

# Tensile City

by

Mario Henri Chakkour

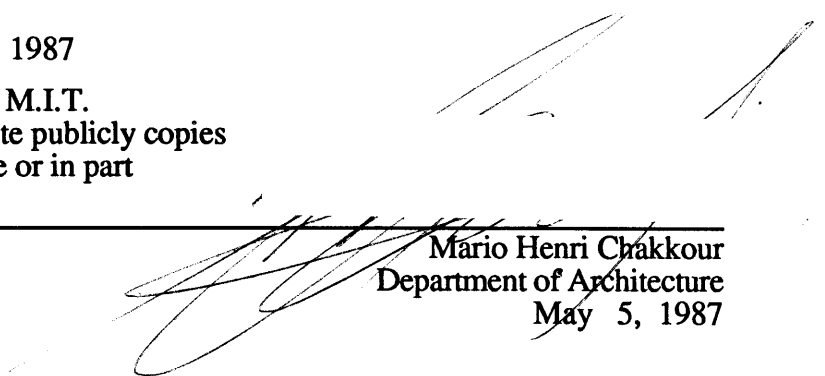
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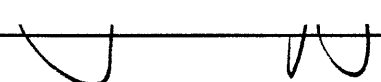
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To a force,  
vast enough to embrace the heavens,  
yet humble enough  
to dwell within the heart ...

To Dr. Dahesh,  
prophet of God.

### Acknowledgements

I would like to thank all my friends and colleagues for their moral support and their time, especially professors Julian Beinart and Ranko Bon who took the time to read my material and offer me valuable suggestions.

Also, I would like to thank professor Dennis Frenchman for acting as my advisor and for doing so at a time I did not have a clear path to guide my thesis on. If not for him, my project, although born, would have been an orphan.

It goes without saying that it is only through the joint effort of many people that any project gets accomplished. Yet in my experience, I find that there is always one person who is ultimately responsible for inspiring any project and later making sure it gets done. And this time there was no exception. This thesis would not have been possible if not for the guidance and persistent coaching of professor Roger Simmonds, a mentor and a friend, who took me under his wing for the whole duration of my stay at M.I.T.

And I would like to go back to my years of undergraduate studies at the Pratt Institute:

I am forever in dept to professor Vittorio Giorgini with whom I had the privilege of working as an apprentice. His work and method of teaching will be with me forever. It is through him that I understood the meaning of the word: process .

# Tensile City

by  
Mario Henri Chakkour

Submitted to the Department of Architecture on May 5, 1987  
in partial fulfillment of the requirements for the Degree of  
Master of Science in Architecture Studies

## ABSTRACT

Tensile City is a story that provides the answer to the following question: " If we were to leap forward in time and visit a city of the future, what would learn about our contemporary city ? "

The story unfolds when M.C., the main character, plans to undertake such a trek. The main reason for the trip is his thirst for knowledge, characterized by a dichotomy between logic and lust for adventure.

He is inspired by a vision he had about a trip into outer space, where there existed a wondrous city -*the* ultimate example.

Although the city in space represents a level that might never be reached on Earth, there was nevertheless something to be learnt:

*We have the means that will enable us to transform the urban environment in such a way that its physical framework allows it to function like a true three dimensional space. Just think of it! A city that practically has no limits in the ways it can grow. But still, there has to be a logical reason for it to exist...*

At this point the other character of the story appears. His name is T.C. and he lives in Tensile City. He will provide M.C. with the proof that Tensile City is a worthwhile experiment and not just the result of M.C.'s lust for adventure.

Therefore, T.C. will often be challenged to prove the validity of Tensile City. M.C. actually spends time in this city. He learns, among other things, that he is in no way qualified to be part of it. In fact he tasted a vision of the future that was not a vision anymore, but reality: and that was scary ...

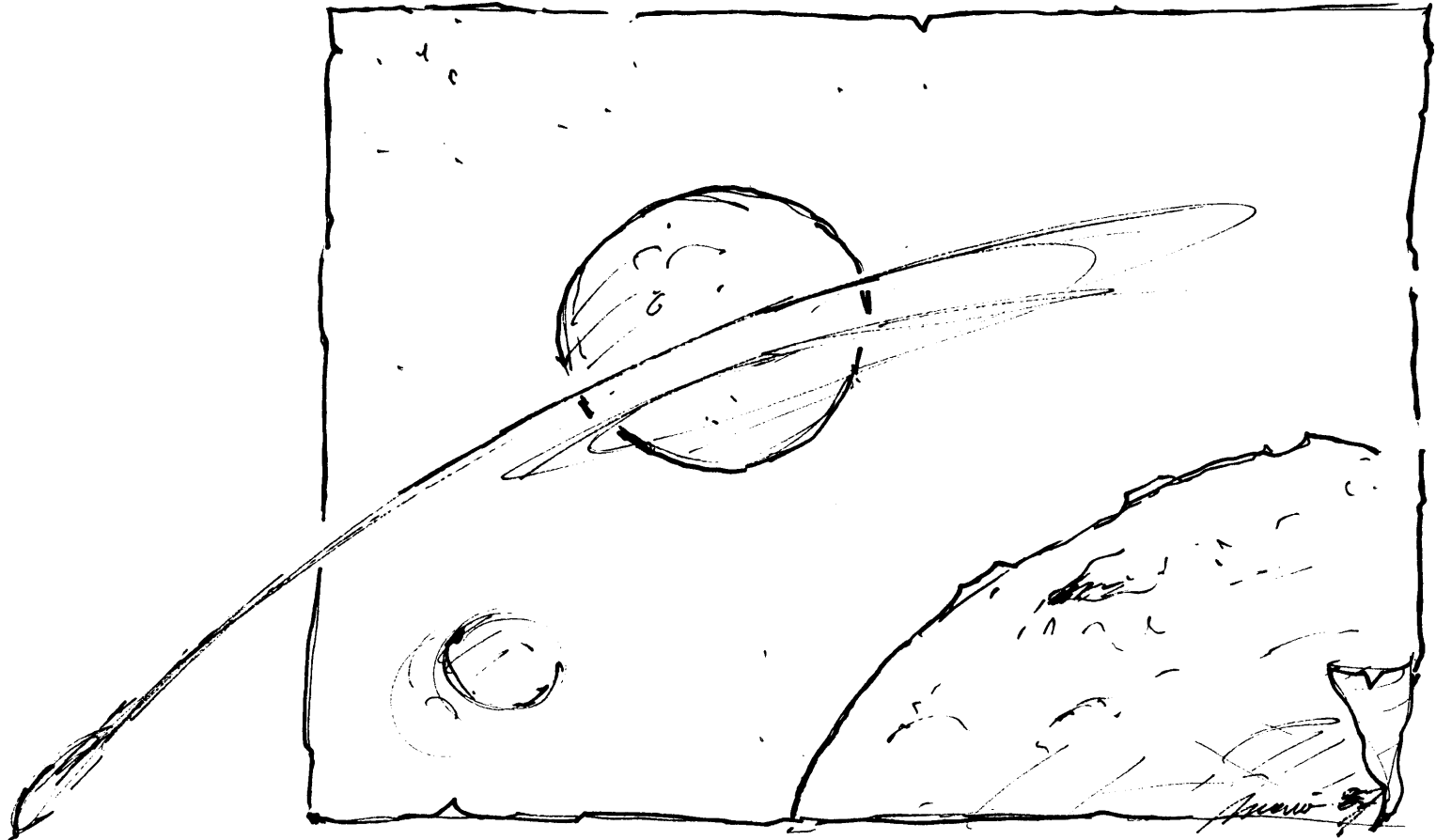
In a letter to T.C., he agrees that Tensile City is indeed superior and-by all means - a logical solution to the issues that it addresses. Yet in his opinion, people -or cities- were not meant to live in this rigid way: the mental and the physical requirements are phenomenal.

He set out to live a fantasy, instead he read an omen. In it he read a message that warned against creating an alarming imbalance in the ecosystem of life. Which in the long run, would require cities such as Tensile City. But is humanity prepared for it ?

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Tensile City- Journey Into Space.

**Journey Into Space.**



Tensile City-Journey Into Space.

**Journey into knowledge.**

Imagine for a moment that you took a journey in Outer Space where gravity had no affect upon you, your destination : a 'niche' where- a very long time ago- an implosion not unlike the one Mumford described in his book: 'The City In History', took place: a fusion between the intergalactic space hunter and the earliest space station dweller. This being the case, a *genetic code* was created for those settlements in Outer Space, thus dictating their forms as cities - in a hostile non-gravity environment- made of a set of basic components assembled by strict determinants, forming a whole.

On your way to that city in Outer Space known as '*Component Number 6 in System Number 20*', your first impression - as you slow down to the speed of light- is that you are approaching a network of planets stretching in all directions,hence forming constellations organized following a tetraprismic order. Then you are told by your guide, a very tall and thin person<sup>1</sup> , that what you were looking at was in fact the *System Number 20*, formed of xxxx number of cities ! An actual planet ! A sight to behold.

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<sup>1</sup> Here, the assumption is that people living in Outer Space will be physiologically different.

Tensile City-Journey Into Space.

Among the barrage of thoughts which suddenly invade your humbled mind, you ask your host: ' Who *controls* all of this?' You then realize the futile attempt of your question when, in return, you are asked: ' Who controls <sup>2</sup> *your* planet ?'

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<sup>2</sup> Historically, control has been achieved through military control and/or the subtle forces of myth and superstition.

Tensile City-Journey Into Space.

The trip to *Number 6* ended with a relatively simple docking maneuver given the fact that there was no gravity. To the naked eye, *Number 6* -a city-is so complex that your instinctive reaction to this environment is to search for spatial clues which will give you an idea about the manner in which the inhabitants perceive and relate to it. Back on Earth-and bound to the two dimensional plane, the 'image of the city' left patterns that you identified in the paths that led to nodes ...There, there was a logical sequence of spatial experiences which came in a way which was possible to learn. Here On the other hand, you are suddenly faced with a world you thought impossible to achieve, for two reasons:

Firstly, the fact that gravity plays an important part in the way we build our cities on Earth. Secondly, this method of building Earthly cities has led us to think about them in terms of a two dimensional frame of reference.

Suddenly, it becomes clear to you that-although you cannot see them- there must exist designated paths and nodes that belong to patterns of movements in this three dimensional network whether the movement is "vehicular", "pedestrian", or involves the physical addition of components in that system, in which case the imbalance created by this addition would require appropriate adjustments to be made, in other words: a complex urban design process...Too complex.

Tensile City-Journey Into Space.

What you have before you is an actual manifestation of levels of understanding about cities that are beyond your reach because you only have a general idea about systems theory and bits and pieces of knowledge about the mechanism of cities as 'huge facts of nature' and as inventions. Nevertheless, you plan to undergo a process of learning in the hope that, when you go back to Earth, you will be able to present the world with a method of thinking about cities. This would hopefully address some of the current as well as age old issues resulting from the application of 'old' ways.

This paper represents your recommendations: a *synthesis* of your observations and an *application* in the form of a city : Tensile City.

### Synthesis

One thing we were exposed to during our trip in space, was a high level of technical achievement deployed with these two questions in mind: ' How can one maintain the integrity of that place as a city, as well as enriching the experience of living in it and solving its problems?'. To relate more to the first question, we can think of the process of explosion the city goes through as the result of the implementation of a mere invention such the hoe or the plow- in the Neo-Paleolithic age, for example- or the invention of the car ... Essentially, any one of these could be considered as being the process of changing the

Tensile City-Journey Into Space.

aspect of one component of a city-a system- thus creating an imbalance on the whole, therefore requiring the necessary adjustments to be made. In certain cases, even those not involving the creation of imbalance at the micro level, the implementation of a new tool can lead to accelerated growth that ultimately causes the city to loose definition. This creates imbalance at the macro level. In outer space, the design of the city at the micro level defies description. To give you an idea of the level of complexity one deals with: the seemingly trivial act of going home from your work station requires such a level of preparation, that each citizen planning to use a high speed transportation vehicle has to qualify as - what we understand on earth - a pilot with an Instrument Flight Rules rating.

In other words, you cannot just hop on your mode of transportation and join the traffic, you would simply be killed, while causing a shock wave of "air traffic" problems, hence disrupting the timetable for a relatively high number of citizens. Both the harsh environment, the limitations, and the level of sophistication in technology, the freedom, must find a 'middle ground'. To illustrate that point let us consider many of our cities where, for one moment, we accept the claim that the process of urban design often leads to non efficient solutions hence, wasteful. To illustrate one particular case: the ratio of land use to return does not justify the act. On Earth, such wasteful acts are less of a threat to comfort and human life not only because Earth is a forgiving environment when compared

Tensile City-Journey Into Space.

with that of cities in Outer Space, but also because the physical tools used in building the urban fabric come with a higher safety margin than those which would otherwise follow exactly the flow of forces, hence requiring from our part, among other things, an ability to predict which must be so great, that if we were to use them -without fully understanding them, the results would be detrimental. Not only would we create an illfunctioning city, we would also unleash forces we might not be able to recognize, let alone control. In that case we have no other choice but to 'air-lock' the city. In other words: literally putting a stop to city growth. This thought alone is a contradiction to what a city should be able to provide for its inhabitants. If that were the case, why bother with cities in the first place? Cities are 'huge facts of nature' simply because we cannot do without them, at least from the point of view of organizing the process of survival.

But *cities* offer more than just the chance to find a place within the machine of life, they are the myths and symbols we believe in. Hence that 'middle ground' spoken of earlier comprises the process of coming to terms as what a city is to the addition of being a place where 'John Doe' lives and works, and intends to invest in real estate.

Tensile City-Journey Into Space.

**Reflection.**

Having been in that city in Outer Space we could not help but wonder about the possibilities that lay within our reach, which might enable us to create -on our "flat" planet- such an urban experience. Being also well versed in the art of asking the right questions, we wonder about the usefulness of such a "type" of environment as well as the risks involved. To tackle the latter question, we will ask another one: was the airplane invented for the sake of transportation? For those who have been at the controls of their own 'bird', an airplane represents the set the wings which "God" never meant to give us; and yet 'somebody' found a practical use for this invention. Once this happened, the airplane-now the newest mode of transportation- had to be fit in the already existing order of the world . Except that in this case, the airplane suddenly made some people aware of another dimension that required more than the naked eye to see. In fact, any person trained to live hundreds even thousands of hours in the sky, does not differentiate between 'land' and 'sky' or 'airspace', the latter contains as many ridges and mountains as the former. In short, a pilot needs a way to help him visualize his 'turf', and by now and in spite many peoples reservation about the act of flying, the airspace is an accepted fact, to the point where the vertical growth of cities are affected by it.

Tensile City-Journey Into Space.

**Method.**

We have witnessed the possibilities that lie within our reach . We will apply a new approach to thinking about cities in order to address pressing issues, such as:

How to keep the integrity of the city while it undergoes the process of explosion.

How to allow for physical growth to happen with less of a negative impact on the whole.

How to cope with the depletion of land due to the growth in population.

How to build an energy efficient city.

How to build a city that recycles its wastes.

We are also aware of the risks involved in 'fooling around' with components of cities, an act which could lead to their destruction.. To be on the safe side,we will explore a new concept of city,*Tensile City*, and test it in order to see what can be learnt., hence applied in our present cities.

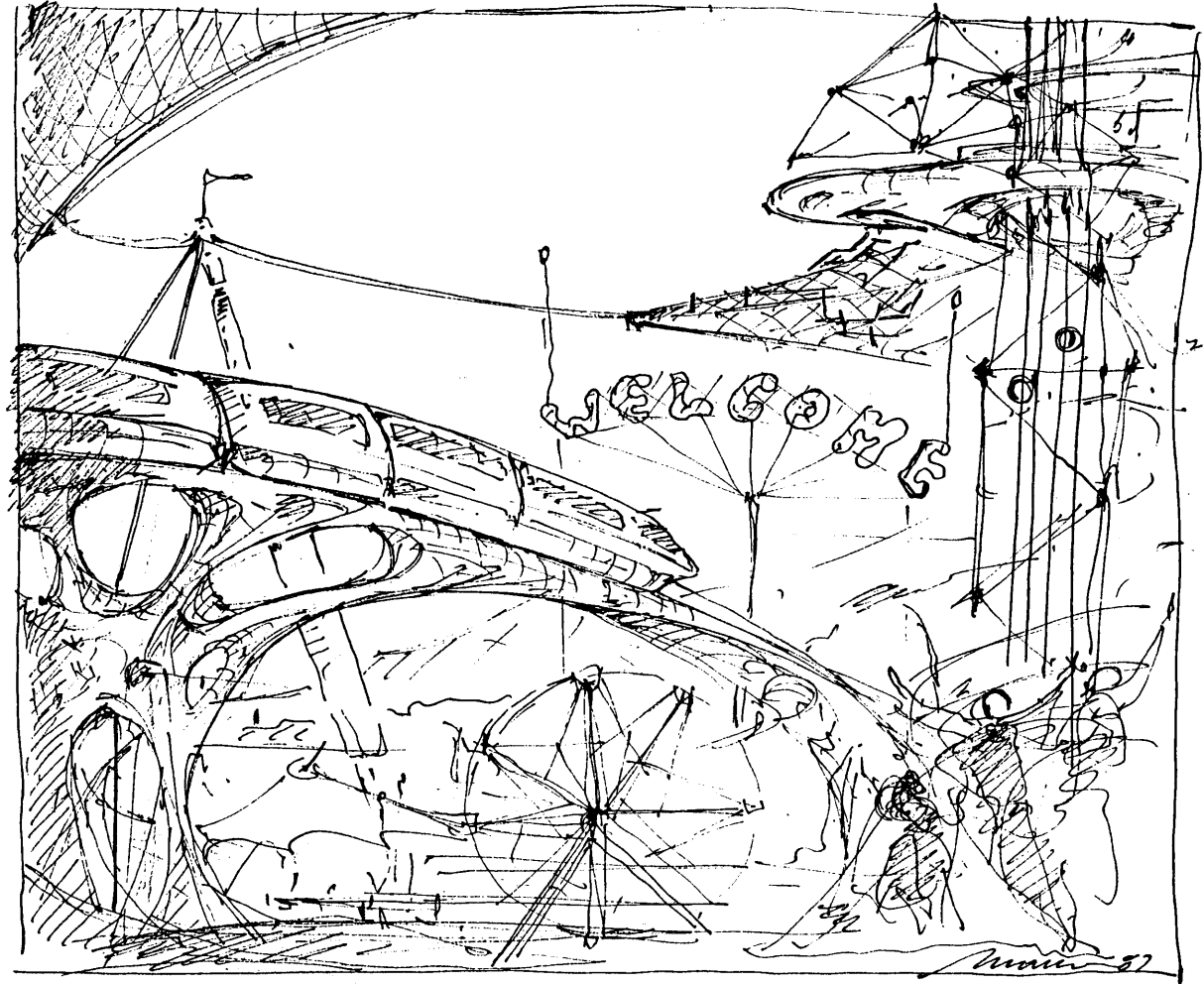
Reflecting upon the experience of inventions such as the airplane,and in order to test the validity of Tensile city, we will keep in mind that among the many services the *city* provides for its dwellers, is the sense of identity with their individual goals. In other words, people live in a place for specific reasons. Furthermore, they each read that same place differently than other people but within the same set of clues.

Tensile City-Journey Into Space.

What is important is that the city provides those sets of clues. By their use, a dweller can have a sense of place. Of course, 'sense of place' and the ability to recognize the urban symbols varies with the type of training one had in one's present environment: Try to convince a New Yorker that getting around in Boston is a 'piece of cake'...This is probably why the first word a visitor utters-when stepping into a new 'world'- is : "Taxi!"; hopefully in this presentation we will do more than that, or at least we will find out once we get there ... So let us take trip to Tensile City, armed with a open mind and an airbag.

Tensile City-Tensile City Or Bust!

**Tensile City Or Bust!**



Tensile City- Tensile City Or Bust!

**Preparation.**

My name is M.C.; together we will witness an image of a world we are yet to build. This image is in the form of a city known as : ' *Tensile City* '. Hence, this document will be the account of our trip.

**The first glimpse at the city.**

Being virtually an 'animal from another kingdom' I instinctively reached for an overpriced copy of the *Frommer's Guide To Tensile City*. To my surprise the book was accompanied by a separate atlas for the city which included pop-up sections -along with the axonometric views... '*Once you determined in which volume your destination lay, you could then refer to a 'flat' view that showed you the steps involved in reaching your point of destination*'. And since the maps were abstract representations of the city, I was greatly surprised to find such a level of detail in them. Little did I know that those 'overdone' maps were merely simplifying what seemed to me to be a tourist's nightmare, once I glanced at the pictures of course. *This* , is a city ?! But why should you take *my* word for it ? Let us see what the *book* says:

Tensile City- Tensile City Or Bust!

*'...More than anything else, it is the lure of the future that draws visitors to Tensile city. From all over the country -and the world , they come to pay homage to the one city that is, more than any other, the birthplace of the twenty first century'.*

*'But there is a lot more about Tensile city to enchant and excite the visitor than the monuments of the future, important as they are ... Tensolians are inordinately proud of their ecological city'.*

Reading through this document you find that *Tensopolis* has a population of 560,000, but as the 'nest' of the greater Tensile city area, which numbers some 2 million people spread out in 83 cities and towns.

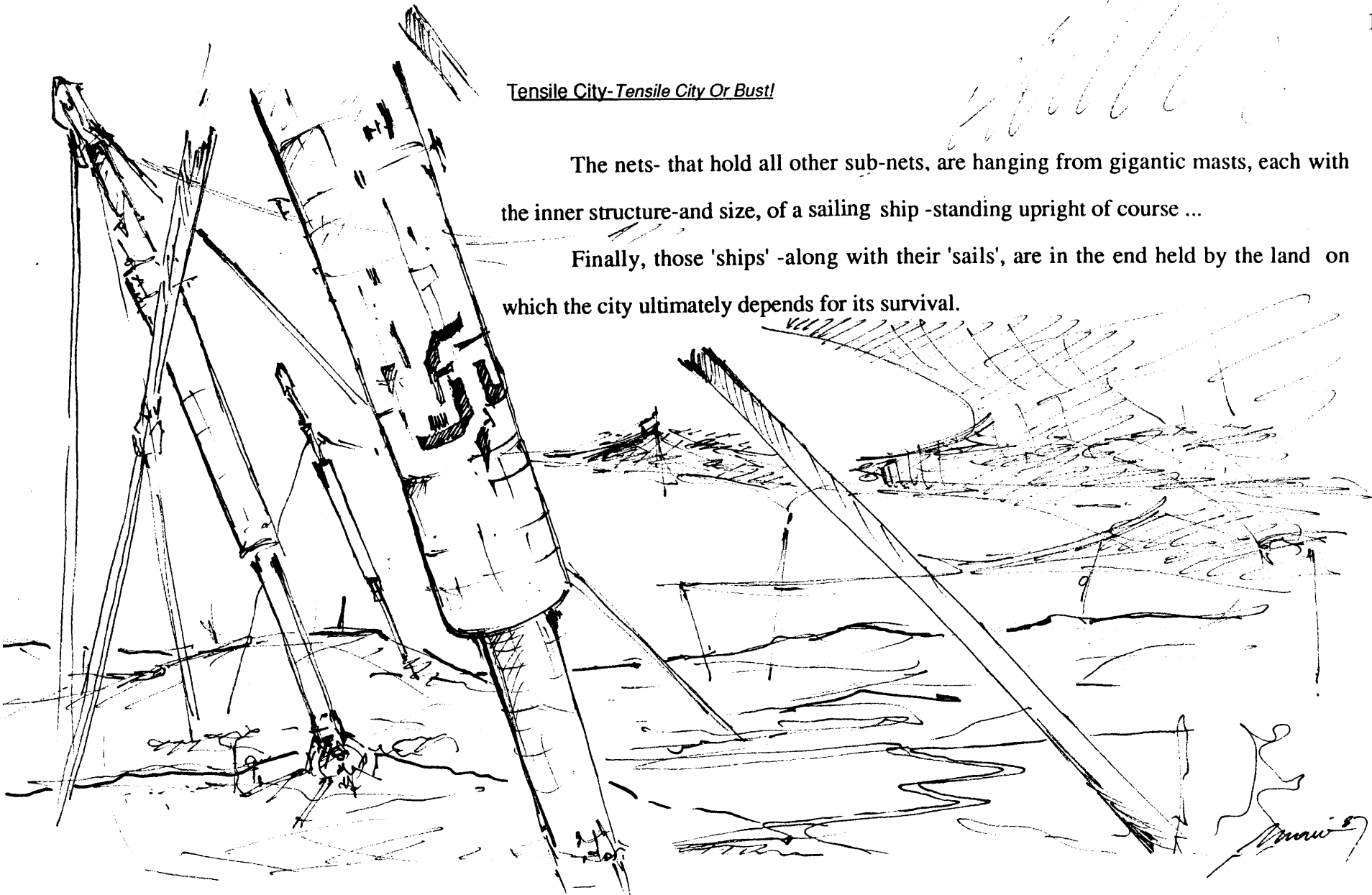
The 'nest' itself is built on *airfill* made of cables, lots of cables. Essentially, what you are looking at is an adaptation -at larger scale- of the technology of tensile structures. In so doing, the city has acquired a 'top', a 'bottom', and whatever happens in between. In other words, the city has a topography which evolves in virtually all directions, but with these two main implications: geometry and airuse are dictated mainly by the loads and the amount of sunlight which can penetrate the nets.

The nets are the supports on which all things hang. Hence they virtually form rigid planes, valleys, mountains and craters, on which dwellings- made of lightweight structure, rest . A giant spider's web if you like...

Tensile City- Tensile City Or Bust!

The nets- that hold all other sub-nets, are hanging from gigantic masts, each with the inner structure-and size, of a sailing ship -standing upright of course ...

Finally, those 'ships' -along with their 'sails', are in the end held by the land on which the city ultimately depends for its survival.



Tensile City- Aboard The Tensile Express.

**Aboard The *Tensile Express.***

Tensile City-Aboard The Tensile Express.

**All Aboard!**

First, for those of you who firmly believe in their motor cars as the ultimate mode of transportation for the 'modern and free', let me say this: you will be greatly disappointed because there are no cars in Tensile City, nor under it. Furthermore, the only means of physically getting to it are: walking, horseback or mule riding, and if you prefer: the Train. You see, the existence of highways is inconsistent with the philosophy of Tensile City. Not that it's great not to have a car, it is practically useless in this environment, and consequently a bother. Of course, there is a racetrack in a designated area on the ground where car enthusiasts can 'log' one or two hours a week. Strangely enough, there was a decline in the enrollment in flying lessons at the nearby airfield, something to do with 'loss of interest' ...

Incidentally, I would like you to meet T.C., our host and companion for this trip. As a resident and active member in the Design Review committee of sector 20\*6\*20<sup>1</sup>-for now, we will take his word for it- he will make sure our visit is educational as well as entertaining.

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<sup>1</sup> These numbers represent a volume.

Tensile City-Aboard The Tensile Express.

**M.C.**

' T.C. I have to be honest with you, I am not sure that I could live in a city without the ability to chose when and how I will go to a place in the event of an emergency. Even if we exclude the luxury of private car ownership, I would sleep much better at night knowing that at any moment, help is only one taxi away.

**T.C.**

' You said the key word : 'Knowing'. In other words: the insurance, the peace of mind that the system will not fail; but what you don't seem to realize is that it takes just about the same amount of 'belief' to live in New York city-just around the corner from a hospital- than to live within the constraints of Tensile City. Are you really more in control of your destiny in New York? Let us assume that all the chains of events went according to schedule: the telephone call, the taxi's showing up on time, the elevators were working so that the need to walk down the stairs was not necessary, and so on ... till you get, without to much delay in traffic, to the hospital. In that case we can only say that we were lucky to make it. Need I remind you of the complex interrelation between the events of our simulation? In addition to their number, within Tensile City we have the added problem of the many levels they each exist on: for example, if you had a flat tire while driving to the hospital you have a situation where a temporary ' local clog' has stopped the system from

Tensile City-Aboard The Tensile Express.

functioning. But if your telephone is not working, and even if all the other chains of events went smoothly (assuming you have your own car) you might still not make it because the hospital-whom you could not call- was not prepared to receive you or- worse, *cannot* receive you due to its limited capacity. In this case, the telephone would have been the physical connection between you and the rest of the other hospitals, whom among other things, might not be equipped to handle certain medical cases, hence the need to travel to another city.'

'Now that I have made that point, my answer to your question would be a description of how Tensile City works, rather than a defense: which tries to argue that Tensile City is *better* or *safer* than this village we are passing through at this moment, for example. You see, each-Tensile City and this village which is built comparatively simpler- has each reached a state of equilibrium, but chose a different way of doing it, the means being the justification for the end.

In the process of choosing a method to achieve the goals- which probably started with the technology at one's disposal, certain physical aspects of the components which went into the 'machine' of the city had to take a form, mass, even velocity in order to achieve the common goal, or goals.'

'Remember, although a city represents different things to different people they -the things- would still have to fit within a common same frame of reference, or denominator, to

Tensile City-Aboard The Tensile Express.

achieve the peoples respective goals : the same way different goals in our society can only be reached after reaching one intermediary goal- 'buying power', or money.'

**M.C.**

' I could not help but notice that you compared what you considered a village, with a city. First: why the differentiation , second: why go to the trouble of building Tensile City if, in the end, the odds of being able to control our destiny, as you call it, would be the same?'

**T.C.**

' I will tackle the first question form a general point of view assuming , of course, that this is the level you are dealing with; otherwise you have to define all the intermediate levels which exist between the stages of 'village' and 'city', assuming that one is an evolution of the other.

Let us assume that cities and villages or any type of human settlement are complex goal-oriented and self- organizing systems, capable of changing their structure while functioning. Next, you would have to come to terms with whether or not such systems are *inventions*, hence: *tools*. In essence, what we are dealing with -cities for example- are inventions through which the subtle forces of nature manifest themselves.

Tensile City-Aboard The Tensile Express.

You could say that a city is a microscope that allows us ,on one hand, to magnify our qualities and with them our negative features, and on the other hand, put them to work for us. These types of inventions are the common denominators of our lives ‘.

‘As systems, cities and villages would have to be made a set of components. If we say-for the sake of simplicity- that there are only five or six basic physical components which make both the city and the village, then our investigation in the differences between the two lies in the ability of each to gain a *symbol status*. In other words: The majority of people ,who at least belong to a higher level in the hierarchy: starting with the people in command along with the law-reinforcing body, seek the luxury of being in their "center of the cosmos". In essence, the feeling that they are not missing a thing : the city is the ultimate tool for the gathering of knowledge.

I will save you the trouble of asking me the following question: "This being the 'information age' where cities-even Tensile City with its structure- still follow the industrial age's organization isn't it obvious that we are now dealing with cities in the metaphysical sense? Therefore, a house can be considered a city by virtue of its connection to satellites and every means of communication available: we need a new name to fit the definition of the *act -of- being -in -contact -with -the -world -from -a- distance.*"‘

‘If that were the case one might as well live in a prison. Or what would you say if I told you that from now on you do not need to work, or leave your house to do your

Tensile City-Aboard The Tensile Express.

shopping, and that everything you need will be provided for you? I don't know about you, but I'll go mad. Cities are therapeutic. Hence, markets and peddlers are as important as museums and libraries.

**M.C.**

‘ You don't have to address the other question ... ‘

**Reader**

‘No! Please do...

**T.C.**

‘ As to why go to the trouble of radically changing the approach to thinking about cities -and believe me, it *is* radical- the reason is simple : the components of the city *need to* and *can* exist in a physical framework which suits best their organization. ‘

Tensile City-Aboard The Tensile Express.

M.C.

‘ Aren't you merely saying to me that it is important for cities to fly because we have invented wings big enough to fit them? I think that, in this case, the need for experimenting went a little bit too far.‘

T.C.

‘ True, true, if the argument for Tensile City rests solely on the fact of creating 'a breathtaking city'. In which case we are building another of Disneyworld , or animated architecture<sup>1</sup>. There, people go to seek breathtaking experiences: it is their only purpose. Should they stay there too long, the exciting would soon become banal. Tensile City is not Disneyworld because of the fact that it has to sustain life, and it does have the added problem of multiple ownership. In that sense, Tensile City is way past the stage of being a by-product of experiments which had different goals: those already took place in the form of small-scale projects seeking new frontiers in spatial expression.

As a result of the observation of these experiments , potential rewards became evident once this 'daredevil' approach was seen under the light of the contemporary urban problems, namely: scarcity of land and the need to build ecological cities that use their

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<sup>1</sup> Read : Architectural Design 52. 9/10-1982.  
Title of issue: 'Animated Architecture.'

Tensile City-Aboard The Tensile Express.

natural resources wisely. Cities that can physically grow without *exploding*, nor suffer due to the limited way in which one could physically add or subtract from it.

This led to the beginning of a learning process which was the basis of the ongoing application. Tensile City now has many objectives. One of them is the application of technology of tensile structures as the basis for allowing inevitable mechanisms- such as city growth at large- to happen with less negative impact on the whole. You see, the potential energy in a new building has enough power in it to damage the urban fabric permanently, as opposed to asking it to 'hold its breath' for a few seconds...

Also, and as a result of this technology, another fact became clear: We are not only introducing a new architectural vocabulary; rather, an approach that requires a higher level of precision and specialization from our urban designers, in order for them to understand the potential risks involved in adding or subtracting from the city.

Besides the calculations for the loads, the engineers have to understand and control certain patterns of urban deformations never before thought to be possible. Nowadays, the word: expansion could mean: *rotation* coupled with *translation* intersecting a centrifugal *implosion* for example'.

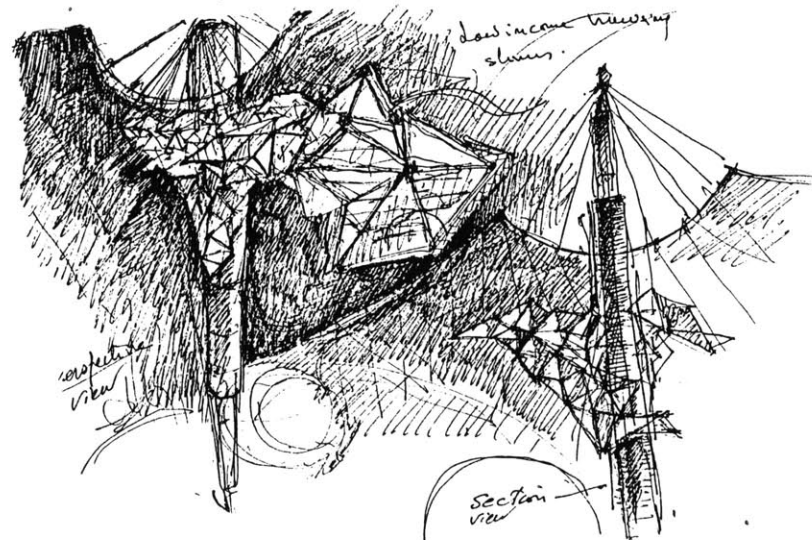
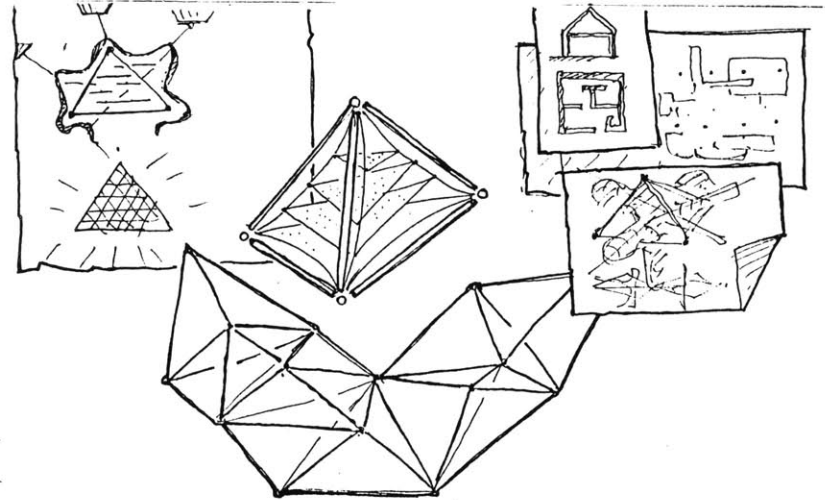
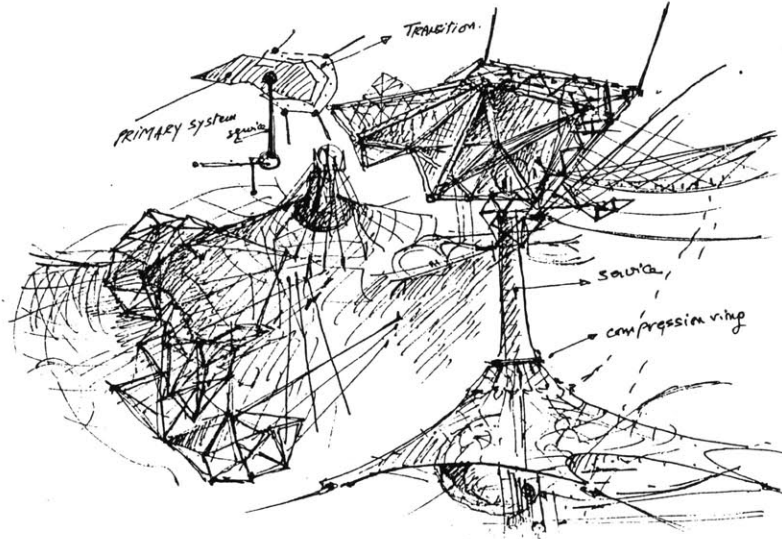
Tensile City-Aboard The Tensile Express.

**M.C.**

‘ Then, what do I need to know in order not to be alienated? I feel like a pilot who is about to step into an alien ship. Although I know there must be a directional gyro somewhere, I can't find it- let alone being able to use it!‘

Tensile City-Anatomy of Tensile city.

**Anatomy Of Tensile City.**



Tensile City- Anatomy of Tensile City.

**Cables and Masts.**

**T.C.**

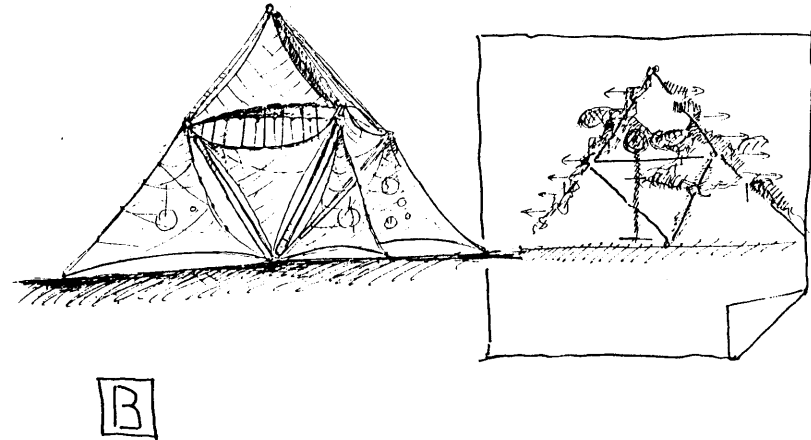
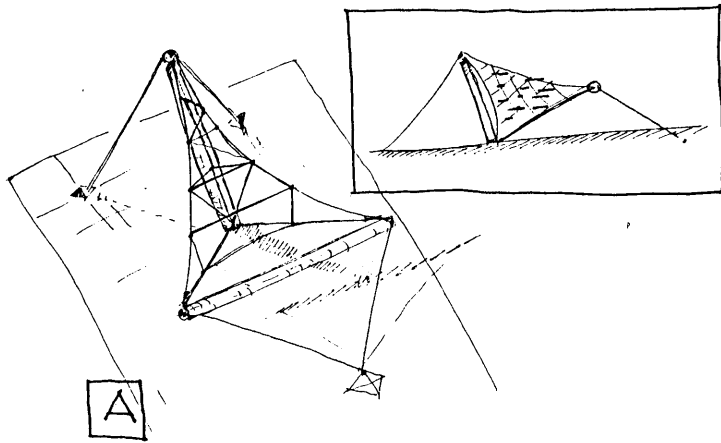
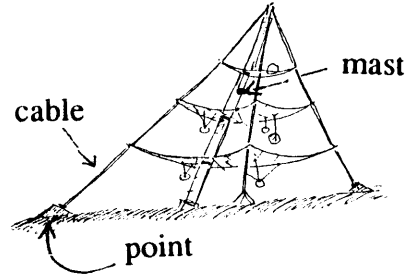
‘ ... Let us start with the easy way : First you find a support . On this support you will pick four points. One of these shall receive compressive loads, while the other three shall act in tension.

Next, you will choose one mast and three cables . Together, they will form the basic framework for all the other elements you choose to hang in there- to form a city of course.

What you have to remember is that in order to maintain the structural integrity in one piece you should never disconnect any one of the four elements. For example, in a typical post and beam building- and assuming that the posts are in compression because nowadays you never can tell, taking away one column will not destroy the whole thing; on the other hand, cut one cable and you have the makings of a blockbuster disaster movie.

Another thing to remember is the center of gravity of the structure- or structures, you put in there. Any time the loading configuration causes the vertical projection of any center of gravity to land outside its limits of safety, you have to balance the system. .

Tensile City- Anatomy of Tensile City.



M.C.

‘ ...Or you could have more cables and masts, hence form different kinds of infrastructures, as in figures A and B for example.’

Tensile City- Anatomy of Tensile City.

**T.C.**

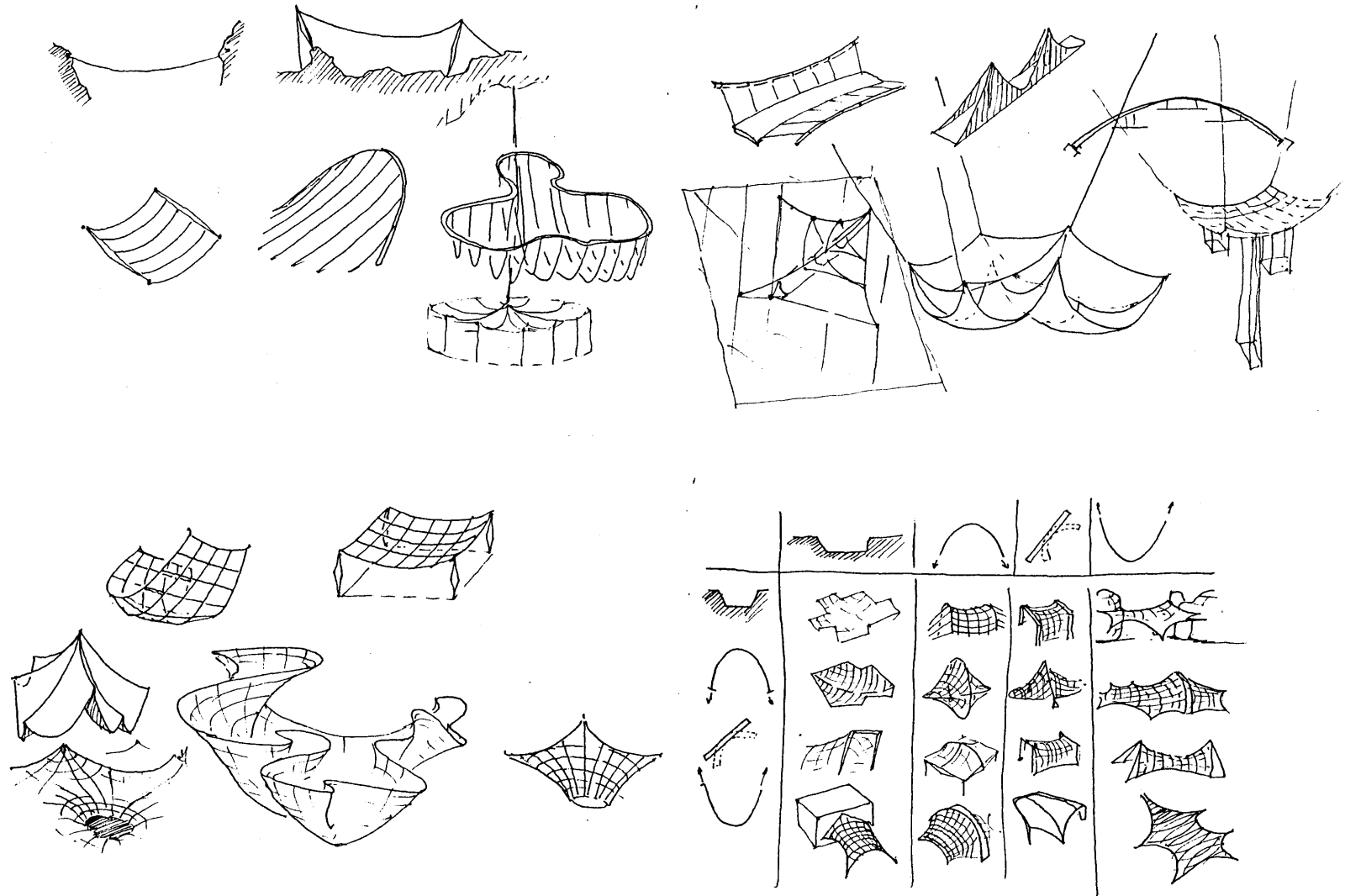
‘ Precisely, and since we are on the subject of infrastructures, we will first look at the physical forms that can be generated in Tensile City. After that, we will examine the types of abstract models that ultimately represent these forms, hence are the tools used in the process of Urban Design. The possibilities of such a system- as far as the cables are concerned- comes from two categories: *prestressed* and *non-prestressed* cable systems that ultimately form what we call as the *Form- Active* structure systems.

**Non-Prestressed Cable Systems.**

**T.C.**

‘ Essentially, a cable connecting two points will assume the shape of a parabola- or close enough. Put one or many point loads on that cable and you have a funicular system which changes geometry to fit the loading conditions imposed on that cable. The same applies if we have a bunch of cables which form a net or a membrane- depending on the density of the weaving. This net or membrane will adjust to varying loading conditions. Such systems are non prestressed cable systems used mostly for enclosure and the support of bridges and elevators, two conditions where vibrations could be tolerated. The following sketches will give an idea about the forms which can be generated by their use.’

Tensile City- Anatomy of Tensile City.



Sketched from "Tensile Structures" By F. Otto

Tensile City- Anatomy of Tensile City.

**Prestressed Cable Systems.**

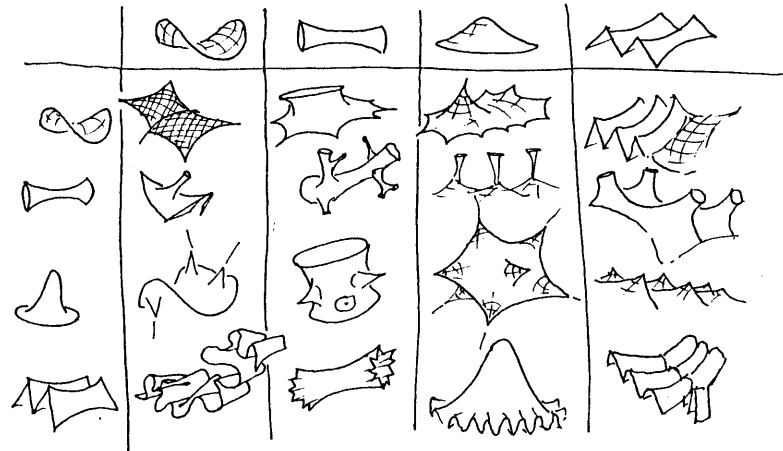
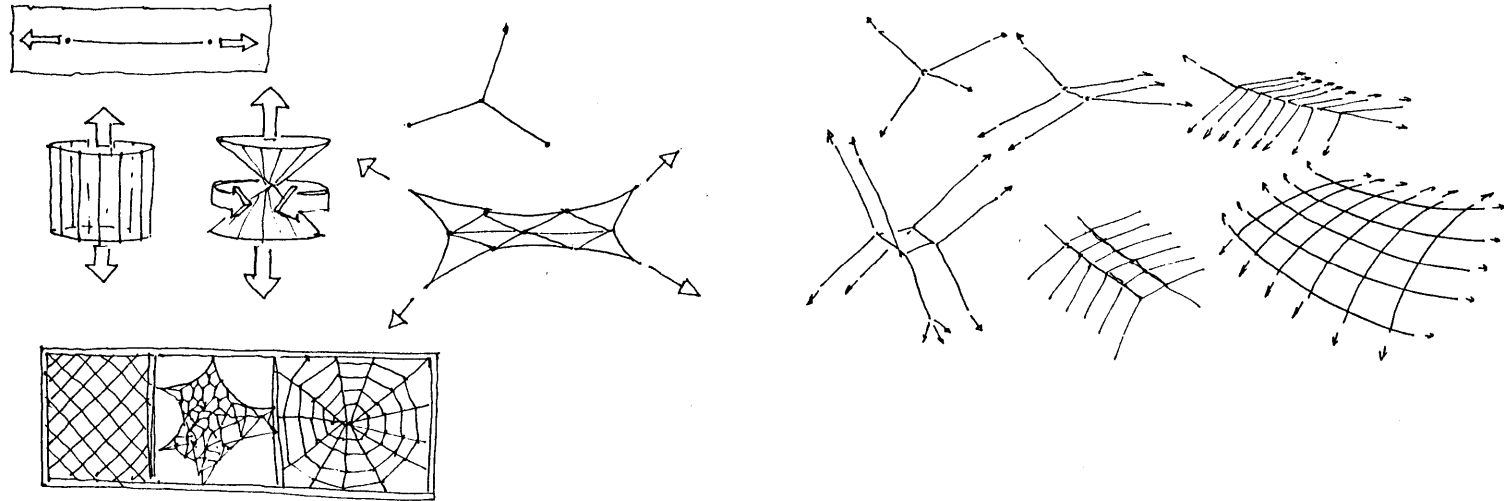
**T.C.**

‘ Now we will look at prestressed -cables-nets and membranes- systems. The assumption is that the cable has not been stretched beyond the yield point, hence loosing its elasticity.

Again, let us take two points. This time we will *stretch* the cable, causing it to loose its curvature- or close enough since there will always be a catenary formed by the dead weight of the cable itself.

A prestressed cable will elongate *less* under additional load, than its non-prestressed counterpart. Therefore, prestressed systems will be used to form the infrastructures in Tensile city. The following sketches will show you- again, the types of forms the infrastructure can acquire‘.

Tensile City- Anatomy of Tensile City.



Sketched from "Tensile Structures" By F. Otto

Tensile City- Anatomy of Tensile City.

**Anatomy of Tensile City.**

‘Cables, nets and membranes are Form-Active structure systems, made of non-rigid, flexible matter, which is shaped in a specific way and which can support itself and span space. The bearing mechanism of form-active structures rests essentially on the material form. Deviation from the correct form, if possible at all, compromises the functioning of the system or requires additional mechanisms which compensate this deviation.

From this premise, the urban form is such that it coincides precisely with the flow of stresses and the natural path of forces.

Also, in a form-active compression system, the natural stress line is in the funicular pressure line ; That of the form- active tension system: the funicular tension line.’

**M.C.**

‘ Then from what you are saying, we could deduce that this type of system cannot become subject to arbitrary design, therefore space-the architectural form if you prefer, is the result of the bearing mechanism. This , in my opinion, limits your possibilities.’

Tensile City- Anatomy of Tensile City.

**T.C.**

‘ ...While bringing the people closer, and imposing method of implementation strategies which are yet to be achieved in your own city; but that is another issue ‘.

‘Now as far as the question of design flexibility is concerned, we have ways of "cheating". For example, any change of loading or support conditions will require a new geometry.

For instance, a cable- a "sagging" system, will assume by itself a new tension line. On the other hand, the arch- a "humping" system, a rigid form, must compensate the change of the pressure line by bending.

Therefore, a suspension cable under different loading conditions changes its form... ‘

**M.C.**

‘ Great! I feel airsick already. ‘

**T.C.**

‘ Ah, but wait! To compensate for that: we "cheat"; in other words we stabilize the cable by prestressing it so that it can receive additional forces. ‘

Tensile City- Anatomy of Tensile City.

**M.C.**

‘...So ,this gain in degree of flexibility in architectural form and form addition , or urban growth has to be compensated for- as usual, by loss of economy.’

**T.C.**

’ Relatively speaking of course; because there would still be enough identity with the natural flow of forces to make possible the use of longer spans and larger enclosures and spaces than you would get in the typical urban environment. Hence, by direct comparison between the two-your city and mine, Tensile city rates first in the "most economical use of structure to achieve the same results " award. But like always, the grass is greener on the other side ...

Now, we will learn about vector-active systems, in other words, compressive and tensile members . In essence, the cross section of these members is small compared with their length; incidentally, if it becomes too small then they become form active systems. As vector-active systems they only transmit forces that run in direction of their length, i.e. tension or compression.

What you need to remember is that whenever we have compressive and tensile members in triangular assemblage we have a stable composition in itself which can now

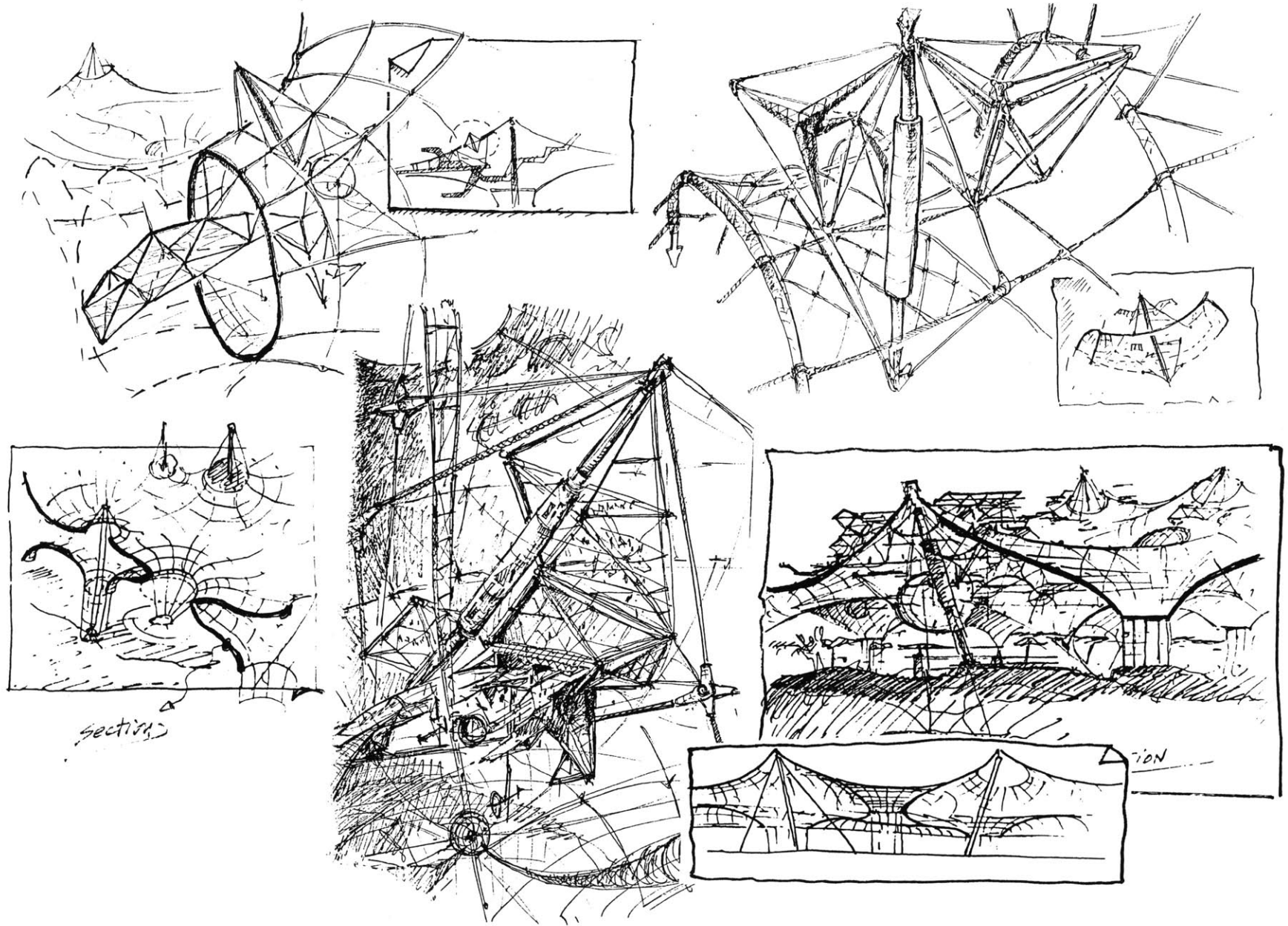
Tensile City- Anatomy of Tensile City.

receive asymmetrical and changing loads and transfer them to the ends. I am merely teaching you the basics in order that you trust the structures you will be walking on .

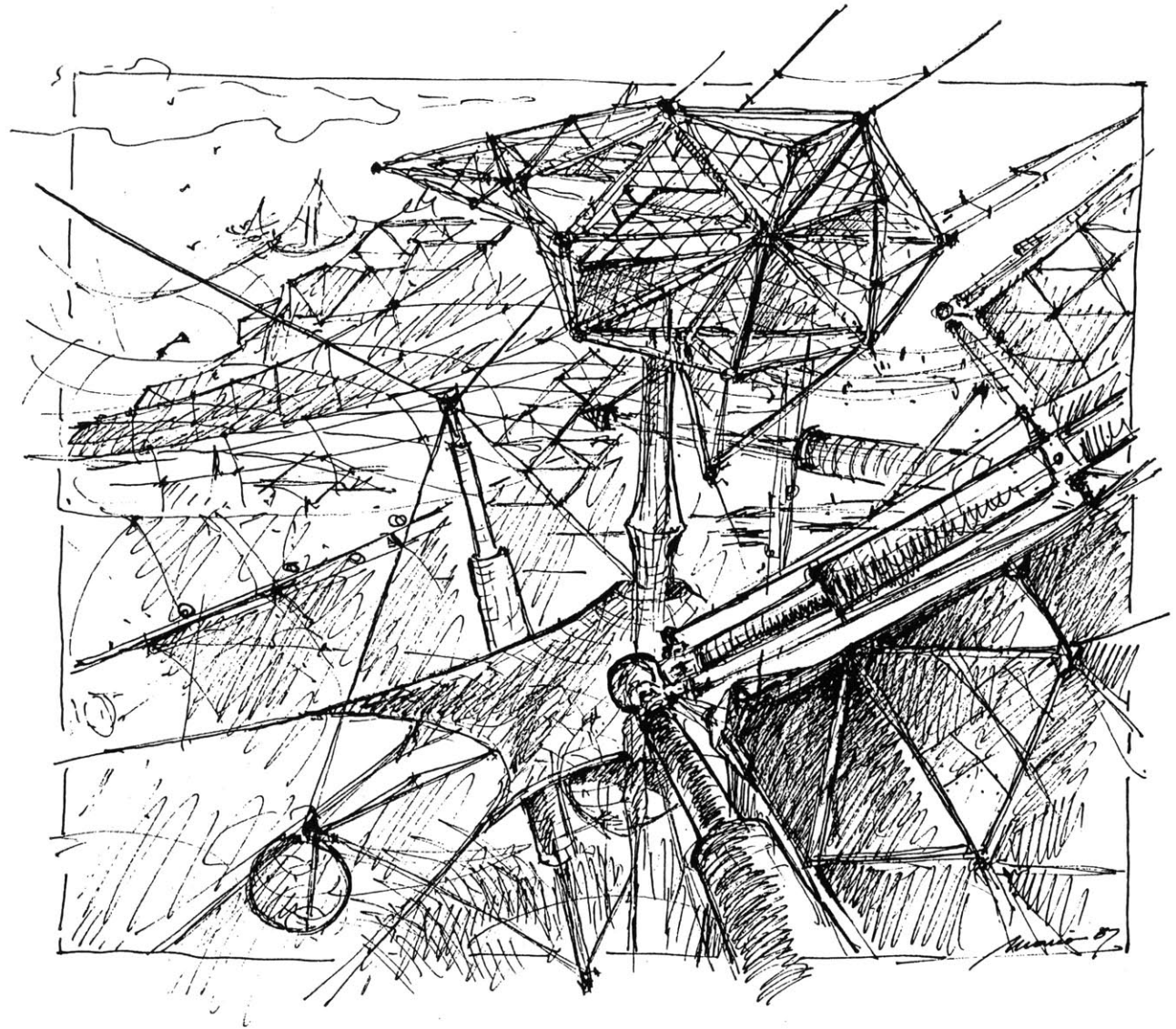
From the sketches you can see that Tensile City is in essence an chunk of space where membranes form supports as well as enclosures. ‘

And T.C. went on showing me graphically what clearly was the evidence of an infinite ways of literally weaving this city. One thing which became evident to me was the fact that "land", although being the source of life , every effort was made to maintain its integrity as a natural environment and not to overload it. In other words, tensile city, compared to other cities, used practically no land at all. On the other hand one could say that this city is held by a thread, which made me wonder about the type of human relations which existed among the people living in that city, it promises to be a tight net of people. To satisfy my curiosity, T.C. promised me a trip to the town hall where a gentleman by the name of *Pmurt Dlo- Naad* is pushing- or should I say-stretching the city zoning laws. But not before I learned to cognate that place.

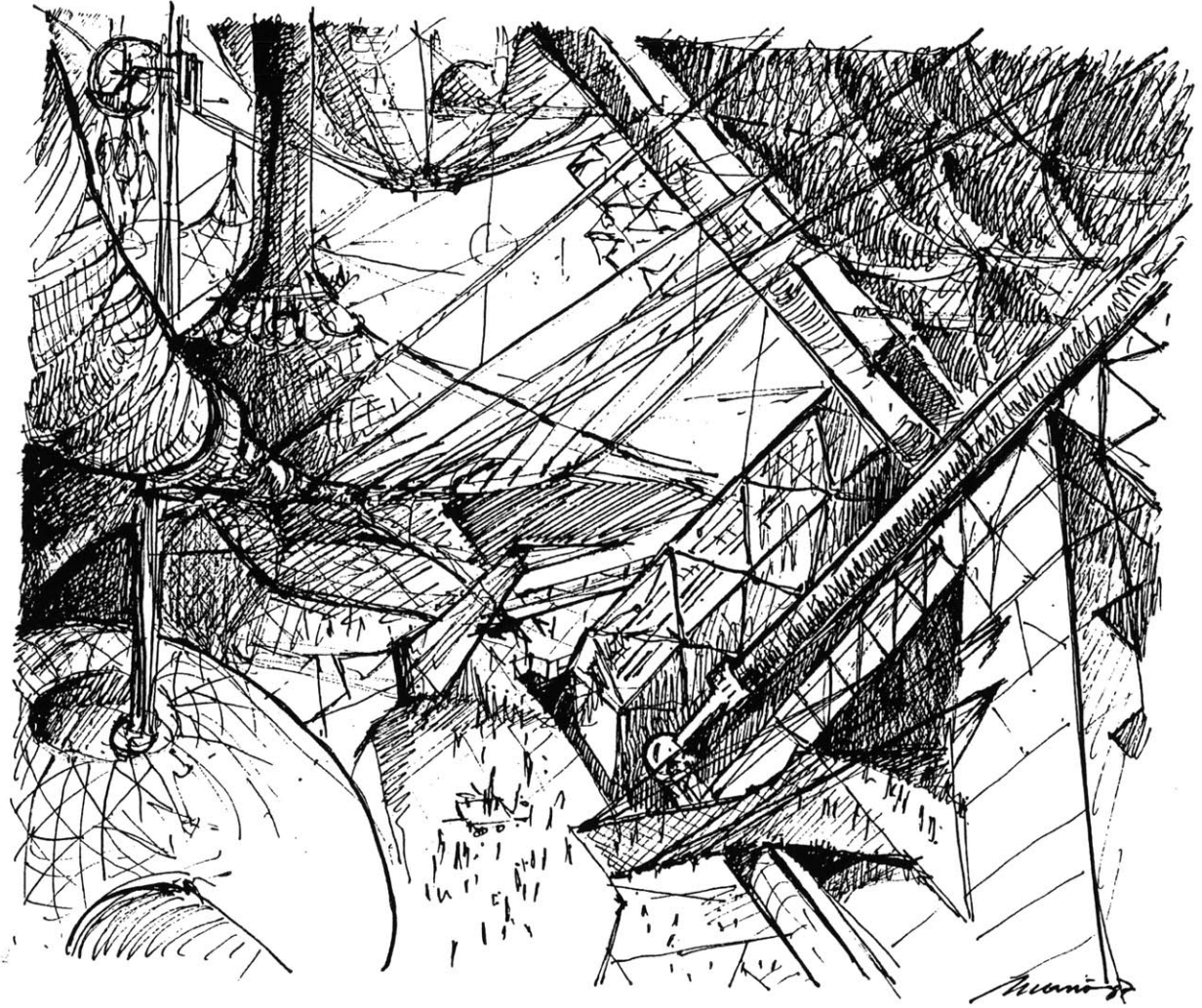
Tensile City- Anatomy of Tensile City.



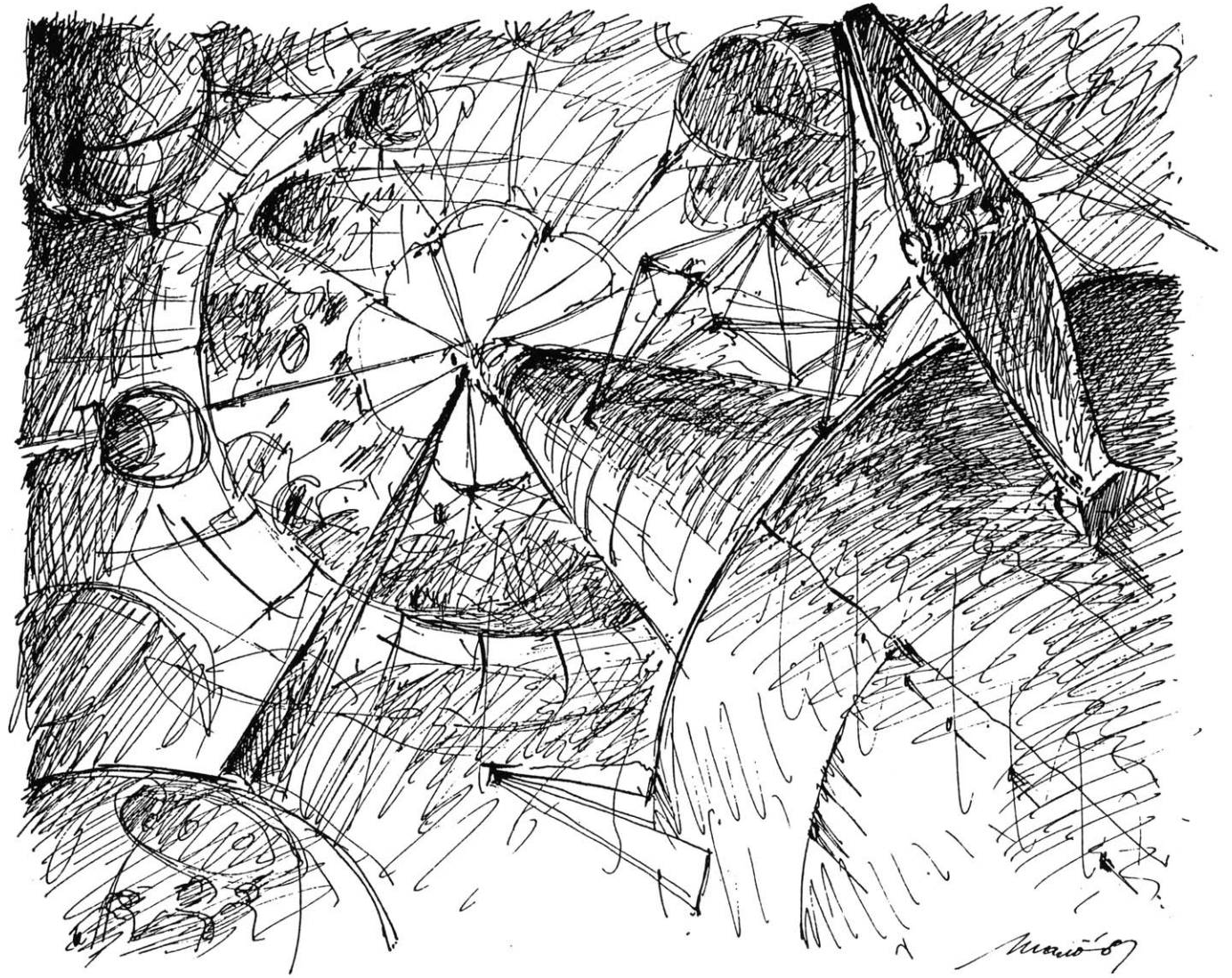
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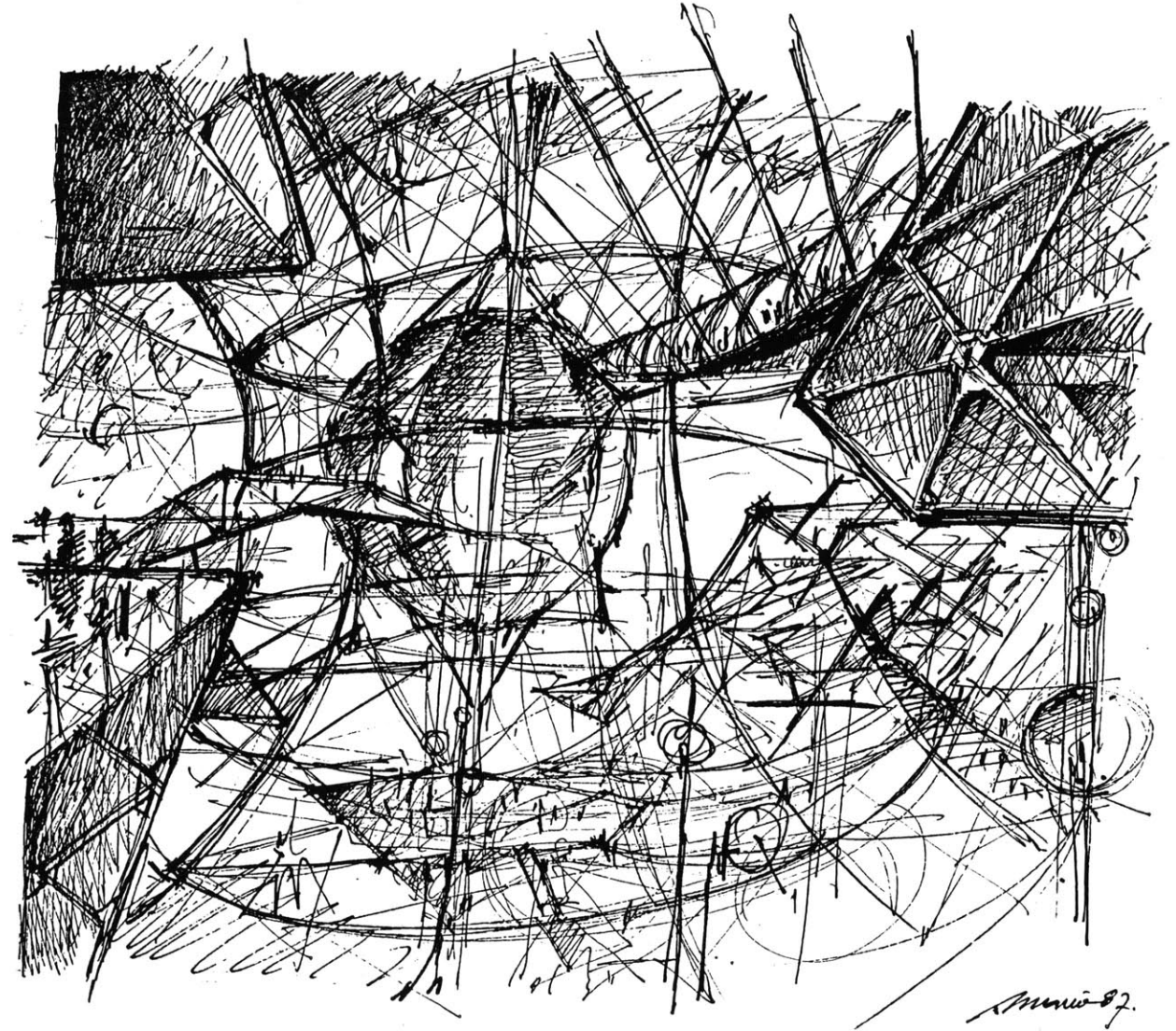
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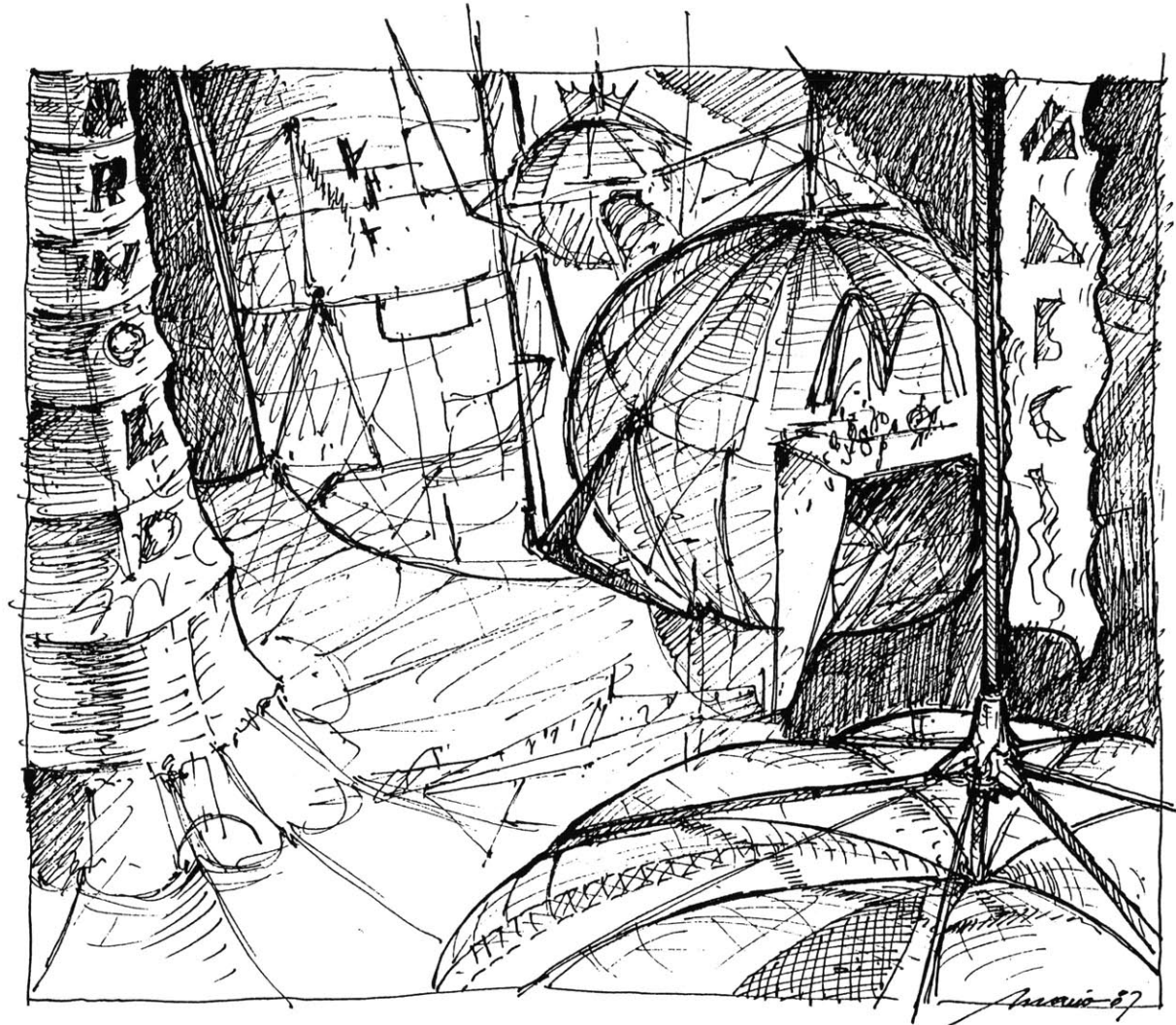
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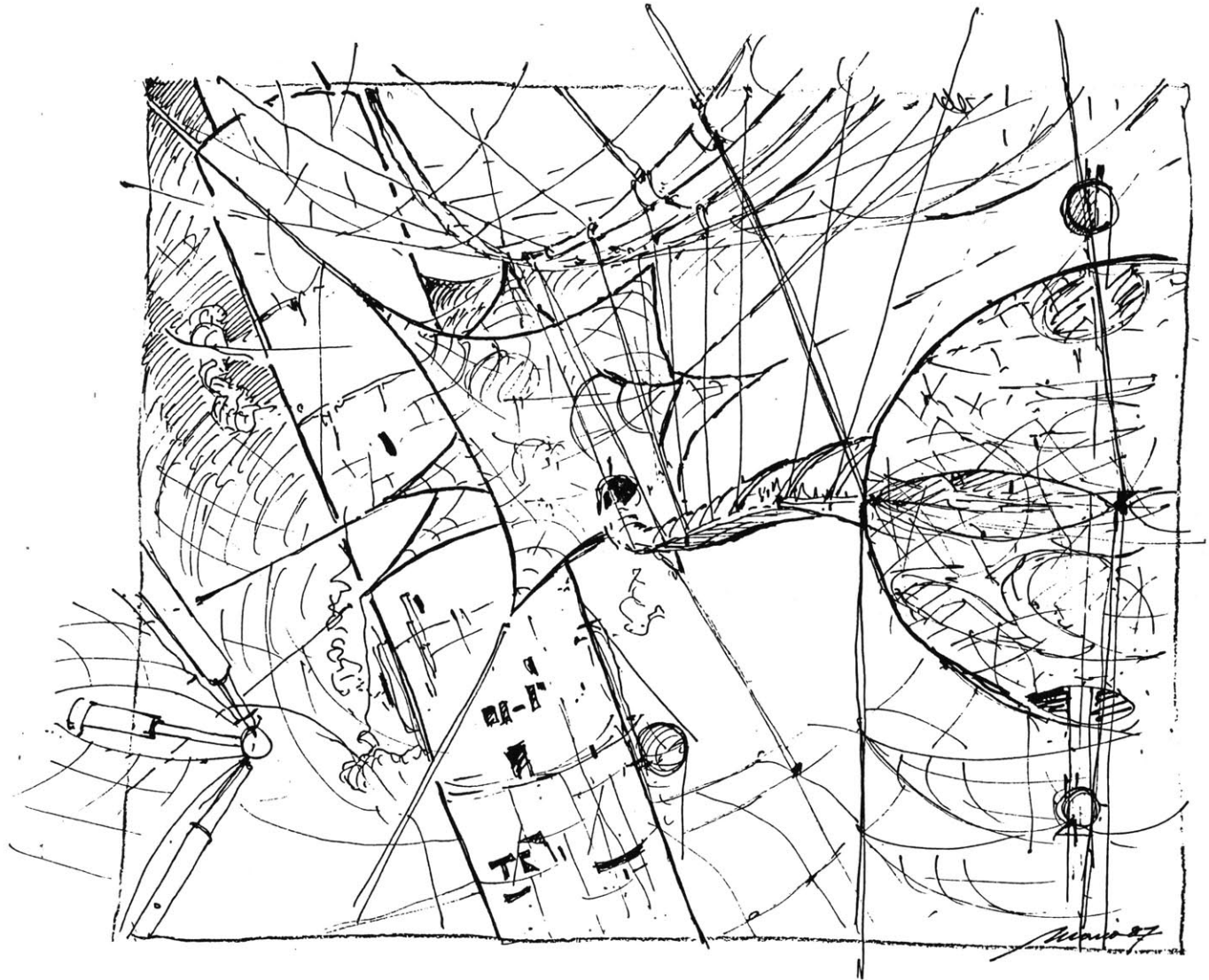
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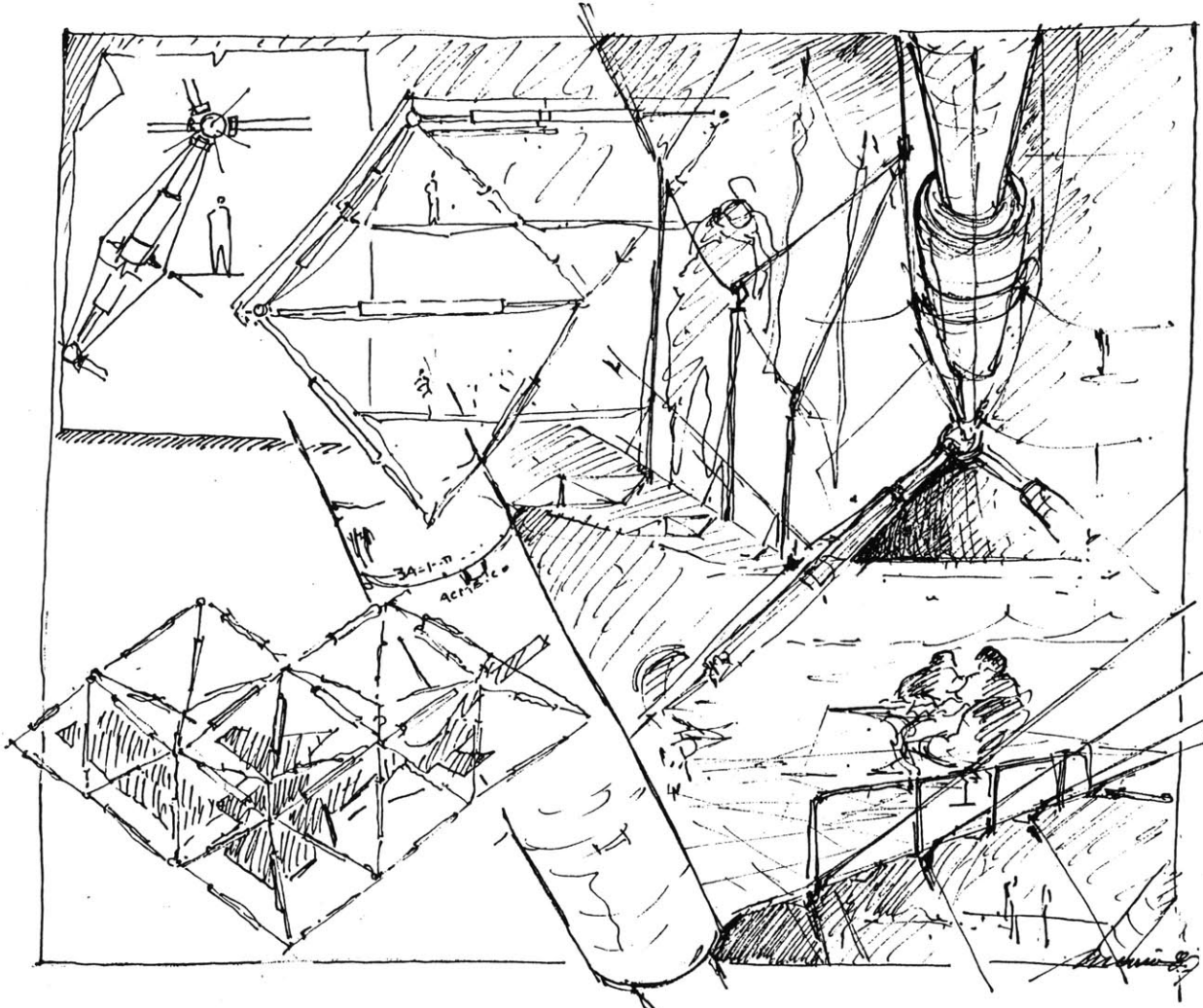
Tensile City- Anatomy of Tensile City.



Tensile City- Anatomy of Tensile City.



Tensile City- Anatomy of Tensile City.



Tensile City- Anatomy of Tensile City.

**T.C.**

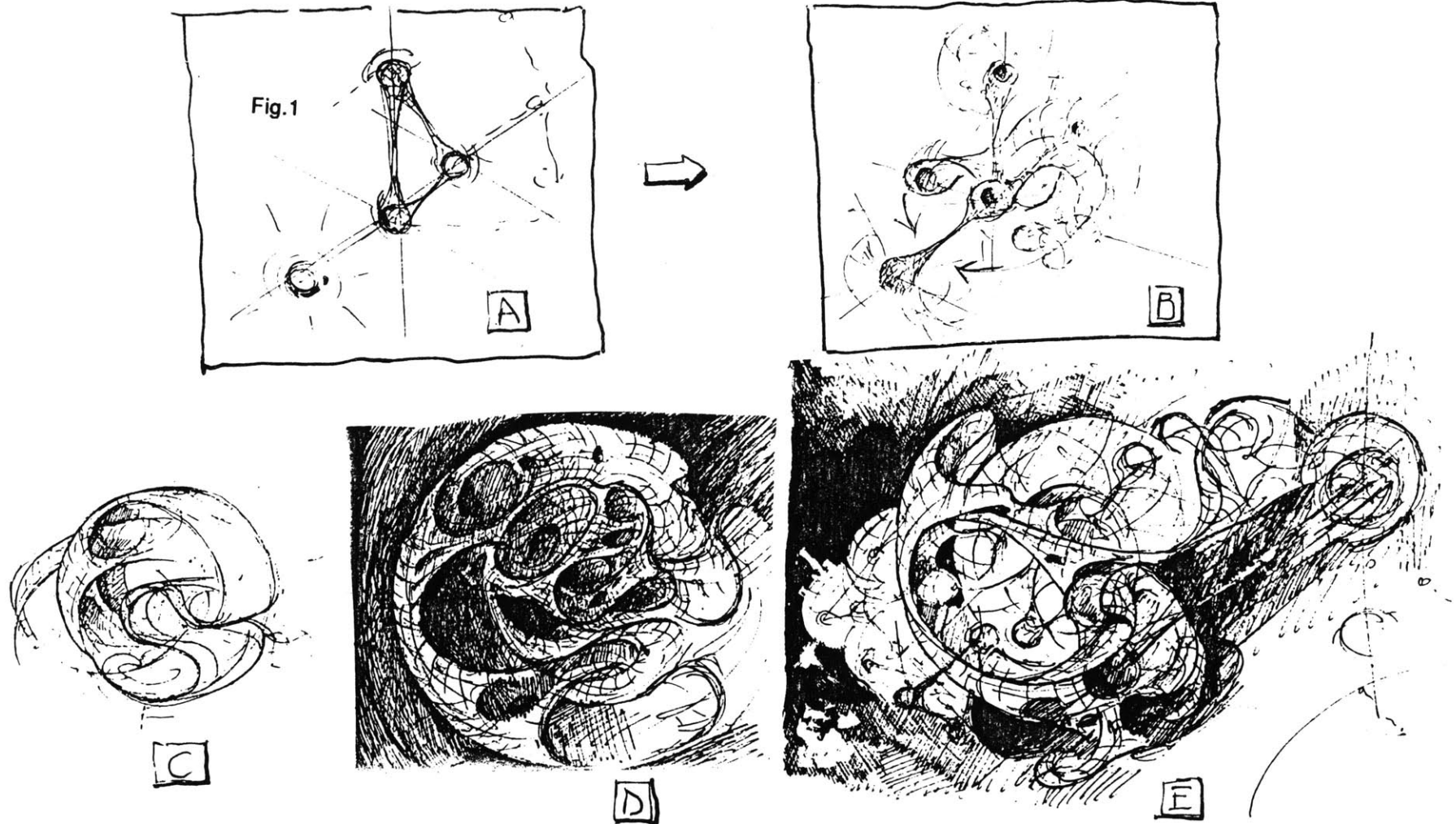
‘ Now that we looked at the city from the physical point of view, we will take a look at some methods that enable us to understand its behavior. In the diagrams you will see we will use points, lines and planes. Each is an abstract representation of one or a group of physical components in the city. The choice of each is dictated by the scale you plan to study the city at. Now, let me show you a simple example:

Let us assume that we have a chunk of space where we have three distinct points of interests that could be in the form of prominent buildings or a group of prominent buildings or major nodes. (fig 1)

Now, let us add a fourth node, close by . Can you imagine the types of urban growths that could be generated over time just around this point, by virtue of the fact that these elements are in space? Add to that factors such as competition, zoning variances and politics: and you have urban forms you never dreamt possible. Unlike this one, your city is bound to the two dimensional plane. Ours virtually evolves in space.’

Tensile City- Anatomy of Tensile City.

Snapshots showing the evolution of an urban "molecule"



Tensile City- Anatomy of Tensile City.

As an ideogram, a typical city already exists on many levels which are essentially parallel. Each level defines a plane where volumes will be arranged following the requirement of the program.

The limitations of that arrangement is that the connections between the volumes is limited to the level they virtually rest on. The result of such an arrangement is the following: in essence every volume has to adjust to an already existing fabric in spite of the fact that it might require a specialized network to sustain it. And since we are on the subject of connections : the volumes in Tensile City are interconnected by suspension bridges, which are parts of bigger membranes which are part of bigger volumes. T.C. pointed out to me that the whole thing was a process of addition, and that not always were the steps flawless, on the other hand Tensile City is learning to discover and use its possibilities on one hand, and to formulate a new process for ownership by virtue of the introduction of new concepts.

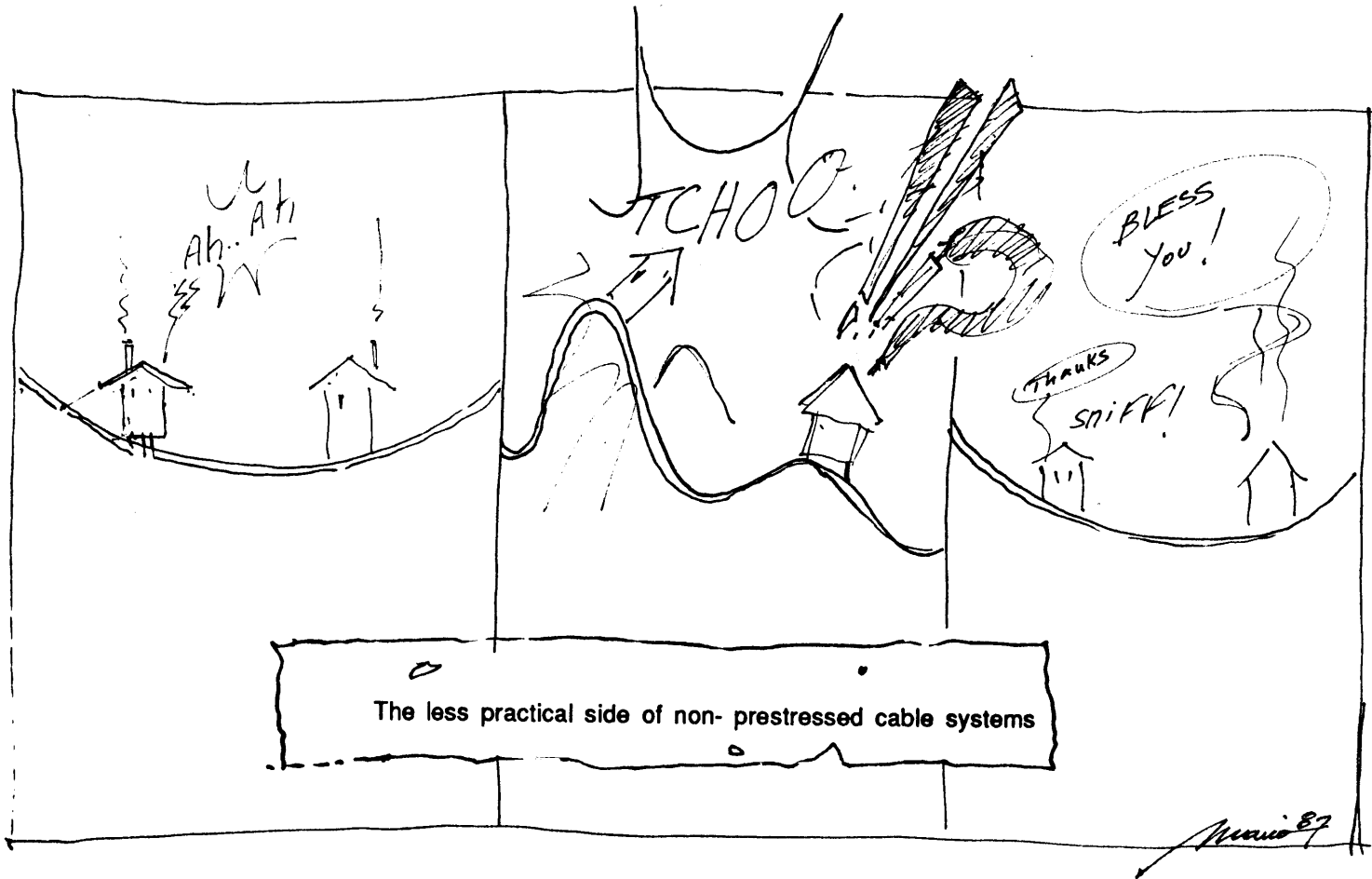
For example, since physical growth is practically achieved in all directions, zoning maps were now drawn in axonometric views. And since the legislators could not really understand the nature of the 'animal' they were dealing with, certain owners practically got away with murder.

Tensile City- Anatomy of Tensile City.

Till that day, there still does not exist an appropriate means to represent all the urban forces which take place, let alone being able to regulate them .

Another issue was the introduction of control zones now that the buying and selling of land was virtually replaced by " anchor points" : in that situation does one own the "plane " which is defined by the points, and what if your plane intersects with another one, many owners found themselves in that situation before Tensile City was completely charted out, on the computer, and so far, the computer has the only means of keeping records of ownerships, and those are in the form of complex mathematical functions which, for the sake of ease, are often rounded off .

Tensile City- Anatomy of Tensile City.



Tensile City- *The Image Of Tensile City.*

## **The Image Of Tensile City.**

Tensile City- *The image of Tensile City.*

**Typical Tourist.**

Six months have passed since I climbed aboard Tensile City. During this time I managed to have a taste of what the average tensolian experiences in this city. The closest thing I could compare the experience in Tensile City to, is my stay in college: a time where- for five years, I would belong -in body and spirit, to a place . Tensile City is such a place, in spite of its huge size; as a matter of fact, I still have to visit most of it. For the longest time I wondered about the strength of the sense of place which this place gave me. Was it the fact that there was so many ways to get lost while going shopping, that you felt like a scout on a hunt trail? Or maybe the fact that the hustle and bustle of its urban malls reminded me of my (...) roots. As an untrained venturer, I read chaos. Now I read rich patterns which are held by a closely supervised program.

I guess the logical way to start our tour is to show you around the house I am presently residing at . I still don't know why they call it house , on the other hand I don't know why they call the balloon frame a ... balloon frame.

Tensile City- *The image of Tensile City.*

The structure of this house-unlike others on the same canopy, is not a formalist design. I know what you are thinking: ‘ How on earth can one tell the difference?’. I mean, they all look like bunch of prisms anyway ... The same goes for Tensile City- a woven mess, or is it? You see, the whole thing is a question of adaptation: I had to train my mind to see what I was looking at.

In this case, the grid -which is a space frame, articulates organically with the requirements of the function and/or the specific emotional needs of the owner -T.C.; it represents the adaptation of contemporary ideas about architecture by the use of lighter weight technology.

Except for the kitchen and bathrooms, everything -although prefabricated, was cut to specific requests. Although T.C. paid a high price for this custom design, he loves every minute of it. Personally I can't blame him: I've been to other houses built from a standard module- an octahedron, and to tell the truth I felt bored or unchallenged. The city at large has certain similar flaws. For example, parts of it were built following an arbitrary grid.

When Tensile City was at its early stages- when the transportation systems were not perfected- a huge part of the population would have to meet at only a few gathering places in order to have lunch or to enjoy the luxury of a shower. In other words, Tensile City had

Tensile City- *The image of Tensile City.*

forums and baths, since the city had no clear plan about managing the transportation of water 1500 feet high in the air, let alone getting rid of the waste.

Today things are quite a bit different. For example garbage disposal is performed by private companies and requires the following: the food is sold in biodegradable containers for the most part except for imported items such as Italian tomato paste ...

In other words, garbage is broken down into categories in your own home before giving it away to the recycling company in order to avoid an overcharge. And since these empty containers have to stay in the dwelling for at least a week-not counting union strikes, they have to be washed . Therefore- along with the standard food disposer hooked under the sink and the garbage compactor , the act of disposing of the garbage is a simple reversal of that of going shopping for food-for some it is as tedious as doing the laundry while for others, it is a healthy process to go through. In other words, every consumer picks up his own plate; a matter of attitude if you will.

T.C. 's house is at an elevation of 900 feet above sea level. It- along with the rest of the block, have managed to cover the cables on which they rest, thus putting a skin over the dozens of pipes that support the dwellings with water and electricity. Most wealthy neighborhoods have got together with the private sector in order to have this added luxury.

Tensile City- The image of Tensile City.

This move on the other hand, sparked strong debates over the consequences of slowly causing Tensile City to lose its qualities. Beside the arguments about reducing the amount of natural sunlight in the inner cores which would greatly affect the people who have to live close to the masts- in eternal shade, the opponents of this trend argue that to cover the cables completely-hence giving the illusion of land, will not remind the dweller of the importance of cooperation between the people in the city to maintain its integrity. *'Soon, the Tensolian will live with a false sense of security which in the long run will prove to be hazardous to the safety of his city.'*

**M.C.**

*'What are the opponents to the Tensile City Beautification Act really saying? What is so wrong about improving the visual qualities in your city? In my town, each owner is actually encouraged to pave his part of the sidewalk or painting his facade with appropriate colors. Although I understand the issue of design integrity - the parts should express their intention and that Tensile City cannot be dressed to look like a down-to-earth city, I still think that at certain scales, it would be consistent with the design philosophy to create continuous surfaces where one could find the qualities of firm land rather than always planning on taking off and landing from one volume to the other. I mean: don't you just feel like walking, rather than crossing bridges and flying in elevators all the time?'*

Tensile City- *The image of Tensile City.*

**T.C.**

‘ I even miss *pollution* sometimes; let me tell you a little story ...

And T.C. went on with the story of a group of apes who once lived in the trees; those apes had a perfect understanding of their world and they were content. One eventful day, the apes learned to walk. In fact, they did so much walking that they eventually left the trees, only to try to find a way to get back to them through inventions which tried to emulate the perfect world they once left behind. The moral of the story: Man gave up his intuitive knowledge of his world in order to acquire the power to create it.

**M.C.**

‘ Isn't it a bit late to go back to the trees? I understand that we did not really need most of the inventions which were created at first by the intuitive drive to seek knowledge and later applied for practical use ... The fact remains that inventions necessitate other inventions to help cope with management and organization.’

**T.C.**

‘ The *fact* is, that in this day and age not enough people know enough about their world: the explosion of information is happening at such an incredible rate, that most unspecialized people are so out of touch with the world, that their connection to it is similar

Tensile City- *The image of Tensile City.*

to that of the early stages of man : a time when superstition was his only connection with the forces that shaped his world.

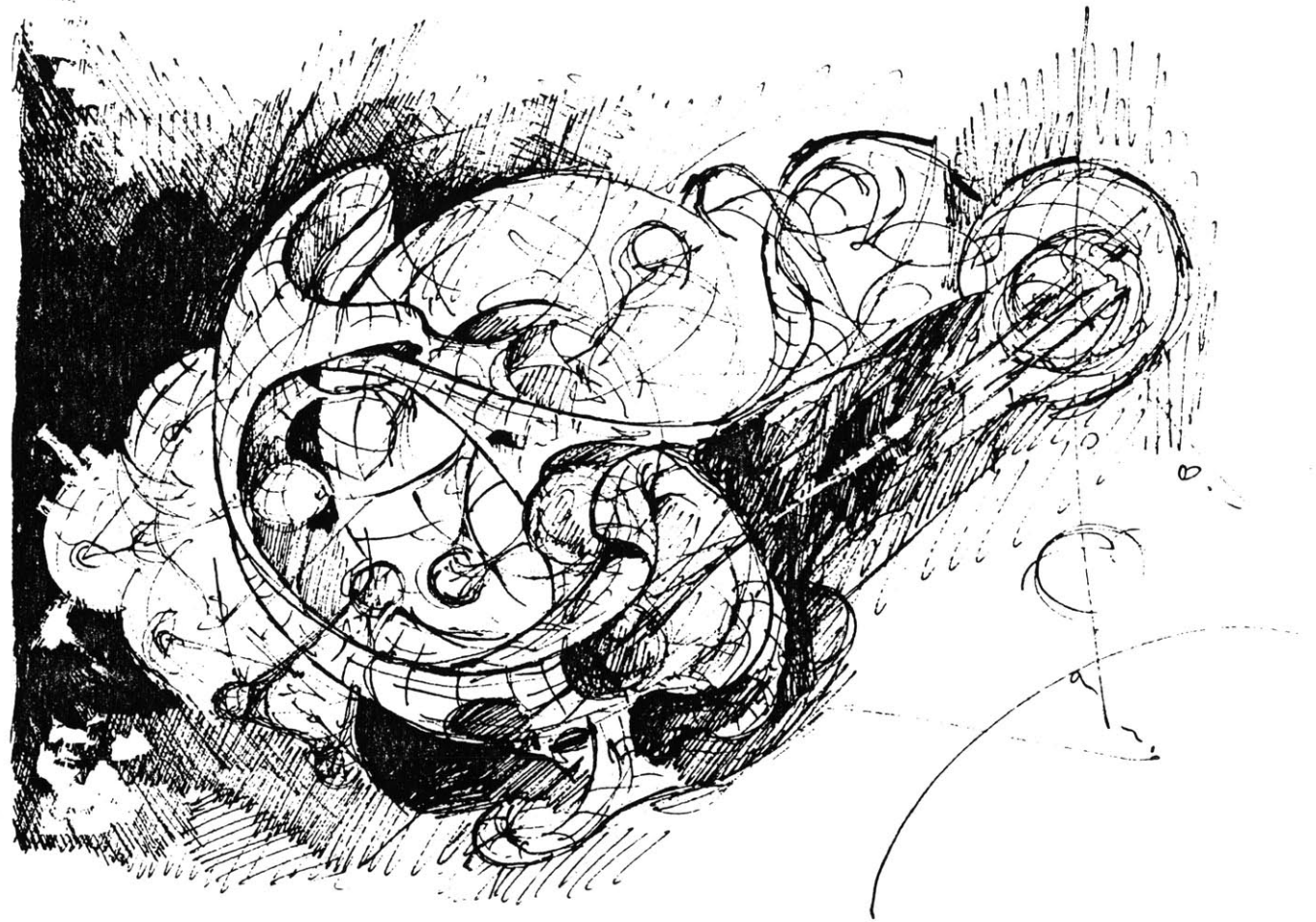
Nowadays, most people accept blindly what is happening around them without asking the right questions, or exercising their right for education. Even if you showed a very educated person -of a different specialization, the knobs and wires of the computers which run the relay systems in Tensile City, do you actually think that he will feel less alienated?

In the beginning we were playing God but now we have invented God and we are worshipping him.‘

Suddenly, T.C. made me realize that I have not experienced the city the way I hoped I would. Was it the fact that one day I would still go back to my suburban home and enjoy the freedoms I do not seem to be able to give up? Have I sheltered myself in a world, some have willingly rejected ?

Tensile City- The Process Of Urban Design.

**The Process Of Urban Design.**



Tensile City- The process of Urban Design.

**City Hall.**

We are on the ground for a change and for a good reason: this is where City Hall is located...Although not exactly. You see, there exists a franchise of city halls throughout the city each dealing with local issues. After receiving approval at the local level you would still have to go through the process of convincing the rest of the city to vote for your project.

As for the reasons for putting the building on the ground: I hear that the gesture is symbolic of neutrality; personally, I think that it is a matter of practicality.

Firstly, travelling for long distances within the core of Tensile City is not a favorite pastime given the number of terminals you would have to intercept .

Secondly, the next best thing to do would be to travel down to the ground and up again, so one out of two is not so bad.

Besides, I don't think that for the sake of neutrality any one was prepared to locate the center of gravity of this city, the center of the cosmos if you like. Instead, the symbol of power is being expressed through the city's ability to build on the most expensive type of real estate property available: the ground.

Tensile City- The process of Urban Design.

Once inside and since the building is completely out of context with the typology that surrounds it , the trick is not to bump into the other people who seem to become disoriented by the huge space under the dome . They are actually alienated by its simplicity! I was tempted to ask some poor soul for directions, but I just didn't have the heart to do it.

The session we were looking forward to was scheduled to appear right after the one in which some film producer was proposing a sequel to "King Kong ", to be filmed right here in Tensile City. When asked if the movie would not in fact be borrowing on an old cliché , the producer didn't think so given the fact that there wouldn't be any car chases- a classic theme in Tensile City- nor any airplanes smashing... I guess he did not understand the question.

While waiting for the session to begin, T.C. offered to show me around the museum space, where the complete evolution of the process of urban design was on display. It contained relics of the past as well as the latest tools . I guess the most fascinating of all was the holographic representation of the computer generated graphics: a maze of rotating geometrical shapes all with beeps and special effects.

**M.C.**

‘ Don't tell me : three -dimensional Cubist art, right?‘

Tensile City- The process of Urban Design.

**T.C.**

‘ Hardly, or at least we don't see it this way. No, what you are looking at is pure data. More precisely, an abstract model of one of the 620 self contained cities within Tensile City. You could say that it is the genetic code of the whole network, containing the necessary components to form the type of communal living one may define as a city. In this model we are presently looking at, the points, planes, and volumes you see spinning freely in space, represent quantitative as well as normative values. Both categories are transformed into a common denominator which is represented by a point and a force or field of forces in space. The key to the harmony of the place is the equilibrium among all the forces that either push , pull ,rotate or translate. ‘

T.C. then engaged the system into the *simulation* mode and the image of the whole city appeared before us, he then chose the *Functional Theory* mode along with a set of variables that represented a potential addition to the existing fabric of the city. By now, the city was an articulation of many types of points, planes and volumes, distributed around nuclei, along with the sectors that showed the distribution of the ethnic groups that thrived in there.

Tensile City- The process of Urban Design.

Once all the givens were defined, he entered the new addition. And almost instantly the 'molecule' started to shift and deform. Soon the tremors would propagate throughout the whole network, hence showing the affects of our simulation -starting from the number of cables to install, to the estimated rise in the price an elevator ticket. All this for the addition of another *pizza parlor!*

**T.C.**

‘ Now for the interesting part: what strategy should we apply to reach the equilibrium suggested by the computer ? As you can see, we have a lot of players involved in this game and the nature of the space we are trying to buy and sell is more complex than in the typical city: as each owner has jurisdiction over air-rights that vary in complexity . ‘

Then T.C. switched on the '*Game of Chess*' mode and showed me how to play a real game of *Implementation Strategy* ...The improved version of course.

Tensile City- Epilogue.

**Epilogue.**

Tensile City - Epilogue.

**Letter To A Friend.**

'Dear T.C.,

I would like to thank you for giving me the opportunity to see a image of a world I am not - to tell the truth - quite prepared to handle, for it would require a lot more involvement and sense of responsibility that I am qualified to provide. I am yet to worry about who picks up the garbage in my neighborhood...

On the positive side though, I feel strongly about things I have often taken for granted. For example, just the other day my neighbor dropped by to ask for my signature on his petition to get a zoning variance so that he could build a new pool room . He was so surprised to see me sign without inquiring about the length of time I would have to endure the noise and dust. In fact so surprised was he, that his first reaction was:

*"Are you feeling alright ? "*

I guess what took him off guard was the fact that I was not playing the traditional role anymore. You see, both you and my neighbor do. Each one of you has been conditioned to live in his own time, following the same pattern of behavior in spite of the change in context. As for myself, it will probably take me some time before I join the rest

Tensile City - Epilogue.

of the crowd, and thus not seem to be an idealist or a dreamer anymore. For now I seem to be living in limbo, for unlike you or my neighbor, I witnessed a prophecy that assumed the form of Tensile City. Ironically, while this vision puts me at an advantage, what good would it do if I cannot share it with anyone else?'

'And if my predictions are accurate, I will be back to my *old self* again very soon, given the fact that I adapt easily to changes in the environment, for the sake of survival more than anything else. Therefore, that is why I need in my hours of "enlightenment" to describe this vision, while it is still fresh in my mind. Otherwise, *how soon we forget!* '

'We often look at our past to learn about our present. Somehow it is by constantly reminding ourselves where we have been, that we hope to get to where we *want* to go.

Also, *where we want to go*, or the future, has always been in the form of vague visions. This arrangement works to our advantage: a vision that is unclear cannot be a threat to our sense of security.

This way, all we are sure of, is that the outcome of the present will be entirely up to us. Besides, who can claim to be a prophet?'

'I sure can't. In fact, I am so *human* that I dared getting closer to a *clearer* vision of the future in the hope that, once I have been a witness to it, I would come back and tell the world how to reach it.'

Tensile City - Epilogue.

'I even dared living in it, in spite of the fact that I did not belong to it. Hence, the flaw in my method.

Therefore, T.C. for as much as I like my experience in Tensile City to have been an event that really happened, I cannot believe it did. On the other hand, it took Tensile City - may it be a dream or reality- to remind me of things I have always known but forgotten.

I have seen that a city - to define a scale of human interaction- is as good as every citizen wants it to be. If certain aspects of the city are huge facts of nature, then it would be logical to assume the following :

Because our world is becoming extremely complex, a greater number of people will be eventually left out from the process that makes it run. Having been left out, an individual will have no other choice but to surrender his destiny to 'unknown ' forces. Belief in the system will soon be replaced by fear from it , hence superstition .

The other question we should ask ourselves is : shouldn't we stop for a moment the explosion which is happening in many fields, in an uncoordinated way, hence causing an alarming imbalance? For example, should we apply certain types of research that help us multiply the population on earth, hence giving every couple a chance to a child, when we can barely deal with conservation and famine? If we knew then, what we knew today, about the car as a shaper of cities and continents, would we still have invented it?

Tensile City - Epilogue.

One thing we know is that as our world is advancing in technology and power. Therefore, so must our skill in predicting the outcome of the act of imposing the tools we invent on the rest of the world. Hence asking *it* to adapt to it.

We can no longer indulge in the pursuit of knowledge, then attempt to find ways to rationalize our actions. And before each one of us goes ahead and contributes "*an invention people won't be able to live without*", are we ready to deal with the consequences? Especially if the world will, indeed, one day require cities such as Tensile City.

I might , one day, create a tool small enough to fit in my pocket and that would allow me to uproot a tree just by the flick of the finger. But, unless I plan to use that tree as firewood, all I would have gained would be:

The feeling of being powerful, a nifty gadget... and a dead tree.'

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