GEPM 375

Project Planning and Construction Management

Negotiation Methods

Today we are going to discuss

- **Requirements** of Conflict Negotiations Methods.

- Negotiation **Techniques** to maintain win-win solution**.**

- ***The key to finding a negotiator's interests and concerns is to ask "why", when he or she states a position***. **Explain.**

- **Phases of Negotiation**

Requirements of Conflict Resolution/reduction or Negotiations Methods:

- **First requirement**, methods must **allow the conflict to be settled** without irreparable harm to the project's objectives.

- **Second requirement**, methods used by the PM is that **they allow (foster) honesty** between negotiators.

- **Third requirement**, that all the **conflicting parties to seek solutions to the conflict** that:
  -not only satisfy their **own individual needs**,
  -but also satisfy he **needs of other parties** to the conflict,
  -as well as the **needs of the parent organization**.

In a **language of negotiation**, that is called **'win-win' solution.**

Negotiating to a win-win solution is the key to conflict resolution in project management.

Negotiation techniques to maintain win-win solution

Following techniques called '**principled negotiation**' ie win-win:

- ***Separate the People from the Problem*.**
- ***Focuses on interests, not positions*.**
- ***Before trying to reach agreement, invent options for mutual gain.***
- ***Insists on using objective criteria.***

Question: Describe the negotiation techniques to maintain win-win solution.

1.Separate the People from the Problem:

- Conflicting parties are often **highly emotional**.
- Conflicting parties **tend to attack one another** rather than the problem.
- To **minimize the likelihood that the conflict will become strictly interpersonal**, the **substantive problem should be carefully defined.**
- Then **every one can work on it rather than each other**.

2. Focuses on interests, not positions:

- **Positional bargaining** occurs when the **PM says to a functional manager**: **'I need this subassembly by November 15,'** The functional manager responds, '**My group can't possibly start on it this year. We might be able to deliver it by February 1.'.**

- These are the **opening lines of dialogue** that sound suspiciously like the haggling of the tourist and the rug of peddler.

- A simple, **'Let's us talk about the schedule for this subassembly'**, would be sufficient to open discussion.

- Otherwise each party **develops a high level of ego**, involvement in **his or her position**.

- And negotiation **never focusses on the real interests and concerns of the conflicting parties** – the central issue of the conflict.

- Such **exchange deteriorates into a series of positional compromise** that **do not satisfy either party** and leave both parties **feeling** that **they have lost something important.**

3. Before trying to reach agreement, invent options for mutual gain:

- Parties-in-conflict **usually enter negotiations knowing the outcome they would like**.

- As a result, **they are blind to other outcomes** and are particularly **not creative**.

- As soon as **substantive problems are spelled out**, some efforts should be devoted to find a **wide variety of possible solutions or elements** that advance the mutual interest of the conflicting parties.

- Success at **finding options that produce mutual gain** positively **reinforces win-win negotiations.**

Example: Reports on a **conflict between a couple** in which, **he wanted to go mountains, and she wanted to go to the shore**.

- A creative win-win solution is sent them both to **Lake Tahoe.**

Lake Tahoe- a large freshwater lake in the Sierra **Nevada** Mountains, straddling the border of California and Nevada.

It's known for its **beaches and ski resorts.**

Lake Tahoe includes **Sand Harbor Beach** and Spooner Lake, a gateway to the long-distance Tahoe Rim Trail.



4. Insists on using objective criteria:

- Rather than bargaining on positions, **attention should be given to finding standards** (ie market value, expert opinion, law, company policy) **that can be used to determine the quality of an outcome.**

- **By doing, this tends to make the negotiation is less a contest of wills or exercise in stubbornness.**

Example:

- If a functional manager wants to use an **expensive process to test a part**, it is **acceptable for the PM to ask** if such a process is required to ensure that the parts meet specified quality standards.

***The key to finding a negotiator's interests and concerns is to ask "why", when he or she states a position*. Explain.**

- Positions taken by negotiators are not truly understandable **without first understanding the interests and concerns** that prompt those positions.

Example:

- Statement that **a test is requested for May 15**, **can not be run until June 2,** may simply mean that the **necessary test supplies will not be delivered until the later date**.

- If the **PM can get the supplies from another source in time** for the May 15 deadline, the test can be run on schedule.

- But the ability to do this **depends on knowing why the test was to be delayed.**

- If the **negotiation remain a debate on positions**, the **PM will never find out** that the test could have run on time.

- So, the **key to finding a negotiator's interests and concerns is to ask 'why?' when he or she states a position.**

Stages or Phases of Negotiation

Once it has been **agreed upon by both parties** to enter into negotiation, both parties should **follow a series of phases or stages** to **achieve maximum benefit from negotiation**: **(PPIOBAF)**

Phase 1: Preparation

- **Collect Documents**: Negotiations will have a greater chance of succeeding if the **arguments are backed by good documentation;**

- **Set Concise Data**: Preparation phase **consists largely of collecting and collating these documents** and **distilling them** into a coincide set of data suitable for discussion.

- **Back up documentation:** Which will give a clear picture of what the issues are.

Phase 2: Planning Stage

- **Find out Intention**: It is pointless even considering a negotiation process if there is **no intention to compromise**.

- **Establish Degree of compromise and the limits of concessions:** Which can be accepted, have to be established in this phase.

- **Location of negotiation:** Must be given some consideration as it may be necessary to call in advisers or experts at some stage.

Phase 3: Introduction

- **Establish Good Relationship and Rapport**: Negotiations are carried out by people and establishment of a good relationship and rapport can be very beneficial.

- **Past Ventures**: Past co-operative ventures should be mentioned.

- **Discussion: Discussion of common acquaintances**, **alliances** and **interests** will help to break the ice and tend to put all parties at their ease.

- **Quick Overview: A quick overview of he common goal as well as the differences** may be enable the parties to focus on the **important issues**, which can then be categorized for the subsequent stages.

Phase 4: Opening Proposal

- **Initial offer:** One of the parties must **make an initial offer** which sets out their case and requirements.

- **Wording:** **Wordings of this opening would give some indication of the flexibility** as an inducement to reaching a mutually acceptable settlement.

- **Body Language:** Other party's body language such as hand gestures, postures, eye movement and facial expressions can give clues as to the acceptance or no acceptance of particular suggestions or offers.

- **Common identification:** It is **of important points** will help to lead the discussion into next phase.

Phase 5: Bargaining

- **Purpose is to reach: An agreement which lies somewhere between the initial extreme positions taken by the parties**.

- **Employ well-known tactics: Both parties may employ well-known tactics** such as veiled threats, artificial explosion of anger or outrage, threats of walking out or other devices, but this all part of the process.

- **Balancing:** Concessions on one aspect can be balanced by enhancement on another.

Example 1:

- A supplier **may reduce his price** to the level required by the buyer, provided his production (and hence his delivery) **period can be increased** by a few weeks or months.

- Buyer has to decide which aspects **takes priority; money or time.**

- **Concessions should always be traded** for a gain in another area, which may not be necessarily in the same units or terms.

Example 2:

- A **reduction in price can be balanced** by an **increase in number of units** ordered or a later delivery.

- Should always be **a number of issues on the table** for discussion, so that '**quid pro quo' deals** can be struck between them.

Quid pro quo: **A favor or advantage granted in return for something**.

Phase 6: Agreement

- **Negotiators are only successful if these end with an agreement.**

- If both parties **walk away without an agreement**, **negotiators have not done their jobs.**

- **Case probably end up in adjudication**, **arbitration** or **litigation.**

- Both parties should be **satisfied enough to wish to continue working or trading together** and both are probably aware that there is always the risk that **the legal costs of an action** can exceed the amount in dispute.

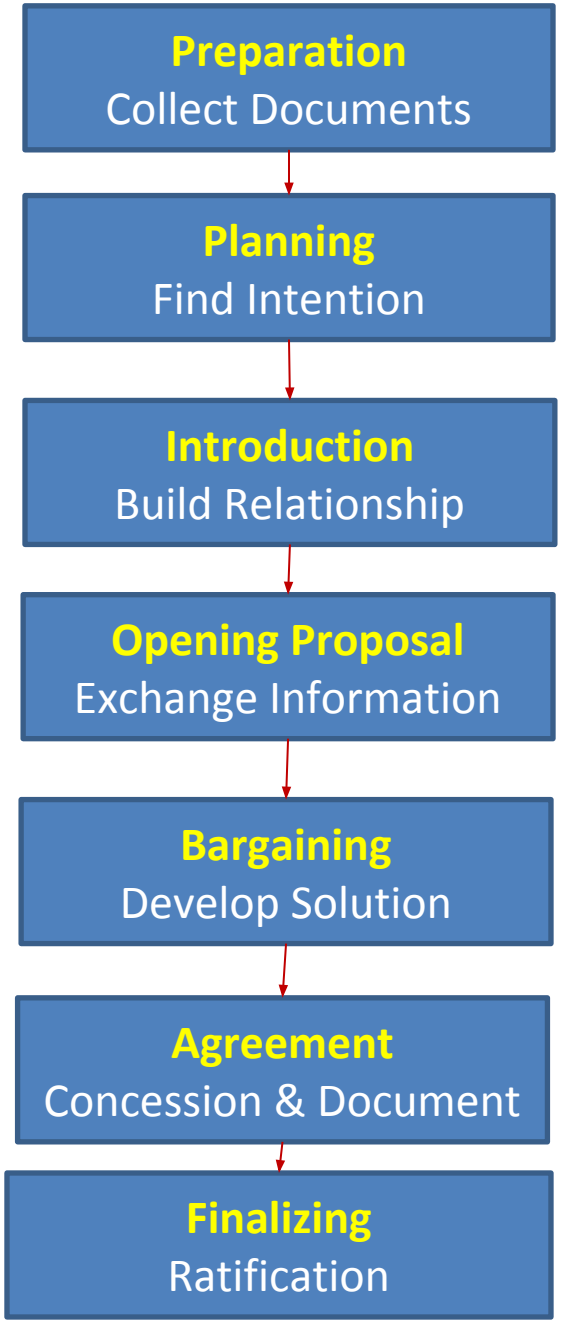
Phase 7: Finalization

- **Written Document**: When agreement has been reached, the **deal has to be finalized by a written statement,** setting out terms of agreement.

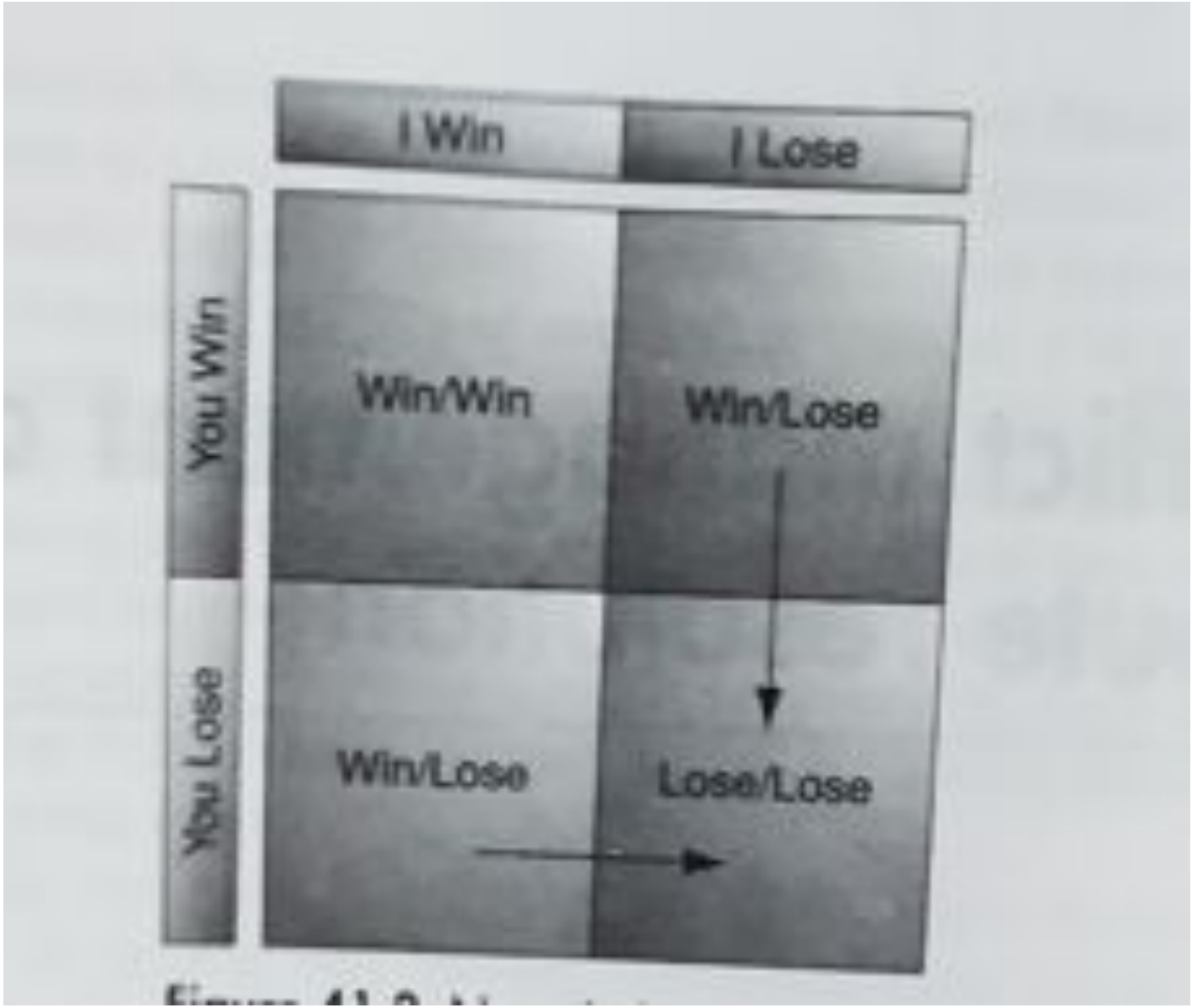
- **Signing: Must be signed by both parties** attending the negotiations.

- **Ratification**: In some cases, the agreement reached will be subjected to **ratification by senior management**, but if the settlement is reasonable, such confirmation is usually given without question.

Negotiation Stages or Phases



Negotiation Outcome



Today what we have discussed?

- **Requirements** of Conflict Resolution/reduction or Negotiations Methods.

- Negotiation **Techniques** to maintain win-win solution**.**

- ***The key to finding a negotiator's interests and concerns is to ask "why", when he or she states a position***. **Explain.**

- **Phases of Negotiation**

Thanks

GEPM 375

Project Planning and Construction Management

Linear Programming

Linear Programming Class-1

What we are going to learn today?

- **What is optimization?**
- Definition of Linear Programming
- **Example of a linear programming problem**.
- Formulating a real life problem in LP problem.
- **Common Terminologies**
- Steps and Process of LP

Optimization, is the way of life:

- We all have **finite** **resources and time** and we **want to make** **the most out of them.**

- From **using your time**, **productively** to solving **supply chain problems** for your company – **everything uses optimization**.

- It **starts with** **simple problems**, but can get very complex.

For example:

- **Sharing chocolates** among siblings is a simple optimization problem. We don't think in mathematical term while solving it.

Question: What is optimization in project management? Describe with example.

- On the other hand **devising inventory and warehousing strategy** can be very complex.

- **Millions of SKUs** with **different popularity** in **different regions** to be **delivered in defined time and resources**.

(A **stock keeping unit- SKU**, is **a store or catalog's product** and **service identification code**; it is often portrayed as a machine-readable bar code)

Inventory refers to the goods, materials, and products a business **holds for sale, production, or use**





Linear Programming (LP)

- LP is **one of the simplest ways to perform optimization.**
- Helps **to solve some very complex optimization problems** by **making a few simplifying assumptions**.
- As an engineer you are **bound to come across different applications and problems** to be solved by Linear Programming.

Question: Define linear programming in project management perspective.

What is Linear Programming?

- A **simple technique** where we **depict** **complex relationships through linear functions** **and** then **find** the **optimum points/solutions**.

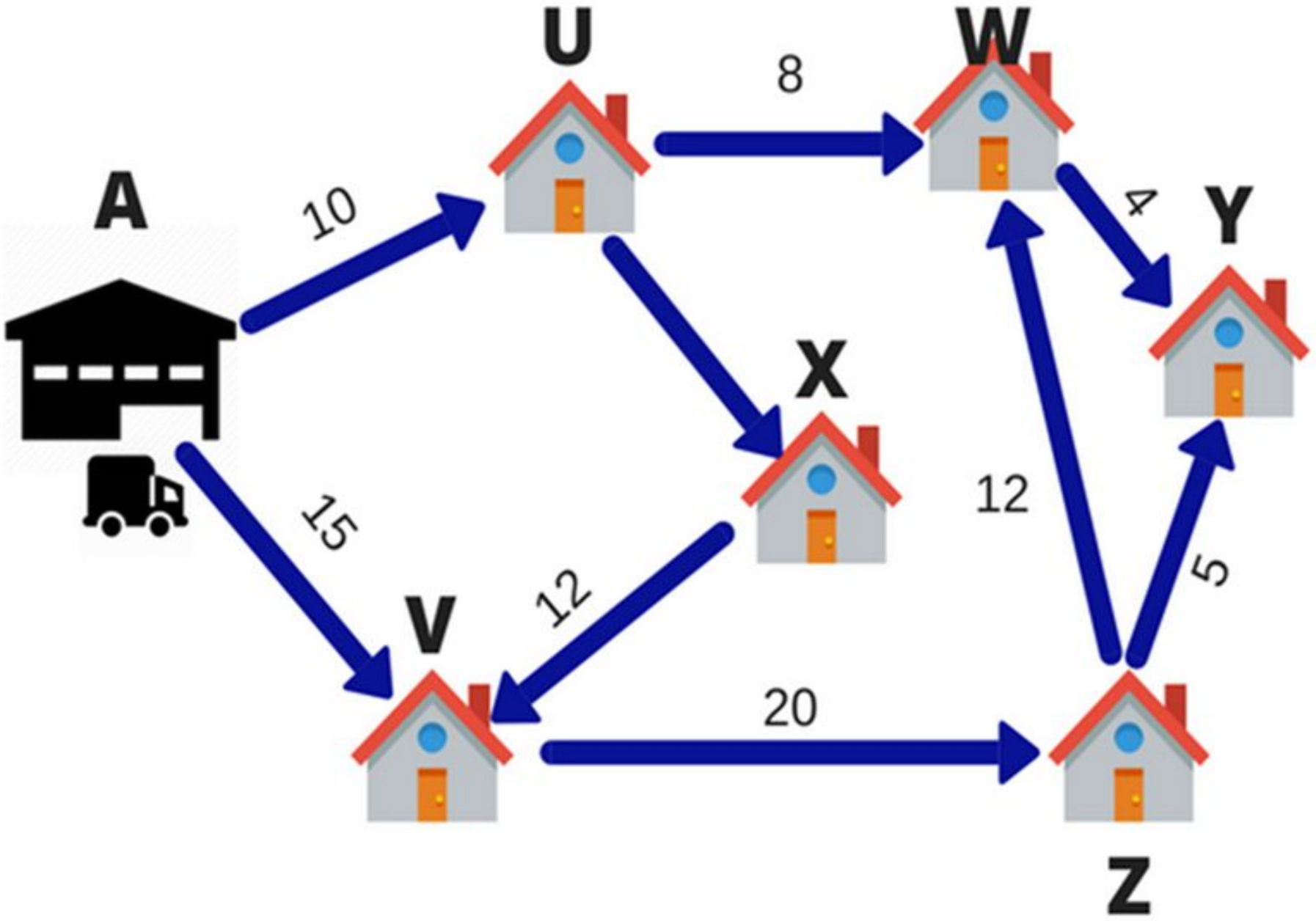
Important word is **depict**.

- **Real relationships might be much more complex** – but we **can simplify them to linear relationships.**

- A **linear function** has one independent variable and one dependent variable.)

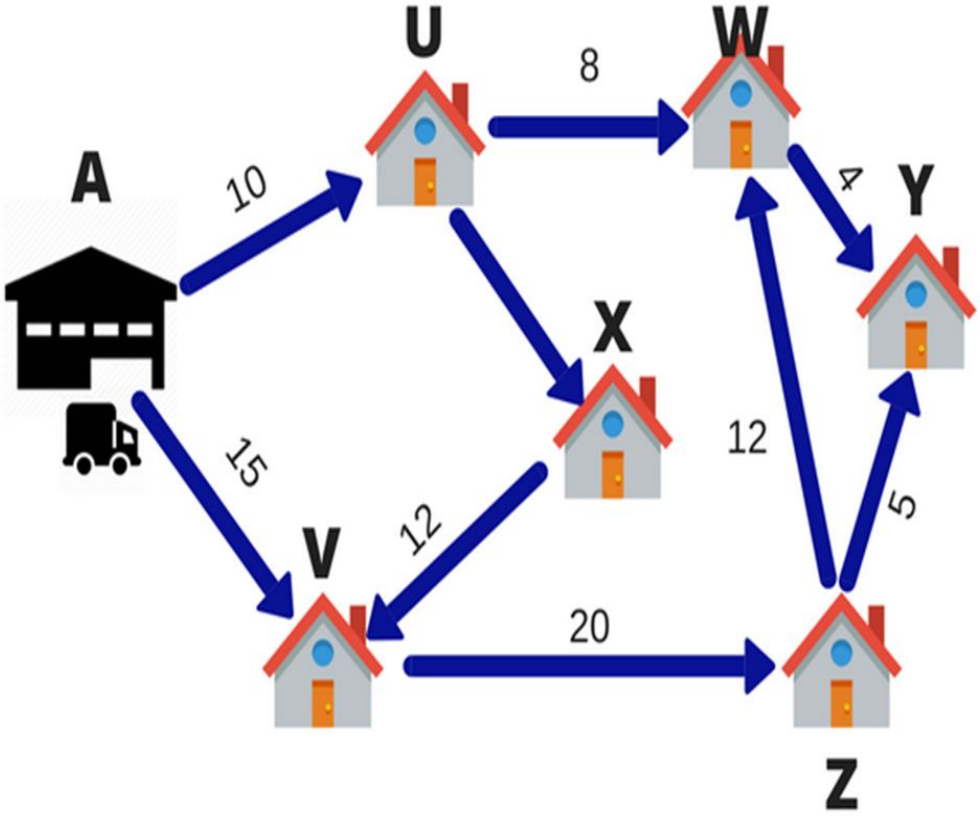
Applications of linear programming are everywhere around you.

- You use LP at **personal and professional fronts.**
- You are using LP when you are **driving from home to work and want to take the shortest route**.
- Or when you have a **product delivery,** you **make strategies to make your team work efficiently** for **on time** delivery.


A
U
W
Y
X
V
Z
10
8
4
15
12
12
5
20

Example of a linear programming problem

- Let's say a FedEx delivery man has **6 packages to deliver in a day.**
- Warehouse is located **at point A**.
- **6 delivery destinations** are given by U, V, W, X, Y and Z.
- **Numbers** on the lines **indicate the distance** between the destinations, cities.
- **Save on fuel and time** the delivery person wants to take the **shortest route**.



- Delivery person **will calculate different routes** for going to all the 6 destinations and then **come up with the shortest route**.

- **This technique of choosing the shortest route is called linear programming.**

Question: Explain linear programming problem with an example.

Here,
Objective of the delivery person is to **deliver the parcel on time** at all 6 destinations.

Process of choosing the best route is called **Operation Research**.

Operation research is **an approach to decision-making**, which involves a **set of methods to operate a system.**

In the above example, the **system is** as the **Delivery model**.

Concept of using LP Method

- **LP is used for obtaining the most optimal solution for a problem with given constraints**.

- In LP, **formulation of real life problem into a mathematical model**.

- And involves an **objective function**, **linear inequalities** with subject **to constraints**.

Question: In linear programming, formulation of real life problem in to a mathematical model. Describe with example.

Example of LP in real life problem:

- **Linear representation of the 6 points** is the representation of **real world**.

- It is **oversimplification** as the **real route would not be a straight line**.

- It would likely have **multiple turns**, **U turns**, **signals** and **traffic jams**.

- But **with a simple assumption**, we have **reduced** the complexity of the problem drastically and are **creating a solution** which should work in most scenarios.

Formulating a real problem into LP:

Let's manufacture some chocolates:

Example: Consider a chocolate manufacturing company which produces only **two types of chocolate** – A and B. Both the chocolates require **Milk and Choco** only. To manufacture each unit of A and B, following quantities are required:

- **Each unit of A** requires **1 unit of Milk and 3 units of Choco**
- **Each unit of B** requires 1 unit of Milk and **2** units of Choco

Question: How do you formulate a real world problem for linear programming? Explain with example.

Linear Programming

- Company **kitchen has** a total of **5 units of Milk and 12 units of Choco**.

- **On each sale**, the company makes a profit of

  Taka 6.00 per unit A sold.
  Taka 5.00 per unit B sold.

- Now, the company wishes to **maximize its profit**.

- **How many units of A and B should it produce respectively**?

Linear Programming

Solution:

- First thing, is to **represent the problem in a tabular form** for better understanding.

	Milk	Choco	Profit per unit
A	1	3	Taka 6.00
B	1	2	Taka 5.00
Total	**5**	**12**	

- **Let** the **total number of units** produced of **A be = X**
- Let the **total number of units** produced of **B be = Y**
- Now, **the total profit** is represented by **Z**

•Total profit the company makes is given by the total number of units of A and B produced multiplied by its per unit profit Tk 6 and Tk 5 respectively.

Total Profit: $Z = 6X+5Y$

which means we have to **maximize Z**.

•Company will try to **produce as many units of A and B to maximize the profit.**

•But the **resources Milk and Choco are available in limited amount.**

Milk:

•As per the above table, each unit of A and B requires **1 unit of Milk**. The **total amount of Milk available is 5 units**.

•To represent this **mathematically,**

$X+Y \leq 5$

Choco:

•Also, each unit of A and B requires 3 units & 2 units of Choco respectively. The **total amount of Choco available is 12 units**.

•To represent this **mathematically**,

$$3X+2Y \leq 12$$

•Also, the **values for units of A and B can only be integers**.

•So we have **two more constraints**, $X \geq 0$ & $Y \geq 0$

For the company to make **maximum profit**, the **above inequalities have to be satisfied**.

This is called formulating a real-world problem into a mathematical model.

Question: What is called the formulating a real time problem in to mathematical model? Explain with example.

Parameters used in Linear Programming

- **Decision Variables**
- **Objective functions**
- **Constraints**
- **Non-negative restrictions.**

Decision Variables:

- Decision variables are the variables **which will decide the output.**

- **Represent the ultimate solution**.

- To solve any problem, it is needed **first to identify the decision variables.**

- For the above example, the **total number of units for A and B denoted** by **X & Y respectively are the decision variables.**

Objective Function:

- Defined as the **objective of making decisions**.

- For the above example, the **company wishes to increase the total profit represented by Z.**

- So, **profit Z is the objective function.**

Constraints:

- Constraints are the **restrictions or limitations on the decision variables.**

- Usually **limit the value of the decision variables**.

- In the above example, the **limit on the availability of resources Milk and Choco are the constraints**.

- Milk for A is 1 and Choco for A is 3 is constraints.
- Milk for B is 1 and Choco for B is 2 is constraints.

Non-negativity restriction:

•For all linear programs, the **decision variables should always take non-negative values**.

•Which means the values for decision variables should be **greater than or equal to 0**.

•Previous example, $X \geq 0$ & $Y \geq 0$

Process/steps to define a Linear Programming problem

Let us look at the **steps of defining a Linear Programming** problem generically:

Step-1:
•Identify the decision variables
Step-2
•Write the objective function
Step-3
•Mention the constraints
Step-4
•Explicitly state the non-negativity restrictions.

For a problem to be a linear programming problem, the **decision variables, objective function and constraints all have to be linear functions.**

- If the all the above conditions are satisfied, it is called a **Linear Programming Problem**.

Question: What is linear programming problem? Describe the different steps of defining a linear programming problem generically.

Thank you

GEPM 375

Project Planning and Construction Management

Linear Programming-2

Process/ Steps in Formulating Real Life Problems into LP Problems:

- **Step-1:** Identify the decision variables –which decides output (X and Y)
- Step-2: Define the objective functions – optimized solution. ($Z=6X+5Y$)
- Step-3: Write down constraints – Limitations on decision variables.
($X + Y \leq 5$ and $3X+2Y \leq 12$)
- State Non-negativity variables ($X \geq 0$ and $Y \geq 0$)

Methods of Solving LP Problems

- **Graphical Method**
- **Open Solver method**
- **Simplex Method**
- **North-West Corner Method**
- **Least Cost Method**

Graphical Method:

- A linear program can be solved by multiple methods.

- **One of the methods is Graphical method for solving a linear program.**

- Graphical method is ***used to solve a two variable linear program.***

- If there is **only two decision variables**, you should use the graphical method to find the optimal solution.

Question: What is graphical method of solving LP program?

Process of Graphical method

• A graphical method involves **formulating a set of linear inequalities subject to the constraints.**

• Then the **inequalities are plotted on a X-Y plane.**

• Once we have plotted all the inequalities on a graph the **intersecting region gives us a feasible region**.

•**Feasible region** explains **what all values our model can take**.

•And model also **gives us the optimal solution**

Question: Write down the process of solving LP problems by graphical method.








Let's understand Graphical methods with the help of an example:

Example: A farmer has recently acquired an **110 hectares piece of land.** He has decided to **grow Wheat and Barley** on that land. Due to the quality of the sun and the region's excellent climate, the entire production of Wheat and Barley can be sold. He wants to know **how to plant each variety in the 110 hectares,** given the **costs, net profits** and **labor requirements** according to the data shown below:

Variety	Cost (Price/Hec)	Net Profit (Price/Hec)	Man-days/Hec
Wheat	100	50	10
Barley	200	120	30

Farmer has a budget of **US$10,000** and an availability of **1,200 man-days** during the planning.

Find the optimal solution and the optimal value.

Solution: To solve this problem, first to formulate the linear program.

Formulation of Linear Problem

Step 1: Identify the decision variables

- Let, the total area for growing Wheat = X (in hectares)
- Let, the total area for growing Barley = Y (in hectares)

X and Y are the decision variables.

Step 2: Write the objective function:

- Since the production from the entire land can be sold in the market.
- Farmer would want to **maximize the profit** for his total produce.
- Here it is given net profit for both Wheat and Barley.
- Farmer earns a net profit of US$50 for each hectare of Wheat and US$120 for each Barley.

Objective function (given by Z) is, Max Z = 50X + 120Y

Step 3: Writing the constraints

- It is given that the farmer has a **total budget of US$10,000.**
- **Cost of producing** Wheat and Barley per hectare is also given to us.
- We have the **total cost spent** by the farmer. So our equation becomes,

1st constraint: $100X + 200Y \leq 10{,}000$

- Availability of total man-days is **1200 man-days.**
- Man-days for wheat and barley is 10 & 30 man-days respectively

2nd Constraints: $10X + 30Y \leq 1200$ **(man-days)**

3rd constraint is the **total area present for plantation**.

- Total available area is **110 hectares**.

- So the equation becomes,

3rd constraint: $X + Y \leq 110$

Step 4: The non-negativity restriction

- Values of X and Y will be greater than or equal to 0. This goes without saying.

$X \geq 0, Y \geq 0$

- Formulation of linear program is done.

- It's time to solve it.

Question: For the problem given, formulate the linear program.

Solving a LP through Graphical method

- Since we know that X, Y ≥ 0, **consider only the first quadrant.**

- To plot for the graph for the equations, first **simplify all the equations**.

- **100X + 200Y ≤ 10,000** can be simplified to **X + 2Y ≤ 100** by dividing by 100.

- **X + 2Y ≤ 100 (cost) --------- (1)**

10X + 30Y ≤ 1200 can be simplified to **X + 3Y ≤ 120** by dividing by 10.

- **X + 3Y ≤ 120 (man-days) ----------(2)**

Third equation is in its simplified form, **X + Y ≤ 110**

- **X + Y ≤ 110 (total land) ---------- (3)**

Plot the equation (1) and (2) on a graph in **first quadrant (like shown below)**

•Optimal feasible solution is achieved at the point of **intersection** where the budget & man-days **constraints are active**.

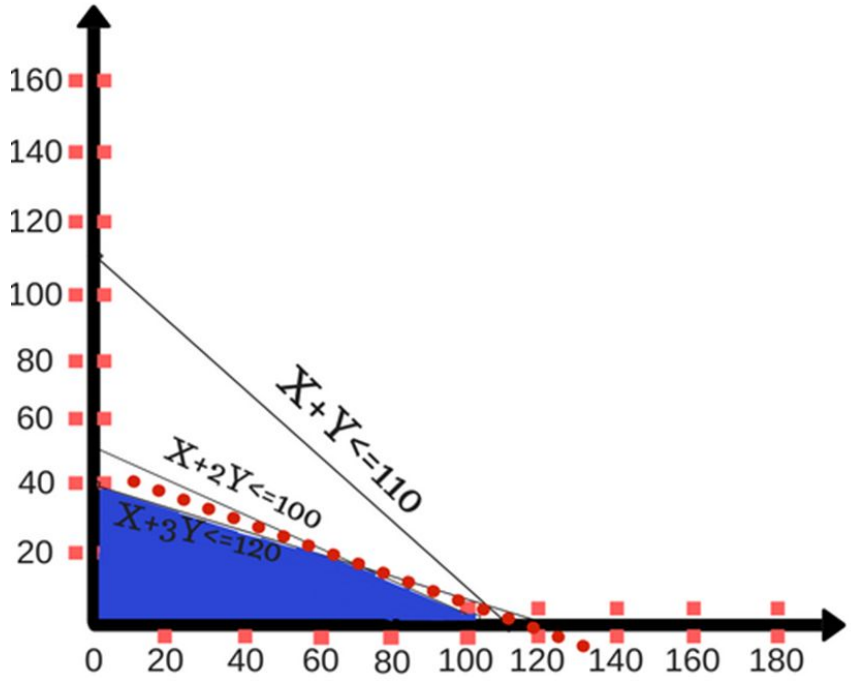
•This means the point at which the equations $X + 2Y \leq 100$ and $X + 3Y \leq 120$ **intersect gives** us the optimal solution.

•Values for X and Y which gives the optimal solution is at (60,20).

•Maximize profit the farmer should produce Wheat and Barley in **60 hectares and 20 hectares** of land respectively

Maximum profit the company will gain is,

Max Z = 50 * (60) + 120 * (20)
= US$5400



Other Methods of solving LP problems

- Open Solver method.
- Simplex Method
- Northwest Corner Method and
- Least Cost Method

Solve Linear Program using Open-Solver

- In reality, a linear program can **contain 30 to 1000 variables** and solving it either Graphically or Algebraically is next to impossible.

- Companies generally use Open-Solver to tackle these real-world problems.

- Open-Solver is an **open source linear and optimizer for Microsoft Excel.** It is an advanced version of built-in excel Solver

Simplex Method:

• Simplex Method is one of the **most powerful & popular methods** for linear programming.

•**Standard technique** in linear programming for solving an optimization problem, typically one involving **a function and several constraints** expressed as inequalities.

Northwest Corner Method:

•Adopted to compute the initial feasible solution of the **transportation problem**.

•Name is given to this method because the basic variables are selected from **the extreme left corner**.

Northwest Corner Method:

- Concept of North-West Corner can be well understood through **a transportation problem** given below:

Source \ To	D	E	F	Supply
A	5	8	4	50
B	6	6	3	40
C	3	9	6	60
Demand	20	95	35	150

Northwest Corner Method:

In the table:

- Three **sources A, B and C** with the production **capacity of 50 units, 40 units, 60 units** of product respectively is given.

- Every day the **demand of three retailers** D, E, F is to be furnished with at least 20 units, 95 units and 35 units of product respectively.

- **Transportation costs** are also given in the matrix.

Source \ To	D	E	F	Supply
A	5 (20)	8 (30)	4	50
B	6	6 (40)	3	40
C	3	9 (25)	6 (35)	60
Demand	20	95	35	150

Northwest Corner Method:

- Select the **north-west or extreme left corner** of the matrix, assign as many units as possible to cell AD, within the supply and demand constraints. Such as **20 units are assigned to the first cell,** that satisfies the demand of destination D while the supply is in surplus.

- **Now move horizontally** and **assign 30 units to the cell AE**. Since 30 units are available with the source A, the **supply gets fully saturated.**

- **Now move vertically** in the matrix and **assign 40 units** to Cell BE. The supply of **source B also gets fully saturated**.

Northwest Corner Method:

- **Again move vertically**, and **assign 25 units** to cell CE, the **demand of destination E is fulfilled**.

- **Move horizontally** in the matrix and **assign 35 units** to cell CF, both the demand and supply of origin and destination **gets saturated**.

Now the total cost can be computed.

- The Total cost can be computed by multiplying the units assigned to each cell with the concerned transportation cost. Therefore,
- **Total Cost** = 20*5+ 30*8+ 40*6+ 25*9+ 35*6 = Tk 1015.00

Least Cost Method:

•Least Cost Method is another method used to obtain the **initial feasible solution for the transportation problem**.

•Here, the allocation **begins with the cell which has the minimum cost.**

•Lower cost cells are chosen over the higher-cost cell with the **objective to have the least cost of transportation**.

Let's understand the concept of Least Cost method through a problem given below:

Source \ To	D	E	F	Supply
A	5	8	4	50
B	6	6	3	40
C	3	9	6	60
Demand	20	95	35	150

Least Cost Method:

Minimum transportation cost can be obtained by following the steps given below:

Source \ To	D	E	F	Supply
A	5	8 (50)	4	50
B	6	6 (5)	3 (35)	40
C	3 (20)	9 (40)	6	60
Demand	20	95	35	150

Least Cost Method:

•**In the given matrix**, the supply of each source A, B, C is given Viz. 50units, 40 units, and 60 units respectively.

•Weekly demand for three retailers D, E, F i.e. 20 units, 95 units and 35 units is given respectively.

•Shipping cost is given for all the routes.

- **Minimum cost in the matrix is Rs** 3, but there is a **tie in the cell BF, and CD**, now the question arises in which cell we shall allocate.

- Generally, the **cost where maximum quantity** can be assigned should be chosen to obtain the better initial solution.

- Therefore, **35 units shall be assigned** to the cell BF. With this, the **demand for retailer F gets fulfilled**, and only **5 units are left with the source B**.

•Again the **minimum cost in the matrix is Rs 3**.

•Therefore**, 20 units shall be assigned** to the cell CD.

•With this, the demand of retailer D gets fulfilled. Only 40 units are left with the source C.

- Next minimum cost **is Tk 4**, but however, the demand for F is completed, we will move to the next minimum cost which **is Tk. 5**.

- Again, the demand of D is completed.

- Next minimum cost is **Tk. 6**, and there is a **tie between** three cells. But however, no units can be assigned to the cells BD and CF as the demand for both the retailers D and F are saturated.

- So, we shall assign **5 units to Cell BE**. With this, the supply of source B gets saturated.

Least Cost Method:

- Next minimum cost is **Tk. 8, assign 50 units** to the cell AE.

- Supply of source A gets saturated.

- Next **minimum cost is Tk. 9**; we shall **assign 40 units** to the cell CE.

- With his both the demand and supply of all the sources and origins gets saturated.

Total cost can be calculated by multiplying the assigned quantity with the concerned cost of the cell.
Therefore,

- **Total Cost** = 50*8 + 5*6 + 35*3 +20*3 +40*9 = Tk. 955.00

Difference between Least Cost method and North west corner method:

- **Least Cost Method** is considered to produce more optimal results than the **North-west Corner because**:

-it **considers the cost** while making the allocation, basing on the availability and supply requirement.

-whereas the North-West corner method **only considers the availability and supply requirement** and allocation **begin with the extreme left corner, irrespective of the shipping cost.**

Thank you