Engineering Economic Decisions

Lecture 1

Presentation based on the book

Chan S. Park, *Contemporary Engineering Economics*
Chapter 1, © Pearson Education International Edition

Introduction and Motivation

Discussion Topics

Rational decision-making process

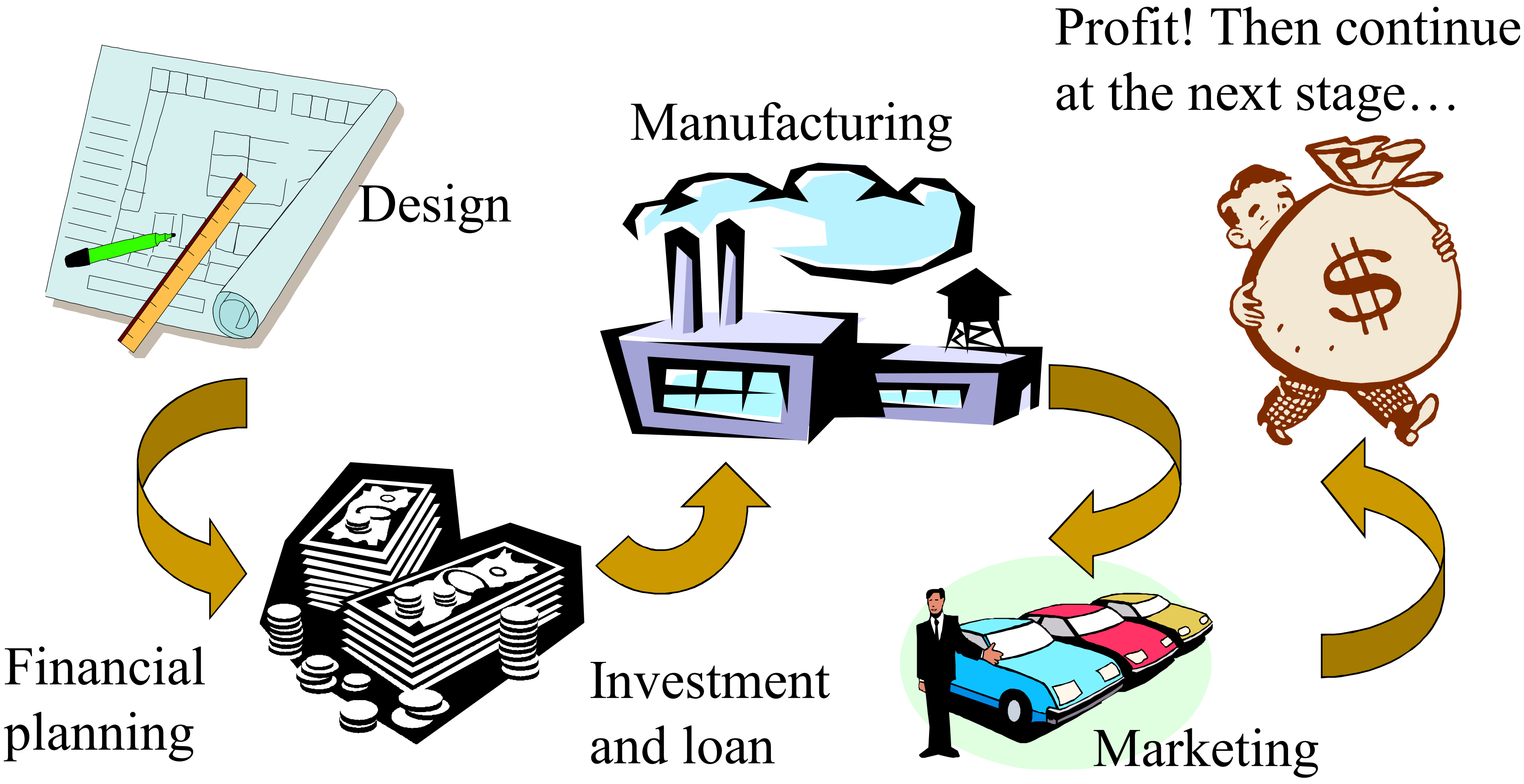
- The role of engineers in business
- What makes engineering economics decisions difficult?
- Strategic decisions
- The fundamental principles in engineering economics

Rational Decision-Making Process

- Recognize the decision problem
- Collect all needed (relevant) information
- Identify the set of feasible decision alternatives
- Define the key objectives and constraints
- Select the best possible and implementable decision alternative

Engineering Economic Decisions

Needed e.g. in the following (connected) areas:



What Makes Engineering Economic Decisions Difficult? Predicting the Future

- Estimating the required investments
- Estimating product manufacturing costs
- Forecasting the demand for a brand new product
- Estimating a “good” selling price
- Estimating product life and the profitability of continuing production

The Role of Engineers in Business

Create & Design

- Engineering Projects

↓

Analyze

- Production Methods
- Engineering Safety
- Environmental Impacts
- Market Assessment

→

Evaluate

- Expected Profitability
- Timing of Cash Flows
- Degree of Financial Risk

→

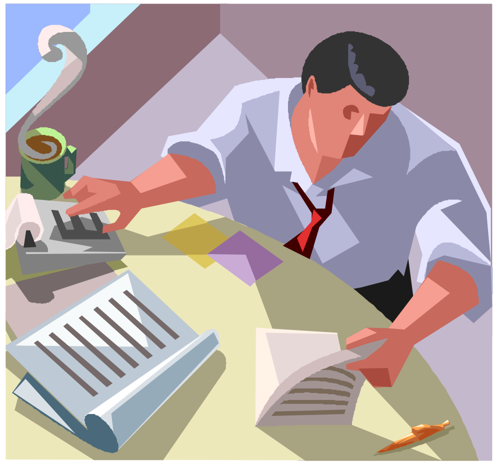
Evaluate

- Impact on Financial Statements
- Firm's Market Value
- Stock Price

Accounting vs. Engineering Economy

Evaluating past performance

Evaluating and predicting future events



Accounting

Engineering Economy

Past

Future

Present

Key Factors in Selecting Good Engineering Economic Decisions

Objectives, available resources, time and uncertainty are the key defining aspects of all engineering economic decisions

The Four Fundamental Principles of Engineering Economics

- 1: An instant dollar is worth more than a distant dollar…
- 2: Only the relative (pair-wise) difference among the considered alternatives counts…
- 3: Marginal revenue must exceed marginal cost, in order to carry out a profitable increase of operations
- 4: Additional risk is not taken without an expected additional return of suitable magnitude

Principle 1

An instant dollar is worth more than a distant dollar…

Principle 2

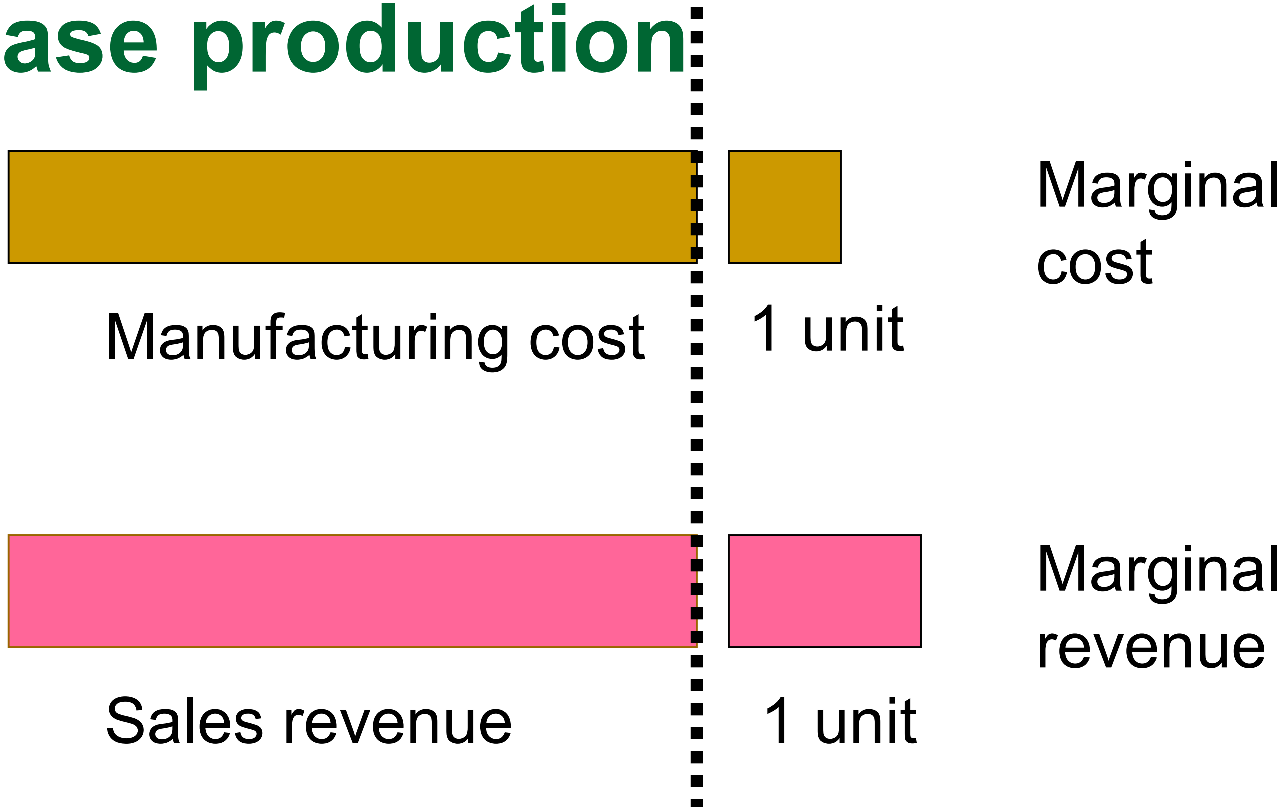
Only the cost (resource) difference among alternatives counts

Option	Monthly Fuel Cost	Monthly Maintenance	Cash paid at signing (cash outlay)	Monthly payment	Salvage Value at end of year 3
Buy	$960	$550	$6,500	$350	$9,000
Lease	$960	$550	$2,400	$550	0

The data shown in the green fields are irrelevant items for decision making, since their financial impact is identical in both cases

Principle 3

Marginal (unit) revenue has to exceed marginal cost, in order to increase production



Principle 4

Additional risk is not taken without a suitable expected additional return

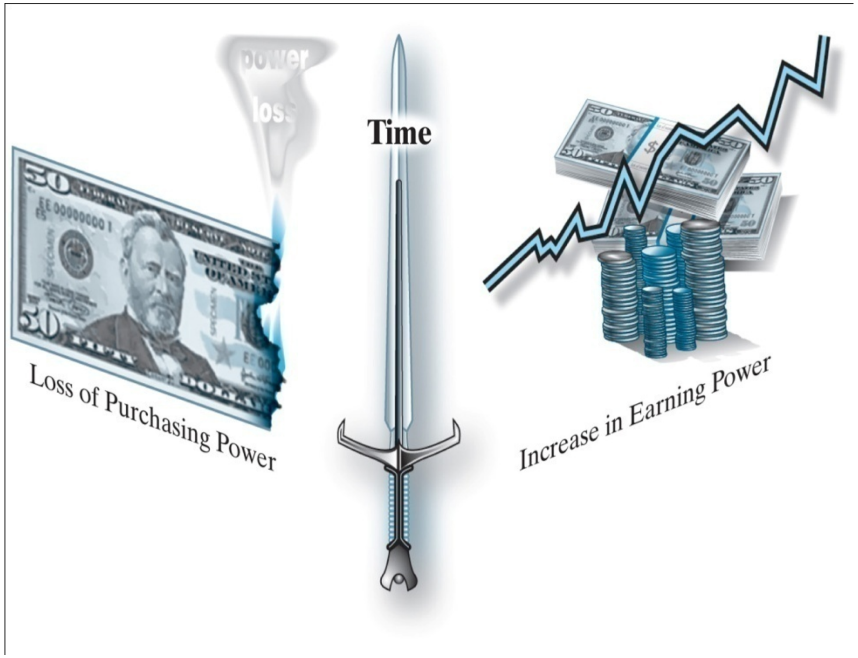
Investment Class	Potential Risk	Expected Return
Savings account (cash)	Lowest	1.5%
Bond (debt)	Moderate	4.8%
Stock (equity)	Highest	11.5%

A simple illustrative example. Note that all investments imply some risk: portfolio management is a key issue in finance

Time Value of Money

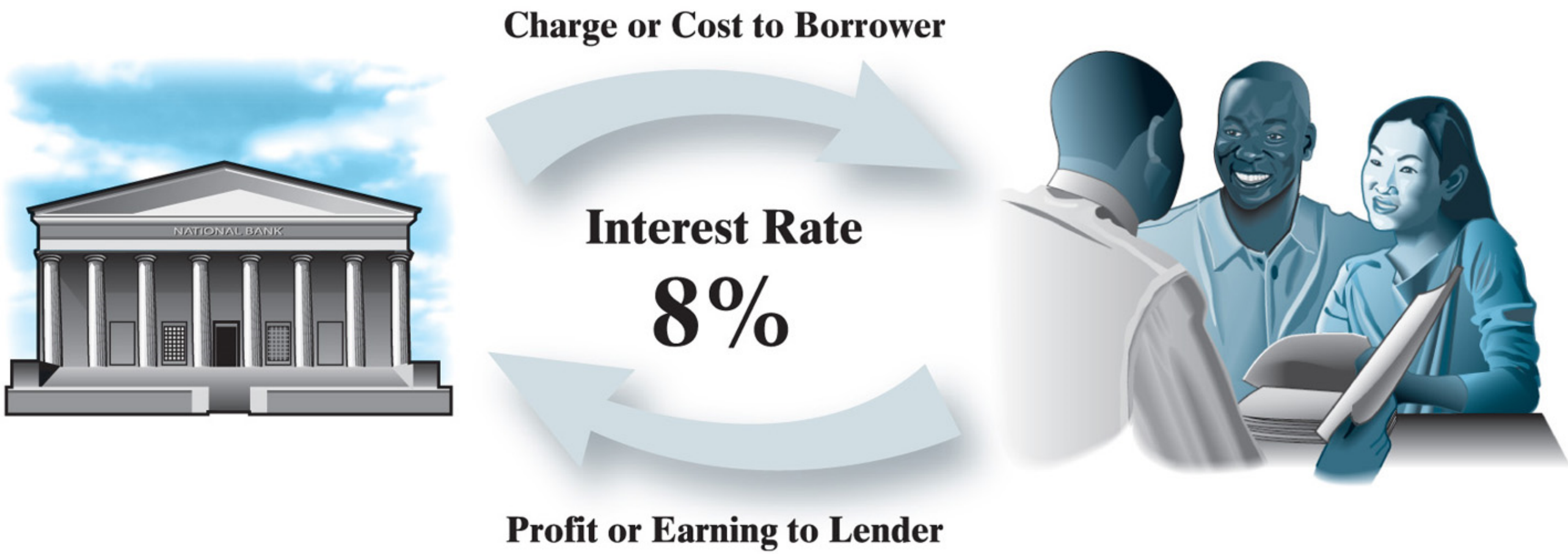
Time Value of Money

- Money has a time value because it can earn more money over time (earning power).
- Money has a time value because its purchasing power changes over time (inflation).
- Time value of money is measured in terms of interest rate.
- Interest is the cost of money—a cost to the borrower and an earning to the lender



This a two-edged sword whereby earning grows, but purchasing power decreases (due to inflation), as time goes by.

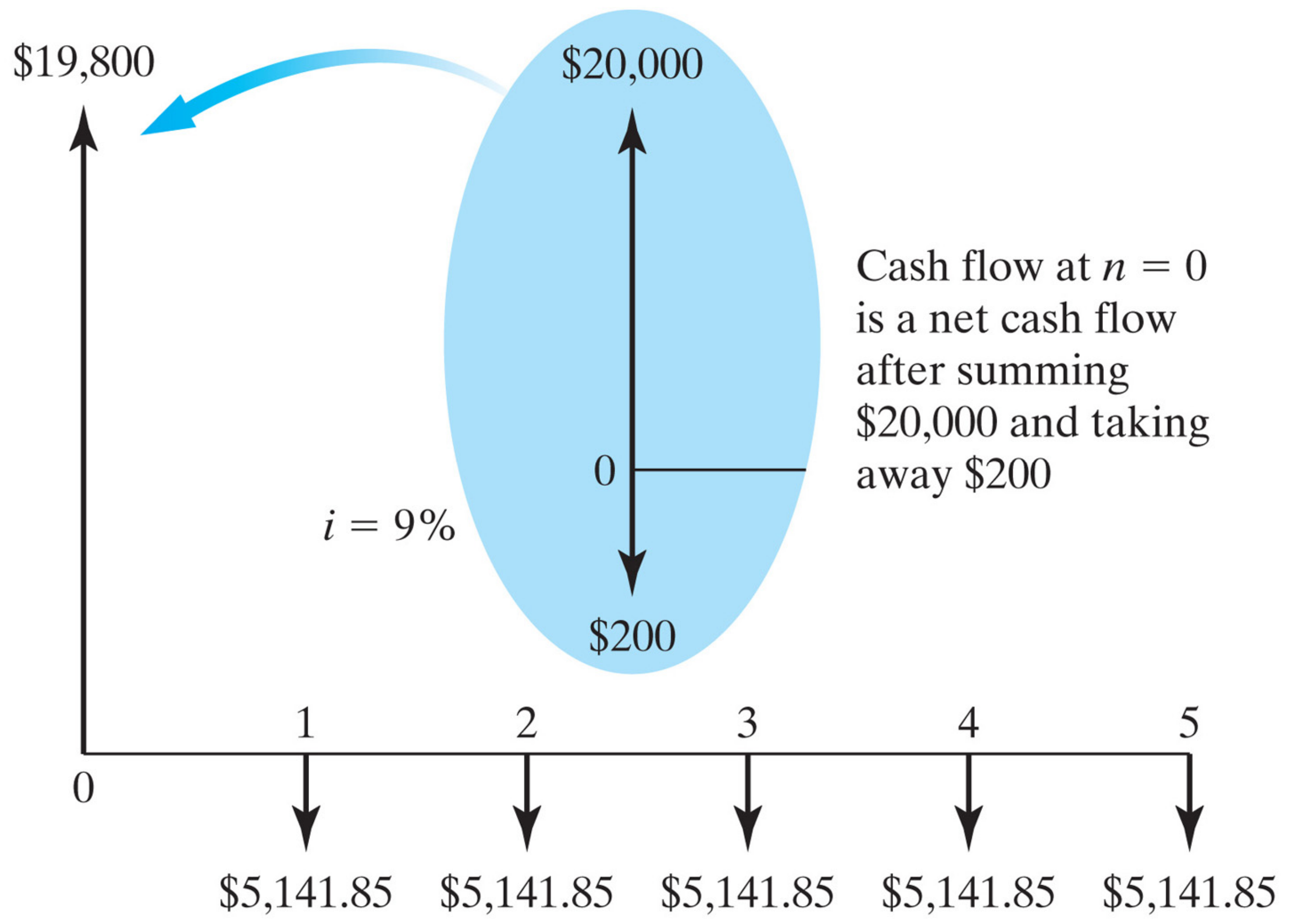
The Interest Rate



Cash Flow Transactions for Two Types of Loan Repayment

End of Year	Receipts	Payments	
		Plan 1	Plan 2
Year 0	$20,000.00	$200.00	$200.00
Year 1		5,141.85	0
Year 2		5,141.85	0
Year 3		5,141.85	0
Year 4		5,141.85	0
Year 5		5,141.85	30,772.48
The amount of loan = $20,000, origination fee = $200, interest rate = 9% APR (annual percentage rate)			

Cash Flow Diagram for Plan 2



End-of-Period Convention

- In practice, cash flows can occur at the beginning or in the middle of an interest period, or indeed, at practically any point in time.
- One of the simplifying assumptions we make in engineering economic analysis is the end-of-period convention.
- **End-of-period convention:**

  Unless otherwise mentioned, all cash flow transactions occur at the end of an interest period.

Methods of Calculating Interest

- Simple interest: the practice of charging an interest rate only to an initial sum (principal amount).
- Compound interest: the practice of charging an interest rate to an initial sum and to any previously accumulated interest that has not been withdrawn.

Simple Interest

- *P* = Principal amount
- *i* = Interest rate
- *N* = Number of interest periods
- Example:
  - *P* = $1,000
  - *i* = 10%
  - *N* = 3 years

End of Year	Beginning Balance	Interest earned	Ending Balance
0			$1,000
1	$1,000	$100	$1,100
2	$1,100	$100	$1,200
3	$1,200	$100	$1,300

Simple Interest Formula

$$F = P + (iP)N$$

where

P = Principal amount

i = simple interest rate

N = number of interest periods

F = total amount accumulated at the end of period N

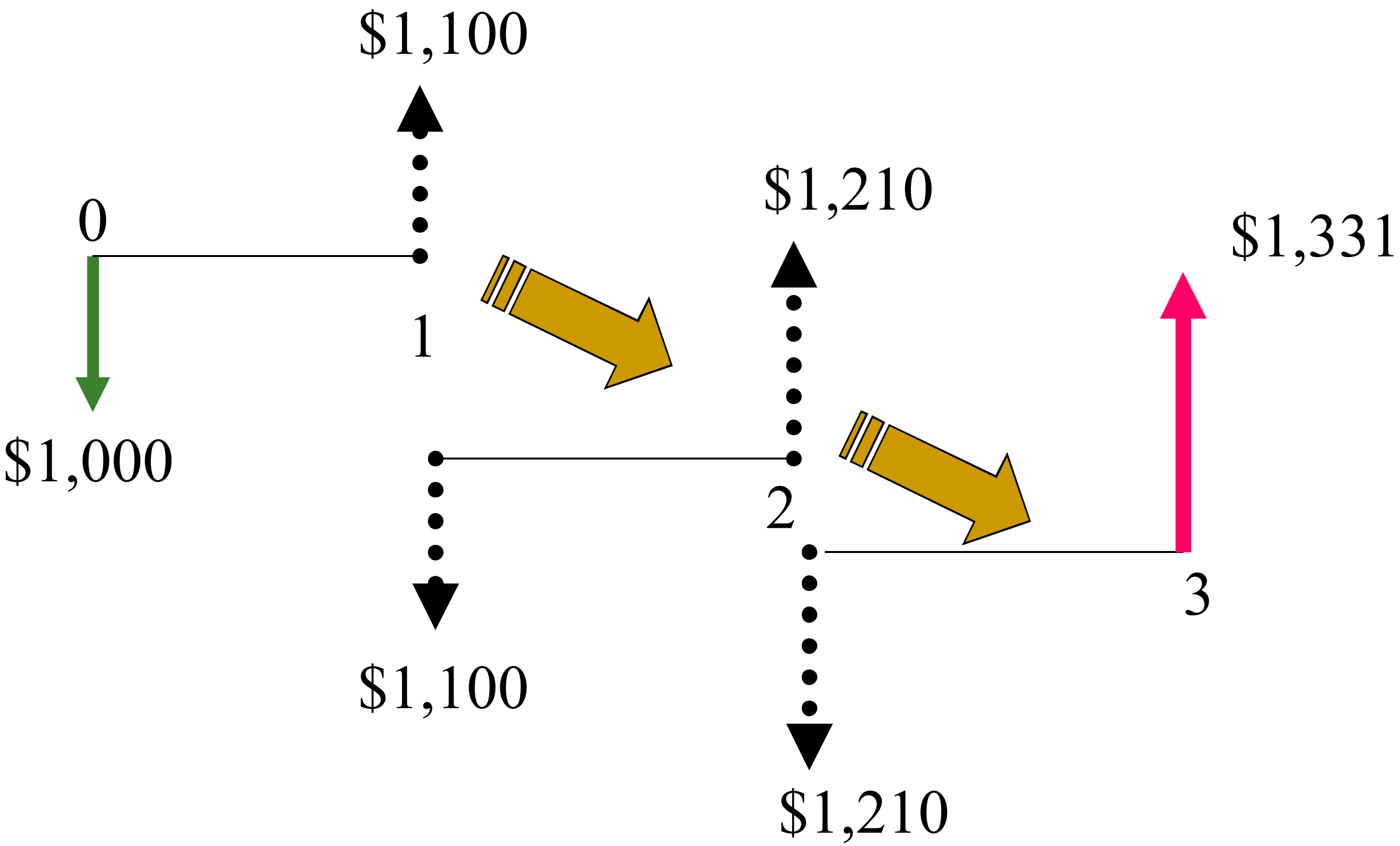
$$\begin{aligned} F &= \$1,000 + (0.10)(\$1,000)(3) \\ &= \$1,300 \end{aligned}$$

Compound Interest

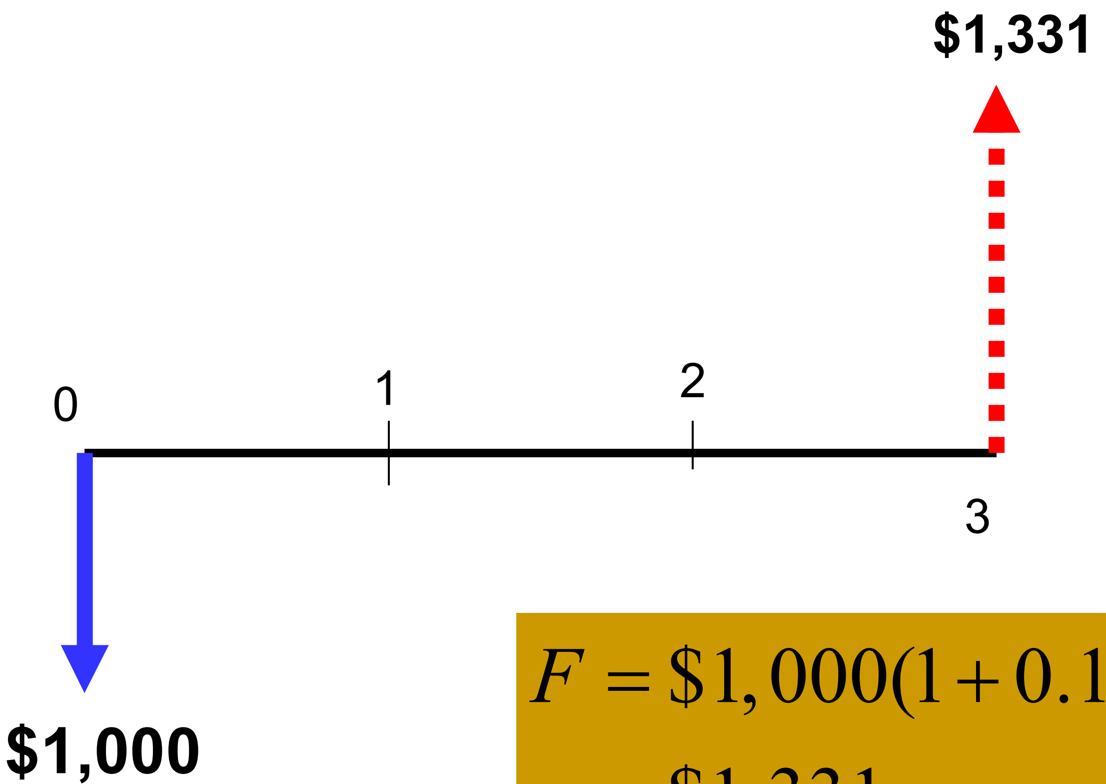
- *P* = Principal amount
- *i* = Interest rate
- *N* = Number of interest periods
- Example:
  - *P* = $1,000
  - *i* = 10%
  - *N* = 3 years

End of Year	Beginning Balance	Interest earned	Ending Balance
0			$1,000
1	$1,000	$100	$1,100
2	$1,100	$110	$1,210
3	$1,210	$121	$1,331

Compounding Process



Cash Flow Diagram



$$F = \$1,000(1+0.10)^3$$
$$= \$1,331$$

Compound Interest Formula

$$n = 0 : P$$

$$n = 1 : F_1 = P(1+i)$$

$$n = 2 : F_2 = F_1(1+i) = P(1+i)^2$$

$$\vdots$$

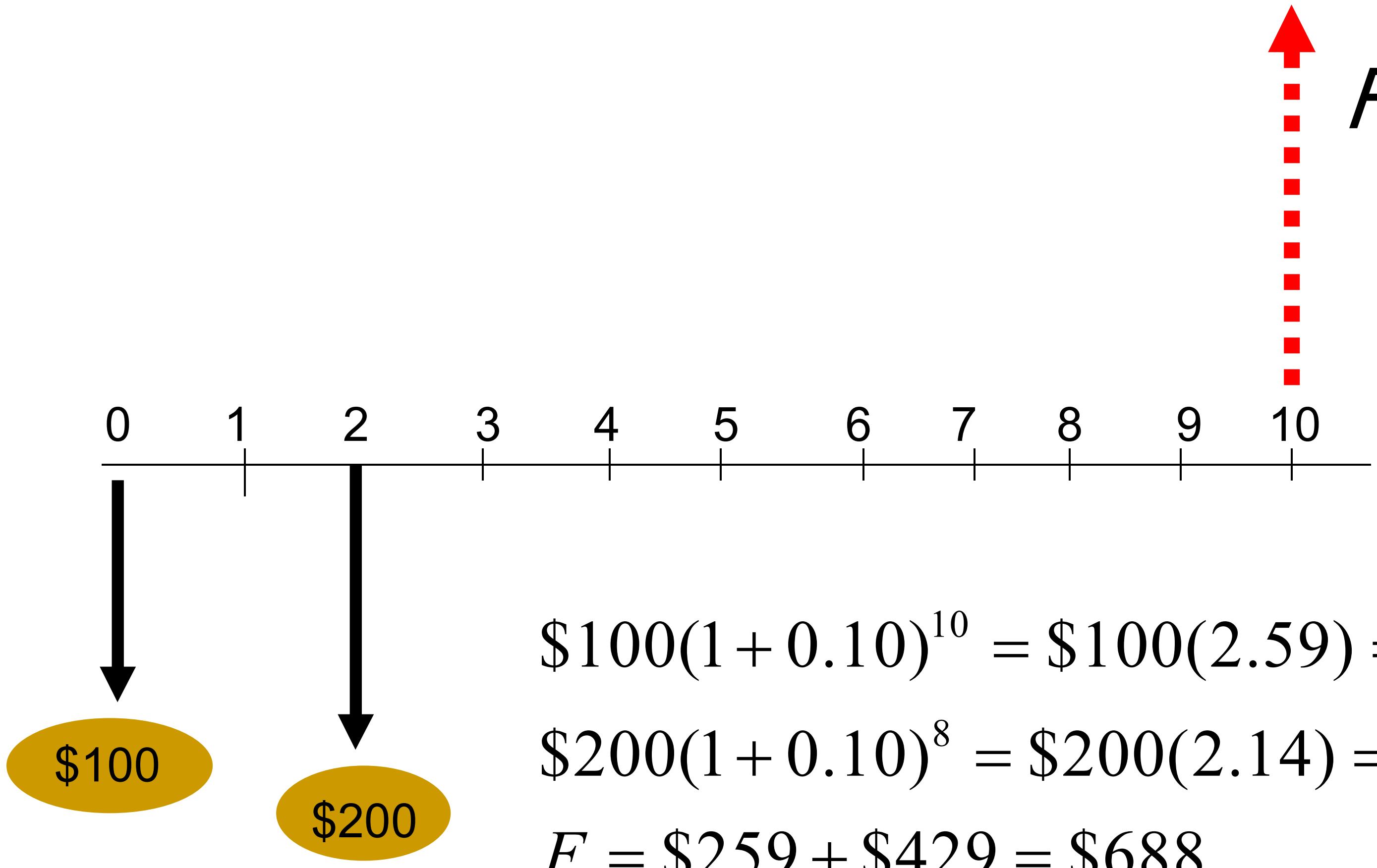
$$n = N : \boxed{F = P(1+i)^N}$$

Practice Problem

- Problem Statement

  If you deposit \$100 now ($n = 0$) and \$200 two years from now ($n = 2$) in a savings account that pays 10% interest, how much would you have at the end of year 10?

Solution



$$\$100(1+0.10)^{10} = \$100(2.59) = \$259$$

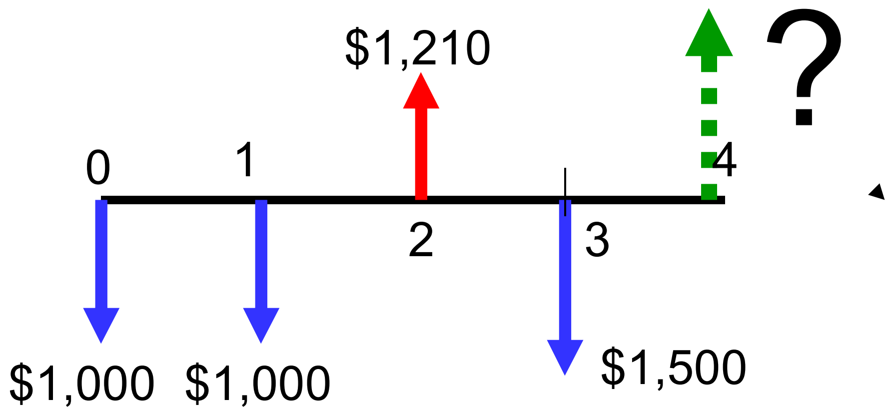
$$\$200(1+0.10)^{8} = \$200(2.14) = \$429$$

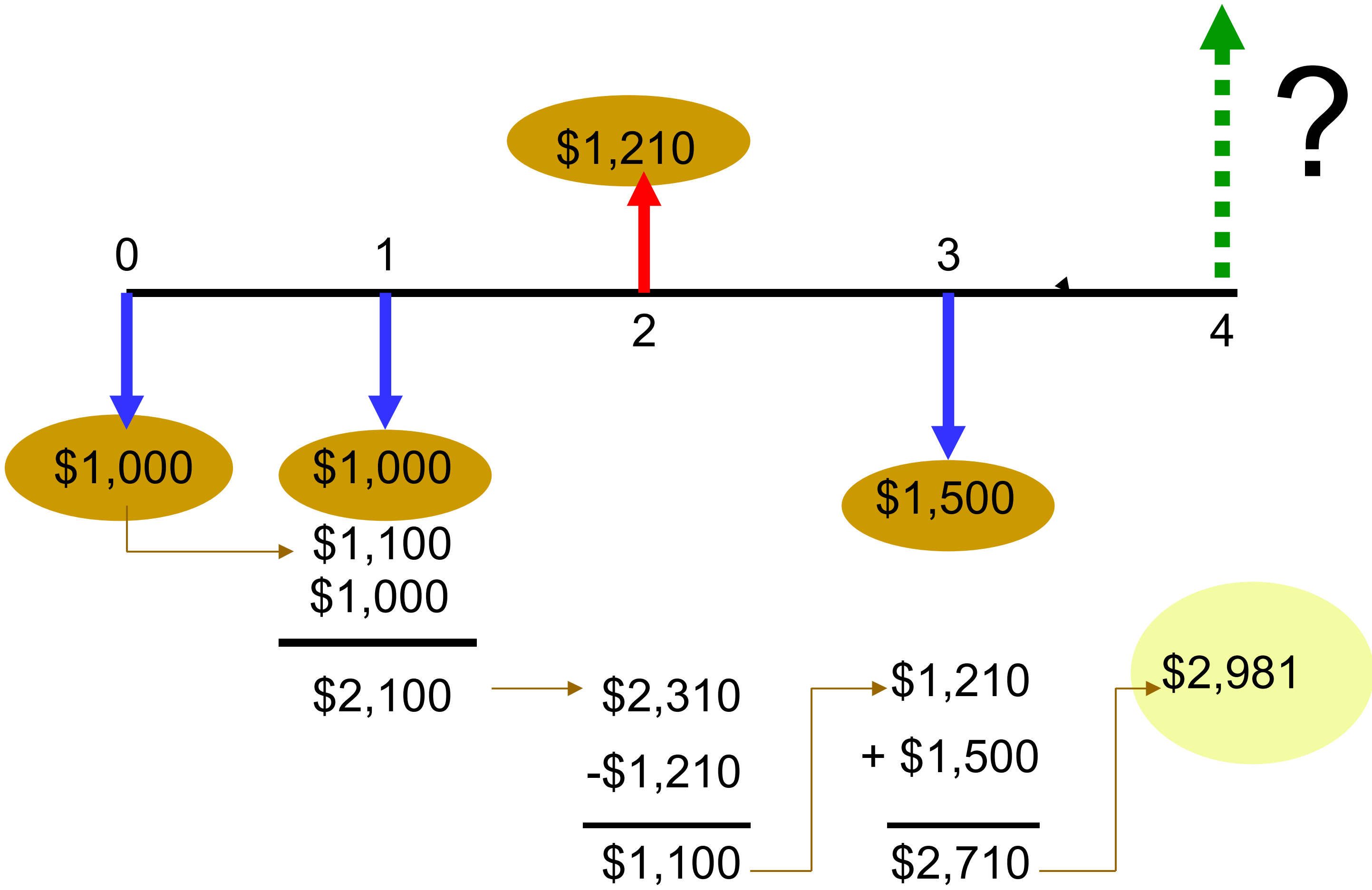
$$F = \$259 + \$429 = \$688$$

Practice problem

- <u>Problem Statement</u>

  Consider the following sequence of deposits and withdrawals over a period of 4 years. If you earn a 10% interest, what would be the balance at the end of 4 years?




$1,210
?
0
1
3
2
4
$1,000
$1,000
$1,500
$1,100
$1,000
$2,100
$2,310
-$1,210
$1,100
$1,210
+ $1,500
$2,710
$2,981

Solution

End of Period	Beginning balance	Deposit made	Withdraw	Ending balance
$n = 0$	0	\$1,000	0	\$1,000
$n = 1$	\$1,000(1 + 0.10) =\$1,100	\$1,000	0	\$2,100
$n = 2$	\$2,100(1 + 0.10) =\$2,310	0	\$1,210	\$1,100
$n = 3$	\$1,100(1 + 0.10) =\$1,210	\$1,500	0	\$2,710
$n = 4$	\$2,710(1 + 0.10) =\$2,981	0	0	\$2,981