

# ATLANTIS

## City Design Competition.

Total Cash Prize of Rs. **12,000** to be won.

### PROBLEM STATEMENT

The problem consists of two parts:

1. Designing a city for a given population and geographical area, taking into account the physical features, terrains, density and other relevant information provided underneath.
2. Constructing the road network in the city. You have to connect different zones in such a way, that the sum of construction cost and the user money cost (traveling cost) comes to a minimum.

### GENERAL RULES:

1. Students currently enrolled for up to an undergraduate/postgraduate program at their institute are eligible for the competition.
2. This competition requires compulsory pre-registration. Each team has to register online at our site when they start working on the problem.
3. Number of members per team should not exceed two.

### DESIGN GUIDELINES

Designing a city will include demarcation of the area into zones - residential, commercial, agricultural and industrial. The maximum numbers of zones permissible in each type are listed below -

- Residential zones - R1, R2, R3 ... max 7 zones
- Commercial zones - C1, C2, C3 ... max 5 zones
- Agricultural zones - A1, A2, A3 ... max 5 zones
- Industrial zones - I1, I2, I3 ... max 5 zones

However you can make lesser number of zones in each. Airport and Railway Station are already been marked in the map.

Designing the Road Network for the city will include the following -

1. The network designed must be a 'Spanning Tree Network' i.e. there is only one way / path to travel from one zone to another and there is no loop / alternative path to traverse to the other zones.

2. All roads should start from and terminate at the center of the zones. (Minor roads within the zone can be neglected and need not be shown in the design). Center of the zone can be taken out using geometry for symmetrical shapes or by calculating the center of the largest inscribed circle in that zone. It should be noted that concave shape of the zones are not allowed.
3. A bridge may have to be constructed for crossing over the river while tunnels have to be constructed to enable passage through the mountains.
4. In constructing the road over the railway line or an already laid road, an extra cost will be added to the construction cost (as explained underneath).

#### **USEFUL DATA & MAPS:**

(Autocad file of the map can be downloaded from our website.)

Total Population of the city is 10,000 and its area is of 100 square km.

Initially the population density of the Residential Zone is 500 people per square km when all the people are there. Then as the day progresses people go to different areas where the population densities become as given underneath:

- Industrial Area 250 people per square km
- Commercial Area 600 people per square km.
- Agricultural Area 30 people per square km.

Occupation distribution of the population

- 30% work in industrial zone
- 12% work (go for shopping) in commercial zone
- 4.5% work in agriculture zone
- 5% going to Railway Station
- 0.5% people going to Airport

Cost of the road network

1. Construction money: It is the cost of constructing the roads. Please see the table below for the exact costs of tunnels, bridges, road over rail and road over road.
  - Simple 2 lane road costs Rs. 2 crores per km.
  - Additional cost of making bridge over the river is Rs. 1 crore per km.
  - For making tunnel across the mountains the additional cost will be Rs.10 crores per km.
  - In case of road over rail/road the additional cost is Rs 0.25 crore.
2. User money: It is cost that comes into account every time you travel on the road (per day basis). User money includes all factors like time of travel, congestion, pollution, traffic et all. This is the most important factor for the long term betterment of society. It can be

taken as 6 Rupees per km. per person. Consider movement of population only from Residential zones to Commercial, Agricultural Industrial zones, Airport and Railway Station and the return journey back to the Residential zones. Movement between Commercial, Industrial, Agricultural zones, Airport and Railway Station need not be considered. To obtain the User Money refer the **Gravity Model**.

The total cost incurred on road network for 10 years will be calculated as:

$$\text{Cost} = \text{Construction Cost} + \text{User Money} \times 365 \times 10$$

### **DELIVERABLES:**

1. AutoCAD file showing in the design of the city. The AutoCAD file must contain atleast the following layers:
  - Layer 1: All Physical features (use the file provided by us).
  - Layer 2: Residential Zones
  - Layer 3: Industrial Zone
  - Layer 4: Commercial Zones
  - Layer 5: Road Network (with names  $L_1, L_2 \dots L_N$ )
  - Layer 6: All the Dimensions of the road links (in meters)
2. Worked out solution showing relevant calculations and working out of the infrastructure required, data assumed and any other footnotes in a maximum of 7 A4 sheets. All junctions, bridges, Road over Rail (RoR), etc. should also be explained in your scheme.
3. PowerPoint presentation highlighting the salient features of the design and the motivation behind it in maximum of 15 slides.

It is preferable that the participants also make PDF back-up of their AutoCAD and PowerPoint files. All the Deliverables must be written on a CD.

*Note:* The Powerpoint presentation is to be brought for the second stage participants only.

*Note:* For first stage submissions, deliverables can be mailed as an attachment to [vamsi@techfest.org](mailto:vamsi@techfest.org).

### **JUDGING CRITERIA:**

1. All participants will have to submit the above deliverables (the AutoCAD file and a brief worked out solution) before 10th January. The elimination will be done on the basis of the city design and on the cost incurred in designing the network.

2. The list of the short listed candidates would be made available at our website, latest by 15th January, 2004. The short listed entries can also improve upon their solution which they have sent for the elimination round.
3. The short listed entries will have to give a presentation during Techfest 2004 (24<sup>th</sup> - 26<sup>th</sup> January, 2004) before the panel of judges.
4. The judging of the selected entries will be on the basis of the their
  - Design of the City
  - Road Network and its cost
  - Presentation of the solution

Emphasis will also be on creativity, aesthetic sense and rationality of the idea along with the design.

#### GRAVITY MODEL:

For decades, social scientists have been using a modified version of Isaac Newton's Law of Gravitation to predict movement of people, information, and commodities between cities and even continents.

The gravity model, as social scientists refer to the modified law of gravitation, takes into account the population size of two places and their distance. Since larger places attract people, ideas, and commodities more than smaller places and places closer together have a greater attraction, the gravity model incorporates these two features.

The relative strength of a bond between two places is determined by multiplying the population of zone A by the population of zone B and then dividing the product by the distance between the two cities squared

$$\text{Let 'F' be some constant} = \frac{A_1}{d_1^2} + \frac{A_2}{d_2^2} + \dots + \frac{A_n}{d_n^2}$$

Then the Gravity Model is:

$$T_{ij} = \frac{P_i \times A_j}{F \times d_{ij}^2}$$

Where:  $T_{ij}$  = no. of people going from zone (i) and to zone (j)

$P_i$  = total number of people going out from Residential zone (i)

$A_j$  = total people working in zone (j)

$d_{ij}$  = road distance between zones i and j.

**User Money between zone i and zone j** =  $T_{ij} \times d_{ij} \times C$

where C is the cost of travelling and is expressed in Rs. per km and in our case it can be taken to be Rs. 6 per km.