

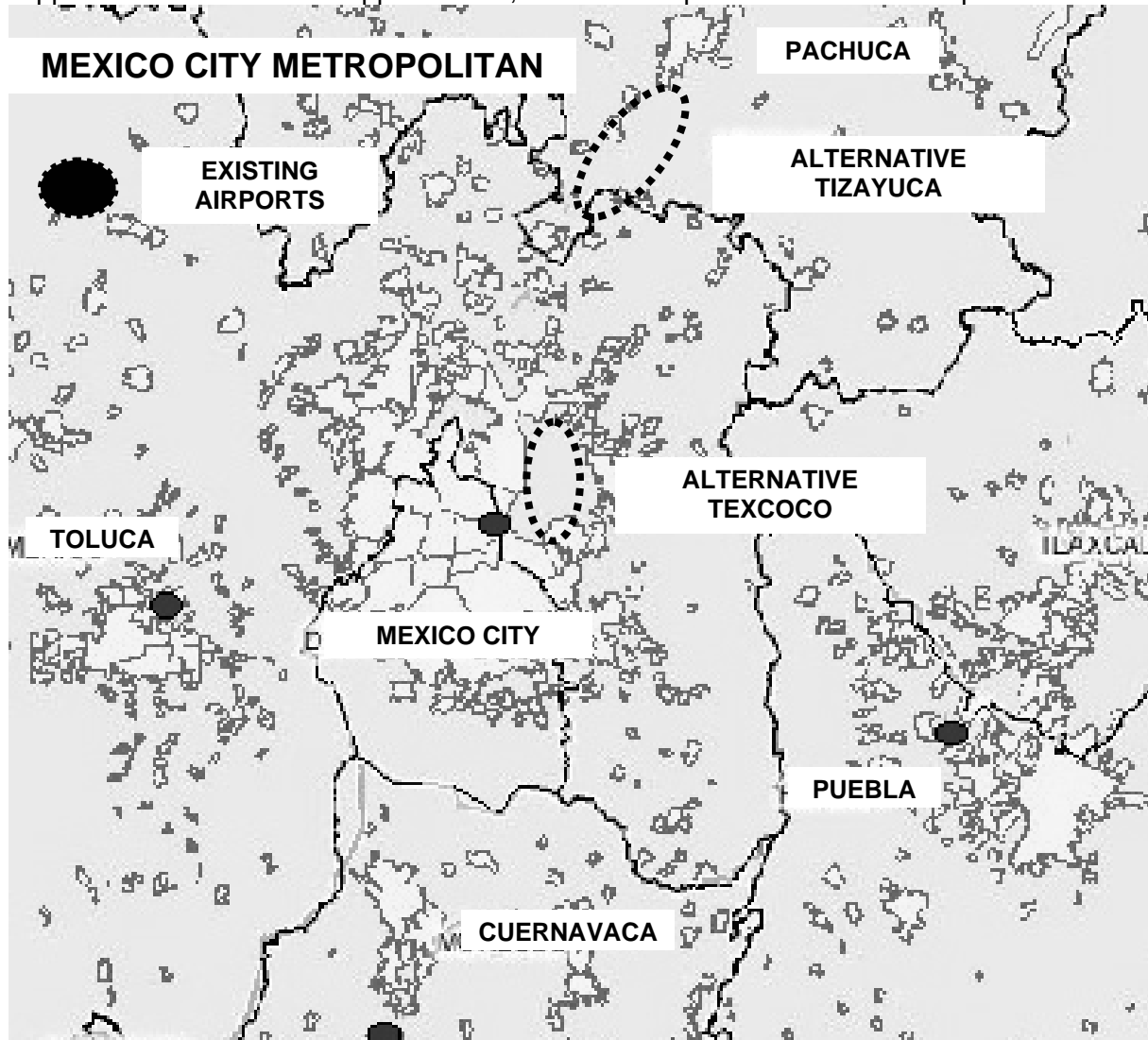
## A NEW AIRPORT FOR THE CONSOLIDATION OF THE AIRPORT SYSTEM OF MEXICO CITY

### PRECEDING

This paper relates to a research being done in the Laboratory of City and Regional Planning of the “Centro de Investigaciones y Estudios de Posgrado” of the “Facultad de Arquitectura” of the “Universidad Nacional Autonoma de Mexico” (UNAM). This work given to UNAM as a result of a contest organized by the State of Hidalgo and the National Council of Sciences (CONACYT) to design a regional plan for the Tizayuca Valley, where this authority desires to build a new airport. Karla Pagaza, Gabriela Jarquin, Juan A. Martínez, Claudia Lozano, Carlos Arias and Paul Hernandez, contributed with some of the analysis and drawings of this paper

### INTRODUCTION

In 2001 a new airport for Mexico City was planned, two alternatives were studied, both with the possibility of at least two runways operating simultaneously, one option in the fringe of the metropolis at Texcoco, the other 70 kilometers ( 43.5 miles) from the City at the Tizayuca Valley. The first alternative required the cancellation of the current airport since its “Approximation Cone” overlapped with it , the second option did not have this problem.



After a thorough analysis, the Texcoco location was selected, therefore, the land acquisition process was started with very negative results including a civil revolt which made this alternative not feasible

Instead of considering the Tizayuca location, the Aeronautical Authorities opted for a third solution, the modernization of the current City Airport and three other airports located near surrounding cities, this option was immediately started and will be finished this year allowing this airport to handle up to 30 million passengers per year, since it only counts with one runway.

The Toluca airport, 70 kilometers from the City has been enlarged and refurbished with a dramatic growth of services in the last two years, other two airports, Cuernavaca and Puebla are in process of modernization.

Last year the Hidalgo State Government, where the Tizayuca Valley is located, decided to make a regional plan of this Valley with an area of 1500 sq. kilometers, this project including an airport with the possibility of three runways if necessary, this action to consolidate the airport system of the region.

So far, our analysis showed that given the modernization of the four airports afore mentioned, the Tizayuca airport could work in conjunction with the others, therefore one runway would be enough to take care of ten million passengers in the future. In any case the airport with all the facilities derived from it will occupy a very small portion of the valley, so it is a very important detonator but territorially speaking it is not that important, hence this paper will show all the factors that would be included in such a plan in conjunction with the airport.

### **SOME HISTORY RELATED TO THE MEXICO CITY INTERNATIONAL AIRPORT (MCIA).**

In 1929 Juan Guillermo Villasana proposed the construction of a civil airport terminal for Mexico City, located beside the Moctezuma Neighborhood and also as part of the Texcoco Ejido on the Northeastern area of the Federal District, entity where Mexico City is located.

The lands of the neighborhood mentioned above, were donated by Alberto Braniff, a pioneer of the aviation and the first Mexican to fly an airplane over Mexico City, he made history by becoming both the first pilot to fly an airplane in Mexico and in Latin America..

On November 1928, Felipe H. García managed to land a biplane aircraft Hanriot on this site. By February of 1929 Mexicana de Aviación, , Corporación Aronautica de Transportes, Pickwick Latinoamericana, Aerovias Centrales and Lineas Aereas Occidentales were operating on this grounds.

The first terminal building before conclusion collapsed as a consequence of an earthquake in 1930. On 1931 the first light system was installed, including one lighthouse, side lights on runways and lamps on platforms for night operations.

On 1934, Aeronaves de Mexico with a Stinson airplane, started operating in this airport with a route to Acapulco.

On April of 1939 a second building including an air traffic control tower was inaugurated by President Lazaro Cardenas, in it, a beautiful mural by Juan O'Gorman was painted on the Tower walls to substitute a previous mural damaged during an earthquake in 1930.

In 1954 a new building known as “Mexico City International Airport” (MCIA) substituted the 1939 terminal . This Airport today is in service not without many transformations, including the one that nowadays is taking place.

### **OPERATIONAL AND PHYSICAL ATTRIBUTES OF MCIA**

MCIA accounts for 35 % of all aeronautic operations in Mexico, gives service to many important cities in the central region of the country such as Cuautla, Tlaxcala, Pachuca, Querétaro, Cuernavaca, Puebla and Toluca, this although , the four cities previously mentioned count with international airports.

MCIA has direct connection with 116 cities in Mexico and abroad, operated by 32 national and international airlines, it also serves 8 Mexican and 27 international cargo airlines.

MCIA occupies 680 hectares (1680 acres), counts with two take off and landing runways, the main one of 4.2 kilometers (2.61 miles) and a separation between them of 300 meters (328 yards), distance not enough to allow simultaneous operations, since international aeronautical standards, require 1.5 kilometers between runways to operate at the same time. The occupied area with buildings is close 120 hectares.



Last year MCIA managed 350 thousand flights, 24 million passengers and 52 million tons of cargo.

Unfortunately this airport is surrounded with urban areas, reason why it is impossible to build a new runway, therefore its operations, regardless of a new terminal building under construction and the modernization of the existing one, in a few years will reach its maximum.



**TERMINAL BUILDING OF AICM**

For this reason and the impossibility of the construction of a new airport in the Texcoco region, option which would've derived in the cancellation of the existing airport, the aeronautical authorities decided to enlarge and modernize airports close to the city to solve this problem in the near future.

### **MEXICO CITY METROPOLITAN AIRPORT SYSTEM**

The Mexico City Metropolitan Airport System, is the result of the decision taken after the Texcoco alternative couldn't be put into practice.

This system is planned to fulfill the future demand for air services of the Mexico City Metropolitan Region, which, the aeronautical authorities foreseen impossible to cover with the MCIA.

This Plan includes the enlargement and modernization of the MCIA and utilizing existing airport facilities in near by cities, which at the present, have had a small demand compared with that of the MCIA.

In the following table, some physical attributes of these auxiliary airports are presented

<b>AIRPORTS NEAR MEXICO CITY</b>					
<b>AIRPORT</b>	<b>RUNWAY LENGTH KM.</b>	<b>AREA HAS.</b>	<b>BUILDING AREA HAS.</b>	<b>DISTANCE TO BUILDING METERS</b>	<b>LENGTH BETWEEN RUNWAYS</b>
TOLUCA	4.2	472.64	70.89	220	170 m.
PUEBLA	3.5.	357.11	23.46	280	
CUERNAVACA	2.8	200.75	19.27	70 .	

In 2006 the number of passengers managed by these airports was 1.8 million at Toluca, 450 thousand at Puebla and 220 thousand at Cuernavaca.

## MEXICO CITY METROPOLITAN AREA

The 2005 Census estimated a population close to 19 million inhabitants for Mexico City which urban area nowadays covers more than 1500 sq. Km. The City is located in 2 federal entities, the State of Mexico and the Federal District, the latter with less than 50% of the total population, and the conurbated municipalities of the State of Mexico with the rest of the inhabitants of the Metropolis.

The Federal District with a total area of 1500 sq. kilometers, includes 16 Delegations with a population close to 9.5 million inhabitants and close to 50 % occupied by urban land. Twenty municipalities belonging to the State of Mexico, which is much larger, conform the other half of the City, however for planning purposes, the Metropolitan Region of the City includes 59 municipalities of the State of Mexico and one of Tlaxcala State; Tizayuca, the more important in this analysis.

The conurbation process of the Federal District with the municipalities of the State of Mexico started in the 50's and increases constantly. As said before, by 2005 it was estimated that the conurbated municipalities surpassed the population of the Federal District.

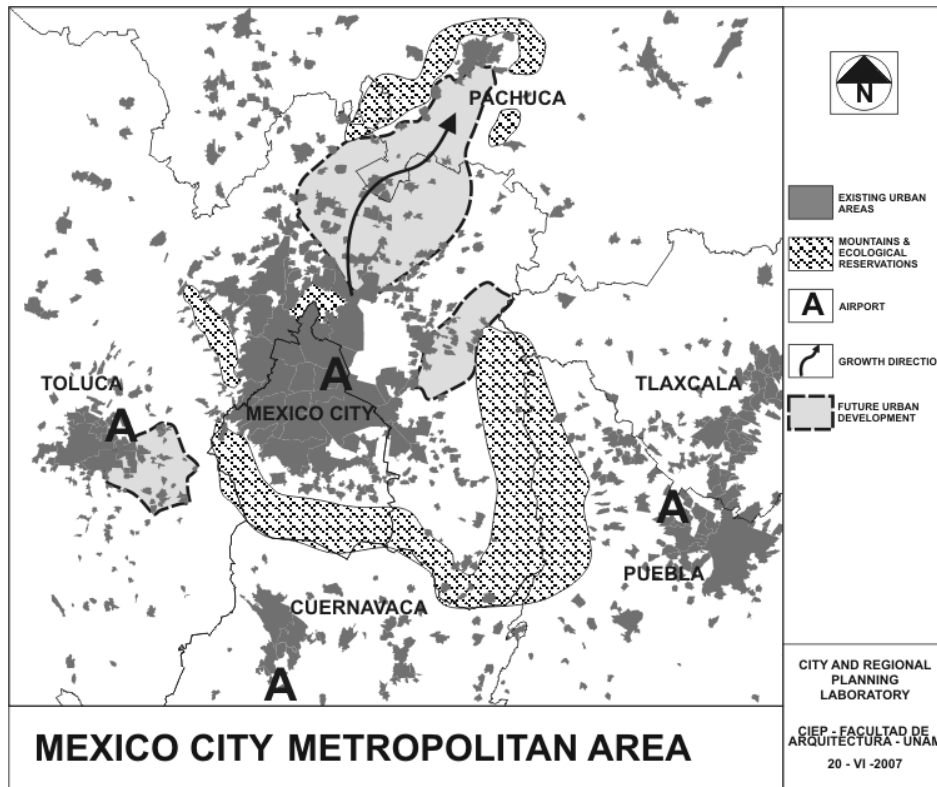
According to forecasts of many scholars, Mexico City will stop growing around 2045, arriving to a maximum population between 24 to 25 million inhabitants. These estimations consider a decreasing trend that the annual population growth rate has shown since the 80's, which by the middle of the 70's reached its maximum of more than 6% and by now it is less than 1% in the Federal District and 1.5% in the conurbated municipalities.

In any case, this Metropolis needs to prepare new or recycle urban spaces for allowing from 5 to 6 million more inhabitants in the following 35 years, that's a lot of people in a very short time. The following table shows a population diagnosis and forecast for Mexico City done by the aeronautical authorities of the State of Hidalgo.

YEAR	AREA (KM.2)	POPULATION (MILLION)
1950	171	3.05
1970	674	8.72
1990	1231	15.31
2000	1563	18.96
2020	1962	23.97

The Valley of Mexico, where the City is located, is a closed basin surrounded by mountains and limiting the Federal District and part of the State of Mexico with the States of Puebla, Morelos, Mexico, Tlaxcala and Hidalgo. These highlands, according to different regional plans, not suitable for urban growth, for this reason the urban sprawl is moving towards the north in the direction of the Tizayuca Valley in the Hidalgo State.

The cities of Puebla, Cuautla, Cuernavaca and Toluca, all located in a closed range of Mexico City and being considered part of the "crown" of the metropolis, grow in its direction, nevertheless, the physical conurbation among these cities with Mexico City seems almost impossible because of the mountain chain surrounding it.



### SOME ATTRIBUTES AND RELATIONS OF THE MEXICAN AERONAUTICAL SYSTEM

There are 60 major airports in the Country. Considering official data from January to September of 2006, and an estimation from October to December of the same year of data regarding origins and destinations of all cities interacting inside the country and abroad, a calculation of number of flights, passengers and cargo was performed for each airport. One important characteristic is that 9 airports concentrate 80 % of the total activities of the whole country standing out the biggest metropolis of the nation in terms of population and the three more important international tourist city-regions of Mexico, the following table includes some relevant figures related to this phenomena.

**MEXICAN AIRPORTS. 2006. (THOUSANDS)**

CITY	FLIGHTS	PASSENGERS	CARGO (TONS)	POPULATION
ZM MEXICO	350.352	23,500.652	352,255.165	19,365.361
CANCUN	81.698	9,255.635	14,682.851	572.973
ZM GUADALAJARA	106.887	5,991.107	160,250.991	4,156.890
ZM MONTERREY	96.161	4,786.878	53,178.967	3,534.506
ZM TIJUANA	65.859	3,505.287	14,116.436	1,353.096
SAN JOSE DEL CABO	27.870	2,624.432	3,417.356	154.162
PUERTO VALLARTA	31.068	2,839.642	2,163.280	220.368
ZM TOLUCA	23.418	1,698.732	24,749.897	1,255.277
ZM LEON	20.824	1,119.312	1,984.139	1,463.708
<b>UP TO HERE 80 % OF THE TOTAL OF 60 AIRPORTS</b>				
HERMOSILLO	32.165	1,106.072	5,540.715	650.359
ZM MERIDA	20.243	951.821	17,715.066	933.938
<b>TOTAL</b>	<b>1,152.843</b>	<b>69,215.839</b>	<b>700,296.802</b>	<b>35,801.335</b>

An analysis of the 60 airports which are part of the system studied in this paper was carried out. This analysis includes national and international information for flights, passengers and cargo and also considers regular flights and charterage.

Also, considering Census data, a population estimation for 2006 of cities where these airports are located was done.

### SOME EXPERIMENTS

Five regression analysis were performed in order to find out the correlations among the more important variables of our interest. In all cases a linear function was considered, the results are presented in the following table.

EXPERIMENT	DEPENDENT VARIABLE	INDEPENDENT VARIABLE	B0	B1	R2
1	Cargo attended in airports	population	- 6587	18.905	.9218
2	Flights attended in airports	population	1.8792	.0183	.9038
3	Pasengers attended in airports	population	8.4045	1.2031	.8330
4	Cargo attended in airports	flights	- 7416	977.57	.9105
5	Pasengers attended in airports	flights	-144.71	67.348	.9643

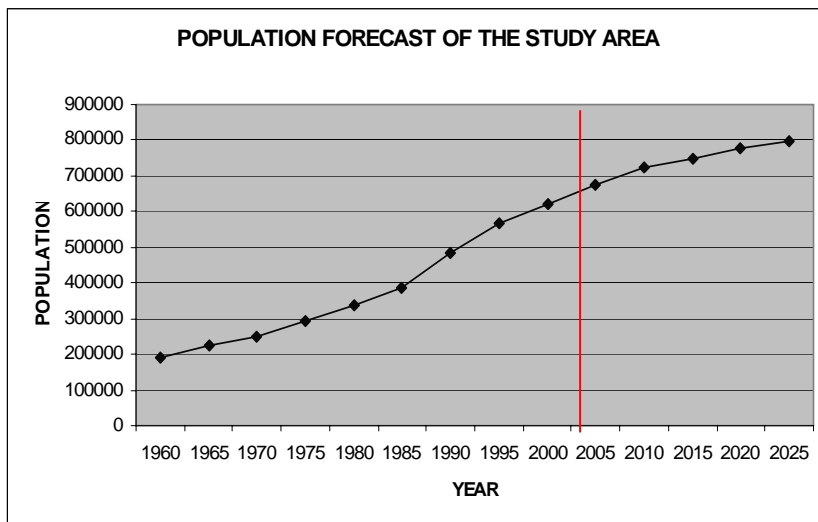
Considering the **R2** resulting from these five experiments we can affirm that:

1. The number of passengers attended in Mexican airports are highly dependent to the number of flights and also to the population where the airport is located.
2. The cargo is also explained by the number of flights and also by the population of the city where the airport is located.
3. There is a very strong correlation between flights and population.

From these results we can conclude that statistically speaking, there are very strong relations between the variables of analysis, therefore, we can make reliable estimations considering the equations given above. The exception to the above would be related to cities-regions with high tourist activities as is the case of Cancun, San Jose del Cabo and Puerto Vallarta.

### STUDY REGION. THE TIZAYUCA VALLEY

For the porpoise of this paper our Study Region will be identified as the Tizayuca Valley, located between Tizayuca Clty and Pachuca, north of Mexico City, it includes nine municipalities of the State of Hidalgo, among them, Pachuca the Capital city, by far the entity with more population.



The following table and graph shows the evolution of the population of this 9 municipalities in the Study Region from 1960 to 2005 and also shows a forecast to the year 2025

Fernando Greene Castillo  
A New Airport for the Consolidation of the Airport System of Mexico City  
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**POPULATION EVOLUTION OF THE STUDY REGION. 1960 - 2025**

LOCALIDAD	1960 CENSO	1965 PROY.	1970 CENSO	1975 PROY.	1980 PROY.	1985 PROY.	1990 CENSO	1995 CENSO	2000 CENSO	2005 CONTEO	2010 PROY.	2015 PROY.	2020 PROY.	2025 PROY.
<b>PACHUCA</b>	131753	157438	171084	200789	232733	268317	331907	394066	431571	471242	503472	521881	541086	553754
<b>TIZAYUCA</b>	6026	6964	8703	9984	11399	13015	30021	39324	45958	55596	59670	62183	64941	67026
<b>TEPEAPULCO</b>	14203	17179	24955	29340	34001	39327	46702	48146	49207	49097	51984	53471	55057	56076
<b>ZEMPOALA</b>	12304	14198	13840	15721	17838	20517	21156	23116	24216	27186	28713	29574	30603	31372
<b>SAN AGUSTIN TLAXIACA</b>	11519	13395	12287	13948	15699	17803	19780	21536	24070	27078	28681	29626	30745	31615
<b>ZAPOTLAN DE JUAREZ</b>	5497	6334	6337	7265	8343	9693	11391	13562	14825	16419	17427	18011	18669	19148
<b>TOLCAYUCA</b>	3286	3795	4460	5009	5628	6355	7951	9977	11262	11676	12419	12860	13371	13738
<b>VILLA DE TEZONTEPEC</b>	4135	4802	4930	5524	6213	7120	7334	8805	8894	10685	11313	11696	12166	12547
<b>TLANALAPA</b>	2797	3260	4023	4608	5282	6081	8971	9646	9732	8448	8964	9249	9550	9727
<b>TOTAL REGION DE ESTUDIO MAS PACHUCA</b>	<b>191520</b>	<b>227366</b>	<b>250619</b>	<b>292188</b>	<b>337135</b>	<b>388228</b>	<b>485213</b>	<b>568178</b>	<b>619735</b>	<b>677427</b>	<b>722642</b>	<b>748552</b>	<b>776187</b>	<b>795004</b>
<b>TOTAL REGION DE ESTUDIO SIN PACHUCA</b>	<b>59767</b>	<b>69928</b>	<b>79535</b>	<b>91399</b>	<b>104402</b>	<b>119911</b>	<b>153306</b>	<b>174112</b>	<b>188164</b>	<b>206185</b>	<b>219170</b>	<b>226671</b>	<b>235101</b>	<b>241249</b>



These results show that Pachuca by the year 2005 accounted for 471 thousand inhabitants and by the year 2025 will reach 554 thousand inhabitants. On the other hand the other eight municipalities in the study region will pass from 206 thousand to 241 thousand inhabitants from 2005 to 2025, this means that the present population of the studied region by 2005 was 670 thousand inhabitants and that by 2025 they will grow to 800 thousand.

**OPERATIONS FORECAST FOR THE TIZAYUCA AIRPORT**

Considering the Study Region population forecast for 2025 and the equations given above, a demand estimation for aeronautical services of the region was done, these being resumed in the following numbers:

<b>FLIGHTS</b>	<b>12,760</b>
<b>PASSENGERS</b>	<b>971,000</b>
<b>CARGO (TONS)</b>	<b>8'537,000</b>

If we add to this calculations the possible demand derived from the Mexico City future population that could settle in this region which is estimated in a least 1 million inhabitants, the demand for aeronautical regional services will rise to

<b>FLIGHTS</b>	<b>28,710</b>
<b>PASSENGERS</b>	<b>2'187,750</b>
<b>CARGO (TONS)</b>	<b>19'208,250</b>

Now, if we consider that Mexico City International Airport (MCI): will reach its maximum capacity in a few years; its future demands will have to be taken by airports in its metropolitan area, such as the one planed in Tizayuca; and that demand is correlated to the economic future development, then our calculations for future demands of the Tizayuca Airport will grow 50% more.

<b>FLIGHTS</b>	<b>43,065</b>
<b>PASSENGERS</b>	<b>3'281,625</b>
<b>CARGO (TONS)</b>	<b>28'812,375</b>

These results based on future demands back off the idea of a new airport at Tizayuca of at least one runway.

**A NEW CITY IN THE TIZAYUCA VALLEY**

In order to be able to handle the total population of our Study Region forecasted for 2025 considering its historical tendency and part of the population due to the future growth of Mexico City which might settle in the Tizayuca Valley, a new spatial plan is under study .

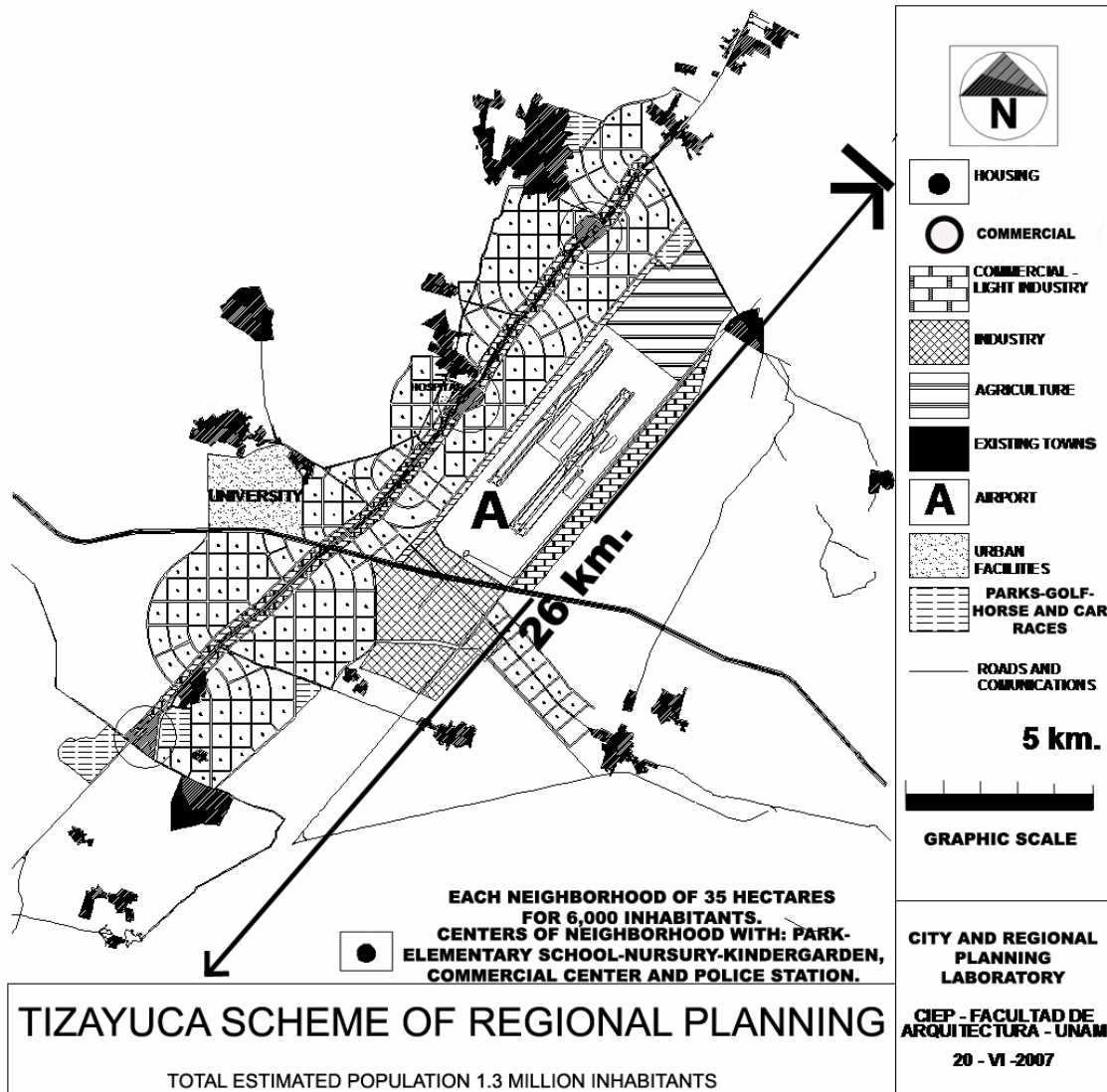
The preliminary physical arrangement for this city is based on a linear project along the axis of the main highway which communicates the cities of Tizayuca and Pachuca, west of the airport under study. This plan differs from others done in the last 7 years, because they located the new city apart from this highway, east of the location of the airport.

The new city is planed for 1.2 million inhabitants, distributed in 170 neighborhoods or barrios, each one for 7000 inhabitants with an average area of 35 hectares (87 acres). Each neighborhood with a central area including: basic educational, health, commercial and recreational facilities.

The Plan also includes: 800 hectares (1976 acres) for industry; 450 hectares (1112 acres) for commercial activities mixed with light industry; 3 commercial regional centers with a total of 100 hectares (247 acres) and 600 hectares (1482 acres) for agriculture surrounding the city. Facilities for higher education and research are planned in 650 hectares (1606 acres), while recreational and amusement regional activities are allowed in 800 hectares (1976 acres).

For the new airport, more than 2,000 hectares (4942 acres) are considered in this project , This area is enough for an airport with 2 runways which could operate simultaneously.

Below a regional planning scheme for this new city is presented.



## CONCLUSIONS

- The Mexico City International Airport modernization and enlargement will allow its operations for a maximum of 7 more years, hence, the refurbish and extension of Puebla, Toluca and Cuernavaca should continue to keep structuring the regional system of aeronautical communications in the region.
- Since huge amounts were invested in the present Mexico City International Airport for its modernization and enlargement, it is recommendable that it should continue operating at its maximum capacity on the long run.
- Considering the above, the Texcoco alternative, since it would cancel the present Mexico City International Airport, is by all means not recommendable.
- With this scenario and considering that Mexico City growth tendency goes towards the Tizayuca Region, a new city in this valley results a positive idea.
- The construction of this new city requires in parallel the implementation of an up to date communication system to make it interact correctly with the other of the region, although its plan is done to make it self sufficient.