INFORMATION CODES OF MUTANT FORMS

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"We are entering a new temporal world where time is segmented into nanoseconds, the future is programmed in advance, nature is received as bits of coded information, and paradise is viewed as a fully simulated, artificial environment."
Jeremy Rifkin: Time Wars

Summary

If we assume that the statements from this quote are true, than we have to ask ourselves the question: "Should we teach architecture as we do?"

This paper describes our experience in developing a knowledge base using a neural network system to serve as a "intelligent assistant" to students and other practicing architects in the conceptual phase of their work on housing design. Our approach concentrated on using the awareness of the designer about the problem, not by building rules to guide him to a solution, but by questioning the categories and typologies by which he classifies and understands a problem. This we achieve through examples containing mutant forms, imperfect rules, gray zones between black and white, that carry the seeds of new solutions.

Artificial intelligence

In recent years with the announcement of the fifth computer generation, the research in the field of artificial intelligence has intensified. Imbued with great visions, intense discussions, but also with considerable dispute, this field presents a huge challenge to a growing number of professions. From experts in the field of computer science to those whose interests lay in reflection on the civilisational developments of our post-industrial society.

The term artificial intelligence (AI) describes several different fields, of research whose joint aim is the attempt to simulate human mental qualities. Efforts go in the direction of processing natural language, pattern recognition, robotics, problem solving and knowledge based systems. Most attention in AI research today, is devoted to knowledge based systems (KBS), which already offers practical commercial products in the form of different program shells.

The aim of these KBS systems is to accept the knowledge, experience and data that experts posses about solving complex (non-numerical) problems and offer it to the less experienced professionals and students, through the new working media in an efficient and intelligent way.

Problems in development and use, as well as questions about its purpose and results are not insignificant and often confront us with important questions about ourselves as human beings. We find this dilemma well described by Dreyfus (Dreyfus, 1979.) when he writes about the dominance of objectivity: "People have become to think of themselves as objects able to fit into the inflexible calculations of disembodied machines: machine for which the human form-of-life must be analyzed into meaningless facts, rather than a field of concern organized by sensory-motor skills. Our risk is not the advent of super intelligent computers, but of sub intelligent human beings".

There is a growing number of architectural schools and research groups who are working on KBS trying to structure architectural experience in order to develop an "intelligent assistant" for the architect which would stimulate his creativity. Knowledge-based systems can be divided into three groups:

a) generative systems (shape grammars)
b) interpretative systems (expert systems)
c) classification systems (neural networks)

After detailed consideration of all three we choose the classification systems as the most appropriate for the development of a knowledge base to be used by students and other practicing architects in the conceptual phase of their work on housing design.

Neural network and associative reasoning

The neural network simulates the behavior of a brain neuron under stimulus. Though the basics of this mechanism, on which the classifying systems are built, were established more than 30 years ago, products for popular use, in the form of neural network shells, have appeared only recently. Its wider use is still to come.

This system offers a simulation of human associative reasoning. It is able to handle, more successfully than the rule-based expert systems, "wicked" problems, which contain "fuzzy logic". These are complex problems which are impossible to completely describe logically and whose solving depends on individual experience and use of heuristic techniques. Architectural problems are prime examples of this.

The works of Wittgenstein (Wittgenstein, 1922; Wittgenstein, 1953.) and Alexander (Alexander, 1964; Alexander, 1979.) describe the inability to logically structure and explain the human living and building experience and activity because of its symbolic nature. To resolve this, Alexander offered in his work "A Pattern Language" (Alexander, 1977.), an example how architectural knowledge and experience could be conveyed with patterns as building blocks, which are a part of a structure but have a life of their own, Patterns (examples, precedents), as we all know, are the elements of architectural communication. They carry different levels of information, and often an emotional charge that could be considered as condensed information.

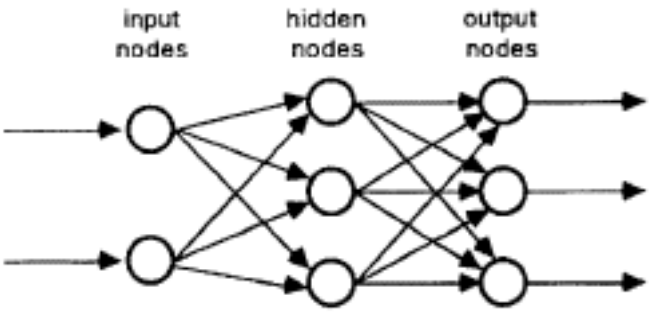

Figure 1 - Network with Hidden Nodes

For our research we chose NeuroShell, a neural network program shell developed by Ward Systems Group, Inc. which utilizes the algorithm. It is a tool which attempts to classify patterns according to other patterns it has "learned" and to give the most reasonable answer based upon the variety of learned patterns. It is not guaranteed to always give an absolutely "correct" answer, especially if patterns are in some way incomplete or conflicting". (NeuroShell, 1990).

Our approach concentrated on rising the awareness of the designer about the problem, not by building rules to guide him to a solution, but by questioning the categories and typologies by which he classifies and understands a problem. The intention was to structure relevant experience to provoke and assist, with intelligence, the architect in the creative conceptual phase of architectural design.

It was necessary to define the current architectural discourse in order to successfully organize the existing ideas and experience.

Architectural discourse

At the end of the second millennium a number of changes are transforming our society and are making it much more complex. The world of chaos, innumerable variables, inconsistent systems, displaced concepts, the violent and short interactions and instability form the world at the end of the 20th century. Once a part of the cultural, ethnic or some other group which defined his identity, the individual now finds himself in a world of global exchange and connections which erase all boundaries.

This moment which is a moment of reevaluation and a turning point, causes difficulties, splits and discordance. The disciplines that the human mind developed should now make a transition to a future state as painlessly as possible.

Within the architecture of this moment we can identify two definitions: the narrative and the abstract (Baletic & Zarnic, 1990).

The first is based on the individual and his consciousness of space, place and time in a historical continuum. The myth, which is exploited by the narrative discourse the historical relations of built forms, the social order and the civil values are continued within Vitruvian categories (Venustas, Utilitas, Firmitas). It is apparent to this point of view that the civilization values of architecture are those which speak of continuity and the laws and

principles of the metier, whose signs and symbols are a part of the everyday mitologems. It is characterized by building under the laws of gravity and the search for a genius loci.

The second, the abstract, gathers its energy from the development of technology and the power of the metropolis. This abstract or modernistic discourse, evolved from the changes brought about by the industrial revolution, defines the problem outside categories of existential space or a certain moment and place. Subordinating the individual to the whole, the abstract view steps into a future condition inspired by the technological and scientific apparatus giving it the power to sublime human virtues.

Both of these discourses seem limited in respect to our future needs. The emerging paradigm should constitute a state in which all artifacts would continuously explain the meaning of survival, existence and complex relationships. It's architectural discourse must harmonize the memory of Arcadia (L. Krier) with the complex ideas of "regular irregularity" (Libeskind). The emotional and rational aspects of reality should be in balance within the future paradigm.

Architecture must answer the following questions: how to maintain the psycho physical integrity of the individual, how to enable the spatial integration of the individual into the collective within the new relationship to nature, and how to define his homeplace.

In the decade that made us reconsider our concept of mother, father and family, the traditional types of the human habitat have also come under reevaluation due to different changes in our society. The Lausanne Institute for Environmental Research has identified six (Rebois, 1989.).

Sociological changes reflect in the population which is growing older, increasing number of families, their diminishing size and a network of diverse domestic groups (people living together, unmarried couples...). It is necessary to rethink the habitat in diversified, adaptable forms.

Urban change is due to a more mobile population. They move house more easily and change their habitat in the course of their lives. Increasing interest in city-center dwellings is an example of this.

Technological change is brought about with new domestic equipment. Now there is the possibility of linking all in an interactive network where the traditional functions of domestic appliances can be controlled and managed.

Economic change is seen in housing becoming a matter for investments.

Spatial change is evident in the increase of average living space per inhabitant and the disappearing of intermediary spaces (entrance halls, stairs...) that stimulate sociability.

Changes in habitat model are evident on one hand, according to Rebois (Rebois, 1989.), in the "Fascination for technology and the movement towards high tech, the loft, domotics, or the ear; while on the other, notions of nature and intimacy are exalted in the taste for natural materials, alternative energy, the house or the pedestrian street".

Having this in mind the practical questions were: What is the experience (patterns) on housing design we want to build into the neural network and how do we structure it in order to be meaningful in design work?

The problem: a two-bedroom apartment

To analyze and structure a complete design problem of designing an apartment house would be too great a task if we want to show the plurality of possibilities that exist, and which confront or supplement each other.

In order to evaluate the possibilities of Neural Networks in the conceptual phase of design, we choose a specific problem within housing design - an apartment. We made two restrictions in the scope of the problem. The first is that we concentrated on organizing the design knowledge only for a two bedroom apartment. The reason for choosing a 2 bedroom apartment is that it is common and its functional characteristics and organizational aspects can be fully developed. In a bedsit or a one room apartment the functions need to overlap. Here they can be defined and formed individually. If there is overlapping it is due to an architectural approach.

The other restriction we made was to limit the experience which was to be organized to examples of apartment housing of the '80. This is because the last decade was witness to a confrontation of different urban and architectural concepts which have produced some very interesting and novel approaches that might influence housing design in the '90.

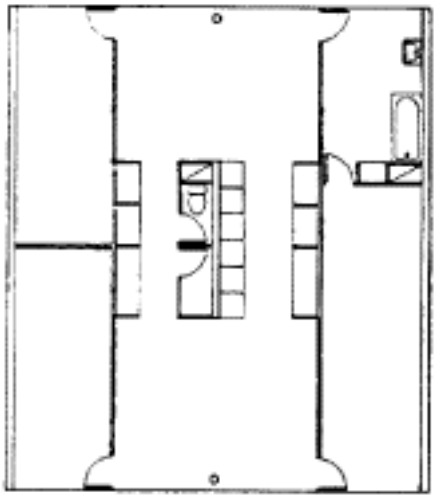

Figure 2 - Nouvel and Ibos: Housing PLA, Nimes, 1985.

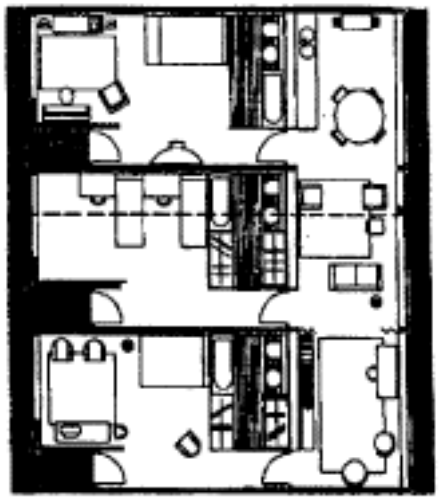

Figure 3 - Musseau and Peltrault: Europan housing project, 1990.

In the design of an apartment the main task is the articulation of the socio-integrative zone and the private zone. This articulation is heavily influenced by contemporary customs, social behavior and habits of the population, specially of the potential tenants, as expressed through direct contact (participation) or the housing market. This input often is conservative and does not reflect the ever changing trends in society, so the architect has to take into account, also, the wider social, technological and formal aspects

that develop within the design as the house will last for generations. In this way the space has to have an independent character.

Building the knowledge matrix

Within the neural network a problem is described by defining characteristics, classifying characteristics and sample eases which define the relation between the two sets of characteristics. For our problem we used the binary version giving the characteristics the value of 1 or 0 (exists or doesn't exist).

A typical matrix would have properties of a problem described with defining characteristics and solutions, being more general problem categories, with classifying characteristics. Depending on the chosen characteristics and based on described and learnt sample cases the program would, simulating associative reasoning, provide us with a solution. An example of this could be a matrix describing an apartment typology according to functional organization. Properties of different flats would explain categories of functionality: full, reduced, undefined, irrational. Though the categories are quite abstract and open to discussion the matrix is quite strait forward. Our believe is that kind of knowledge structuring and results are of little use for an architect who is designing.

We decided on an unorthodox approach we called "prolonged reasoning". In our matrix the defining characteristics are a mixture of different functional, technical and formal definitions. There are no general categories that unite them. A chosen set of them could be recognized only within an example itself. This is why the sample cases are also the classifying characteristics. Each example is a category itself. We wanted to get, as a result of reasoning, a layout, a plan. Being a symbol of spatial and social order it carries a lot more meaning than we are able to explicitly define through the defining characteristics.

The network would perform associative reasoning and offer the architect a sample of different examples from a large knowledge base. The "solutions" should be such to make him more conscious of the problem space and provoke him, depending on his conceptual approach, to do further inductive, deductive or abductive reasoning or to create a mythological context.

As Rifkin (Rifkin, 1987.) suggests "... part of the new computer world is like a simulated version of Freud's unconsciousness. ... The computer analogue to the unconscious is raw data, pieces of experience disconnected from their historical context, made into bits of information, waiting to be reordered and put to use". The architect is free to define the level of synthesis based on the offered information. He can directly transfer elements (pieces of information), or a part of them, to his design ("Collage" pattern), compose a new plan were the original elements would still be recognizable but would have added meaning ("Archimboldo" pattern) or create a poetic synthesis, a myth, in which the information codes would gather new meaning and establish a life of their own ("Pegasus" pattern). What is offered by the network is an impulse. A challenge to his creative genius.

The task in building the matrix is to explicitly define as much as possible of the problems' properties through characteristics and examples, and to interrelate all the codes. In this process we applied all of the criteria to all the examples which, in this early phase, gave us a fresh view on some of the architectural approaches.

Defining characteristics

In order to define the list of characteristics by which we will recognize the aspects of the problem we referred to the books on housing by Strizic (Strizic, 1956), Baylon (Baylon, 1974), and Knezevic (Knezevic, 1986.). After analyzing some contemporary examples of dwellings the list of characteristics had to be revised and added to. This lack of characteristics was due to the origin of the books in the functionalist experience and practice.

We defined some 25 categories with 118 characteristics. The list is structured on the criteria of importance, and this is said conditionally, to the articulation of the two main apartment zones. In the design process there is a constant negotiation of influence between these elements. The groups are:

a) Functional aspects: -formed spaces
-interrelationship of spaces
-adaptability of the spaces
b) Organizational aspects within the building
c) Organizational aspects within the apartment
d) Formal and conceptual aspects
e) Personal evaluation

The personal evaluation is different to the rest of the characteristics because it offers a subjective value to each case given by the housing expert. The cases were evaluated by Prof. Knezevic based on the following criteria:

- the cleanness of zoning in relation to the size (division into private and socio-integrative zone)
- level of intern adaptability (relative flexibility)
- specifics (positive and negative)

The greater atomization of the case studies we achieve the complexity of the problem will be better described.

We also consulted the works of Vitruvius, Palladio, Duran, Daly, Chernikov, H. Meyer, Archigram, Moore, Venturi, Alexander, Norberg-Schultz, Toyo Ito, and books on the bioclimatic design to identify characteristics that could be useful in the description of the problem. Also analyzed was Feng Shui, the old Chinese art of spatial organization.

Classifying characteristics and Sample cases

As we mentioned earlier the sample eases and the classifying characteristics are the same.

To describe the problem we analyzed the housing trends in the 80's and selected 80 examples with their plans, facades or sections. These examples come from different architectural styles, concepts, climatic zones, societies etc. They test and give meaning to the defining characteristics. In this kind of

approach we did a comparative analysis of a multitude of architectural themes. After redefining some of the characteristics we set the standard for all other examples. The following properties of the problem were identified:

-patterns with new elements not yet listed in defining characteristics;
-patterns where under the same name are two different contents and vice versa;
-patterns that are of mutant typologies; could be one or the other characteristic;
-patterns that have two or more characteristics of the same criteria depending on the viewpoint;

As a product of reasoning, the network offers several examples, each with a percentage of being the right solution.

The properties of these examples might be very different depending on the definition of the problem's characteristics. For example, we made a distinction between kitchen niches, kitchens and domestic kitchens. These are the main types but within the some of them there are examples where the content is so different that it might not be recognizable, and which redefines the scope of the old category or asks for a new one. Such is the example with a "non static eating machine" as the kitchen evolved in the design of the "Living pod" by David Green (Landau, 1968.) of the Archigram group which we did classify as a kitchen. This is where we find Alexander's pattern language lacking. It explains patterns of a closed esthetic, social, and so on, system (the 19th century European city, the narrative discourse). Our aim was to interrelate different architectural discourses.

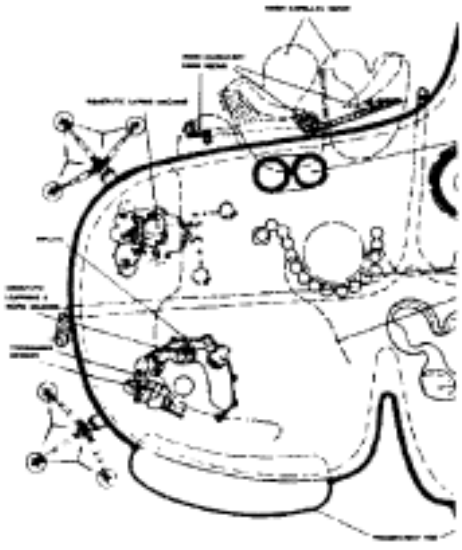

Figure 4: Greene, Living Pod, project, 1966.

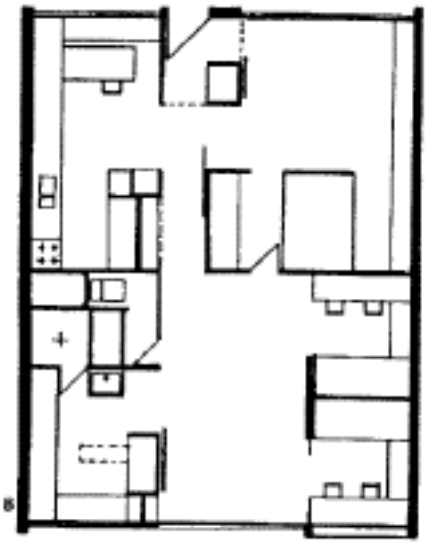

Figure 5: Cheineux: Experimental housing proposition for l'O.C.I.L, 1958

This example was taken to illustrate, also, another aspect of architectural experience. The ideas or visions that were of interest twenty years ago, are non-existent in current architectural discourse, but as it is in the nature of architecture to recycle ideas, the matrix should give an indication of former architectural experiences and ideas. This is why we included 12 examples of 2 bedroom apartments from outside the eighties.

This is a sample case which illustrates some of the aspects we mentioned earlier:

Sample Case: 19

... entry space
... kitchen
... store room / utility
bathroom balcony
functionality: reduced

organization: passage through the living room to the bedroom group
organization: enlarged communication
organization: circular communication
organization: not possible to systemize (when partitions are closed)
space character: dynamic
readability: formal
readability: substantial

flexibility: relative - internal
morphology; interpolation
communication - flat: from the gallery
communication placement: on the back facade
construction: transversal walls
flat size: standard
number of floors: 1
orientation: double sided
plan in relation to daylight: regular
illumination: partly natural
ventilation: transversal
sanitary block: 1
kitchen position: pulled in from the facade
formal articulation: based on the building
paradigm: abstract
style disposition: Neo-modern
personal evaluation: very good

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19 Duinker / van der Torre / Duvekot

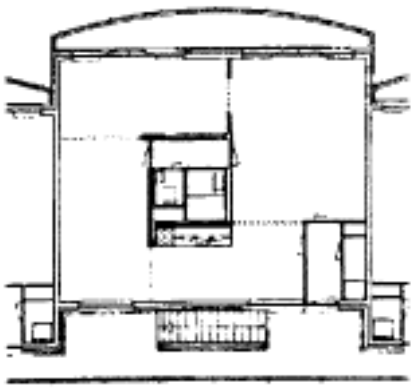

Figure 6- Duinker, van der Torre and Duvekot: Housing, Amsterdam, 1989.

Learning to respond

After structuring the experience in the matrix we developed two versions which differ by the way characteristics are input in the shell. The first we called the "reasoning matrix" and the second the "memory matrix".

The quality of the first is that it can suggest the best answer among different options. For the outcome of reasoning to be valid it needs at least several characteristics. The memory matrix give you the possibility to inquire about a singular, specific characteristic. This matrix does not simulate any intelligent mental behavior apart from learning things by heart.

The importance to develop both, was in the larger flexibility of exploration through the problem space depending on the connections between the two (serial, parallel).

The process of "learning" the reasoning matrix with 118 input nodes and 80 output nodes, took more than 32 hours on the PC 486/33. During the "learning" we increased the number of hidden nodes from 70 to 130, to make it more efficient. The memory matrix took less than 13 hours to "learn".

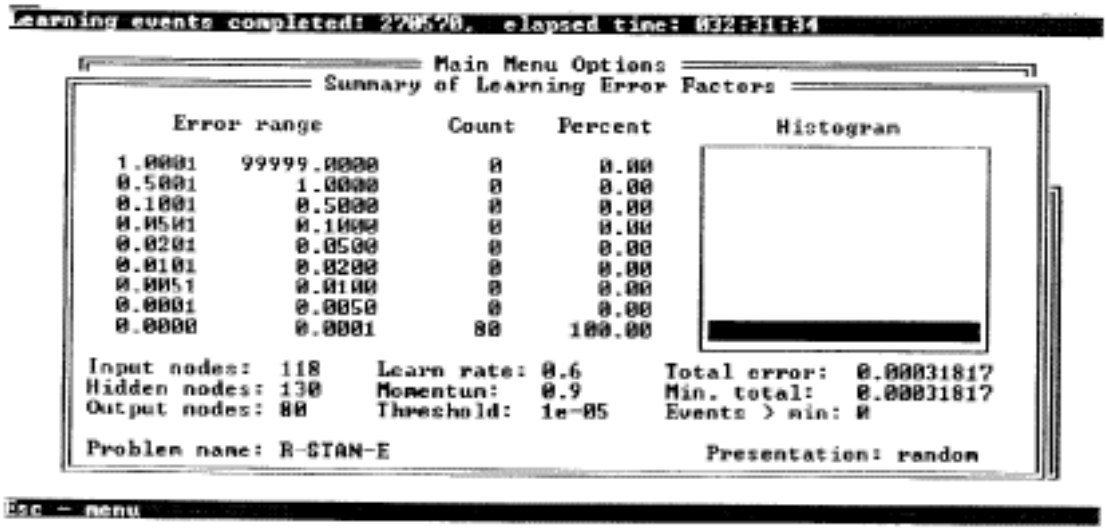

Figure 7- Histogram showing finished learning of apartment problem

The following classifications have been done with the reasoning matrix. They illustrate the different levels of precision of output depending on the input:

Classified Case: 1

functionality: irrational
---
62 Lainer / Auer 0.61
72 David Greene 0.69

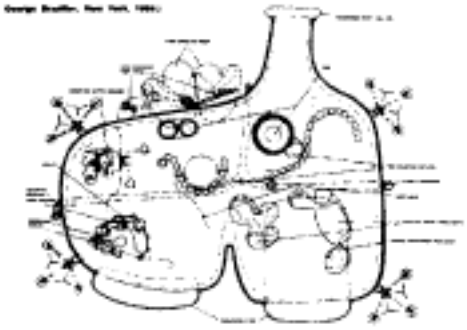

Figure 8- D. Greene: Living Pod, 1966.

Classified Case: 2

functionality: irrational
style disposition: High-tech
---
14 Christiane i Francois Deslangiers 0.64
16 Richard Rogers & Partners 0.76
72 David Greene 0.89

Classified Case: 3

style disposition: Participatory pluralism
---
26 Leon Krier 0.51
35 Lucien Kroll 0.81
62 Lainer / Auer 0.62

Classified Case: 4

... living room
... dining room
... wc
... study
.. master bedroom
.. playing space
functionality: reduced
space character: dynamic
morphology: urban block
sanitary block: 1.5
style disposition: Poetic high-tech
---
9 Nouvel / Ibos 0.57

12 Nouvel / Ibos 0.59
22 Manfred Wolff-Plottegg 0.81
27 Rob Krier 0.72

Figure 9: M. Wolff-Plottegg: Housing, Graz, 1989.

Classified Case: 5

... living room / dining room
... hall
... domestic kitchen
... wc
.. study
.. master bedroom
.. children's bedroom
.. bathroom
. balcony
functionality: reduced
organization: passage through the living room to the bedroom group
space character: dynamic
readability: formal
flexibility: partly relative

morphology: housing block
communication - flat: from the stairwell
communication placement: on the back facade
construction: transversal walls
flat size: standard
number of floors: 1
orientation: double sided
plan in relation to daylight: regular
illumination: fully natural
solar: direct gain
ventilation: transversal
sanitary block: 1
kitchen position: pulled in from the facade
formal articulation: based on the building
paradigm: narrative

No classifications exceeded threshold.

Classified Case: 6

... living room
.. bathroom
. loggia
functionality: undefined
organization: not possible to systemize
space character: dynamic
readability: substantial
morphology; interpolation
communication - flat: from the stairwell
communication placement: in the middle
construction: columns
flat size: large
orientation: double sided
plan in relation to daylight: deep
ventilation: transversal
sanitary block: 1
kitchen position: centrally placed in the plan
formal articulation: based on the building
paradigm: abstract
style disposition: Deconstruction
personal evaluation: very good
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7 Coop Himmelblau 0.88

Figure 10: Coop Himmelblau: Project, Vienna, 1985.

For a fully the neural network should be connected with a graphic data-base containing operational system plans and images of the patterns. This is at the moment a technical problem due to limitations in the media for mass storage and their speed of retrieval.

Instead of a conclusion

"Historical terms like "fate" and "inevitability", which so dominated the thinking of the age of progress, are being replaced with psychological terms like "choices" and "scenarios" as we make the transition. The new future image conceives of reality as a vast reservoir of information to be fashioned into simulated experiences. ... The world is represented in coded messages, pieces of information that can be edited together to create thoughts, ideas, and activities. ... The new universe resembles a giant computerlike mind, ever expanding, creating new information and new knowledge, filling the cosmos with higher and higher levels of consciousness." argues Rifkin (Rifkin, 1987.). His thoughts on some of the changes in the post-industrial era, describe so well, the feeling we had while building a neural network knowledge based system about architectural design.

The mutant forms, the imperfect rules, the gray zones between black and white, are those which carry the seeds of new solutions. In our matrix we wanted to indicate the similarities between different architectural approaches or the differences within the same and to show the inconsistency and diacronicity of architectural experience.

Figure 11: M.C. Escher: Liberation, 1955.

Between the known elements we establish new relations which can offer a fresh view of the problem and stimulate the architect's creativity.

Based on this we are now building a larger matrix with the characteristics and examples of housing neighborhood design. These two, and all other future matrixes, will constitute a knowledge universe where they will be interconnected to allow the architect to explore architectural know how and his esthetic preferences.

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