# Chapter 5 Present Worth (Value) Analysis

- **Introduction**
  - Given a set of "feasible" alternatives, engineering economy attempts to identify the "best" (most viable) alternative(s) from an economic perspective.
  - Economic perspective requires a quantitative criteria for decision making.
  - In this chapter, we study the *present worth* criteria.

- **Types of economic projects**
  - *Mutually exclusive alternatives*
    - From a set of feasible alternatives, pick *only* one. E.g., which car to buy.
    - Mutually exclusive alternatives "compete" with each other.
  - *Independent projects*
    - From a set of feasible alternatives, select as many as possible to meet the economic criteria the most. E.g., where to invest money?
    - In the absence of a budget constraint, choose all alternatives that do better than the "do nothing" alternative.

- **Do nothing (status-quo ) alternative**
  - This is the alternative of not changing the current situation. E.g., keep money in a saving account, rather than in stocks.

- **Cash flow types for projects**
  - *Revenue* – each alternative generates costs and revenues over the life of the project. E.g., what product to introduce?
    - Criteria: Select the alternative that maximizes the economic measure of merit, which is profit-based.
  - *Service* – each alternative has only cost cash flows. Revenues are the same for all alternatives. E.g., which 100-seat plane to buy?
    - Criteria: Select the alternative that minimizes the economic measure of merit, which is cost-based.

- **Present Worth (PW) analysis**
  - This is the process of obtaining the equivalent worth of future cash flows at present time (time 0).
  - That is, finding PW of cash flows.
  - We say that future cash flows are “discounted” to time 0.
  - For revenue-type projects, the higher the PW, the better off.
  - PW is evaluate based on an interest rate, which is equal to the organization’s MARR.

- **PW analysis of equal-life alternatives**
  - *Mutually exclusive projects*
    - For one project, it is financially viable if PW ≥ 0.
    - For two or more alternatives, select the one with the (numerically) largest PW value, provided PW ≥ 0 for this alternative.
  - *Independent Projects*
    - Select *all* projects with PW ≥ 0
    - However, in practice a budget limit exists (see Ch. 12)

- **PW analysis of different-life alternatives**
  - For alternatives with unequal lives the rule is

    *PW must be compared over the same number of years.*
  - This is called "equal service" requirement
  - Equal service requirement can be met in two ways
    - *LCM*
      - Evaluate alternatives over the lowest common multiple of lives. E.g., lives of 4 and 6, use $n = 12$.
      - Assume reinvestment at same cash flow estimates in each life cycle of the LCM planning horizon.
    - *Study period*
      - Assume a fixed planning horizon and evaluate the alternatives over it.
      - Ignore cash flows beyond the planning horizon.

- **LCM assumptions**
  - The service provided is needed for LCM years or more.
  - The selected alternative is *repeated* over each the life cycle of the LCM in exactly the same manner.
  - Cash flow estimates are the same in every life cycle.

- **Study period and alternative life**
  - Depending on the life of an alternative, three cases could occur when adopting the study period approach.
    1. *Alternative life equal to the study period.* No adjustment to the cash flow is required.
    2. *Alternative life longer than the study period.* An implied salvage value must be added to the alternative at the end of the study period.
       - The salvage value may be estimated based on the *market value* of the asset generating the cash flows.
       - It may be also based on the PW of remaining cash flows.
    3. *Alternative life shorter than the study period*. Assumptions must be made on what happens in the additional years between end of life and end of study period.
       - For service (cost) alternatives, one can estimate the costs of continuing service over the additional years.

        - For revenue alternatives, one may assume that the net receipts are invested at MARR for the additional years.

- **Future worth (FW) analysis**
  - Similar to PW analysis but uses future instead of present values.  (MARR is also used to find future values.)
  - Utilized when
    - A prime goal is to maximize future wealth of stockholders.
    - Asset may be sold after some time of startup (e.g., buy a company and sell it in three years).
    - Projects will not "come online" until end of investment period (e.g., construction projects).
  - FW and PW criteria are equivalent in comparing alternatives.

- **Capitalized Cost (CC) analysis**
  - Capitalized cost is the present worth of a project that lasts forever.
  - This occurs
    - Public Sector Projects.  E.g., roads, bridges, dam.
    - Not-for-profit organization endowments.
  - For these projects, the life cycle, $n$, is either very long, indefinite, or infinity.
  - The CC for an infinite uniform series of cash flows (with annuity $A$) is

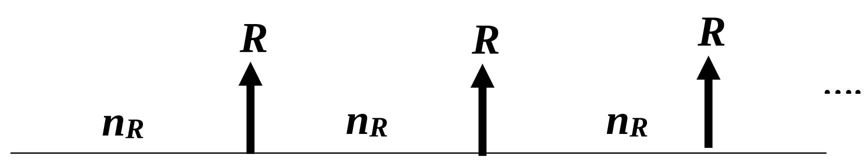
$$CC = \lim_{n\to\infty} \frac{A}{i}\left[1-\frac{1}{(1+i)^n}\right] = \frac{A}{i}.$$

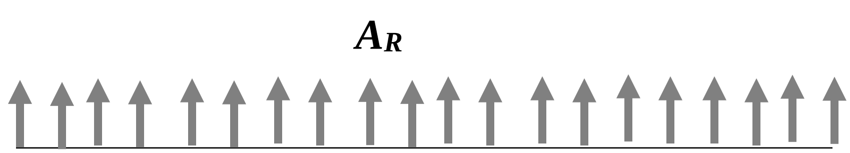
- To evaluate CC for any cash flow, do the following.
  - For nonrecurring (one-time only) cash flows
    - The CC of the cash flows is their PW.
  - For a recurring cash flow of value *R*, that repeats every $n_R$ years
    - Find equivalent uniform annual worth through one life cycle of recurring amounts,

$$A_R = R(A/F, i, n_R) = Ri/[(1+i)^n - 1].$$

    - Fin equivalent CC for the AR series,

$$CC_R = A_R / i = R/[(1+i)^n - 1].$$




- Alternatives that have infinite lives can be compared on the basis of CC, which is equivalent to PW criteria.
- When an alternative with a finite life is to be compared with another having infinite life, the guidelines for alternatives with life shorter than study period (here infinity) are applied.

- **Payback period analysis**
  - Payback period is the estimated time it will take for the revenues of a project to recover the initial investment.
  - The payback period, $n_P$, is such that

$$0 = -P + \sum_{t=1}^{n_P} NCF_t (P/F, i, t),$$

    where $P$ is the initial investment and $NCF_t$ is the net cash flow at time $t$.
  - This equation can be solved using trial an error or using a computer package (e.g., Excel solver.)
  - If $i$ = 0%, $0 = -P + \sum_{t=1}^{n_P} NCF_t$. If, in addition, $NCF_t = NCF$ for all $t$, $n_p = P/$ NCF.
  - This method estimate of $n_P$ is often used in practice for quick initial screening.
  - Payback period analysis should not be used as the primary means of making an accept/reject decision on an alternative.
  - E.g., one reason for caution with payback analysis is that it ignores cash flows after time $n_p$.

- **Payback period analysis in Excel**
  - For a project of life $n$ years, having an initial investment, $P$, at Time 0, a uniform cash flow, $A$, from Times 1 to $n$, and a terminal value, at time $n$, $F$, a built-in function, gives the payback period, NPER($i$,$A$,$P$,$F$).
  - If the cash flows don't follow the ($A$, $P$, $F$) structure, then typically trial an error is needed to find the payback period. See the example in the Excel file on the course website.