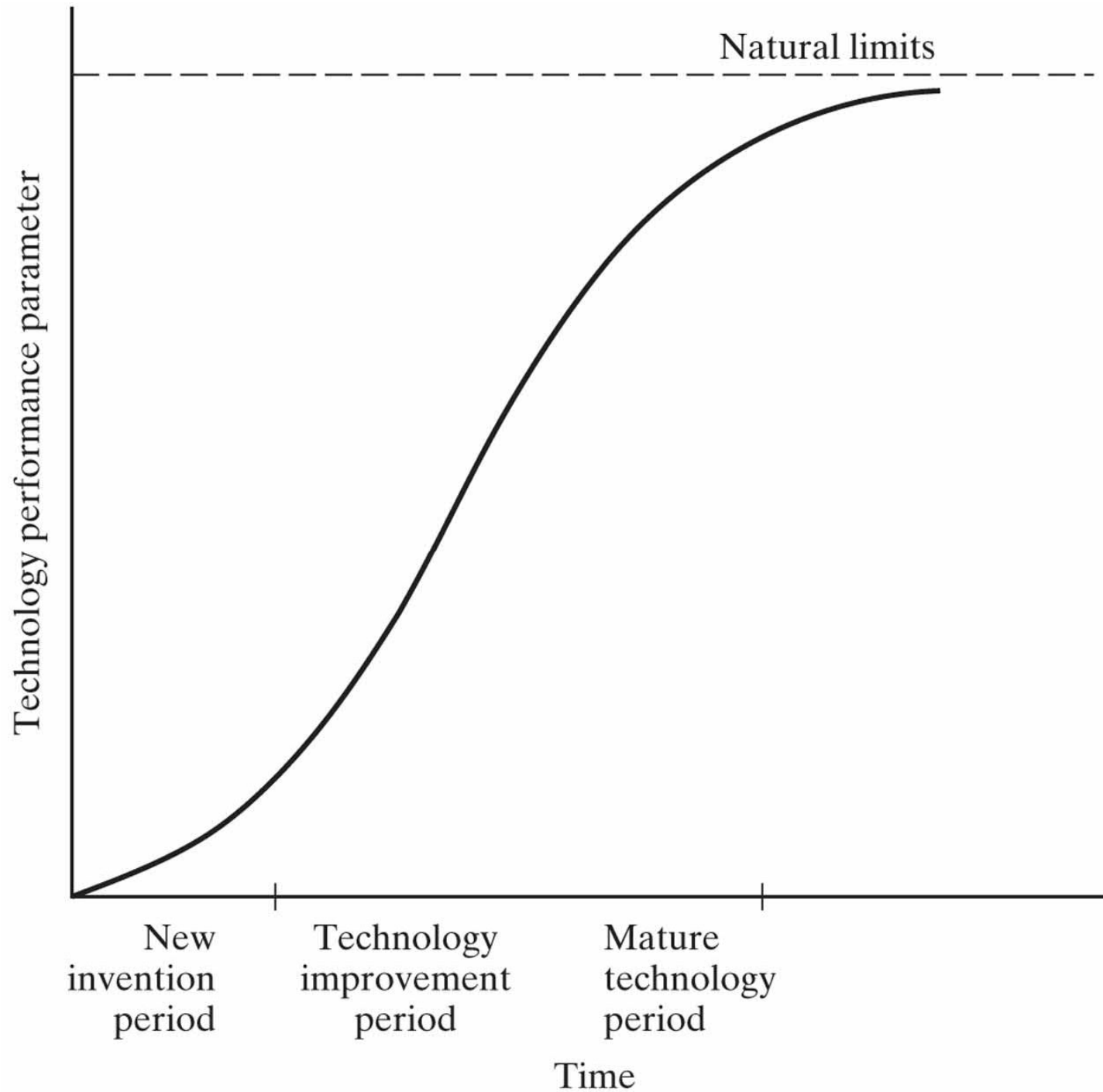
- Operations strategy
 - Forecasts are the basis for many decisions
 - Work to improve short-term forecasts
 - Accurate short-term forecasts improve
 - Profits
 - Lower inventory levels
 - Reduce inventory shortages
 - Improve customer service levels
 - Enhance forecasting credibility
- Supply chain forecasts
 - Sharing forecasts with supply can improve forecast quality in the supply chain, lower costs and shorter lead times



Good Forecast

- Forecasting new products
 - First use judgmental
 - Expert opinions
 - Consumer intentions
- Technological forecasting and strategies for managing technology
 - Invention and innovation
 - Entrepreneurship
 - Managing technological change
 - Government regulation

Technology S-curve



Further Reading



- Planning in Organizations (video and texts)
 - <http://education-portal.com/academy/topic/planning.html>
 - Planning as a Function of Management (8:52)
 - Types of Planning: Strategic, Tactical, Operational & Contingency Planning (9:23)
 - What is a SWOT Analysis? (5:35)
 - Company Mission Statements: Definition & Examples (5:42)
 - Chapter Exam

