5. Manpower Planning

# Sets

* : set of skill levels of the manpower {Unskilled, Semi-skilled, Skilled}
* : set of years in the planning horizon {Year 1, Year 2, Year 3}

# Parameters

* current number of workers with skill (all have more than one year of service)
* : number of workers with skill required for year
* : number of workers with skill that can be recruited any year
* : cost of redundancy (dismissal) per worker with skill
* : cost per worker of skill per year for overmanning
* : cost per worker of skill per year for short-time

# Variables

* + : number of workers employed in year
* *Recruitment*
  + : number of workers recruited in year
* *Retraining*
  + number of unskilled workers retrained to semiskilled in year
  + number of semi-skilled workers retrained to skilled in year
* *Downgrading*
  + number of skilled workers downgraded to semi-skilled in year
  + number of skilled workers downgraded to unskilled in year
  + number of semi-skilled workers downgraded to unskilled in year
* *Redundancy*
  + number of workers made redundant in year
* *Short-time working*
  + number of workers on short time working in year
* *Overmanning*
  + number of superfluous workers in year

# Objective

Minimize redundancy

Minimize total cost (retraining, redundancy, overmanning, short-time working)

# Constraints

1. Continuity: Workers at each time depend on the wastage, recruitment, retraining and redundancy
2. Retraining Semi-skilled workers: The retraining of semi-skilled workers to make them skilled is limited to no more than one quarter of the skilled labour force at the time
3. Overmanning: There cannot be more than 150 workers more than needed at any year
4. Requirements: The number of workers required must be the workers available, the short time workers minus the overmanning workers
5. Upper bounds
   1. Recruitment
   2. Short-time working
   3. Retraining