IENG 450
INDUSTRIAL MANAGEMENT

CHAPTER 3
PLANNING AND FORECASTING

31.03.021

Function of Management (by Fayol)

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Management Functions
    │
    ├──────────────────────── Planning
    │                              │
    │         Decision Making ─────┘
    │
    ├──────────────────────── Organizing
    │
    ├──────────────────────── Leading
    │
    └──────────────────────── Controlling
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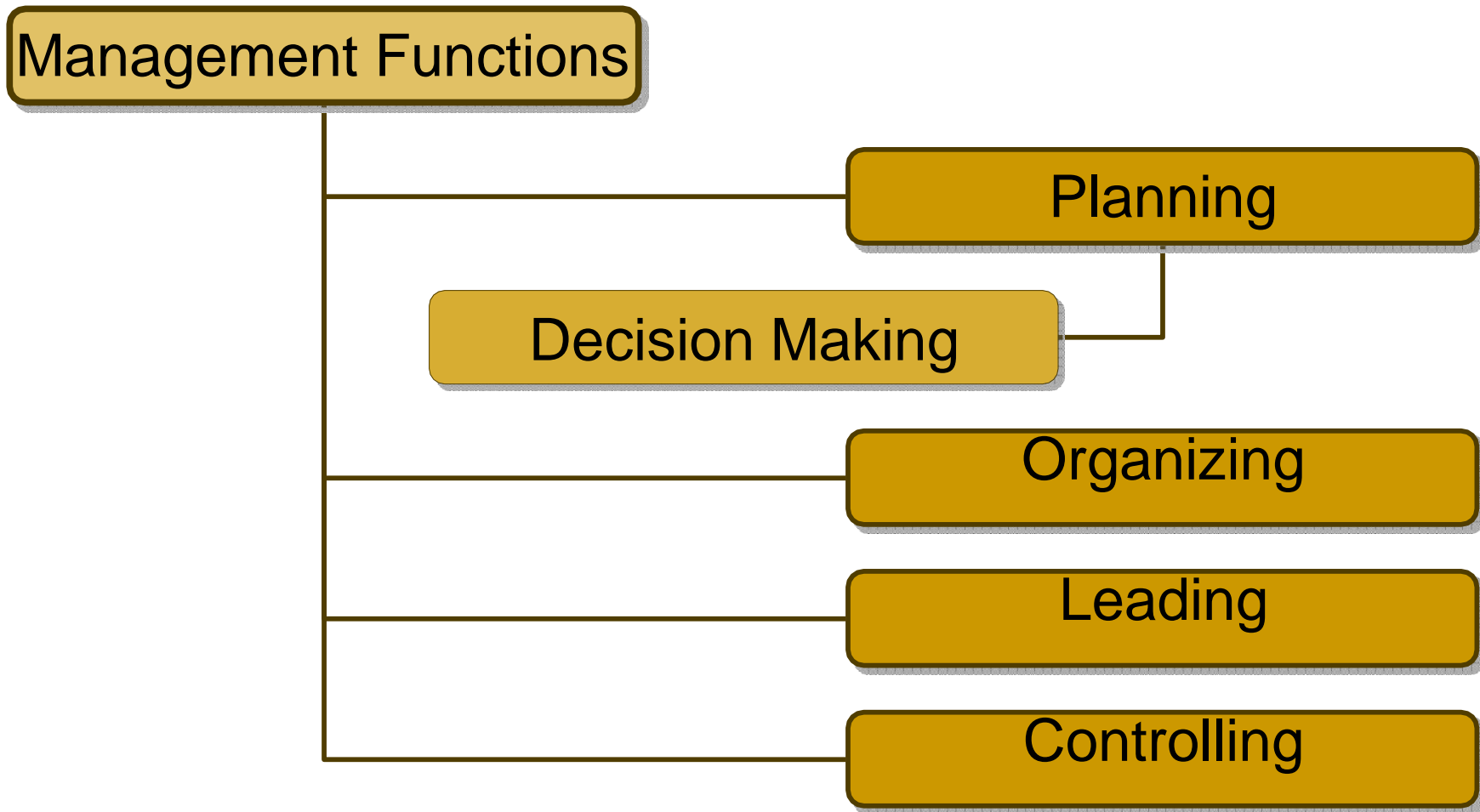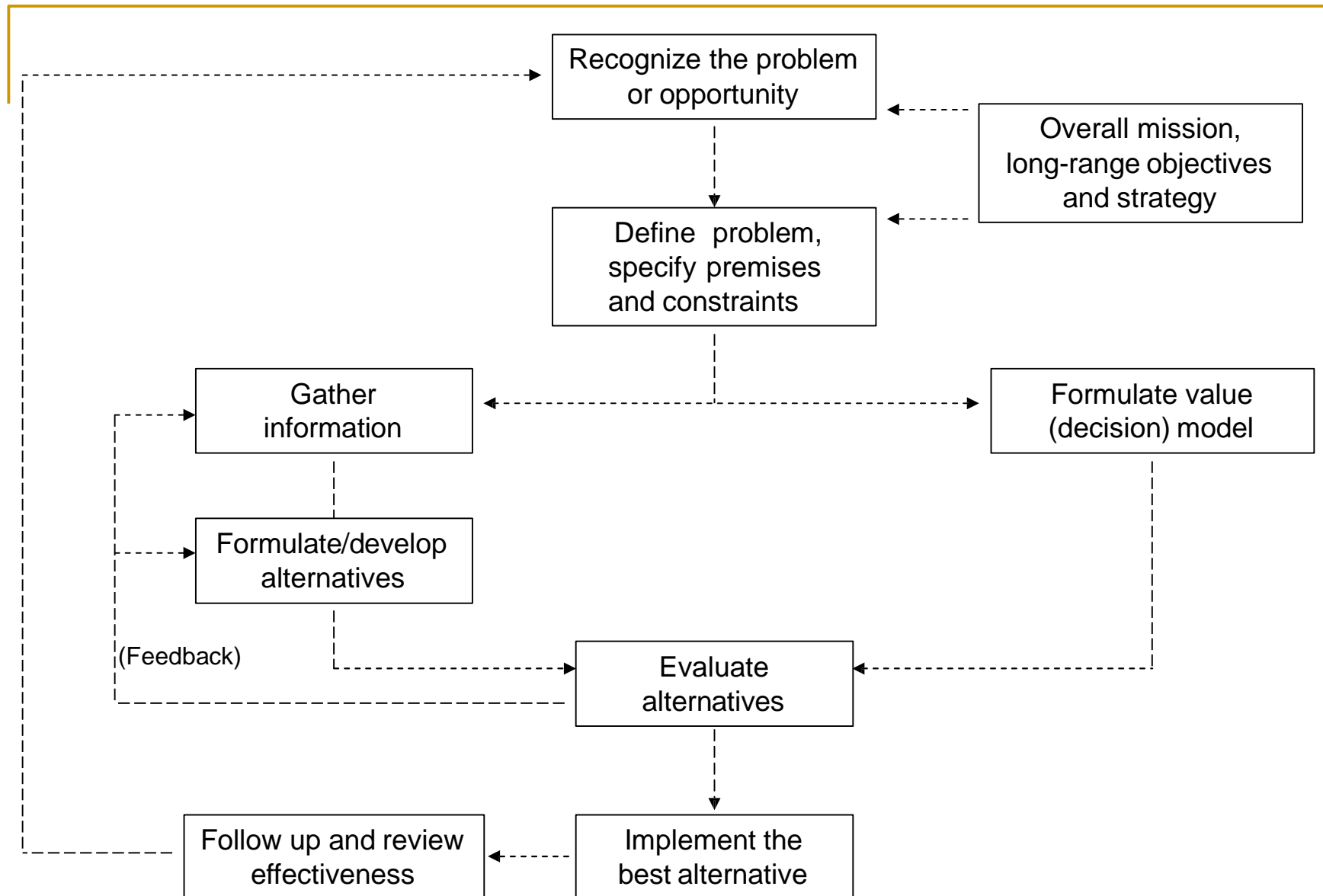
Planning

- Planning plays an important role in any business venture—large or small. It can make the difference between the success or failure of an organization.

- Strategic planning has become more important to the engineering manager because technology, competition, and ongoing changes have made the business environment less stable and less predictable.

- There are as many strategic planning models as there are strategic planning experts. There are many models that have a different number of steps, but the overall purpose remains the same: set goals, conduct the work, study the effect of the work, and then realign goals to improve the implementation of the plan.

- Companies, organizations, educational institutions, nonprofits, committees, and individuals use a broad range of information, formats, and styles in their strategic planning models.

Importance of Planning

- Planning provides a method of identifying objectives and designing a sequence of programs and activities to achieve the objectives.

- Amos and Sarchet (Management for Engineers, Prentice Hall, 1981)
  - Planning is simply "deciding in advance what to do, how to do it, when to do it and who is to do it".
  - From this definition, planning must obviously precede doing!

The planning/decision making process

The Foundation for Planning

- Strategic Planning
  - A successful enterprise needs to develop effective strategies for achieving its mission, and strategic planning is the organize process for selecting these strategies.

  - Strategic planning suggests ways (strategies) to identify and to move toward desired future states.

  - It consists of the process of developing and implementing plans to reach goals and objectives.

  - In short, strategic planning is a disciplined effort to produce fundamental decisions and actions that shape and guide what an organization is, what it does, and why it does it, with a focus on the future, both internally and externally.

The Foundation for Planning

- Strategic Planning
  - The identification of organization's vision and mission is the first step of any strategic planning process.
    - A **vision statement** describes where the goal setters want to position themselves in the future.
      - Ex. Dept. of EENG's vision statement: We envision a department that is one of the best in the region with a diverse and stimulating intellectual environment that provides leadership in the field through its education and research agenda.

    - A **mission statement** sets forth what the company is attempting to do and is usually what the public sees.
      - Ex. Dept. of EENG's mission statement:Our mission is to serve society through excellence in education, research, and public service. We aspire to instill in our students the attitudes, values, and vision that will prepare them for professionalism and life-long learning. We strive to generate new knowledge and technology and aim to educate our graduates for following technological and theoretical developments, and use them to serve the society.

The Foundation for Planning

- **Strategic Planning**
  - It is difficult to develop future strategies for the business without knowing the current status and their success at this point.

  - An analysis of the status needs to be made.

  - One tool which is often used is the ***SWOT analysis*** (Strengths, Weaknesses, Opportunities, and Threats).

Strategic Planning

- **_SWOT analysis_**
  - ❑ Strenths and weaknesses are basically internal to an organization and may include the following:
    - ■ Management,
    - ■ Marketing,
    - ■ Technology,
    - ■ Research,
    - ■ Finances,
    - ■ Systems.

  - ❑ The external opportunities and threats may be in some of the following areas:
    - ■ Customers,
    - ■ Competition,
    - ■ New technologies,
    - ■ Government policies.

Once the SWOT review is complete, the future strategy may be readily apparent, or as is more likely the case, a series of strategies or combinations of tactics will suggest themselves. Use the SWOTs to help identify possible strategies as follows:

Build on Strengths
Resolve Weaknesses
Exploit Opportunities
Avoid Threats

SWOT Analysis Nike, Inc.

- **Strengths**
    - Nike is a very competitive organization.

    - Nike is strong at research and development, as is evidenced by its evolving and innovative product range. They then manufacture wherever they can produce high quality product at the lowest possible price. If prices rise, and products can be made more cheaply elsewhere.

    - Nike is a global brand. It is the number one sports brand in the World.

SWOT Analysis Nike, Inc.

- **Weaknesses**

  - ❑ The organization does have a diversified range of sports products. However, the income of the business is still heavily dependent upon its share of the footwear market.

  - ❑ The retail sector is very price sensitive.

SWOT Analysis Nike, Inc.

- **Opportunities**
  - Product development offers Nike many opportunities. The brand is strongly defended by its owners whom truly believe that Nike is not a fashion brand.

  - There is also the opportunity to develop products such as sport wear, sunglasses and jewellery.

  - The business could also be developed internationally, building upon its strong global brand recognition.

SWOT Analysis Nike, Inc.

- **Threats**
  - Nike is exposed to the international nature of trade. It buys and sells in different currencies and so costs and margins are not stable over long periods of time. Such an exposure could mean that Nike may be manufacturing and/or selling at a loss.

  - The market for sports shoes and garments is very competitive.

  - The retail sector is becoming price competitive. This ultimately means that consumers are shopping around for a better deal.

Some Planning Concepts

Responsibility for Planning

Planning is a continuing responsibility of every manager. The higher managers rise, the more time they must spend in planning, and the further into the future they must try to foresee. Most large organizations have staff offices for planning. The planning staff can coordinate the overall planning effort, gather and analyze information on the economy, markets, and competition, and perform other assigned tasks.

Planning Premises

An essential for effective planning is establishment of the premises, or assumptions, on which planning is to be based. Weihrich and Koontz define planning premises as "the anticipated environment in which plans are expected to operate. They include assumptions or forecasts of the future and known conditions that will affect the operation of plans." Examples of planning premises include assumptions about future economic conditions, government decisions (regulation, tax law, and trade policy), the nature of competition, and future markets.

Some Planning Concepts (cont.)

Planning Horizon

The planning horizon asks how far into the future one should plan. This varies greatly, depending on the nature of the business and the plan.

Weihrich and Koontz summarize this difference in the "commitment principle: Logical planning covers a future period of time necessary to fulfill the commitments involved in decisions made today." For example, High-technology products may have short effective lives, therefore, short planning horizons. The decision of a utility company to build a nuclear power plant, on the other hand, must consider at least 10 years' time to obtain necessary approvals and build the plant, and several decades' operation to recover the investment.

Systems of Plans

Usually, not just one plan is involved, but a system of them. In 1916 Henri Fayol divided his Plan of Action in a Large Mining and Metallurgical Firm into yearly forecasts and "ten-yearly forecasts," the latter redone every five years. Current practice is not much different, involving strategic plans of from 3 to 15 years futurity and operating plans. Complex programs will require not just a single plan, but a system of plans, each describing a related activity.

Some Planning Concepts (cont.)

Policies and Procedures

Policies are guides for decision making that permit implementation of upper-management objectives, with room for interpretation and freedom of choice by subordinates. Rules, in contrast, do not permit discretion. Policies have a hierarchy of levels, just as plans do. To be effective, policies should be clear, flexible, and communicated throughout the organization; involve participation in their development; and be reviewed regularly.

A **procedure**, on the other hand, is a prescribed sequence of activities to accomplish a desired purpose. Procedures tell you if you want to do this, do it this way. For example, while the decision to approve (release) a design drawing requires technical judgment, the established procedure for doing so must be followed to assure that appropriate individuals have had a chance to approve the drawing and that its official existence is communicated to those who need to be informed of it.

Forecasting

An essential primary to effective planning is foreseeing, or forecasting—what the future will be like.

Planning provides the strategies, given certain forecasts, and forecasting estimates the results, given the plan.

Planning is what the organization ought to do, and forecasting relates to what happens if the firm tries to implement given strategies in a possible environment.

There must be alternatives to the plan based on the forecasts. For example, if one of your strategies is to encourage people to travel by car more to your destination, and the price of gasoline is at an all-time high, then there should be an alternative strategy.

Forecasting

The engineer manager must be concerned with both future markets and future technology, and must therefore understand both sales and technological forecasting.

The most important assumption in planning and decision making is the level of future sales.

Almost everything for which we plan is based on this assumption—the production level (which determines how many people we must hire and train, or if production declines, lay off); the need for new facilities and equipment; the size of the sales force and advertising budget; new funding for purchases; and for investment in inventory and accounts receivable.

Forecasting – Qualitative Methods

- **Jury of Executive Opinion**

  - The executives of the organization (VP's of various divisions) each provide an estimate (educated guess) of future volume and the president provides a considered average of the estimates.

  - This method is inexpensive and quick (simplest method).

Forecasting – Qualitative Methods

- **Delphi Method**
- begins with the present state of technology and extrapolates into the future, assuming some expected rate of technical progress.

- A common forecasting method is the use of a board of experts in the technical field involved. Panels are sometimes consulted using the Delphi method.

- Each expert is asked independently when some future technical breakthrough (such as the launching of a space shuttle or the feasibility of a new product, for example) will occur, if ever.

- Averages of the estimates are then reported back to panel members, who are then given a chance to modify their estimate or explain why they hold their belief. A final value is adopted after several such iterations.

- One of the advantages of this technique is that it eliminates the effects of interaction among experts.

Forecasting – Qualitative Methods

■ **Sales Force Composite**

  ❑ Members of the sales force estimate sales in their own territory.

  ❑ Regional sales managers adjust these estimates for their opinion of the optimism or pessimisim of individual salespeople, and the general sales manager "massages" the figures to account for new products or factors of which individual sales people are unaware.

Forecasting – Qualitative Methods

- **Users' Expectation**

  - When a company sells most of its product to a few customers, the simplest method is to ask the customers to project their needs for the future period (market testing / market surveys).

- **Choice of Method**

  - Companies with effective planning will combine a variety of methods to achieve at the bast sales forecast.

  - Qualitative estimates from the sales force and customer surveys may be compared with more quantitative estimates obtained from moving average or regression models.

Forecasting – Quantitative Methods

- **Simple Moving Average**
  - Where the values of a parameter show no clear trend with time, a forecast F_{n+1} for the next period can be taken as the simple average of some number n of the most actual values A_t:

$$F_{n+1} = \frac{1}{n}\sum_{t=1}^{n} A_t$$

  - Ex: if sales for years 2000, 1999, 1998 and 1997 ($n=4$) were 1600, 1200, 1300, and 1100 respectively, sales for 2001 would be forecast as

$$F_{2001} = \frac{1600 + 1200 + 1300 + 1100}{4} = 1300$$

Forecasting – Quantitative Methods

- **Weighted Moving Average**
  - Simple Moving Average has disadvantage that an earlier value (e.g. 1996) has no influence at all, but a value n years in the past (1997) is weighted as heavily as the most recent value (2000).

  - We can improve on our model by assigning a set of weights w_t that total unity (1.0) to the previous n values:

$$F_{n+1} = \sum_{t=1}^{n} w_t A_t, \qquad \text{where} \qquad \sum_{t=1}^{n} w_t = 1.0$$

Forecasting – Quantitative Methods

- **Weighted Moving Average**

  - Ex: Using the weights of 0.4, 0.3, 0.2, and 0.1 for the most recent (n=4) past years;

$$F_{2001} = 0.4A_{2000} + 0.3A_{1999} + 0.2A_{1998} + 0.1A_{1997}$$
$$= 0.4(1600) + 0.3(1200) + 0.2(1300) + 0.1(1100)$$
$$= 1370$$

Forecasting – Quantitative Methods

- **Exponential Smoothing**
  - The weighted moving average techniques have the disadvantage that you (or your computer) must record and remember n previous values and n weights for each parameter being forecast, which can be burdensome if n is large.

  - In this technique the forecast value for the next period $\boldsymbol{F_{n+1}}$ is taken as the sum of
    - The forecasted value F_n for the current period, plus
    - Some fraction of the difference between the actual (A_n) and forecasted (F_n) values for the current period:

$$F_{n+1} = F_n + \alpha\left(A_n - F_n\right)$$

$$F_{n+1} = \alpha A_n + \left(1 - \alpha\right)F_n$$

Forecasting – Quantitative Methods

- **Exponential Smoothing**

		Forecast F(t)	
Year (t)	Actual Value A(t)	$\alpha = 0.3$	$\alpha = 0.7$
1998	1100	1100	1100
1999	1300	1100	1100
2000	1200	1160	1220
2001	1600	1172	1208
2002		1300	1443

$$F_{2000} = 0.3A_{1999} + 0.7F_{1999}$$
$$= 0.3(1300) + 0.7(1100) = 1160$$

$$F_{2001} = 0.3A_{2000} + 0.7F_{2000}$$
$$= 0.3(1200) + 0.7(1160) = 1172$$

Forecasting – Regression Models

- Regression models attempt to develop logical relationship that not only provide useful forecasts, but also identify the causes and factors leading to forecast value.

- Regression models assume that a *linear relationship* exists between a variavle designated the *dependent (unknown) variable* and one or more other *independent (known) variables*.

Simple Regression Model
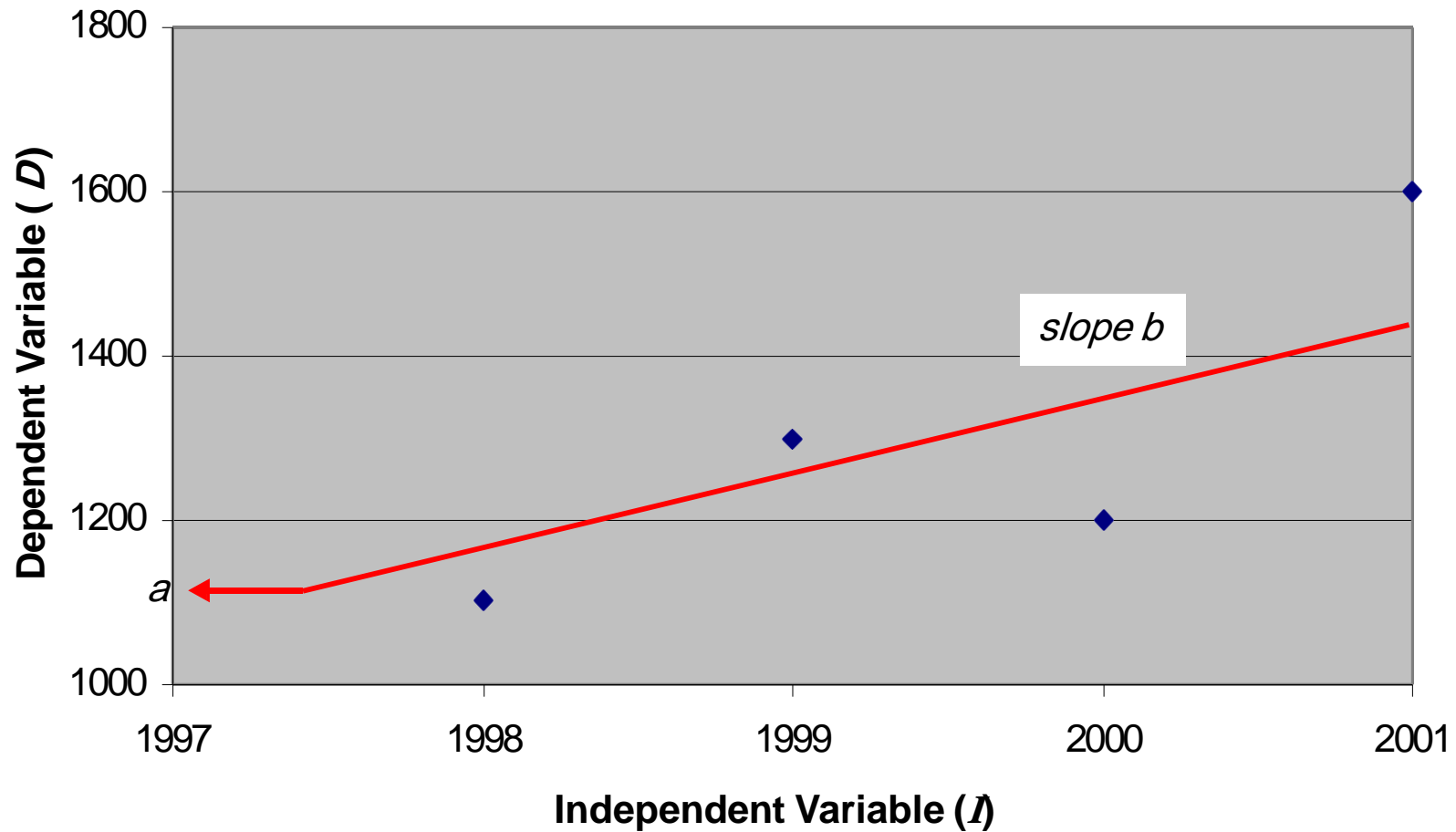
Forecasting – Regression Models

- **Simple Regression Model**
  - The simple regression model assumes that the independent variable I depends on a single dependent variable D.

  - The regression problem is to identify a line;

$$D = a + bI$$

$$b = \frac{n\sum(I_i D_i) - \sum I_i \sum D_i}{n\sum(I_i^2) - (\sum I_i)^2}$$

$$a = \sum \frac{D_i}{n} - b\sum \frac{I_i}{n} = \overline{D} - b\overline{I}$$

where $\overline{D}$ and $\overline{I}$ are the mean values of D and I, respectively.

Forecasting – Regression Models

- **Simple Regression Model**

	I	*D*	*DI*	*I^2*
	0	1100	0	0
	1	1300	1300	1
	2	1200	2400	4
	3	1600	4800	9
Total	6	5200	8500	14
Mean	1,5	1300		

Forecasting – Regression Models

I	D	DI	I^2
0	1100	0	0
1	1300	1300	1
2	1200	2400	4
3	1600	4800	9
Total	6	5200	8500	14
Mean	1,5	1300		

- **Simple Regression Model**

$$b = \frac{4(8500) - 6(5200)}{4(14) - (6)^2} = 140$$

$$a = \frac{5200}{4} - 140\left(\frac{6}{4}\right) = 1300 - 140(1.5) = 1090$$

and we can forecast a value for 2000:

$$b = \frac{n \sum (I_i D_i) - \sum I_i \sum D_i}{n \sum (I_i^2) - \left(\sum I_i\right)^2}$$

$$a = \sum \frac{D_i}{n} - b \sum \frac{I_i}{n} = \overline{D} - b\overline{I}$$

$D_{2000} = 1090 + (4)(140) = 1090 + 560 = 1650$

$$D = a + bI$$

0=1996, 1=1997, 2=1998, 3=1999, 4=2000, …

Forecasting – Regression Models

- **Multiple Regression**

  - In multiple regression, the dependent variable D is assumed to be function of more than one independent variable I_j, such as;

$$D = c_0 + c_t I_j + \frac{c_2}{I_2} + c_3 I_2^3 + ...$$

Forecasting – Regression Models

- **Multiple Regression**

  - ❑ The dependent variable can be assumed to be proportional directly or inversely, proportional to a power or a root, proportional in some other way to indepnedent variables.

  - ❑ Past values of dependent and independent variables are then used in regression analysis to reduce the independent variables to the most important ones and to find the values for the constants c_i that give the best fit.

  - ❑ Ex: a manufacturer of replacement automobile tires might find that the demand for tires varied with the cost of gasoline, the current unemployment rate, sales of automobiles two years before, and the weight of those automobiles.

Technological Forecasting

- Engineers usually are involved in planning environments where technology is changing, and it is essential that planning be done according to the best estimate of the technology that will be available in the future.

- According to Marvin Cetron, a technological forecast is a prediction, based on confidence that certain technical developments can occur within a specified time with a given level of resource allocation.

- Two types of technological forecasting should be considered: **normative** and **exploratory**.

Technological Forecasting (cont.)

- In **normative technological forecasting**, one works backward from the future to the present. A desired future goal is selected, and a process designed to achieve this goal is developed.

- For example, the U.S. government might decide that it is essential to have power available from nuclear fusion in commercial quantities in the year 2030, and will work backward to establish a schedule for a full-scale demonstration plant, a smaller pilot plant, the research tasks that must precede them, and finally develop the overall budget and schedule required to reach the normative goal.

Technological Forecasting (cont.)

- An **exploratory technological forecast** is the Delphi method described earlier in the chapter.

- For example, Japan's Science and Technology Agency polled some 2,800 of the nation's leading specialists in research institutes and universities to identify R&D goals for the next 30 years.

- The five most important goals (and the year they were expected to be achieved) were as follows:

  1. Commercialization of technologies to eliminate air pollutants such as nitrogen oxides (2003)
  2. Invention of a computer to operate faster than 10 teraflops (10 trillion calculations per second) (2004)
  3. Discovery of the major development mechanism of cancer (2010)
  4. Commercialization of effective methods to prevent the spread of cancer (2007)
  5. Diffusion of global-scale environmental preservation technologies (2011)

- Thank You For Your Attention!!!