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PhD Thesis
Research Regarding the Application of Neural Networks in the Organizational Management

SUMMARY

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CONTENTS

PREFACE

Keywords

Artificial intelligence; neural/neuronal networks; organizational management; computer systems; competitive strategies; strategic management; nonconventional technologies; NeuroSolutions MATLAB

The PhD thesis is structured in 8 chapters, chapters comprising 194 pages, 90 figures, 28 tabels, 261 bibliographical references and 3 annexes (168 pages).

The first chapter, **”Aspects of the current state of use of "Neural Networks" in management”** presents some research fields and applications in production of neural networks and the first contributions of the author herself regarding the definition of the „neural network” vs. „neuronal network” phrase.

The second chapter, **”System approach of neural networks”** presents the definition elements of the neural networks, the structures and the classification of the neural networks.

Chapter three consists of **”Research goals and objectives of the PhD thesis”.**

It summarizes the conclusions of the analysis of the current state of the implementation of neural networks in the field of management as well as the main objectives and future directions of research.

The fourth chapter is titled **"Contributions regarding the involvement of informatic systems in the development of neural networks**" and presents the system concept with the related informatic subsystems and the definition and adaptation of some softwares and programs for the realization of some applications in the field of neural networks: NeuroSolutions and MATLAB.

Chapter five, **”Contributions regarding the use of neural networks in human resource management and establishment of the organizational structure**” presents the approach to the reproduction of the biological neuron in the structure of an organization, and the contributions to the adoption of a certain organizational structure of some industrial organizations with specific activity in the field of Nonconventional Technologies.

Chapter six, **“Contributions regarding the use of neural networks in establishing competitive strategies in organizations with activity in the "Nonconventional Technologies" field”,** presents the necessary elements for the elaboration of these strategies.

Chapter seven, **“Contributions regarding the design of neural networks applicable to the strategic management of an organization”** highlights the results obtained in modeling with feed-forward and neuro-fuzzy neural networks.

Chapter eight presents **”Final conclusions, original contributions and future research directions”.**

Within the doctoral program of scientific research, 10 papers were made and published, out of which 7 as the first author, 5 of which were published in magazines indexed in international databases and 5 in volumes of conferences with sections in the thesis’s field (ISI, EBSCO, ProQuest, Google Scholar, etc.).

CAPITOLUL 1

ASPECTS OF THE CURRENT STATE OF USE OF "NEURAL NETWORKS" IN MANAGEMENT

When creating an artificial intelligence system, one of the difficult problems is the computer simulation of certain actions: to create sounds and to judge, to draw conclusions on the basis of mere perceptions of certain situations.

After 1995, mostly in the last 4-5 years, major applications are being developed of neural networks in modeling, simulation and management of industrial processes.

In 2013, scientists from the University of Illinois, Chicago (UIC) have tested one of the best artificial intelligence systems - ConceptNet 4 and the results showed that the system is as intelligent as a normal child with the age of four years, except the fact that the scores varied from one subject to another (figure 1.1).

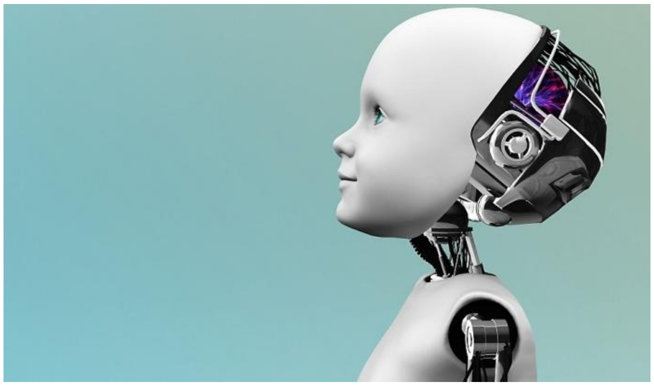

Figure 1.1. Robot as a child

Professor Robert Sloan, who led the study, said that: "If a child get scores that vary so much, then it would be something wrong with him," and that the system has done very well in analysis test of the vocabulary and the analysis of the ability to recognize similarities.

Figures 1.2., 1.3., and 1.4 show a comparison between an artificial neural network and a biological neural network to highlight the similarities between the two.

Biological Neural Network	Artificial Neural Network
Soma (cell body)	Neuron
Dendrites	Inputs
Axon	Outputs
Synapses	Weight
	Hidden Layer

Figure 1.2. Comparison between biological neural network and artificial neural network

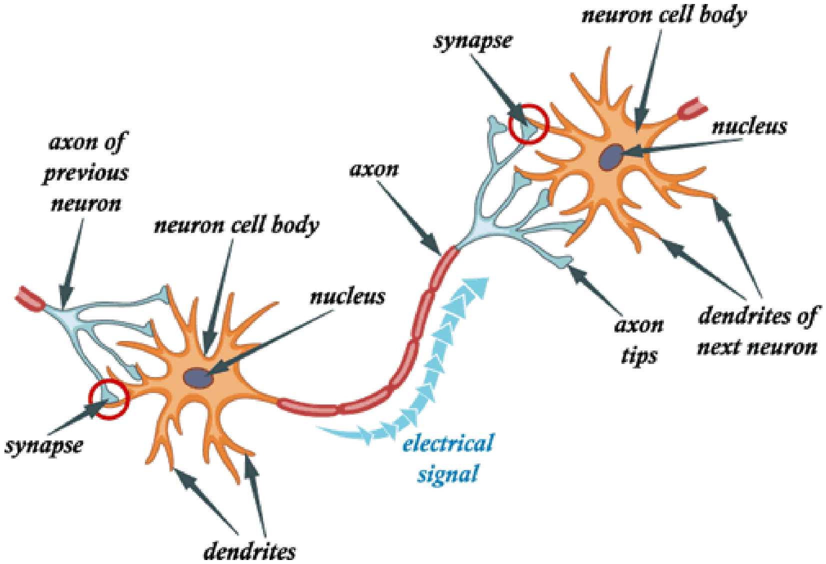

Figure 1.3. Interconnecting neurons

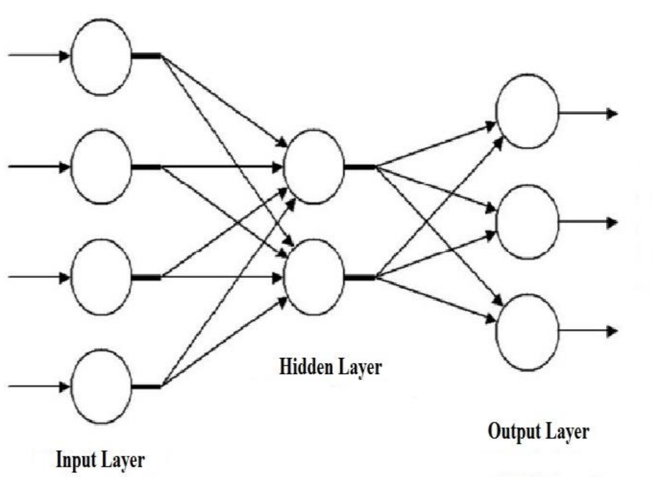

Figure 1.4. Artificial Neural Network

Figure 1.5 shows the differences between a computer and the human brain.

Computer (von Neumann)	Human brain
One or several processors with high speed (response time, ms) and high computing power	A large number (10^{11}) of functional units of relatively low speed with limited computing power
One or several high-speed communication arteries Memory accessed by address	Large number (10^{15}) of limited speed connections Memory with associative character
The component that incorporates knowledge is separate from the intended calculations	Knowledge stored in synapses
Reduced adaptability	Adaptation is achieved by modifying the connections

Figure 1.5. Comparison between a computer and the human brain

The neural network is easier than the neuronal network, having lower computing units capacity. Therefore, by following advanced studies in this field, it is primarily intended to carry out a range of comparative research "targeted approach versus systemic approach," "neural network versus neuronal network", "artificial intelligence versus intelligence of the living world" "organizational neuron versus biological neuron."

In this context the three parts that make up the neuron (neuron structure, Figure 1.6): cell body, dendrites and axon will be compared with the structure of an organization in order to determine within it who has which role / position, how can the biological neuron can be reproduced and its reproduction at the structuring level of an organization.

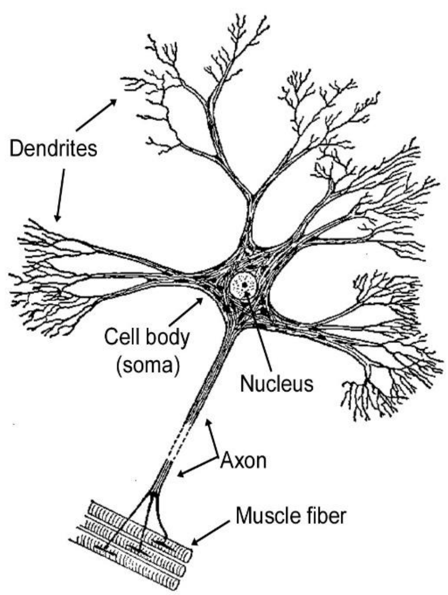

Figure 1.6. Components of a neuron

Nerve cells called neurons are fundamental elements of the central nervous system (CNS). In this system there are about 5 billion neurons.

Neurons have five specialized functions:

- receive signals coming from the vicinity of the neuron;
- integrates (sums up these signals);
- give rise to nerve impulses;
- lead these impulses;
- transmit impulses to other neurons.

The **nucleus** is the cell body and supervises biochemical transformations necessary for the synthesis of enzymes and other molecules necessary for the neuron’s life. The cell body has a few micrometers in diameter.

Each neuron has a **dendrite** structure around it; they are thin tubes, cross, extended on several tens of micrometers. Dendrites are the main receiving recipients of the neuron, receiving signals from other neurons, signals they transmit to the **neuronal soma (body neuron).**

The **axon** represents the centrifugal ending of the neuron, which aims to transform signals to target cells represented by the neurons that he makes synapses with. In the axon the signals are converted into nerve impulse trains or nerve impulses or potential of neuronal action. The axon is longer than the dendrites ranging from one millimeter to more than a meter long; axonal endings are called the done button.

The connections between neurons are achieved via synapses. **Synapses** are connections between the axonal endings of the transmitter neuron and soma or dendrites of the receiver neuron. Synapses can have through a chemical mediator an excitatory or inhibitory effect.

There is no generally accepted definition for neural networks, the majority of authors agree that they represent some simple processing assemblies aimed at interacting with the environment and also holding biological brain abilities to learn, being strongly interconnected and operating in parallel.

Personally, I think that the neural networks represent a simulation (clone) of the capacity of the human brain, weaker, however, than the neuronal networks, with the power to learn, but only as much as they will be allowed by the person that schedules them (creates them).

Therefore, I will use the term "neural network" for all research and personal statements and the expressions: "neural network" or "neuronal network" as seen in the works analyzed in the literature.

CHAPTER 2
SYSTEM APPROACH OF NEURAL NETWORKS

Neural Networks have connections with a lot a fields, including: **Biology, Neurophysiology, Cognitive Psychology, Informatics (**Artificial Inteligence,Data Mining), **Engineering (**Signal Processing, Adaptive Control), **Mathematics (**Liniar Algebra, Numerical Analisys, Statistics, Differential Equations), **Economy (**Stock Prediction, Risk Analysis).

As in any other field, the study of neural networks has also experienced periods of intense research, and periods when the estate was neglected.

Studies began its state in the late nineteenth century, early twentieth century, and those who issued the first theories in this area are Hermann von Helmholtz, Ernst Mach and Ivan Pavlov.

The first practical application, the perceptron, appeared in 1959 - carried out by Frank Rosenblatt-used for character recognition.

Amongst the areas where the use of neural networks had good results, are:

- Approximations of functions;
- Control of industrial robots;
- Classification;
- Recognition of patterns and voices;
- Financial projections;
- Market Research;
- Forecast of marketing;
- Medicine etc.

In recent decades, advances in neuroscience have been spectacular, particularly those related to the properties of neurons and complex molecules that affect neuronal response[1][49].

Thus, the discovery of brain nature and principles which govern the activity, we may be able to understand the functions of perception, learning and other mental functions.

Knowledge of the human brain functions, central nervous system, allowing us to understand how the artificial neuronal networks (neural networks) work and are developed.

In 2013, scientists from the University of Illinois, Chicago (UIC) have tested one of the

[1] Dzitac, I., “*Inteligenţa artificială”*, Editura Universităţii Aurel Vlaicu Arad, 2008.

best artificial intelligence systems - ConceptNet 4 and the results showed that the system is as intelligent as a normal child with the age of four years, except the fact that the scores varied from one subject to another.

The Turing Test consists in a simple conversation between a human being and a machine (computer) softwared specifically for the test. Those who participated at the conversation were not able to see or hear each other. If the jury, after the conversation, could not distinguish the man and the computer, then the computer (the artificial intelligence) won. Turing started from a very simple idea: if we can not define intelligence, but still say about a person that is smart, then why can’t we say the same thing about a machine (robot) that would act like a human.

- **Structure and classification of neural networks**

Even if their functioning resembles the neuronal networks, the neural networks have a different structure, much simpler, composed of units with lower computing capacity than the neural networks.

Some of the criteria underlying the classification of neural networks are[2] [46]:

- The number of layers of artificial neurons;
- The type of the used artificial neurons;
- The interaction and influence between neurons;
- The network topology;
- The type of learning;
- The symmetry of the connections, the number of layers;
- The evolution time of the network status, etc.

- **Typical disadvantages of the neural and neuronal networks:**

- A drawback of neural networks is the lack of theory that specifies the number of elementary neurons, the type of the network and the interconnection method.
- A drawback of neuronal networks is the fact that, in some cases, they require a lot of steps, even thousands of steps which require a long time to be resolved. This disadvantage is also for the neural networks, due to the fact that the processor of a standard computer can calculate only separately each network connection. This is troublesome for large networks with a large amount of data.

- **Properties and Characteristics of Neural Networks**

Simon Haykin believes that a neural network is a massive parallel processor, distributed,

[2] Dumitrescu, D., Hariton, C., “*Reţele neuronale. Teorie şi aplicaţii*.” Editura Teora, Bucureşti, 1996.

which has a natural tendency to store experimental knowledge and make them available for use[3] [140].

The main properties of neural networks are: information and knowledge are distributed throughout the network (through synaptic weight values); neural networks provide a global response; possess learning (training) properties, adaptation, generalization, parallelism, robustness, fault tolerance and disturbance.

The neural network's characteristics are:

- *The Ability to Generalize:* If they have been properly trained, neural networks are able to give correct answers even for different inputs from those who have trained them, as long as these inputs are not very different;
- *The Ability to Summarize*: Neural networks can decide or draw conclusions of their own, even when they are confronted with noisy information or inaccurate or partial information;
- *The Ability to Learn* (the main feature): Neural networks do not require strong programs, but are rather the result of training on a massive set of data. Neural networks have a learning algorithm, whereupon the weights of the connections are adjusted on the basis of presented models; neural networks learn from examples.

Some of the criteria underlying the classification of neural networks are [4] :

- the number of artificial neurons layers;
- the type of used artificial neurons;
- the reaction and the influence between neurons;
- the network topology;
- the learning mode;
- the connection symmetry, the number of layers;
- the evolution of the network state over time etc.

CHAPTER 3

OBJECTIVES AND RESEARCH DIRECTIONS OF THE PHD THESIS

Managerial activity involves a continuous, coherent and successive decision-making

[3] Neagu, C., Ioniţă, C., "*Reţele neuronale. Teorie şi Aplicaţii în modelarea şi simularea proceselor şi sistemelor de producţie"*, Editura Academiei, 2004

[4] Dumitrescu, D., Hariton, C. – *Reţele neuronale. Teorie şi aplicaţii*. Editura Teora, Bucureşti, 1996

process. In this context, the decision is found in all management functions and, as a result, in the forecasting component, neural networks being a real help in this direction.

Given the complexity of the organizational management issues, the development of future research will be directed specifically towards the use of neural networks in the field of Strategic Management and Human Resource Management.

In this respect, in order to achieve the "foresight" act, we will pursue the definition of the specific stimules and neurons - in order to make the most relevant decisions applicable to the industrial organization in the decision-making process.

At the same time, research will be developed on modeling and simulation of neural networks built for various structures of the industrial organization, ranging from SMEs to large organizations with complex organizational structures.

CHAPTER 4
CONTRIBUTIONS REGARDING THE INVOLVEMENT OF INFORMATIC SYSTEMS IN THE DEVELOPMENT OF NEURAL NETWORKS

Neural Networks (NN) can be a working tool (prediction) useful to all three constitutive subsystems (decisional, informational and operational) of the organizational system, representing, also, an operational working means of the organizational management, applicable to the IT system of the respective organization.

- **Defining and adapting software and programs for applications in the field of neural networks**

Solving the neuro-fuzzy problem was done using Matlab.

MATLAB, using specialized toolboxes, Fuzzy Logic Toolbox- FLT creates the possibility of implementing techniques based on fuzzy logic, using FUZZY and FUZZYDEMOS. The FUZZY subdirectory contains function type files, grouped into categories of functions and operations[5]:

- functions for graphical user interface (GUI); editing functions for fuzzy inference system (FIS), membership functions, the rules used, the diagrams and the associated control surfaces; functions for generating FIS (by); functions for the implementation of other routines (FIS Sugeno type, type C-means clusters, etc.);
- operations that relate to the difference between two membership functions with different forms (sigmoid, Gaussian, trapezoidal, triangular, etc.), to the concatenation of matrices, to

[5] Curteanu, S., "*Iniţiere în Matlab*", Editura Polirom, Iaşi, 2008

the mesh of the FIS's, to the evaluation of the multiple membership functions etc.

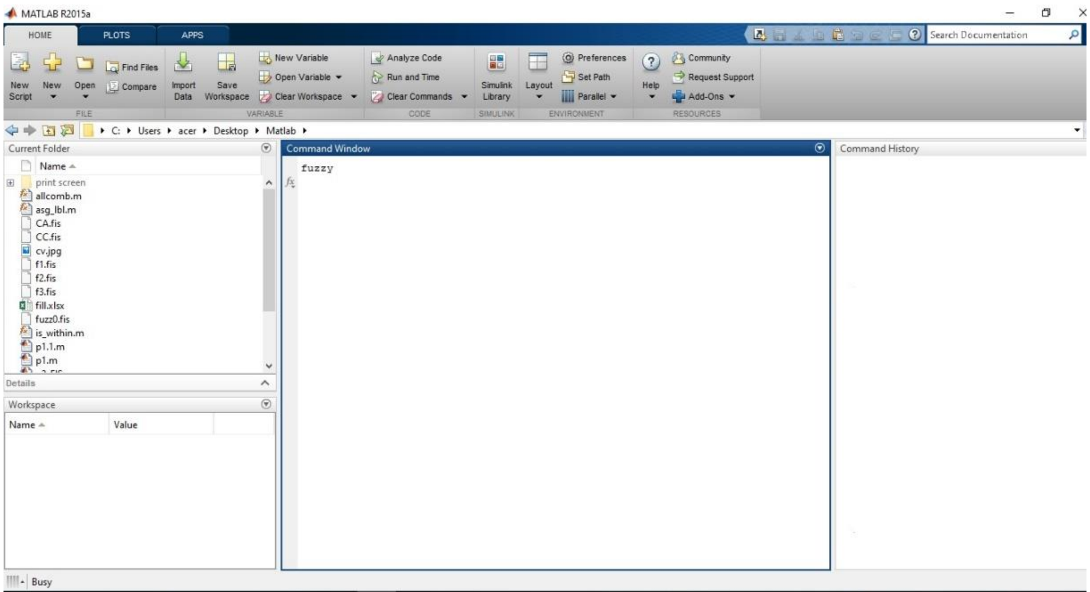

Figure 4.1. Command window

Fuzzy toolbox is accessed by typing "fuzzy" in the command window (Figure 4.1.).

The system displays the FIS type editor, which processes the corresponding information of the systems based on fuzzy inference. At the top, the diagram of the system to be created is displayed; the entry and the exit are marked (Figure 4.2.).

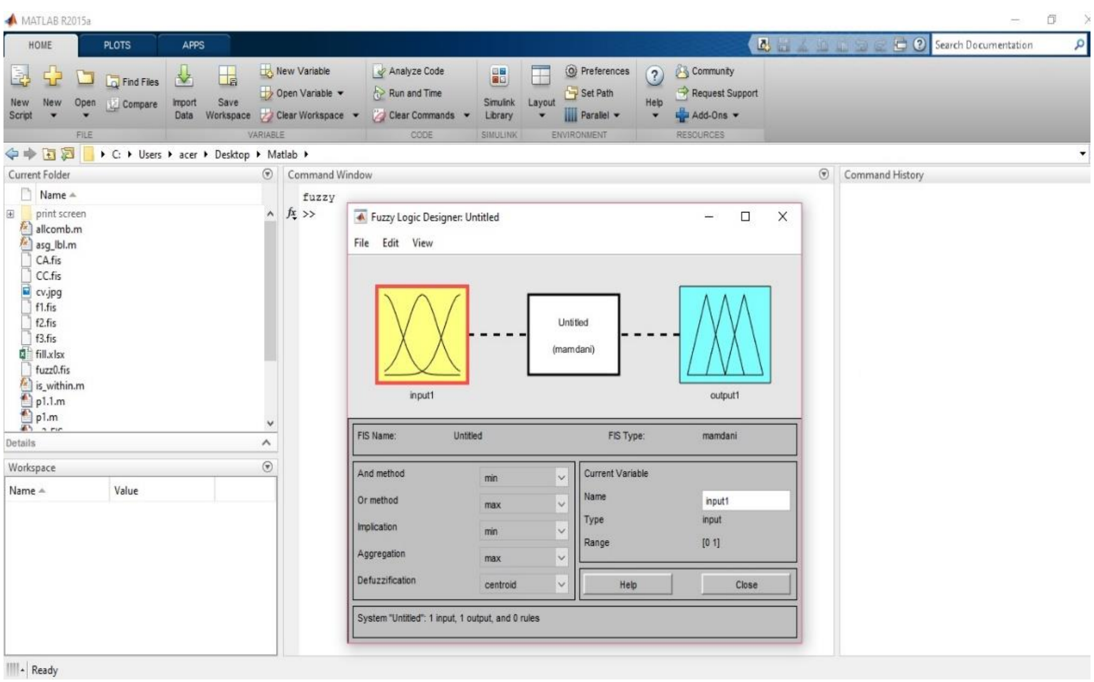

Figure 4.2. „FIS” Editor

It should be mentioned that the user can define multiple input and output variables.

Entering input and output variables is realized in the following way: in the Edit menu select Add Variable - Input (for adding input variables) or Output (for adding output variables) (Figure 4.3.).

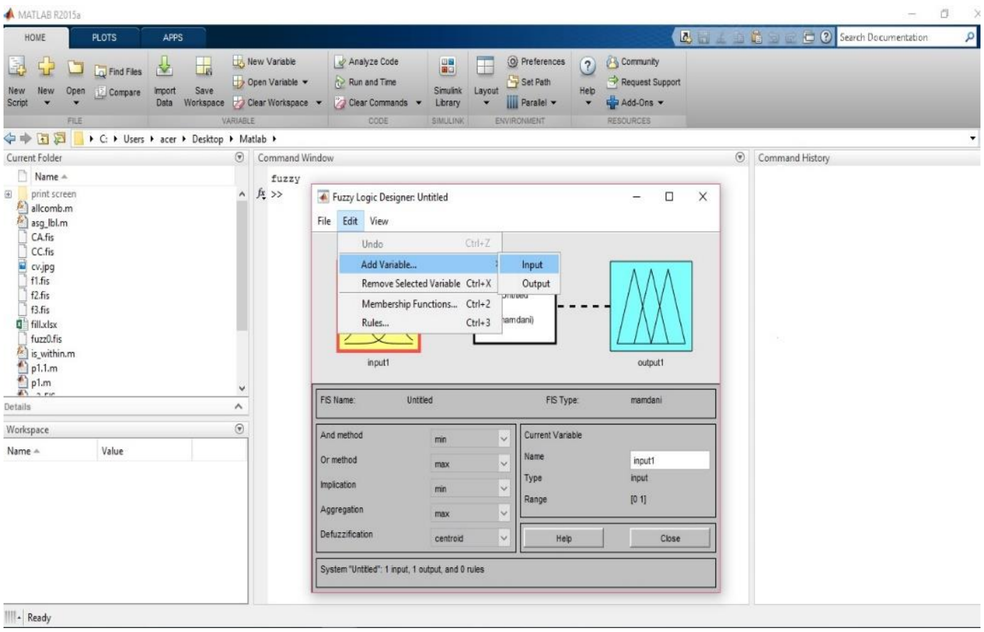

Figure 4.3. Selecting inputs/outputs

To delete these variables you select the variable you want to delete and from the Edit meniu and you select Remove Selected Variable.

After entering the variables, their names are established: the variable’s box is being selected and its name is being entered in the Name box.

After defining the name of the input and output variables, you define the membership functions and the universe of discourse for each variable. After that, you select the variable to be configured (from the Edit menu select Membership Functions) - Figure 4.4.

The editor of the membership functions (Membership Function Editor) (Figure 4.5.) is used to create, cancel or modify the membership functions of the fuzzy system.

Synthetic, defining the membership function involves the following steps:

- from the Edit menu of the Membership Function Editor graphic interface you select Add MFS;
- in the Membership Functions dialog box you select the number of membership functions that the variable can have;
- in the Membership Functions box you determine the overall shape of the membership

functions (triangular - triumph, trapezoidal – trapmf, bell - gbellmf, Gaussian - gaussmf etc.);

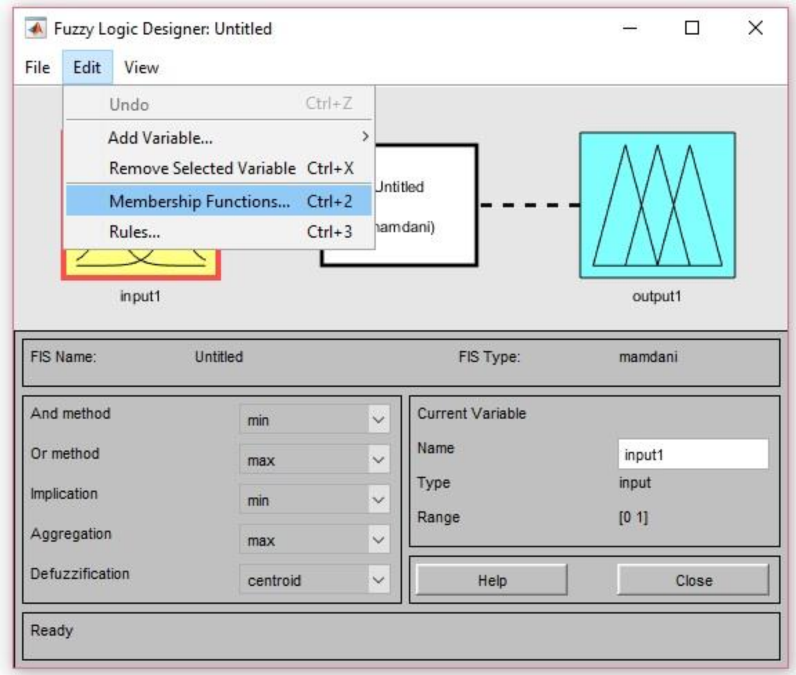

Figure 4.4. Selecting membership functions

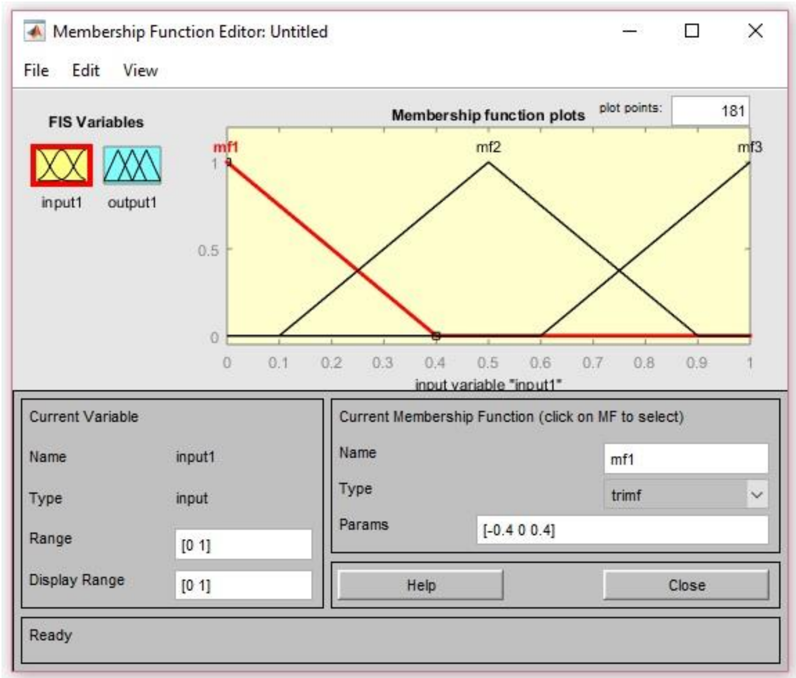

Figure 4.5. „Membership Function" Editor

- the universe of discourse is defined in the Range box;
- in the Display Range box, the user can choose to display the entire universe of discourse

(in which case the same numbers as in Range box are entered), or to display a single sequence within the universe of discourse (in which case the numbers within the range displayed in the Range box are entered);

- parameters that define the geometry of the membership function are set in the Params box- figure 4.6.

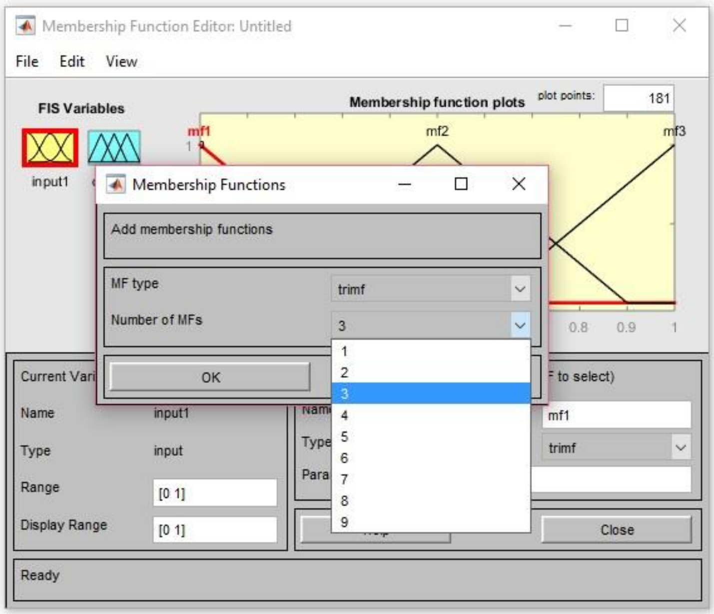

Figure 4.6. Number of membership functions

- for defining the functions, you select them one at a time and assign them proper names.

To redefine the shape of each function, you select one function at a time, after which its geometric profile is selected from the "Type" down list belonging to the Membership Function Editor (Figure 4.7.); to clear a function, you select it and from the Edit menu you choose Remove Selected MF.

After defining the input and / or output variables, follows editing the rules for the Fuzzy system:

- ❑ you open one of the FIS Editor or Memberships Function Editor or Editor windows;
- ❑ from the Edit menu you select "Rules"; the program will display the Rule Editor edit window (Figure 4.8.). As the rules are written, they will be displayed.

To define the rules, you follow the next steps:

- ➢ you select the appropriate function to be edited from the entry list;
- ➢ you click on the Add rule button and the rule will be automatically edited in the upper window of the rules editor (Figure 4.9.).

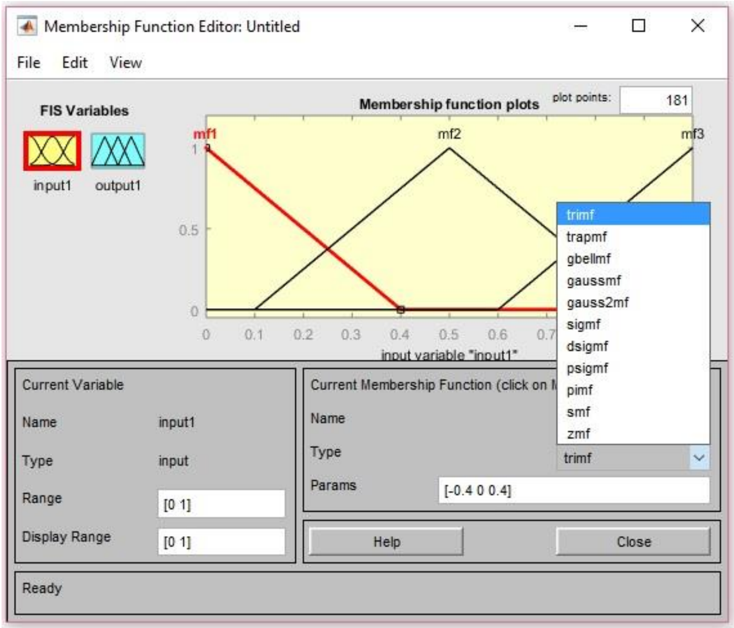

Figure 4.7. Changing the shape of a membership function

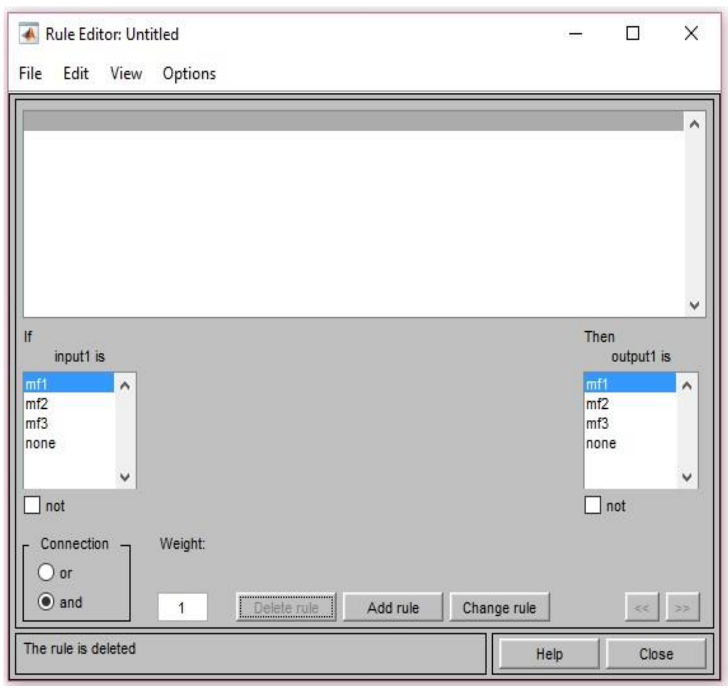

Figure 4.8. "Rule" Editor

To delete / modify one rule, you select it and then, subsequent, one of the "Delete rule" (for deletion) or "Change rule" (for change) buttons will be operated.

To view the rules or surfaces, you select from the View menu one of buttons "Rules" or "Surface" (Figure 4.10.).

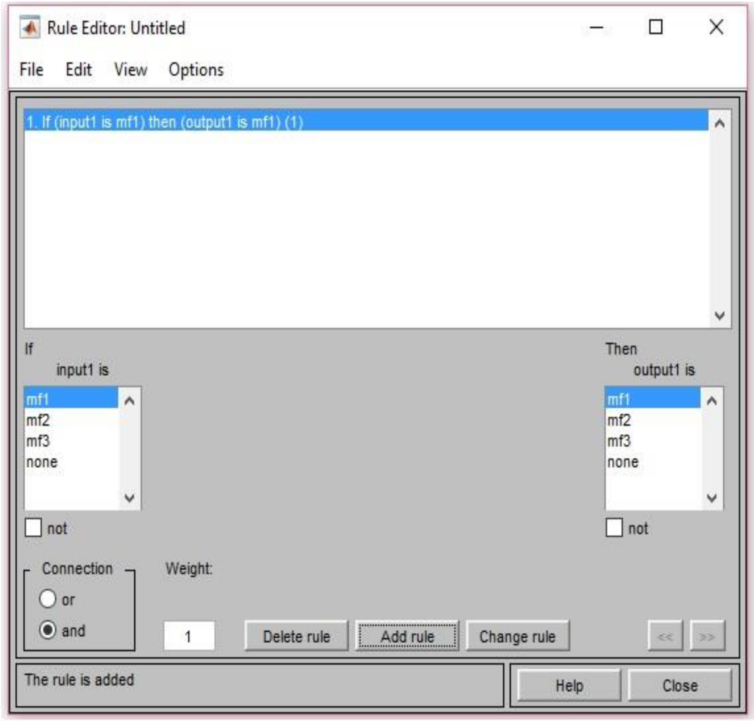

Figure 4.9. Define rules

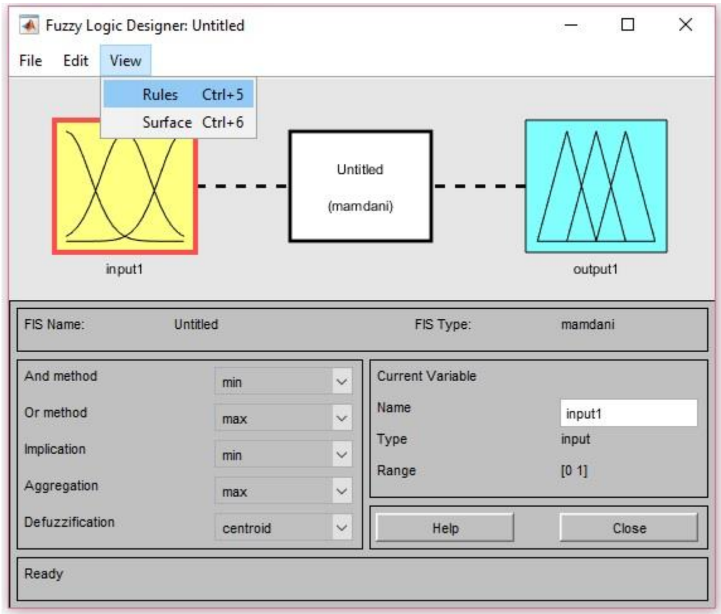

Figure 4.10. Selecting viewing rules or surfaces

- modeling with neural networks, neuro-fuzzy type

To model the relationship between indicators and strategy, a draft version of the model was to develop a neuro-fuzzy model[6]. Defining the membership functions and the corresponding values

[6] Marinescu S.I.- Research on Applications of Neural Networks in Organizational Management. In ACTA Universitatis Cibiniensis, Vol. 65, Issue 1, pg.64-68. 2014, ISBN (online) 1583-7149, DOI: 10.1515/ancts-2015-0011, 2015, de Gruyter.

are the most important steps in defining the model. After training, the structure of the rules of the model is obtained. When the user changes the input values, the system automatically generates the output value.

A surface graph showing the relationship between inputs (indicators) and exit (strategy) is shown in Figure 1 which illustrates the locations of the fuzzy inferences, obtained for each variable fuzzy output (strategies) expressed by the first 2 entries (risk factor and compensation potential regarding the financial representative). The fuzzy inference spaces visually express the dependence of the fuzzy output variables, towards the fuzzy input variables on all the support area of the membership functions[7].

- **Creating the neural network**

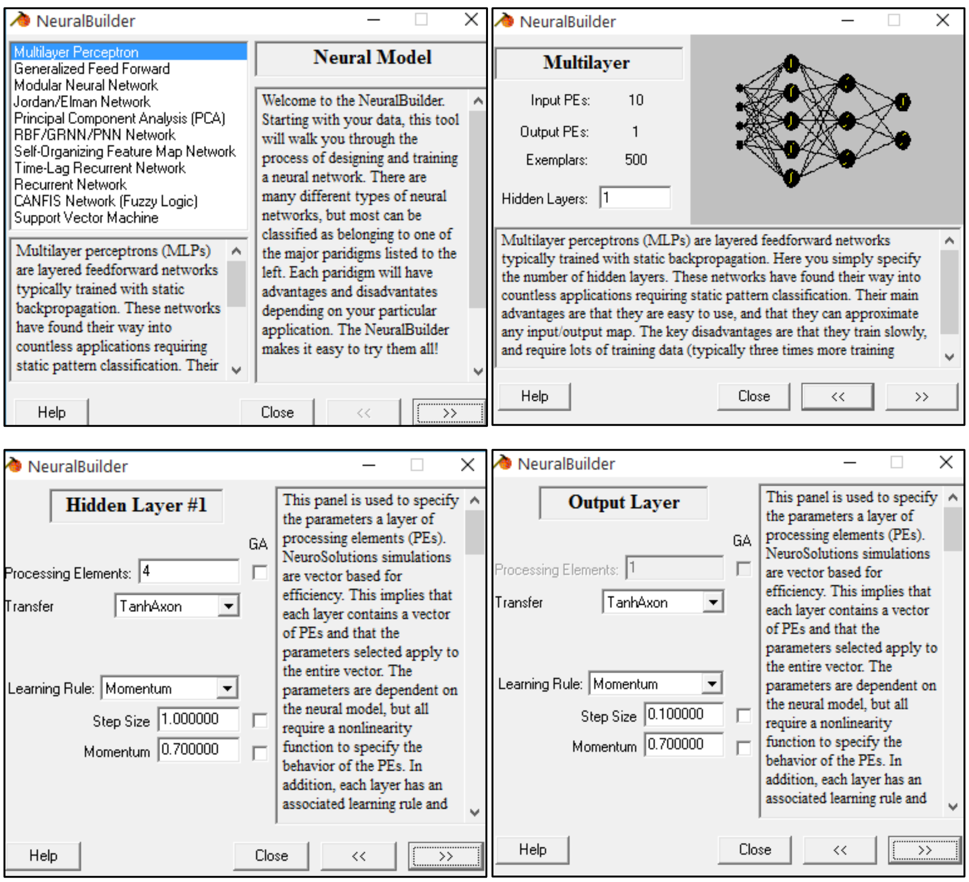

Figure 4.11. Steps to generate a neural network a) select the NN type; b) select number of hidden layers; c) Selection of options for the hidden layer; d) Select elements for the output layer

[7] Marinescu, S.I., Titu, M.- Aspects Regarding the Possibility to Use "Neural Networks" in the Selection of the "R&D" Strategy in the "Nonconventional Technologies" Field. In ACTA Universitatis Cibiniensis, Vol67, Issue 1, Pg 179-184, 2015, ISSN(online) 1583-7149, DOI: 10.1515/ancts-2015-0086, 2015, de Gruyter.

The next step is to generate a neural model.

This can also be achieved using the system NeuroSolutions with the option NeuroSolutions → Create/Open Network → New Custom Network. In this way, a new window is generated that will allow the selection of several types of neural networks (figure 4.11.).

The generated network will be indicated in NeuroSolutions as a group of interconnected neurons as shown in Figure 4.12.

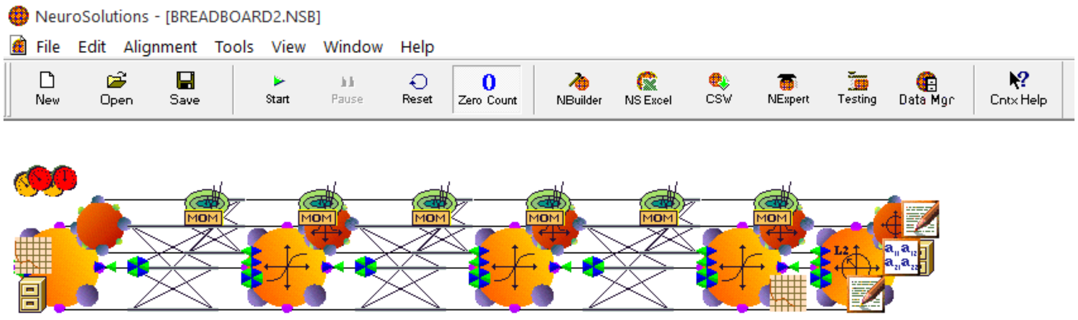

Figure 4.12. Neural network generated in NeuroSolutions

CHAPTER 5

CONTRIBUTIONS REGARDING THE USE OF NEURAL NETWORKS IN HUMAN RESOURCE MANAGEMENT AND ESTABLISHMENT OF THE ORGANIZATIONAL STRUCTURE

Neural networks can intervene by delivering useful-foresight-organizational management information to make relevant decisions, especially with regard to recruitment.

A case on how to use a neural network (NN) will be presented, based on certain characteristics of a company[8].

It aims at presenting how a biological neuron will be transposed into an artificial neuron (people or departments within the company) and its reproduction at a structure level of the organization (functions of the nucleus, axon, dendrites, and so on).

To illustrate such a neural network, a Research-Development company was chosen as a model (Figure 5.1.).

[8] Marinescu S.I.- Research on Applications of Neural Networks in Organizational Management. In ACTA Universitatis Cibiniensis, Vol. 65, Issue 1, pg.64-68. 2014, ISBN (online) 1583-7149, DOI: 10.1515/ancts-2015-0011, 2015, de Gruyter

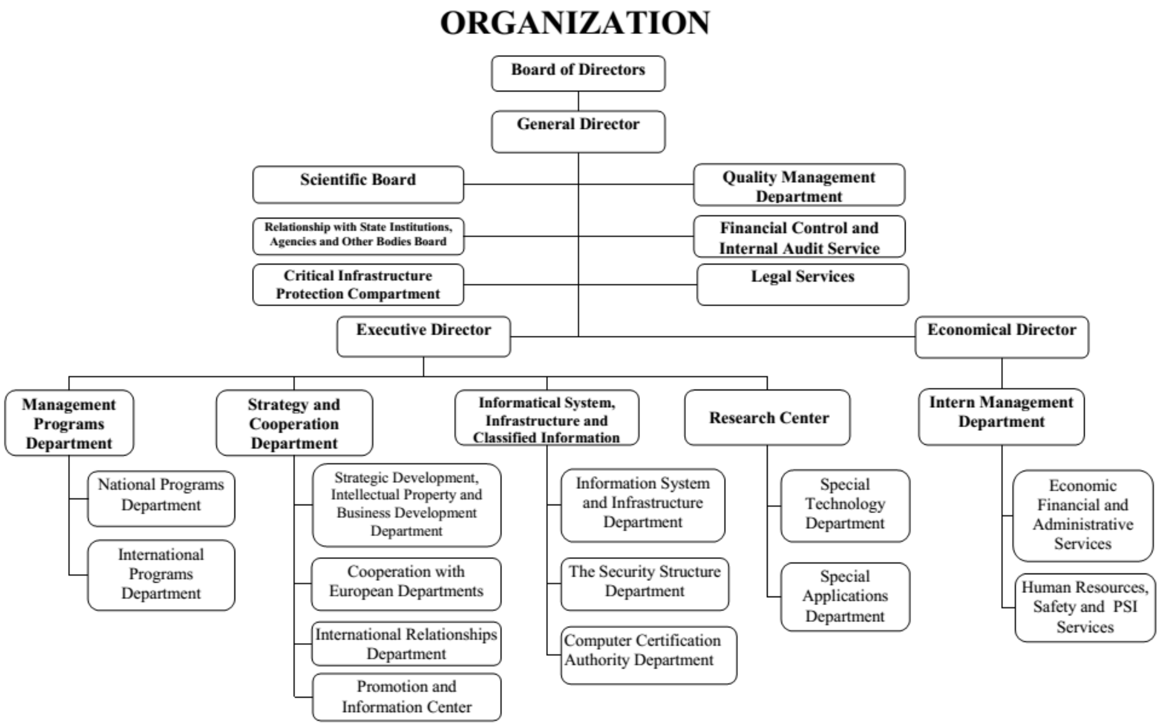

Figure 5.1. Flowchart of an R&D company

In this case, the components of the organizational neuron are the following:

Nucleus: The people in the department;

Dendrites: The information that the department has to receive;

Axon: The information coming out of the department to the higher level:

Synapses: Top decision-making body from the department.

We consider the Board of Directors is the **nucleus**, while the General Director (the CEO) is the **cell body**.

The **Dendrites** are: Scientific Board; Relationship with State Institutions, Agencies and Other Bodies Board; the Critical Infrastructure Protection Compartment; Quality Management Department; Financial Control and Internal Audit Service; Legal Services; Executive Director and Economical Director.

The **Axons** are: Management Programs Department; Strategy and Cooperation Department; Informatical System, Infrastructure and Classified Information Department; Research Center and Intern Management Department.

The **Synapses** are considered to be: National Programs Department; International Programs Department; Strategic Development, Intellectual Property and Business Development Department; Cooperation with European Departments; International Relationships Department; Promotion and

Information Center; Information System and Infrastructure Department; The Security Structure Department; Computer Certification Authority Department; Special Technology Department; Special Applications Department; Economic, Financial and Administrative Services and Human Resources, Safety and PSI Services.

Neural Network Analysis can be applied, similarly, to large industrial organizations, with the prediction possibly leading to the disappearance/emergence of new departments with direct financial implications.

CHAPTER 6

CONTRIBUTIONS REGARDING THE USE OF NEURAL NETWORKS IN ESTABLISHING COMPETITIVE STRATEGIES IN ORGANIZATIONS WITH ACTIVITY IN THE "NONCONVENTIONAL TECHNOLOGIES" FIELD

The main starting point of the management impact moments is the important area of the scientific research, where the management action directions are explained by the considered types of strategies:

a. **the offensive strategies**, characterized by high risk, high compensation potential in terms of financial results obtained as a result of assuming a risk, high potential in technological innovation, competence to analyze the market and of realizing commercial products;

Although, theoretically, these successful offensive strategies are adopted, especially for large industrial organizations, they can also be used successfully for small and medium organizations.

The large organizations, with high economic potential, can strongly support a R&D department in the "NT", but are often strongly motivated by those products and technologies that can make a substantial contribution to its profits and look less favorably at the new products that require a longer time to reach a substantial volume of sales.

The small organizations can easily adopt some offensive strategies of the R&D in the "NT" field, because of the fact that the same profit, which for a large organization is only part of the total, at the small organization it brings a contribution relatively much more important in the overall level of profitability. These organizations often provide more favorable conditions materialized in management style and leaner organizational structure, opportunities to focus its own resources, at some point, through a single project.

b. **the defensive strategies**, characterized by low-risk and low compensation potential, are suitable for those industrial organizations able to make a profit in conditions of strong competition, through the ability of controlling some of the market. This type of strategy is recommended to those industrial organizations with better results in the production and marketing than in the R&D field.

c. the acquiring strategies (purchase of licenses) at which two aspects can be considered:

- purchase of licenses which presents, at one time, the opportunity to earn commercial gainings, by buying the results obtained from the R&D investment of other companies. This is because it usually obtains a small gain through the rediscovery through R&D in "NT" field of what was obtained from another cheaper source.
- patenting some of its major innovations: represents a support strategy for small companies and a convenient strategy for large companies;

d. the interstitial strategies, which have as main condition for applying the knowledge of the strengths and weaknesses of competitors; As a result, this type of strategy stems from the deliberate attempt to avoid direct confrontation, by analyzing and exploiting the weak elements in the R&D field of the potential competitors on the market and exploiting them when they match their strength items.

e. the "incorrect" strategies: the application of new technologies in the industrial organization has great experience in developing new products whose market is owned by other companies. These strategies can not give favorable results, constant over time, unless they are also supported by an offensive strategy that maintains their won position.

The main factors to be taken into account in formulating the R&D strategy in the "NT" are:

A. The technological prognosis on the environment in connection with the managerial strategy of the industrial organization treated in the strategic planning; it aims the following requirements in "N.T." field:

- the phenomenological analysis and the new economic processes;
- formulation of realistic development options;
- ensuring a dynamic balance between the goals of permanent evolution and the level of resources.

The strategy which refers to R&D in the "NT" field, which can be seen as an extension of the strategic planning process, is using the technological forecast in a similar way, in the following areas:

1) identifying future competitive threats and maintainance chances and the expansion into new markets;
2) avoiding the competition’s surprises;
3) the major reorientation of the industrial organization’s politics in the following directions:
   - identifying new technologies;
   - changing the industrial development
   - strategy in the R&D field;
4) the improval of the operational decision-making in the directions:
   - R&D portfolio;
   - selection of projects for R&D;
   - allocation of resources;
   - personnel policy.

In conclusion, we can say that all industrial organizations which have as object of activity and the introduction, the use or research in the "NT" field, will have to adopt some form of technological forecast, market-oriented, and the amount of effort for implementing these techniques must take into account the following:

- the rate at which changes occur in the economic environment;
- the planning horizon;
- the managerial strategy of the organization;
- the creation and production potential of the organization;
- the proven and potential resources that are available.

B. The risk-compensation relationship

R&D should consider the risks arising both in addressing the entire set of “NT” projects and individual projects. Inherent risk occurs in the global approach of the “NT” problematic and is divided into the projects’ crowd at a certain level. Therefore, in a company focused for example on “NT” research, both the offensive and defensive strategies can be applied, depending on each project.

After “analyzing the risk”, it results that the large industrial organization, able to relate risk to a large number of R&D projects, can favour an offensive strategy, while a small company, because of the fact that it performs a limited number of projects, should focus, at first glance, towards a defensive strategy.

However, taking into account, in the smaller companies, the informal managerial style, the simple organizational structure (which avoids the hierarchical dilution of the willingness to accept the risk), the possibilities to concentrate the efforts at a particular time towards a product- project, the risk awareness, it can be said that the small companies, either research or production in the "NT" field, may adopt an offensive strategy.

Subsequently, the management decision (Figure 6.1.) can have two contradictory reactions:

- the decision to transfer the R&D effort fast, in the "NT" field and reducing the attempts to bring the classical technology closer to the upper limit of the performance;
- the decision to invest the bulk of capital in the existing technology.

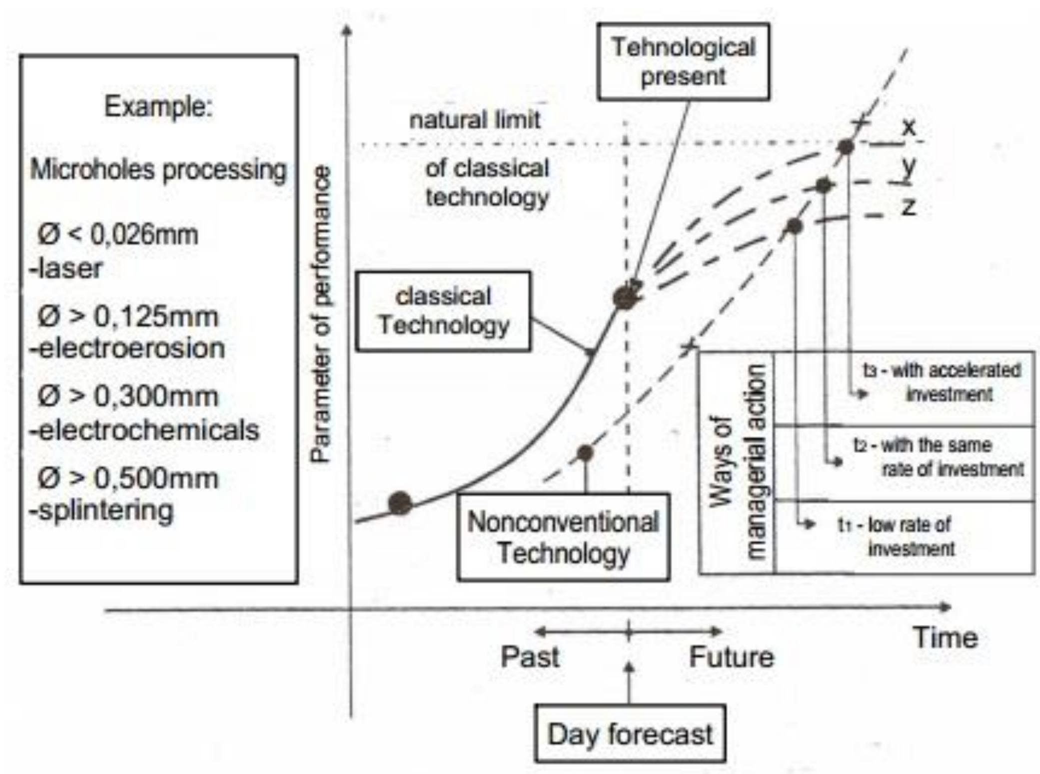

Figure 6.1. Establishing the management decision

According to Figure 6.2, the evolution of the life cycle of a particular nonconventional technology results as a synthesis of the life cycles of the components. They evolve by the same law, but there is a certain hierarchy, according to their share when developing this technology.

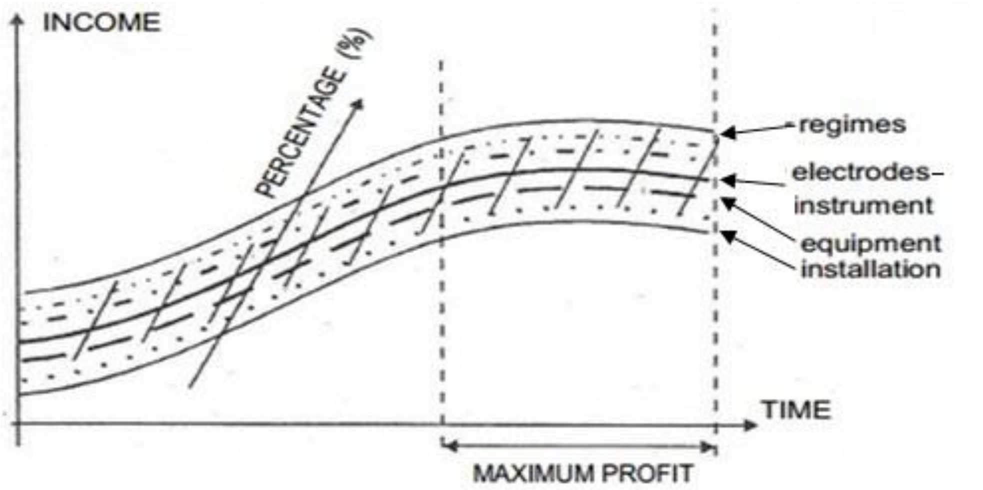

Figure 6.2. The evolution of the lifecycle of a nonconventional technology

For small companies (Figure 6.2.) specialized either in production or in R&D in this area, with a limited material base, it is considered that the design and the construction of the related tools and the used operating modes, have the decisive influence over the technologie's rentability, while for the large, specialized, companies, the ranking may be different.

In these circumstances, the companies must predict the evolutionary way of the commercial launch's lifecycle of a technology, for establishing the moment of action in order to enhance, so that it withstands the competitive market.

This prediction consists in determining the nodal point in achieving the maximum corresponding to components for determining the timing of action on each one (Figure 6.3.).

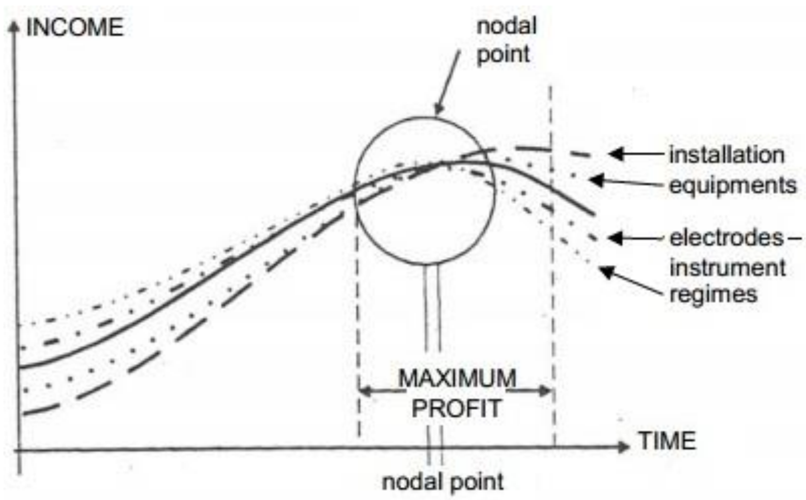

Figure 6.3. Determination of nodal point

Considering that the four action courses over the "nonconventional" product's life cycle are being reduced to two main directions: I-conceptual direction (embedding specialized facilities and equipment); II- user direction (embedding processing tools and schemes), the analysis of the life cycle curve highlights both the preponderance of the first and creating the premises of any local or general monopoly.

Determining the moment of the nodal point can be achieved depending on the specifics of each company, correlated with its involvement in the two strands, given the inherent difference between the two absolute maximums.

The correct analysis of the life cycle of the unconventional technology allows the establish of the optimal strategy for the company, both for for extending the profit period, and in the conditions of the analysis of some similar competitive products of the directions of action, in order to maintain and extend the marketplace with its own products.

CHAPTER 7

CONTRIBUTIONS REGARDING THE DESIGN OF NEURAL NETWORKS APPLICABLE TO THE STRATEGIC MANAGEMENT OF AN ORGANIZATION

"NN" may be particularly useful in forecasting the future strategy of joining the network (indications) and the corresponding outputs (proposed strategy) being highlighted in the table (matrix) 7.1. and Figure 7.1.

Table 7.1. Analysis indicators for the selection of the strategical variant using the “NN”

Strategy / Indicator	Offensive -A-	Defensive -B-	Absorbance -C-	Interstitial - D -	Incorrect -E-
a. risk	high	low	low	medium	low
b. compensation potential regarding financial result	high	low	high	low	medium
c. potential in technological innovation	high	medium	high	medium	medium
d. the competence to analyze the market	high	high	high	high	high
e. the competence to concrete commercialize the products	high	high	high	medium	medium
Note: Each indicator will receive a score between 0 and 1, the allocated share being established by the analyst					

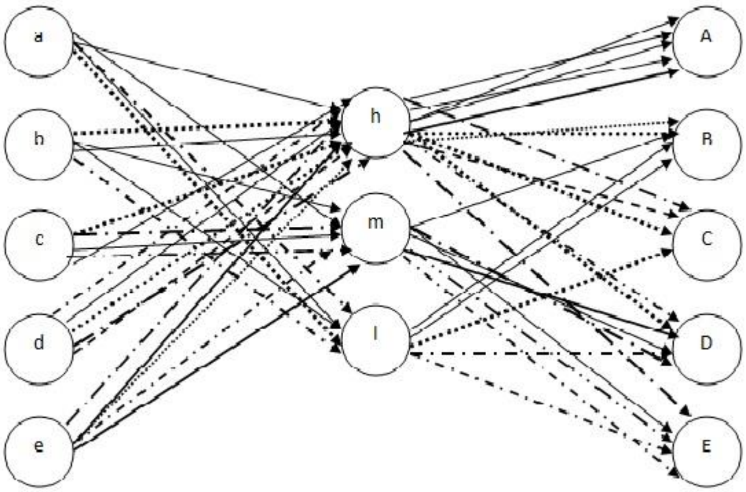

Figure 7.1. The neural network for establishing the strategy

An example of allocating the numerical values of the indicators (X1 ... Xn) for different variants for choosing the future development strategy (Y1 ... Yn) is presented in Table 7.2.

Table 7.2. Values assigned to the analysis indications with "NN"

Strategy / Indicators	Offensive -Y1-	Defensive -Y2-	Absorbance -Y3-	Interstitial - Y4 -	Incorrect -Y5-
X1 risk	[0,3…0,4]	[0,1…0,2]	[0,1…0,2]	[0,2…0,3]	[0,1…0,2]
X2 compensation potential regarding financial result	[0,1…0,2]	[0,1…0,2]	[0,1…0,2]	[0,2…0,3]	[0,2…0,3]
X3 potential in technological innovation	[0,1…0,2]	[0,2…0,3]	[0,1…0,2]	(0…0,1]	[0,1…0,2]
X4 the competence to analyze the market	(0…0,1]	[0,1…0,2]	[0,1…0,2]	[0,1…0,2]	[0,1…0,2]
X5 the competence to concrete commercialize the products	(0…0,1]	(0…0,1]	[0,1…0,2]	(0…0,1]	(0…0,1]
Note: for each Yn: min ∑Xi = 0,5; max∑Xi=1					

The value of min ∑Xi represents the capacity to analyse the topmanagement in a first phase, the capability of the institution to approach different strategies. The range Xi Є [0,5…1] and, implicitly, the max ∑Xi=1 value give the opportunity to apply the principles of any of the strategies taken in the analysis.

The basic idea based on neural network modeling consists in applying an accessible methodology that will lead to very simple networks, but that will provide very precise predictions. For this purpose, the attempts of modeling took into account the following aspects:

- various softwares were used: Matlab and NeuroSolutions, comparing the results both in terms of their accuracy, and procedure;
- different types of neural networks were tested, mainly from the category of feed-forward neural networks (multilayer perceptron, generalized feedforward, modulation) and neuro-fuzzy;
- five input variables were taken into consideration: risk factor, x1, compensation potential in terms of financial results, x2, potential for technological innovation, x3, competence in market analysis, x4, competence to sell the products, x5. The proper ranges of these variables were: $x_1 \in [0.1...0.4]$, $x_2 \in [0.1...0.4]$, $x_3 \in [0.1...0.3]$, $x_4 \in (0...0.2]$, $x_1 \in (0...0.2]$, these statements corresponding to "low", "medium" and "high";
- the output variable was the strategy type that has been defined by combining the values that the input parameters take, respectively: offensive strategy, defensive strategy, absorbing strategy, interstitial strategy and incorrect strategy; the outputs of the five variables were associated with the numerical values 1, 2, 3, 4 and 5;
- also, other issues have been formulated, with fewer inputs, respectively the following three cases, with three input variables each. Case 1 has inputs x_1, x_3 and x_4, case 2 - x_2, x_4 and x5 and case 3 - x_3, x_4, x_5.

Using the neuro-fuzzy model several runs were made, the aim being to determine the strategy is case in which different values of the input parameters are being considered. Table 7.3. shows the obtained results. From the statistical point of view, for the 18 considered cases, different strategies have been obtained: offensive (1), defensive (4) interstitial (8) and incorrect (5).

Table 7.3. Results of neuro-fuzzy model

Case	**Parameters**					**Resulted strategy**
	x1	**x2**	**x3**	**x4**	**x5**	
1	0,15	0,15	0,15	0,15	0,15	Defensive
2	0,35	0,15	0,15	0,05	0,05	Incorrect
3	0,15	0,15	0,25	0,15	0,05	Defensive
4	0,32	0,10	0,12	0,15	0,05	Interstitial
5	0,3	0,2	0,25	0,01	0,1	Incorrect
6	0,4	0,1	0,12	0,1	0,1	Interstitial

7	0,38	0,15	0,1	0,2	0,05	Incorrect
8	0,4	0,3	0,3	0,2	0,2	Offensive
9	0,3	0,1	0,01	0,01	0,01	Interstitial
10	0,15	0,15	0,15	0,2	0,1	Defensive
11	0,25	0,25	0,15	0,2	0,2	Defensive
12	0,3	0,12	0,1	0,1	0,1	Interstitial
13	0,35	0,2	0,05	0,15	0,05	Incorrect
14	0,3	0,1	0,25	0,15	0,1	Interstitial
15	0,3	0,1	0,1	0,15	0,2	Interstitial
16	0,32	0,25	0,15	0,05	0,05	Incorrect
17	0,36	0,28	0,08	0,12	0,06	Interstitial
18	0,35	0,15	0,15	0,1	0,1	Interstitial

Given the fact that two modeling techniques have been applied, obtaining neural models with feed-forward type networks and neuro-fuzzy models, a comparison between them was necessary, both in terms of accuracy of results and applied methodology. Table 7.4. shows some example of predictions, pointing out that both models give the same results.

In the modeling with feed-forward neural networks, a work algorithm was established, which takes into account, gradually, the possibilities to improve the models’ performance. Such attempts were: • testing different types of neural networks; • designing various topologies (number of hidden layers and number of neurons); • considering different sets of input data as number of entries (5 or 3); • different coding of outputs, depending on the chosen variant of modeling (regression or classification); • using different databases, expanded or collapsed (number of values); • dividing in different percentages in training and testing data; • using a different number of driving epochs.

Under these circumstances, the performances for training and testing for different models were recorded, of which the following have been selected for illustration: MLP (5: 40: 20: 1), MLP (5: 30: 15: 1), MLP (5: 12: 4: 1), MLP (5: 5: 1).

Table 7.4. Comparison of the predictions made by the neural network MLP (5: 5: 1) and the neuro-fuzzy model

Experiment no.	Parameters					Experimental strategy	NN Strategy	Neuro-fuzzy strategy
	x1	x2	x3	x4	x5			
1	0.15	0.15	0.15	0.15	0.15	2	2	2
2	0.35	0.15	0.15	0.05	0.05	5	5	5

3	0.15	0.15	0.25	0.15	0.05	2	2	2
4	0.32	0.1	0.12	0.15	0.05	4	4	4
5	0.3	0.2	0.25	0.01	0.1	5	5	5
6	0.4	0.1	0.12	0.1	0.1	4	4	4
7	0.38	0.15	0.1	0.2	0.05	5	5	5
8	0.4	0.3	0.3	0.2	0.2	1	1	1
9	0.3	0.1	0.01	0.01	0.01	4	4	4
10	0.15	0.15	0.15	0.2	0.1	2	2	2
11	0.25	0.25	0.15	0.2	0.2	2	2	2
12	0.3	0.12	0.1	0.1	0.1	4	4	4
13	0.35	0.2	0.05	0.15	0.05	5	5	5
14	0.3	0.1	0.25	0.15	0.1	4	4	4
15	0.3	0.1	0.1	0.15	0.2	4	4	4
16	0.32	0.25	0.15	0.05	0.05	5	5	5
17	0.36	0.28	0.08	0.12	0.06	4	4	4
18	0.35	0.15	0.15	0.1	0.1	4	4	4

The best model was MLP (5: 5: 1), trained at 10,000 epochs, which provided 100% correct answers to the test. The results were also verified through formulating a classification problem.

Also, in this case, the MLP model (5: 5: 5), with binary coded outputs had the best results, 100% correct answers.

In the considering cases of three input variables (in different variations) instead of five, the results are not too good, the percentage of correct answers was 59%, 73% and 94%.

Weaker results have been obtained, especially the smaller percentages from the previous listing can be attributed to the removal of significant variables for some strategies, that, as a result, have been wrongly classified.

Once again, this modeling is an argument for the complete case with five entries, respectively, for the fact that the 5 initial entries determine the considered strategies (100% correct answers).

Neuro-fuzzy models were designed using the Matlab system. Under this strategy, the most important steps are represented by the definition of the membership functions and the corresponding values. Subsequently, after the completion of the training phase, the model’s structure of the rules is being obtained, and then the model can be used to make predictions for different input data sets.

A comparison between the neuro-fuzzy model and the MLP neural model (5:5:1) highlights the fact that the two types of patterns generate identical results. In these circumstances, the tools that have generated them are left for comparison, respectively Matlab and NeuroSolutions. Both are equipped with specialized software graphical user interface, choosing between the two methods is up to the user, depending on the preference and his ability.

CHAPTER 8

FINAL CONCLUSIONS, ORIGINAL CONTRIBUTIONS AND FUTURE RESEARCH DIRECTIONS

Applications of neural networks in the management, compared with traditional statistical techniques are based on a number of advantages, such as:

- N. N. can provide more accurate results than regression models;
- N. N. are capable of learning complex relationships and to approximate any continuous function, maneuvering nonlinearities directly or implicitly;
- significance and accuracy of models based on N. N. can be determined using traditional statistical measures (e.g., mean square error and the coefficient of determination);
- neural networks automatically handle any interactions between variables;
- neural networks, as a preliminary nonparametric methods do not involve assumptions on the distribution of data input-output;
- neural networks are very flexible in relation to missing or incomplete datas;
- neural networks can be applied dynamically;
- neural networks exceed a number of limitations of other statistical methods;
- neural networks have associative skills - once developed, a neural network is robust to missing or inaccurate data;
- multi-collinearity does not affect the NN as in the regression model;
- neural networks are reliable tools for predicting the basic elements of quality relationships.

Besides the advantages of using neural networks in management, disadvantages can also be recalled:

- methods for determining the significance of independent variables (input) have not yet been developed;

- in neural modeling, based on the principle of black boxes, qualitative informations and precise methods for determining their configuration are missing;
- weights of neural networks can not be interpreted in the same way as the regression coefficients, they indicate the importance of entries, but the analysis becomes difficult, sometimes impossible, due to the complex interactions of the interlayers;
- it is difficult to determine the best solution; although there are techniques to avoid local minima, there is no guarantee defining the best networks;
- model selection and its training is "art" not "science", based on trial and experience, however, a careful methodology may be followed, that would lead to the best model, even if it is not optimal;
- like any other dynamically model, when submitted to changes in the external environment, the neural model needs to be rebuilt and retrained;
- the learning process can sometimes be very long.

In general, compared with multivariate statistical methods, in many cases, neural modeling is a preferred alternative, both from the point of view of results, as well as a working methodology. Three arguments can be made for this comparison:

- by applying neural networks in management issues, numerical or analytical inputs can be used;
- complex interactions between input variables does not influence the performance of the neural model or the validity of the results, as it happens in the regression analysis;
- it is possible the labeling of the intermediaries neurons and thus can be examined the conjunction of the factors that contribute to each hidden node to evaluate their impact on the modeling's performances;

The managerial activity involves a continuous decision making process, consistent and sequentially. It was, thus, considered that the decision was in all of the management functions, and, hence, in the forecasting component, neural networks being of great help in this direction.

In the context of the performed analysis regarding the involvement of the neural networks in the organizational management, it was found that human resources are the most important category of resources for an organization. The success or failure of an organization (including for those with specific production) depends crucially on the quality of the available workforce, its degree of motivation etc.

In this context, neural networks can provide estimative datas of real value to the organization management for making decisions.

In this framework (of forecasting), neural networks can provide very useful information for the top management for making decisions as fair and balanced as possible, with a margin of success.

Just as there are several classes of neurons that perform different functions, and still have the same basic structure, likewise there are many businesses, companies, firms, which, although they have different functions, they have the same basic structure.

Each department within the company, institution, firm ... has certain assignments, roles, tasks to fulfill, to meet both customer requirements and simultaneously creating products of the highest quality.

The assimilation of the organizational structure of a company with a neural network, will clearly allow the optimization of the managerial activity and getting a profit closer to the ideal value.

The paper highlights the possibility of assimilation of the departments provided in different organizational structures of companies, in eventual neurons of a neural network built on the specific of the company.

The assimilation of the organizational structure of the company with a neural network will implicity require the definition of the other specific network elements: input data, component layers, output data etc.

The strategic thinking translated into a neural network through the input elements, must take into account the specific elements of the moment of decision regarding the future strategy of the company.

In these circumstances, the use of Neural Networks- which is, nevertheless, a method of prognosis- is determined by all the information of the topmanagers in the field in which it is desired a scientific prognosis determined on the basis of basic elements, such as:

- the establishment of technological advance;
- advantages specific to the precursor;
- disadvantages reported by the precursor.

Establishing with the aid of Neural Networks of the future strategy (offensive, defensive, absorbance, interstitial, incorrect) can be achieved by considering a number of entries like:

- the compensation potential concerning the financial result;
- the potential in the technological innovation;
- the ability to comercialise the products.

Through similarly with the possibility of using the "NN" in selecting the strategy of a company specialized in "NN", the application can expand -in accordance with the "product's life cycle" (as shown) and on the nonconventional technology- considered as product- described through the four features: plant, specialized equipment, tools, operating modes.

Using "NN" - in taking managerial decisions in a comercial company – is being constituted in a provisional method, useful to the top management in order to ensure the maintenance and development of the company on the competitive market.

The paper briefly presents how to use the "NN" in the decision making process of establishing a future R&D strategy of a company specialized in NT, as well as the possibility of applying the method even up to the technological processes.

In conclusion, it follows that the success and development of any industrial organization, that in the market economic system aims at designing, implementing and developing the "NT", means the adoption of appropriate R&D strategies in all of the manifestation directions of the enterprise's functions.

The main original contributions

A. Theoretically

- defining the concept of "NEURAL NETWORK" versus the concept of "NEURONAL NETWORK";
- defining the specific elements of a neural network applicable in the addressed field;
- defining the industrial and R-D structures in which neural networks can be applied in order to establish a future strategy;
- defining some organizational and staff structure analysis options for R-D organizations;
- define and adapt some softwares and programs (MATLAB; Neurosolutions) for specific applications;
- proposals have been made regarding the reproduction of the biological neuron in the structure of an organization;
- the necessary elements for the use of neural networks in defining competitive strategies have been defined;
- the strategies to be considered (offensive, defensive, absorbent, interstitial and incorrect) have been defined;

- how to assign numerical values specific to input indicators was presented.

B. Practically

- some general organizational models have been developed, for which, decision making by applying the neural networks can be adopted;
- a package of information on the possible "entry" and "exit" data from a neural network applicable in the addressed field was elaborated;
- some neural network structures adapted to specialized softwares have been developed (Neurosolutions and MATLAB);
- specific case studies have been developed;
- the neuro-fuzzy network modeling of the relationship between input indicators and strategies was analysed;
- databases on the learning and training of the designed neural networks have been obtained.

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