TEZĂ DE ABILITARE
Habilitation Thesis

Optimizarea managementului proceselor si proiectelor din domeniul ingineriei industriale. Utilizarea metodelor inteligentei artificiale

Optimizing the projects and processes management in the field of industrial engineering. Using artificial intelligence methods

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I. ABSTRACT

The habilitation thesis **Optimizing the projects and processes management in the field of industrial engineering. Using artificial intelligence methods** reflects the activity of the author, performed after graduated the both PhD and 2014. It is based on original contributions performed during research activities at "Politehnica" University of Timisoara, West University of Timisoara, "Ioan Slavici" University of Timisoara, and also in other universities (inside the partnership and stages in Szeged, Novi-Sad and Nyregyhaza).

The thesis combines the two fields of expertise (engineering and inside computers aplied in industrial engineering and economic and inside management and finance), mainly concerned by graduating from more specializations and Bologna cycle stages:

1. Industrial engineering (machine buiding technology) license –Politehnica Timisoara University 1983

2. Automatics and computer license –Politehnica Timisoara University1994

3. Finances license – West University Timisoara -2000

4. Management license – West University Timisoara 2001

5 Industrial engineering doctorate – Politehnica Timisoara University –"Contribution to computer aided design of machine-tools with numerical control in order to manufacturing complex geometrical entities" PhD Thesis 1994

6. Finance doctorate – West University Timisoara – „Financial management optimization using artificial intelligence methods", PhD Thesis, Timisoara, 2006.

These are part of the fundamental basic training, continuously improved through complementary trainings and educational programs.

It is hard to be framed within scientific, professional or academic achievements, although bellow I try to split them:

A. Scientific achievements

A1. usage of artificial neural network in forecasting bankruptcy

A2 Scientific research planning using specific statistical methods. Aplyig ANNs to estimate best results

A3. applications of the artificial intelligence in the sustainable agribusiness – case study regarding energetic plants

A4. Contributions to the manufacturing and measuring control using numerical techniques

A5. Contributions to the optimization of the manufacturing processes through electrical erosion

A6. Industrial Parks and Technological and Scientific parks projects. Start up and spin off projects

A7. optimization of artificial neural network architecture

A8. projects and grants access and implementation

B. Professional achievements

B1. Professional prestige

B2. Completion of Professional training by graduating from more specializations and Bologna cycle stage

B3. Permanent publishing activity

B4. Participation in national and international conferences events

B5. Accessing and implementing projects/ grants, focused on professional component

B6. Forming new entities from professional component point of view:

B6.1. The constitution of modern scientific and professional entities:

- technological and scientific park - TSP Tim Science Park Timisoara

- the spin off and start-up company constituted – SC Slavici Spin-off SRL, responsible for research commercial capitalization;

- Cenei Industrial Park – on-going implementation.

B6.2. The constitution of Ioan Slavici Foundation for Education and Culture in Timisoara, within which the University was formed.

B6.3. Creating new laboratory at the level of Politehnica University from Timişoara (manufacturing and measurements numerically assisted) and at the level of Ioan Slavici University Timisoara (integrated engineering, companies' simulator).

C. Academic achievements

C1. Step by step and on the basis of legal contest evolution within academic functions hierarchy

C2. Academic achievements by completion of more specializations and Bologna cycle stages:

C3. Permanent publications activity

C4. Participation in national and international conferences events

C5. Teaching in foreign universities

C6. Involvement in student practice activities

C7. Founding new entities in the academic sector:

- The founding of Ioan Slavici Foundation for Education and Culture in Timisoara, within which the University was formed.

- The founding of 5 university specialization fields (Accounting and Information Management, Finance, Business Administration, Computers, Information Technology), for which I personally have formulated and organized the ARACIS authorization documentation.

- Creation of new labs at the level of Politehnica University from Timisoara (manufacturing and measurements numerically assisted) and at the level of Ioan Slavici University Timisoara (integrated engineering, companies' simulation).

The plan for advancement and career development is based on the proven skills to conduct and coordinate high-level research and teaching activities at academic level and to initiate successful international collaborations in the field of using computers tools in economic.

A complex educational and research system, developed based on national and international research grants will provide an ideal platform to train and educate graduate as well as undergraduate students in an almost unique multidisciplinary exploration topic, involving computer science and also economic field, creation of sustainable collaborative mechanisms with national and international partners in the field of decision is a priority of the research group. The results are planned to be valorized in the scientific community, but also to be oriented towards the public interested in the subjects of the research activity.

In summary, based on the activity developed so far, an extended set of activities at local, national and international level are foreseen; the results could be significantly enhanced if the research team will be enlarged with doctoral students, coordinated as a result of the habilitation thesis.

I. REZUMAT

Teza de abilitare **Optimizarea managementului proceselor si proiectelor din domeniul ingineriei industriale. Utilizarea metodelor inteligentei artificiale** reflectă activitatea autorului, desfășurată după susținerea celor doua doctorate pana in anul 2014. Ea este bazată pe contribuțiile originale ale autorului realizate în cadrul Universităților Politehnica Timișoara, Universității de Vest Timișoara și Ioan Slavici Timișoara și de asemenea în cadrul parteneriatelor și stagiilor din Universitățile din Szeged, Novi-Sad si Nyregyhaza.

Teza combină cele două domenii de specialitate a autorului (inginerie si in cadrul acestuia calculatoare aplicate in inginerie industrială și economic, în cadrul acestuia finanțe si management) concretizate în principal prin absolvirea a patru licențe și două doctorate, în cadrul ciclului Bologna, astfel:

Licență în inginerie industrială (tehnologia constructiilor de masini) – Universitatea Politehnica Timisoara, 1983

Licență în automatica si calculatoare – Universitatea Politehnica Timisoara, 2004

Licență în domeniul economic, managementul firmei – Universitatea de Vest Timisoara, 2001

Licență în domeniul economic, Finanțe și bănci – Universitatea de Vest Timisoara, 2000

Doctorat în inginerie industrială – „*Contribuţii la proiectarea asistată pe calculator a MUCN în vederea prelucrării entităţilor geometrice complexe”* Universitatea Politehnica Timisoara, 1994

Doctorat în finanțe – Universitatea de Vest Timisoara 2006, cu titlul “Optimizarea managementului financiar utilizand metodele inteligentei artificiale”

Acestea sunt numai formele fundamentale, conform ciclului Bologna, fiind îmbunătățite continuu prin alte programe și cursuri complementare de formare.

Este dificil de împărţit realizările în domeniile științific, profesional și academic, prezentându-se în continuare totuși o divizare a acestora:

A. Realizări științifice

A1. utilizarea rețelelor neuronale artificiale în previziunea falimentului

A2. eficientizarea planificarea cercetarii stiintifice folosind met specifice statisticii. Aplicarea RNA in previziunea rezultatelor

A3. aplicații ale inteligenței artificiale în agribusiness sustenabil – studiu de caz privind plantele energetice

A4. Contributii la optimizarea proceselor de prelucrare prin eroziune electrica

A5. contributii la controlul prelucrarii si masurarii utilizand tehnici numerice

A6. Proiecte din domeniul parcurilor industriale si a celor stiintifice si tehnologice. Proiecte se tipul start-up si spin-off.

A7. optimizarea arhitecturii rețelelor neuronale artificiale

A8. accesarea și implementarea granturilor și proiectelor

B. Realizări profesionale

B1. prestigiul profesional

B2. completarea pregătirii profesionale prin absolvirea mai multor forme ale cicului Bologna

B3. activitatea publicistică permanentă

B4. participarea la conferințe naționale și internaționale

B5. accesarea și implementarea proiectelor/granturilor din perspectiva componentei profesionale

B6. crearea și dezvoltarea unor entități moderne din perspectiva componenței profesionale

B6.1 constituirea entităților de cercetare-dezvoltare:

-parcul științific si tehnologic "Tim Science Park Timisoara";

-societatea de tip spin-off si start-up SC Slavici Spin-off SRL, specializată în valorificarea comercială a cercetării;

-parcul industrial Cenei – în curs de finalizare

B6.2 Crearea Fundației - Universitatea "IOAN SLAVICI" Timisoara

B6.3 Crearea a noi laboratoare în cadrul Universității Politehnica Timisoara (prelucrare și măsurare asistate de calculator) și în cadrul Universității Ioan Slavici Timisoara (inginerie integrată si intreprinderi simulate);

C. Realizări academice

C1. avansarea pas cu pas prin concursuri legale în ierarhia universitară;

C2. realizări academice prin absolvirea mai multor componente ale ciclului Bologna

C3. activitatea publicistică permanentă

C4. participarea la evenimente, conferințe naționale și internaționale

C5. susținerea de cursuri în universități străine

C6. implicarea în diferitele activități studențesti

C7. crearea și dezvoltarea unor entități moderne din perspectiva componentei academice:

- crearea Fundației - Universitatea "IOAN SLAVICI" Timisoara

- înființarea a cinci specializări noi (contabilitate și informatică de gestiune, finanțe și bănci, administrarea afacerilor, calculatoare, tehnologia informației) pentru care am elaborat documentația de autorizare/acreditare;

- crearea a noi laboratoare in cadrul Universității Politehnica Timisoara (prelucrare și măsurare asistate de calculator) și în cadrul Universității Ioan Slavici Timisoara (inginerie integrată și intreprinderi simulate);

Planul de dezvoltare a carierei este bazat pe capacitatea dovedită de conducere a activităţii de cercetare de înalt nivel ştiinţific, pe calităţile dovedite în activitatea de educare la nivel academic şi pe capacitatea de iniţiere şi coordonare a colaborărilor internaţionale în domeniul utilizarii calculatoarelor in mediul economic.

Sistemul de educare şi cercetare în curs de implementare, pe baza granturilor nationale şi internaţionale ale autorului asigură platformă ideală pentru pregătire şi educare la nivel de licenţă, masterat şi doctorat într-un subiect cu potenţial multidisciplinar aproape unic, implicând ingineria calculatoarelor si domeniul economic. Stabilirea unor mecanisme de colaborare durabile cu parteneri naţionali şi internaţionali ramane o prioritate, iar rezultatele obţinute vor fi valorificate în comunitatea ştiintifică, dar vor fi orientate şi înspre publicul interesat de subiectul cercetării.

În concluzie, bazat pe activitatea desfăşurată până în prezent la nivel naţional şi internaţional şi având în vedere planul care se intenţionează să fie implementat; se estimează că rezultatele pot fi semnificativ îmbunătăţite prin lărgirea colectivului de cercetare cu doctoranzi, coordonaţi ca urmare a abilitarii pe baza acestei teze.

SECTION I

SCIENTIFIC, PROFESSIONAL AND ACADEMIC ACHIEVEMENTS

II. PREPARATION, PREMISES, ACKNOWLEDGEMENTS

2.1 Acknowledgements

Now, after the paper is finished, my first word of gratitude is for the professors from the Politehnica and the West University of Timisoara, where I have completed my education as a student, Ph. D. candidate, and later on as researcher and professor. I give my thanks to all of those who, directly or indirectly, for personal interest or not, have contributed to this paper. Unfortunately, as the space is limited, I could not include their names and contribution here.

Also, my thanks to the members of the certification committee, who have, with great competence and professional attention, assessed the present thesis.

Not in the last, I am also grateful for the help given by the members of my young team from the Ioan Slavici Foundation and University, a real family who has contributed greatly to the achievements exposed within the paper, especially with project implementation (of projects presented in chapter IV).

2.2 Interference of areas, and the author's background. Premises

The existence of this certification paper was possible mostly due the extraordinary development of IT, creating unlimited opportunities for industrial engineering and management sectors applications. In this manner the premises for best use of my background's training were created by the interference of industrial engineering and applied informatics on one side, and the economic sector, on the other side.

My multidisciplinary background (engineering and inside computers aplied in industrial engineering and economic and inside management and finance) allowed the formulation of this paper in the framework of various fields' interference and also permitted the integration of my academic and professional expertise, not only the scientific one; in this respect I encouraged the build-up of research and teaching teams, of new entities like technological and industrial parks, industrial parks, spin – off companies.

In accordance with European and national stipulations and tradition, a certification thesis must emphasize the scientific, professional and academic achievements, on thematic disciplinary and multidisciplinary directions, which cannot be assimilated as a new PhD thesis or a continuation of the existing ones, and must present the candidate's personal evolution on a large scale of capacities and availabilities, being thus not reduced to the scientific achievements. It is hard to be framed within scientific, professional or academic achievements.

2.3 The specifics of new artificial intelligence paradigms and their application in the industrial engineering sector

The artificial intelligence, as a branch of informatics, has consecrated its own concepts and brought new approaches to others, by making their understanding more suitable to the purpose of the scientific field.

The artificial intelligence (AI) can be regarded as the branch of informatics focused on projecting systems endowed with certain properties that are usually associated with human intelligence: language recognition, learning, reasoning, problems solving, and theorems demonstration.

One of the common features of all the AI methods is their real potential to be implemented by using programming languages and the mandatory character of this implementation; in most cases, in the absence of adequate software, these methods cannot be positively used for solving real applications.

By monitoring the latest developments in industial engineering sciences it can be noticed the introduction of a solid axiomatic support, the growing accuracy and use of mathematics; however there is still a discrepancy between theories and mathematic models and the economic practice, which often, due to inertia, tradition and conservatism is rejecting them; it remains to be seen if the evolution of the two sides will be convergent, parallel, or in the worst scenario, divergent.

There are several reason that could explain why the economic theories have not been successfully implemented within classic economic reality, the new AI paradigms being more suitable to their specific:

- the mathematical model of the process is unknown, has a great complexity associated to an insufficient accuracy, and in some cases it cannot be determined; the industrial engineering processes have not an exclusively determining character;
- the available data are in some cases incomplete, affected by noise and disruptive signals (the noise notion can be extrapolated from the technical field to other categories of industrial engineering processes, genetics);
- there are some restrictions applied to the system that need to be simultaneously optimized;
- the theories are formulated in terms of classic mathematics, having two logical variables (Boolean) and the afferent classic theory; this is not applicable for industrial engineering due to the fact that human reasoning and decision making is based upon a relative incertitude, specific to the human language, the classic mathematics being not able to express this degree of incertitude; there is also a human preference for complex choices that cannot be quantified using classic methods;
- the complexity of the existing models that are trying to present the overall industrial engineering status is under an extraordinary expansion, claiming more and more sophisticated models; the simplification demand emerges naturally but comprises the risk of diminishing the purposes accuracy; the mix up of precision, incertitude and relevance has to be produced and followed; however in many cases, industrial engineering decisions and predictions operate with linguistic terms like: “the oil price will not substantially increase in the near future”; this type of predictions are determined by the common sense, using industrial engineering knowledge and information relevance, which is often presented in terms having linguistic tones

All this consideration allow the usage of artificial inteligence methods in new fields of industrial engineering.

III. SCIENTIFIC ACHIVMENTS IN THE FIELD OF INDUSTRIAL ENGINEERING PROCESSES OPTIMIZATION. USING OF ARTIFICIAL INTELIGENTS METHODS

3.1. Contributions to the optimization of the manufacturing processes through electrical erosion

3.1.1 Case study: making the numerical control of a electrical erosion machine with wire electrode. Hardware structures [60], [61], [69]

3.1.1.1 Hardware structures for commanding the electrical erosion machines with wire electrodes, using IBM-PC compatible computers. Preliminary considerations [60] , [61], [69]

The purpose of this paragraph is to detailate the hardware architecture of the interface between the electrical erosion machine of type ELEROFIL 10CNC and a PC with minimal hardware requests. The prototype was realised in the laboratories of the Technology Department of the Politehnica University of Timisoara, being industrially implemented afterwards through contracts with UAMT Oradea and IPS Pitesti.

In order to transmit data between the computer and the machine, a parallel LPT interface was utilised: the usage of different pins (respectively bits from different registries) will be analysed in the following according to the two cases of numerical command utilised:

I – first case, in which the power converters used for the two step-by-step engines (MPP) corresponding to the two axes x and y are directly commanded; in this case there are necessary only four bits for commanding these converters;

II – second case, in which the built-in command of MPP is used: computer commands two EPROM memories, which in turn address conveniently the power amplifiers; in this situation there are necessary 8 bits for addressing the EPROM, namely 4 for each axis.

3.1.1.2 Principle of block diagram

In Figure 3.1.1-1 the block diagram of the interface between the technological equipment and the computer is presented, for the first case; one can distinguish the following input/output channels of information traffic:

3.1.1.3 Signals utilised for the interface

A first category of information is circulated through the computer's LPT parallel interface:

- 2 lines of 2 bits each (tact and sense) to command the power converters attached to the 2 axes;

- 1 bit for reading the fault signal, which includes (logical sum) the failure of multiple conditions necessary for the progress of the technological process: wire break, limit reach, loss of properties of the dielectric liquid, etc.

One should remark that inside the manual command module, the same bit is used for receiving the null impulses, utilized in centering operations.

- 1 bit for command (start/stop) of the erosion generator, strictly following the program progress (there exist strict moments in which the generator must be stopped, i.e. a failure);

- 1 bit for monitoring the eventual appearance of a short;

- 4 bits read through the manual input stand, representing manual displacements commands for each axis (x+, x-, y+, y-), in the event that the command is issued through the input stand of the machine; (these 4 bits are utilized only when the manual displacements are generated through computer, also being designed the situation in which these displacements are generated through an oscillator);

A second category of information is circulated through the development board, which contains three reversible counters on 32 bits (this board, together with the specialized circuits make object to another work); the usage of the channels (counters) is as following:

- first two channels (counters) are utilized for taking the information from the two numeric linear incremental transducers, afferent to the two axes x and y; each of these two transducers generate two offset impulse sequences A and B; the precedence between A and B establish the increment, respectively decrement of the counter, thus resulting the sense of displacement on the respective axis;

- the third channel (counter) takes the impulse sequence from the generator; its contents is read (by a software) periodically, the existence of a difference between two successive reads representing, thus, the condition of continuing the advance movement (the factual continuing of technological process);

In order to take the signals A and B (rectangular impulse sequences offset at 90 degrees depending on the sense of displacement) from the position transducers, two counter circuits LS 7166 were used, and a third one was used in order to count the impulses from the generator. The base circuit used for interfacing the transducers with the computer is the counter circuit LS 7166.

The circuit LS 7166 is a quadrature counter on 24 bits built by CMOS technology, which could be programmed to work in multiple modes (increasing, decreasing, binary, BCD code, clock, one cycle).

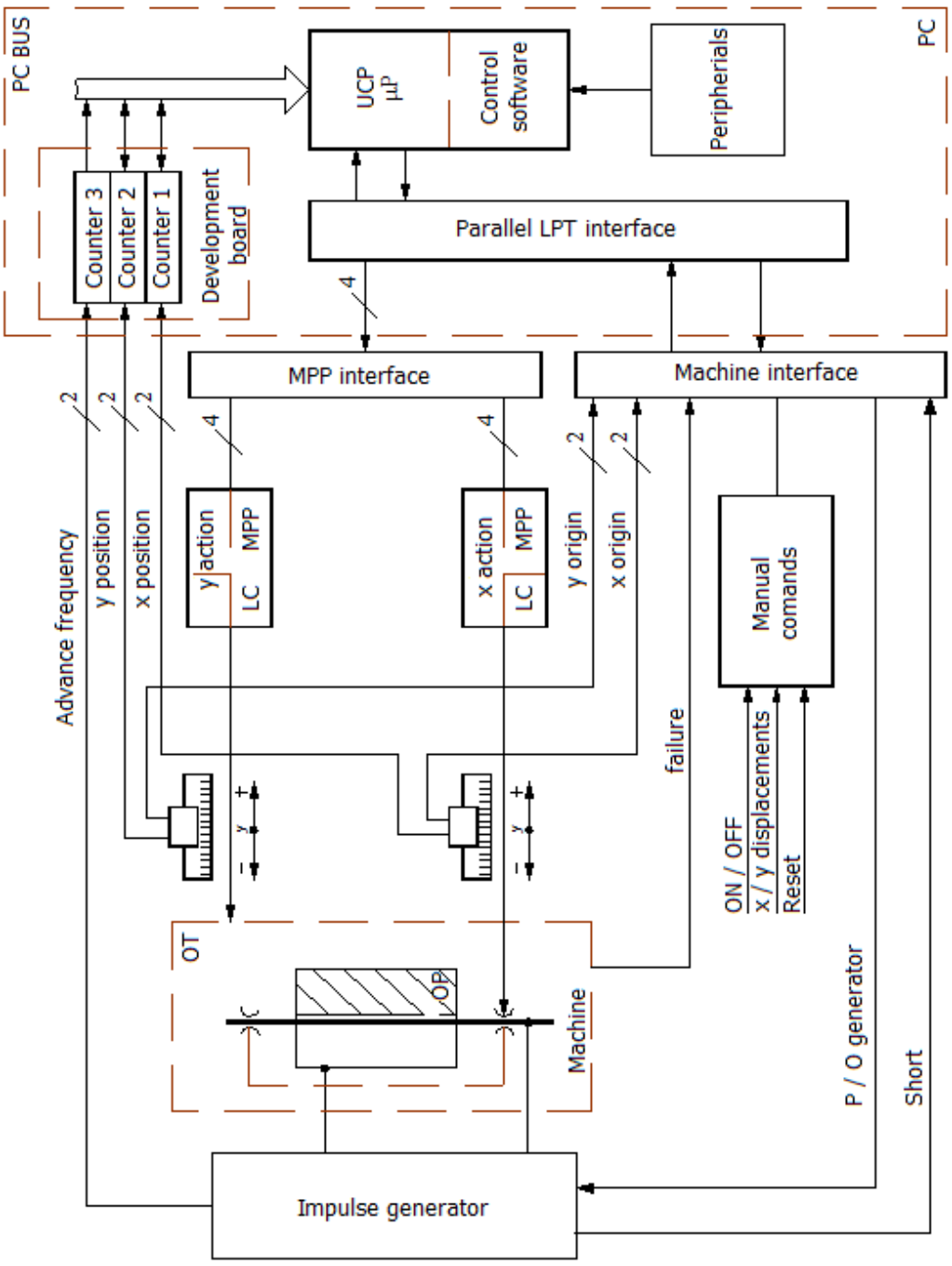

Figure 3.1.1-1 Block diagram for interface between technological equipment and computer

On the development board (*Figure 3.1.1-1*) are three counter circuits of the type LS 7166; two afferent to the two transducers (one for the x-axis and the other for the y-axis) and one that counts the impulses coming from the generator. Also, there exist 3 address-decoder circuits (one decoder for each counter) and three optical couplers with protection role.

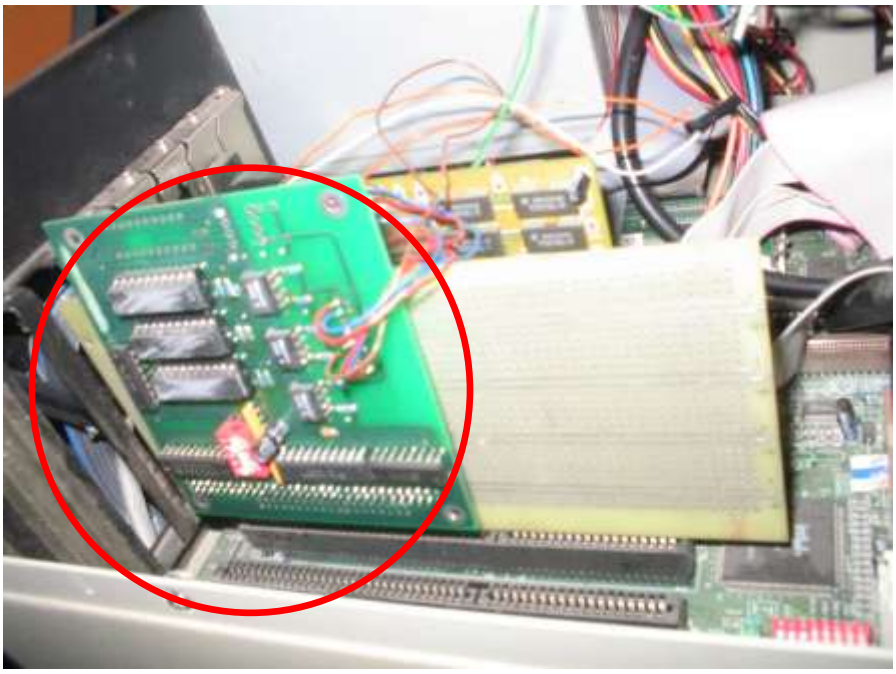

Figure 3.1.1-2 Development board

3.1.1.4 Preliminary conclusions

The realization in a first phase of the prototype of the machine in the laboratories of the Mechanical Technology Department at the Faculty of Mechanics at UPT Timisoara and then implementing it at different industrial societies lead to multiple advantages of the proposed solution:

- by using IBM-PC compatible computers was created the facility of access to all the domain-specific softwares (KATIA, SOLIDWORKS, AUTOCAD, MASTERCAM....) and also to the peripheral equipment specific to them;

- the cost is very low, besides the actual computer being necessary only one development board, with an approximate price of 300 $;

- the reliability of the command equipment is given by the reliability of the IBM-PC computer which, as it is known, has reached exceptional standards.

3.1.2 The architecture of the programs utilized to the automate control of the machine

3.1.2.1 The algorithm of adaptive command of advance

In the case of processing by erosion with wire electrode, the adaptive command of advance present an exceptional importance in conditioning and continuing the very principal process of manufacture, and also determines the productivity of the manufacture and the precision of the surfaces; depending on the type of the utilized generator, the information on the gap state is taken and processed in different ways, thus determining and conditioning the further execution of the advance movement.

Concerning our studies, GEP generators were used, for which the advance conditioning is given by the presence of an impulse sequence emitted by the generator; the frequency of the impulses is a measure for the scale of the possible advance, practically the generator incorporating a tension-frequency converter.

a) the advance movement

Within the elaborated algorithm, the impulse sequence generated by the generator hits the input of a counter; the state of this counter is periodically read in the program with C instructions of the type: [1]

new= inport (BASE_ADDRESS+displacement);

in which the base address is the address seen by the computer for the board containing the counter, and the displacement is the address of the registry composing the counter.

This integer value is compared to the value of the last read and the further execution of the advance is permitted only if the difference between new and old exist, through an instruction of the type:

if (new != old)

{perform the advance movement}

By examining the above relation, it is evident that in the absence of the impulses from the generator it cannot further exist the advance movement, thus entering in a wait loop while continuously testing the state of the counter.

Further, we analyze distinctly the two considered situations for MPP command:

I. direct command of the power converters

In this situation, the half byte utilized for the converter command has the following componence:

- bit 0(4) - sx=x-axis advance, equal to 1 for the positive direction and 0 for negative direction;
- bit 1(5) - sy=y-axis advance, with the same encoding;
- bit 2(6) - tx=x-axis tact, the value 1 representing a level of logical 1 and 0 a level of logical 0;
- bit 3(7) - ty=y-axis tact, with the same encoding;

Following this encoding, for instance the displacement on y+ axis implies the following succession of half bytes sent to the converter:

```
outport ( o | 0x60 & 0x7f);
push1  (o & 0xdf);
outport (0 & 0xdf);
outport ( o | 0x60 & 0x7f);
push1  (o & 0xdf);
outport (0 & 0xdf)
.....
```

The current value of the byte was denoted by “o”, thus noticing the existence of some bit-level logical operations before the transmission of the data to the converter in order to set only the specific bits and not affect the other bits. Thus, on the first outport, two phases were utilized:

- logical or with 0x60 = 0110 0000 with effect of setting sy=1, signifying the selection of + direction on y and also tx=1 with the role of inhibiting an eventual unwanted tact on the x-axis;

- second phase, corresponding to a logical and with 0x7f=0111 1111, with the effect of forcing ty=0 corresponding to the first front corresponding to a tact;

The second instruction is push1 (o & 0xdf), thus pushing in a stack 1 (this will be justified in the next paragraph, where the recoveries from shorts will be treated) the current byte after performing the logical and with 0xdf= 1101 1111.

II – EPROM memories command

b) withdrawal in the case of a short

The presence of a short is detected through the interrogation of a bit (i.e., a pooling), bit which is component of one of the component registries of the parallel LPT interface of the computer; the cycle of withdrawal from the short has thus the following encoding in C source code:

```
while (short !=)0
{
short = (( inport(0x379) & 0x80)
    performing the advance
    .....
    }
```

The maximum importance problem which arises in the case of withdrawal from a short is that the withdrawal trajectory to be identical to the one generated in the case of the precedent advance movement; from the utilized solutions we opted finally to save in a stack the codes for all the steps effected in the advance movement; in the following, the two considered situations are distinctly analyzed:

I. direct command of power converters

The succession of instructions in this situation is the following:

f2=pop1(); extraction from the stack created at the advance movement, followed by transmitting the byte to the power converter;

outport(adr,f2);

push2(f2^0x30); save in a second stack of the transmitted byte, by complementing the bits corresponding to sx and sy; this was realized by applying the function or-only and using the mask 0x30=0011 0000, the bits 4,5 being complemented and the rest of the bits remaining unchanged;

f2=pop1(); the second group of instructions corresponding to the second front composing a tact follow

outport(adr,f2);

push2(f2^0x30);

II – EPROM memories command

c) withdraw movement in special situations

At this point is discussed the frail situation in which the withdrawal following a short has generated the unwanted situation of returning to the precedent phase; in the case of many traditional numerical command equipment, the occurrence of a short while passing from a phase to another leads in many situations to intolerable errors. This case is detected by the program through the presence of a negative value for the global index i1p; the algorithm is as following:

while (i1p<0) {

f2=pop2();

outport(adr, f2); extract from the stack created at the displacement in case of short and send to the converter in the case of the first component front of the tact;

f2=pop2();

outport(adr,f2);

.....

}

3.1.2.2 Utilization variants

Because of the industrial usage reasons, three working possibilities were imposed:

- proper processing – in which the elements of execution are commanded, the advance being established in an adaptive manner, in function of the progress of the process;

- drawing – in which case the command is realized with a constant advance; it is utilized for the verification in machine command mode;

- verification – situation in which the machine is not effectively commanded, but only the drawing on the computer’s display.

From a software point of view, the difference between the three variants is realized by using some integer variable as follows:

- time variable, which has value 0 for drawing and visualizing and a positive integer value for proper processing; it is determined correlated with the hardware structure of the advance block specific to the generator;

- variable syncro, equal to 0 in the case of a proper processing and equal to 1 in the other situations; it appears in the instruction

new = old + syncro;

in which new and old are the actual and previous content of the registry counter of impulses received from the generator;

- variable short equal to 0 in the case of drawing and visualizing in order to eliminate theoretically the possibility of short occurrence, obviously in the case of processing a pooling being performed on a special bit.

3.1.2.3 Algorithms for trajectory correction

It is obvious that because of the work in the closed position loop there appears the problem of performing the position tuning accordingly to the specific laws of automate tuning by comparing the prescribed position (w) with the real one (the reaction r); the problem fits in the general theory of automate tuning systems, the system we present being included in the category of numerical automate tune systems (NATS);

According to the NATS theory, one must determine two elements specific to the numerical tuning:

a) the tuning law – following the theoretical study, but also the experimental trials (described in the following paragraphs) we opted for a nonlinear law of the tripositional type (*Figure 3.1.2-1*). This law ensures a variation of the deviation between two limits amin and amax imposed by dimensional precision reasons. Materializing the above exposed, we present in *Figure 3.1.2-2* the nominal trajectory denoted by the points A_1,A_2, ...A_5 and the effective one denoted by the points B_1,B_2,...B_5...; the pairs of points A_k,B_k correspond each to a sampling, respectively a reading of the position transductor; in each situation are computed the differences

delta x = xnominal -x efectiv and

delta y = ynominal - yefectiv;

In the situation in which delta x or delta y is greater or equal to an allowed value, the correction of the trajectory is performed by interrupting the interpolation algorithm and executing a correction segment. In *Figure 3.1.2-2* two situations were presented:

- in the case of the position A_2, adeltax2,y2<allowed value and even if there exists a trajectory error it is estimated that it fits the tolerance zone and no correction is performed;

- in the case of position A_5, $\Delta x5$ or $\Delta y5$ are greater than the allowed error and thus the trajectory correction will be manifested through the execution of segment $A_5A'_5$ of restoring the nominal trajectory, the position A'_5 being to the limit identical to the position B_5, but in reality the correction segment $A_5A'_5$ is accompanied by errors.

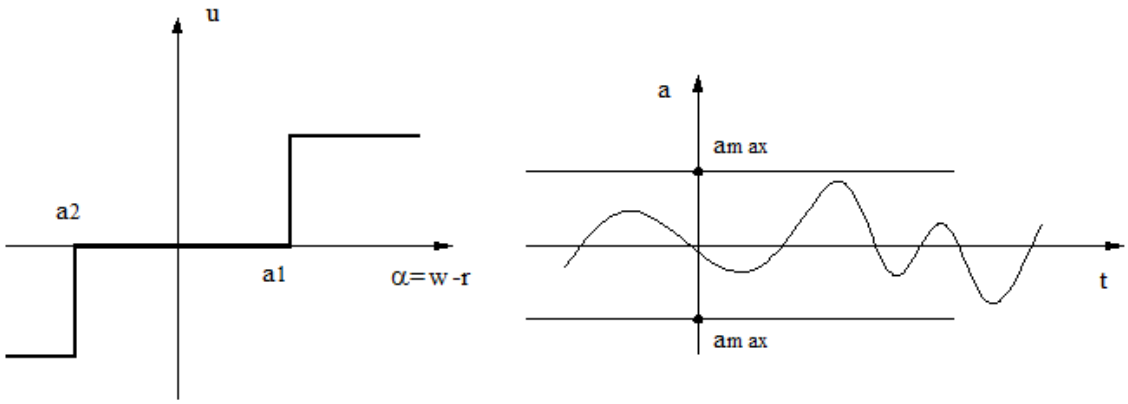

Figure 3.1.2-1 The tuning law

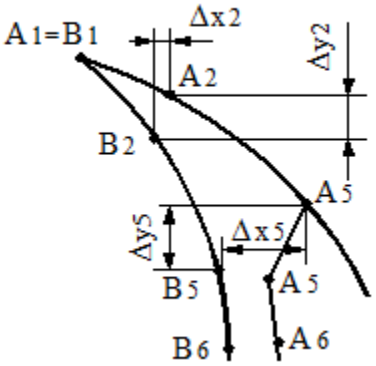

Figure 3.1.2-2 Nominal trajectory

In the elaborated program, the correction segment is treated as any segment which generates a linear interpolation, being possible the three technological working phases analyzed above, namely: advance movement (a), withdrawal from short (b) and recovering after short in special cases (c). During the experimental work performed, different values of the maximum allowed value were tested in the domain of 0.004 - 0.012 mm; a value too small of the allowed error leads to a more frequent execution of the correction segment and thus generates an instability of the process.

b) sampling time – is a very important characteristic of the numerical tuning systems, in this context of position tuning having a great importance; a compromise between productivity and processing precision must be imposed, a sampling time which is too small generating a good precision but decreasing the productivity due to the presence of too many correction segments; inside the elaborated programs the sampling time has not an absolute value, but it is reported as a multiple of the number of performed theoretical steps; there were experimented values of te in the domain (100,300) times the elementary (theoretical) step time; in *Figure 3.1.2-3* is presented the situation of a circular interpolation, the measure for the sampling time being converted in the amplitude of the angle $\Delta\alpha$ on which the converter reading is performed.

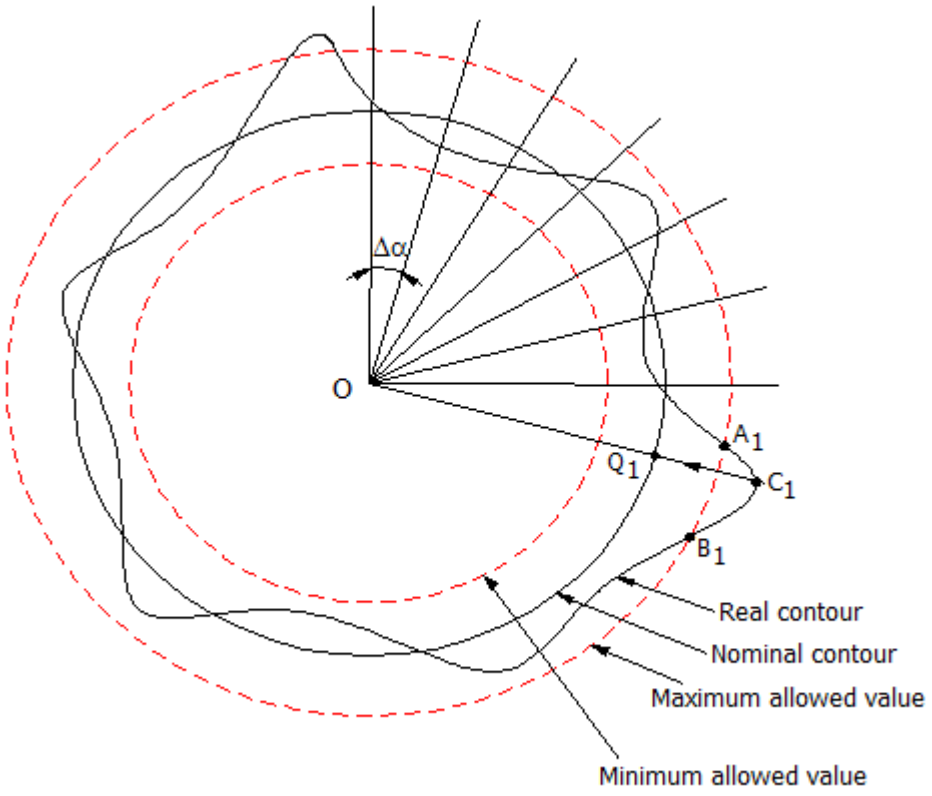

Figure 3.1.2-3 Circular interpolation

One should remark that in the final phase of research a more performing correction algorithm for the trajectory was elaborated. This algorithm is presented in *figure 3.1.2-4*; thus, in the case of a linear interpolation a realization of the segment defined by the points $P_{in}P_{fin}$; according to the established sampling time the first read of the position converters is made, thus finding the position of the point P_1; regardless of its position error, there will not be executed a correction segment, but the interpolator aims to execute the segment P_1P_{fin}; similarly, at the next reads the interpolator aims to execute the segments P_2P_{fin}, P_3P_{fin} even if practically the following segments will be executed:

$$P_{in}P_1,\ P_1P_2,\ P_2P_3,\quad ,\ P_{n-1}\,P_{fin}.$$

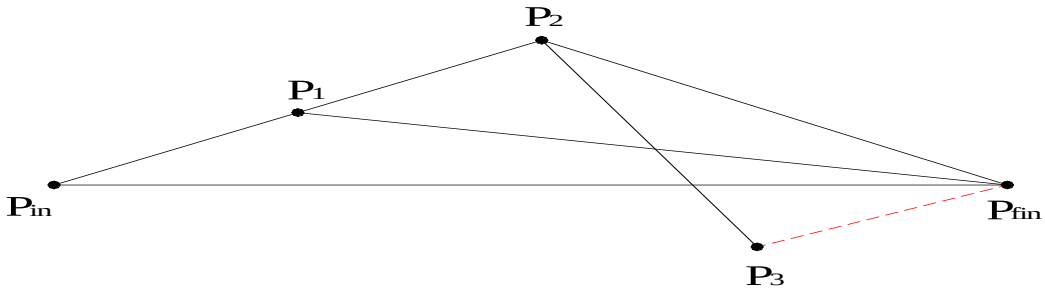

Figure 3.1.2-4 Trajectory correction algorithm

3.1.2.4 Management of the nominal position (usage of position stacks)

A problem of maximum importance in the management of the position precision is the correct management of the theoretical position, prescribed in generating a trajectory; the problem described here is totally different than the problem of trajectory correction by exploiting the information received from the converters, regarding practically the correctness of commanding in open loop.

The difficulty of the problem consist in the coexistence of the three types of movements: proper processing (a), withdrawal from short (b) and recovery after short in the case i1p<0;

In order to solve this problem, a number of four position stacks were created (two for each axis x and y), which are managed in parallel with the stacks which memorize the codes transmitted through the power converters utilized for the MPP command.

a) proper processing

In this situation, in stacks 3 and 5 (*figure 3.1.2-5*) are saved the values prescribed for the x and y axes, expanding the respective stacks; the two stacks are of a circular type, i.e. after saving in the stack a certain number of positions (for instance 1000), the new positions are saved over the old ones, evidently losing the old information. Simultaneously it takes place the increment of the theoretical counter i1p++ which supervises the theoretical generation of the trajectory.

b) withdrawal from short

According to the figure, is realized an extraction from the stacks 3 and 4 created at point a), in the meantime as executing the corresponding steps and decrementing the global counter i1p--; new steps performed are saved in a second pair of stacks 5 and 6 which will be exploited at point c);

c) recovery after the short

Simultaneously to the increment of i1p++, it is realizes the extraction of the values of the positions from the pair of stacks 5 and 6, created in the case of occurrence of a short.

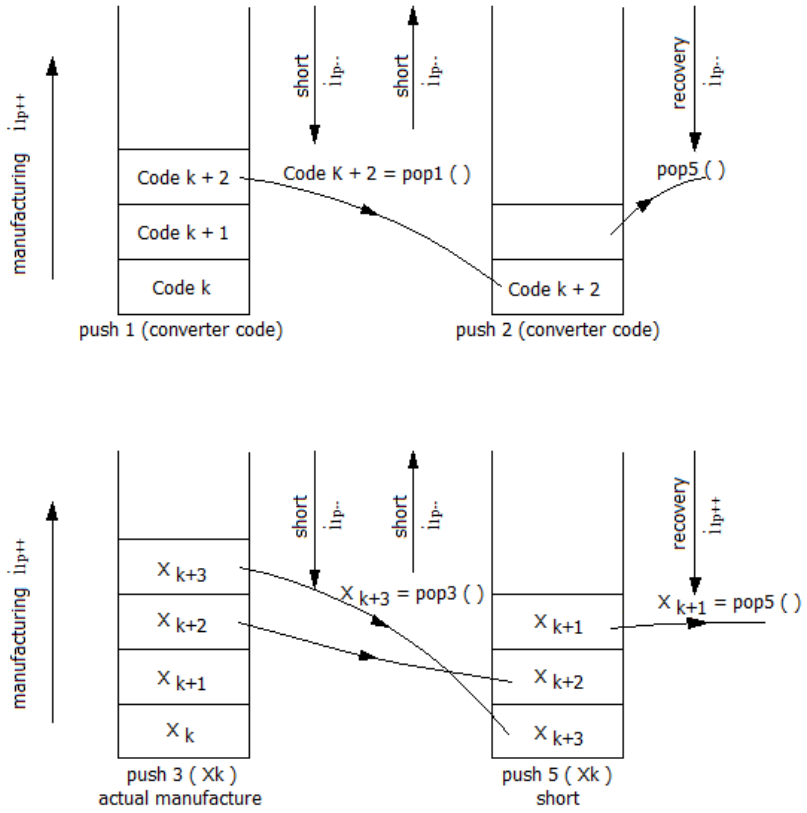

Figure 3.1.2-5 Stack

3.1.3 Particular aspects of modern automation of electrical erosion machine with wire electrode using expert systems [46], [47], [73]

3.1.3.1. Introduction

In general, the modern automation is based on digital information technology. For automation to be successful in a modern system, it must be connected to a multiplicity of devices and information sources and destinations. [71]

Electrical discharge machining is a machining method primarily used for hard metals or those that would be very difficult to machine with traditional techniques. EDM typically works with materials that are electrically conductive. In *wire electrical discharge machining* (WEDM), also known as *wire-cut EDM* and *wire cutting*, a thin single-strand metal wire, usually brass, is fed through the workpiece, submerged in a tank of dielectric fluid, typically deionized water.

For modern automation of electrical erosion machine with wire electrode it can use also an expert system.

In this paper is proposed some aspects for to use a specific method based on artificial intelligence in mechanical engineering, in which the results can be optimal and better than traditional methods.

3.1.3.2 Using controlled pulse generator at processing

The necessity to increase the processing productivity quickens the development of controlled pulse generators with pulse's characteristics suitable for the processing processes through power erosion with wire electrode [39]. The evolution of static contactors, particularly those made with MOSFET transistors had enabled the implementation of some controlled pulse generators with short durations current impulse, hundreds of nanoseconds, with amplitudes of 100 ... 200 A and growth and falling fronts tens of nanoseconds. In recent years there were built controlled generators with complex shapes of the current pulse, with large filling coefficients, with repetition fervencies fi = 200 ... 400 kHz, which allowed the achievement of some substantial increases in productivity, up to aprox. 500 mm2/min.

A characteristic problem of processing through power erosion with electrode wire derive from water use, respectively from aqueous solutions/emulsions, which have a residual conductivity γ [μS], actively controlled. As a result, the erosion effect with electric spark is accompanied by slight electrochemical erosion, due to the medium component different from zero of the voltage pulse, respective current, which is applied on the clearance. This situation, which may harm the quality of the piece area, can be avoided (or at least greatly reduce) by applying an average voltage, equal to zero, on the clearance.

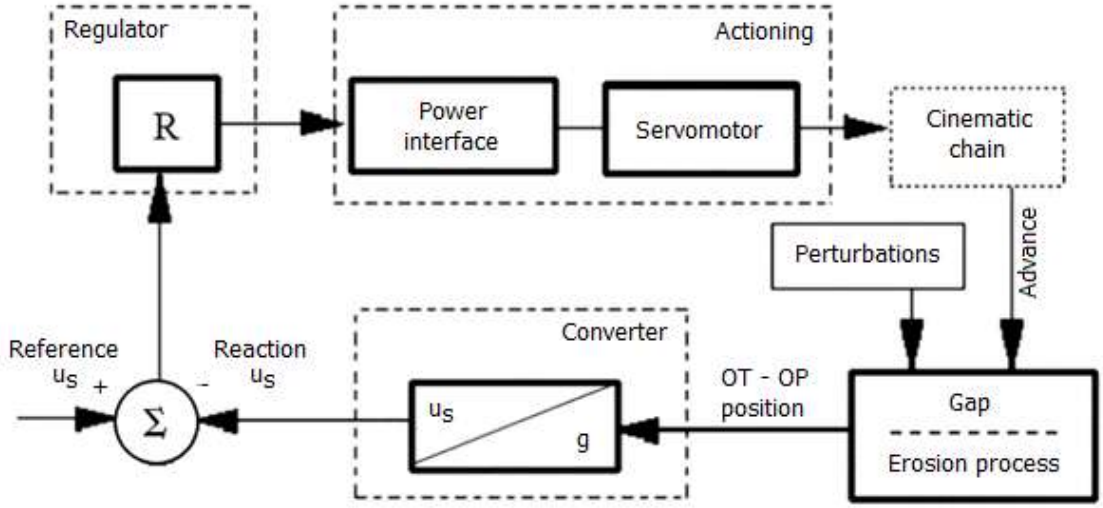

Figure 3.1.3-1 Block diagram of the SRA

3.1.3.3. Expert system development environment

Expert systems are used to reach a conclusion, a solution or a recommendation. EXSYS CORVID uses for these conclusions/recommendations term GOALS (alternative-purposes). The execution rules for obtaining conclusions/recommendations are necessary responses to be taken from users through specialized interfaces or interfaces with other external programs. This knowledge of the system are stored and subsequently evaluated by the rules. If permission from the IF of a rule is true knowledge will enable spare part for THEN, otherwise knowledge will enable parts of the ELSE. If the ELSE part will stick to cold the next rule in the decision tree. EXSYS CORVID uses two types of facts (pieces of knowledge) Questions and Variables.

It aim to create a prototype expert system to decide how to set the parameters of cutting machine, the prototype will be called CUTTING given the subject matter knowledge base. From this point it can proceed to create a new knowledge base or the consultation or updating existing ones. After a good experience and respecting general principles of product design information available it recommend that the analysis problem resolved to undertake knowledge that the following parts: goals, questions and specific variables EXSYS CORVID generator. The analysis and summary of the field for the task its are the following pieces of knowledge:

Goals:

1. generator

2. speed wireless

3. Advanced

4. Offset

Questions:

1 What type of material you wish to debit?

2 What is the thickness of the material?

3 How is desired processing time?

4 What is the level of roughness that you want to achieve?

To solve this problem using several types of variables (Fig.3.1.3-2):

1 station list (list from which you can choose the appropriate option): Tip_material, Grosi-me_Material, Timp_procesare, roughness;

2 Continuous - Numeric value (numeric values): Generator, Viteza_Fir, advance offset;

3 Collection (variable type list where you can add strings): Report;

4 Confidence (variable expressing confi-dence) index.

Building Block Logical rules requires activation page that allows it to add, modify, delete and move rule. Following activation of a corresponding button on this page, depending on where it want to introduce the rule, it get a mock takeover of parts of knowledge in the IF-THEN components. The screen shown in Fig.3.1.3-3 work. As can be seen in Fig.3.1.3-3 is required to complete the IF and the THEN. This window has several areas:

- An area of selection and editing logical block name;

- A text editing toolbar common commands (Copy, Cut, Paste, etc.).

- Editing the rules;

- Buttons for entering the IF-THEN compo-nents, namely to pursue a written rules.

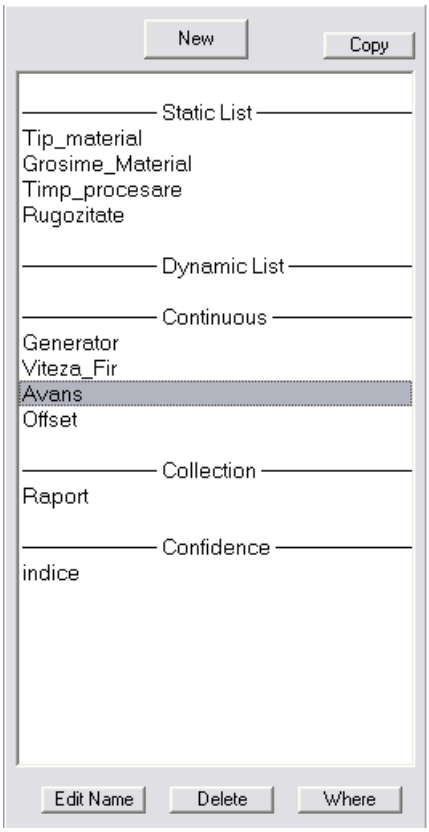

Fig.3.1.3-2. List of variables used.

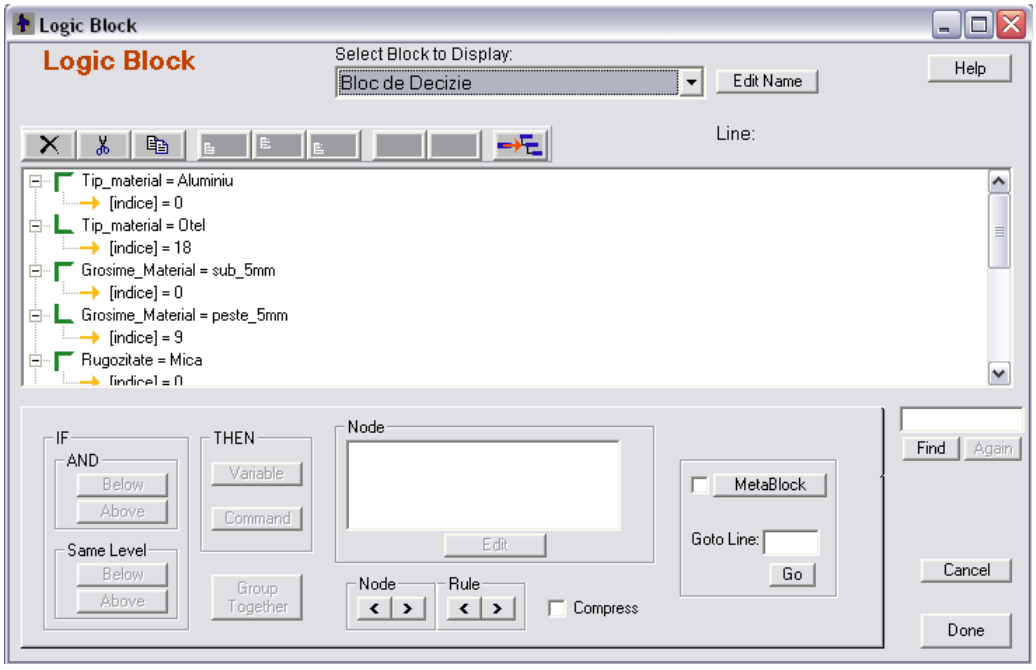

Fig.3.1.3-3. Input window of the rules

In the category of premises can have pieces of knowledge in the form of questions, variables, goals (in case one want to test the level reached certainty factors). The same

components are found in category conclusions, stating that the goals are followed by an assignment of a value of certainty factor as one of the following specified parameters in the control panel.

Building block execution is achieved by creating a control block. Thus, Fig.3.1.3-4 presents a control block called "block execution."

Fig.3.1.3-4. Control block called "block execution".

Within this block is going on all processes that need to be executed.

After completing the above steps to generate a file type *.html*, which contains an expert system. To run it is necessary to use an Internet access program. When starting the program a window will appear (Fig.3.1.3-5) expert system that contains the title.

Fig.3.1.3-5. Window title contains expert system.

3.1.3.4. Conclusions

One of the most important properties of the developed expert system is that it can generate the report with recommendations in a file type .Txt, .Csv or .Pdf. If the computer running the expert system is a database, it can be set to generate results directly in the database.

Thus for each processing type it will be possible to use the expert system to make the best decision regarding the setting of pulse generator.

Notations

PCB – Printed Circuits board

EDM – Electrical Discharge Machining

WEDM – Wire cut Electrical discharge Machining

IC – Integrated circuit

3.1.4 Modern structure in electrical erosion processing control [48]

3.1.4.1. Introduction

Electrical Discharging Machining (**EDM**) has become an indispensable process in modern manufacturing industry because of its ability to produce complex shapes with high degree of accuracy in difficult-to-cut materials. With the developments in Computer Numerical Control (**CNC**), the versatility of EDM has reached tremendous heights.

3.1.4.2. The paper

The movement of the wire is computer controlled in two axis (and sometimes more). This is exactly like any other CNC controlled process but in CNC EDM the shape is generated independently by guiding the wire. In the case of complicated shapes requiring cuts or angled, conical, or other unusual surfaces, the upper and lower wire guide systems carry out differing movements accordingly.

The workpiece and the wire represent positive and negative terminals in a DC electrical circuit, and are always separated by a controlled gap, constantly maintained by the machine. This gap must always be filled with a dielectric fluid, in this case deionized water, which acts as an insulator and cooling agent. Of equal importance, it flushes away the eroded particles from the work zone.

Sparks are formed through a sequence of rapid electrical pulses, generated by the machine's power supply thousands of times per second. We identify two phases:

- first, when the current enters into the workpiece and the wire (Ton), and each spark forms an ionization channel under extremely high heat and pressure, in which particles flow between the wire electrode and the workpiece, resulting in vaporization of localized sections;

- the second phase (Toff) when machine's power supply is "off" and the vaporized metallic debris created by this process, from both the workpiece and wire material, is subsequently quenched and flushed away by the flow of dielectric fluid through the gap. As the machine advances the wire through the workpiece, it cuts a slot slightly larger than the wire diameter. Since the wire is also eroded and used up in this process, the machine constantly feeds new wire into the cut as "fresh" electrode material.

The two phases are short lasting. Meanwhile, the CNC must have a very exact control of the wire (Figure 3.1.4-1). If the Ton time is too short the process has a low speed but the CNC can process a good algorithm with a very good precision.

If the Ton time is too big, the power supplied by the generators is big and the process has a good speed but the CNC algorithm's precision is low. In Toff phase the dielectric must irigate the distance between the workpiece and the wire and the CNC must check the positions of the wire and make the next command for the wire.

If Toff is too short the CNC can't do the verifications and it's possible to obtain dimensional and precision errors. If Toff is too big, the process has a low speed but the CNC can process a good algorithm with a very good precision. We want to create a system that can process different positions of the wire in a very short time and with a low price.

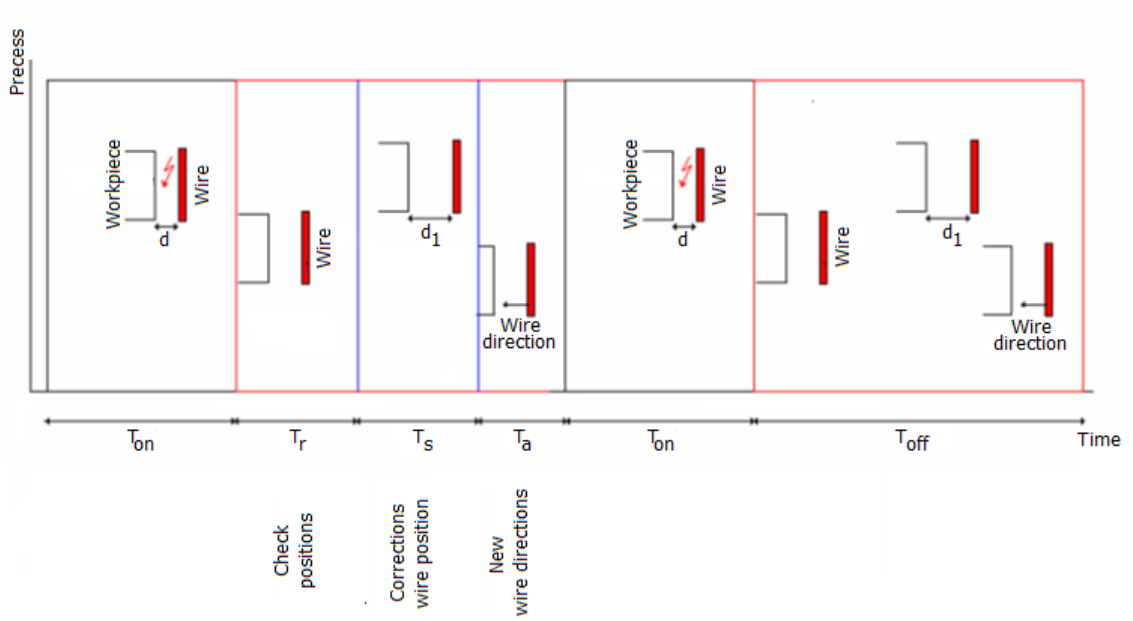

Fig. 3.1.4-1. Time of WEDM

We can use a personal computer to control the wire and the parallel port to generate the signal to the stepper motors for the individual axis. In this case we must increase the Toff time because the feed-back time between computer and machine is slow. If we increase the Toff time the productivity is low. Other solutions come from microcontrollers. The microcontroller has the same properties as a computer, with smaller dimensions and low cost.

The microcontroller is designed to be all in one. No other external components are needed for its application because all necessary peripherals are already built into it (memory, central processing unit, Bus, In/Out units, communications port with other devices, Timer/Counters, Converters, etc.)

All microcontrollers can be programmed for different applications.

For Wire cut Electrical Discharge Machining, a dedicated microcontroller with few functions who can do the Toff operations in a short time can control the wire.For this function, we decide to use microcontroller PIC16F8520.

PIC16F8520 is a high-performance RISC CPU with low power, industrial and extended temperature ranges. Characteristics: it can work up to 40 Mhz, has a clock input, four external interrupts pins, three 16 bits timer/counters, two addressable USART modules for communications, converters and more functions.

For wire controlling applications, we can connect the microcontroller in the system as shown in figure 3.1.4-2.

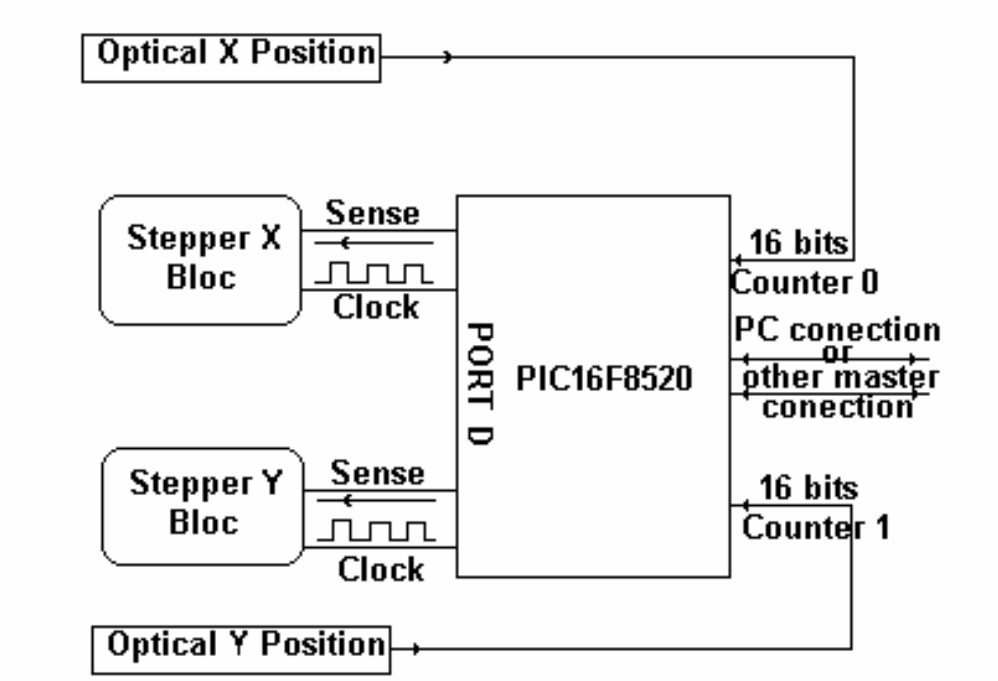

Fig. 3.1.4-2. Electrical schematics for control the wire cut erosion process with PIC microcontroller

In figure 3.1.4-2 we observe one of the electric schematics to control the wire cut erosion process with microcontroller PIC16F8520. The command for wire moving and coordinates comes from the master pc. The microcontroller makes the mathematical calculations for linear interpolations of circular interpolations and sends the command to the stepper motors bloc.

The real wire movement it's read by optical position devices and increases the counter 0 value for x-axis and counter 1 value for yaxis. When Toff time starts the microcontroller reads the value, makes mathematical calculations for new wire movements (with eventual corrections included) and commands the next step to the stepper motors bloc.

When Toff is finished, the wire is in a better position for the process and for the dimensional precision cut.

The program for WEDM applications is made using the logical schematics from figure 3.1.4-3.

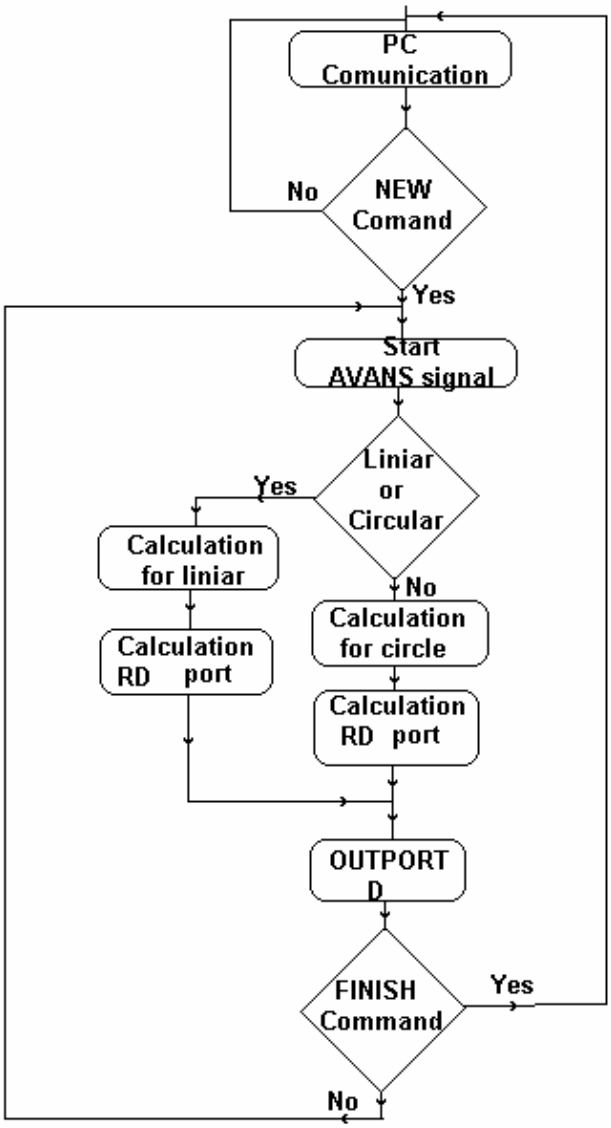

Fig. 3.1.4-3. Logical schematics for microcontroller program

In logical schematic for microcontroller program, it is easy to understand the step of the program and is easy to realise what can increase the production with a small precision or to increase the precision but with lowest productivity.

In function of the type of processing, it is possible to modify the program so that we can increase the precision, even to 0.001mm, but the Toff time will be very big and with low productivity.

With the same logical schematics, we can build an algorithm for big processing speed but with low precision. The times of mathematical calculations can be modified using deferent microcontroller frequency.

When we increase the microcontroller speed, it is possible to reduce the times of the process.

3.1.4.3. Conclusion

The times of Wire cut process are very important and in order to minimise this times we must use preferred equipment to control the wire.

There are two important times in the process: Ton when the generator sends the signal to produce sparks and than the sparks actually vaporize the metal. The sparks create a succession of craters in the workpiece.

The other phase is Toff time when between the workpiece and the wire there is 0V tension. In this phase, the deionised water must flush the processed zone for next sparks to occur.

Meanwhile, the CNC must have a very precise control of the wire and do the command for next wire movement.

If the Ton time is too short the process has a low speed and if the Ton time is too big the power from the generators is big and the process has a good speed but a CNC can't process a good algorithm for a very good /precision. Also, if Toff is too short, the CNC can't do the verifications and it's possible to obtain dimensional and precision errors of the piece but if Toff is too big the process has a low speed but the CNC can process a good algorithm at a very good precision.

The microcontroller PIC 16F8520 can do mathematical calculations for the next step of the process in a short time.

Therefore, when we use a microcontroller PIC 16F8520 for controlling wire in Wire cut Electrical Discharging Machining we can increase the productivity because we can minimize the Toff time.

The microcontroller is easy to programme and is easy to change the program to increase the production or the dimensional precision cutting.

3.2 Contributions to the manufacturing and measuring control using numerical techniques

3.2.1 Modern techniques for the use of computer assisted numerical control for the optimization of materials' processing [36], [60], [61], [69] [70], [72]

Below are concisely presented the algorithms optimized by the author and used in the implementation of numerical commands for the laser processing stand, EDM machine and other devices used by the author. The algorithms are part of the numerical command equipment realized by the author in the Timişoara's Polytechnic Institute - Mechanical Faculty's laboratories (including the wired EDM machine and the laser processing equipment), and later used in industrial settings (UAMT Oradea, Pitesti). This research is a continuation of the PhD thesis entitled „Contributions to the computer assisted design of MUCN for the processing of complex geometrical entities" (Timişoara, 1994). In a final stage, the research in the field was used for the creation of a Spin-off (SC Slavici Spin-off SRL) and the implementation of a EU financed project through the Increase of Competitiveness Operational Program.

Flexible and modular equipment for the numerical control of technological processes	POS-CCE	200.000 euro	Structural funds 2008/9	Priority axis 2 – Competitive-ness through research, technological development and innovation	DMI 2.3 – Facilitating the access of enterprises to research, development and innovation – The Ministry of Education and Research, second place in the country

3.2.1.1 General consideration

Due to high importance of interpolation algorithms used for obtaining precision of trajectories and locations, below are presented the algorithmic bases used for creating packets of software.

The following algorithms were considered:

- ADN type algorithms;
- Algorithms based on a calculated discriminant, according to the sign that leads to the approximation of the current point of the trajectory related to the real curve;
- The algorithm of the coordinates' difference, based on the impulses emitted on the two axes with a frequency established according to a certain rule;
- Algorithms with the direct calculated function using the octant method

Below is presented the algorithm based on a calculated discriminant, an algorithm that has been used with good results for the computer assisted control of devices and that was successively optimized by the author.

3.2.1.2 Linear interpolation calculus

The base of the algorithm is a properly calculated discriminant D, whose sign will determine the position of the current point of trajectory in relation with the nominal outline of the piece to be processed.

The basic scheme is presented in figure 3.2.1-1, in which were used the same notations as in the source software (in C) – see annexes.

x54, y54 – the coordinates of the starting point (for the linear interpolation);

x64, y64 – the coordinates of the final point (of the linear interpolation);

The angle coeficient of the line defined by the two points is:

inclination = arctg (=(y64-y54) / (x64 -x54);

An additional variable sm is defined with the following values:

1 – if the inclination <0, corresponding to an angle with values between (90, 180) grades;

-1 –if the inclination >=0, corresponding to an angle with values between [0, 90] grades;

A current point P is considered with the coordinates x20, y20, with the purpose of determining its position relative to the segment PinPfin; a new line segment PinP can be defined, with an angle coefficient m defined by:

m = arctg (= (y20 - y54)/(x20 -x54)

The linear interpolation method [50] requires the continue testing of the P point's position, and its correction stage by stage so that the point is brought back on the nominal Pin,Pfin segment; in the case of point P it is clear that the realignment is made through a dx segment parallel with the x axis; for comparison, we present on the same figure the case of a P' position, for which the realignment with the PinPfin segment is made through a dy segment, parallel with the y axis.

There is the problem of establishing an evaluation criteria for the necessity to make corrections on the x or y axis:

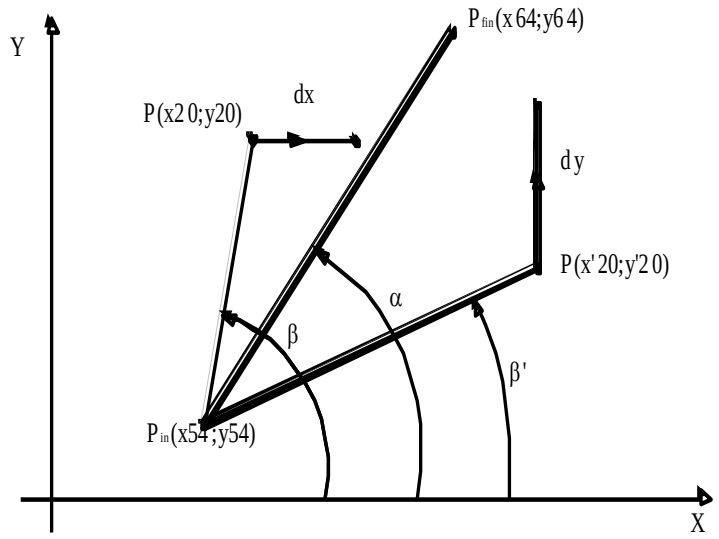

Fig 3.2.1-1 Linear interpolation

The following discriminant is defined:

delta= delta=sm((x64-x54)*(y20-y54)-(y64-y54)*(x20-x54));*

If *delta*>0 or the interpolation segment is parallel with the y axis it is recommended to make a step on y axis; in the opposite case it is recommended to make a step on the x axis.

Notice that the direction of movement is determined prior to the launching of the interpolation algorithms by setting some direction variables afferent to the two axes, as follows:

se1=1 for x54<x54 and -1 if not:

se2=1 for y54<y64 and -1 if not

3.2.1.3 Circular interpolation

The schematic diagram is presented in *Figure 3.2.1-2*

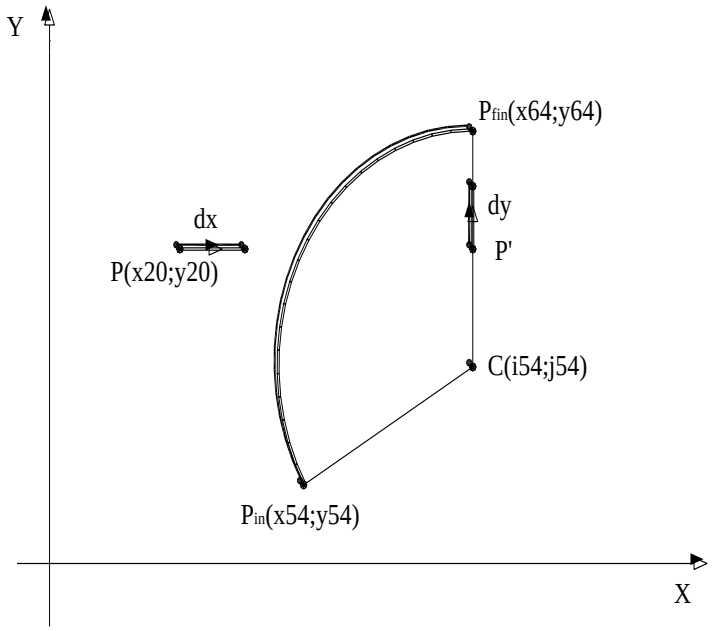

Fig 3.2.1-2 Circular interpolation

The problem is similar with linear interpolation, but in this situation a new criterion must be established to determine the condition for making a step on the x axis or y axis. The criterion to be used is the comparison of the distance from the studied point to the center of the circle with corresponding radius:

- In the case of point P, with the coordinates x20, y20, the distance Pc is larger than the radius of the circle, so that is necessary to make a correction dx parallel to the x axis;
- In the case of point P', its distance to point C of the circle is smaller than the radius, and in this situation is necessary to make a correction dy parallel with the y axis;

These calculations lead to the following expression for the delta discriminant:

delta=((x20-i54)(x20-i54)-(x54-i54)*(x54-i54)*

+(y20-j54)(y20-j54)-(y54-j54)*(y54-j54)) * cadran;*

The interpretation of the sign of the delta is identical to the situation of linear interpolation.

In the annex is listed the content of the C++ function that implements the interpolation algorithms described above.

3.2.2 Contribution to the integration of digital measurement data acquisition systems [36], [60], [61], [69] [70], [72]

Below are presented the acquisition systems realized by the author in the numerical control of the processes laboratories in the Politehnica Timişoara and the „Ioan Slavici" University Timişoara. It is to be remarked the integration of the system in the processing system, resulting a CAM (computer aided manufacturing) cell. From the integrated devices, it is presented below the integration of the digital micrometer; similarly has been realized the integration of the digital calipers and comparators.

This research is a continuation of the PhD thesis entitled „Contributions to the computer assisted design of MUCN for the processing of complex geometrical entities" (Timişoara, 1994). In a final stage, the research in the field was used for the creation of a Spin-off (SC Slavici Spin-off SRL) and the implementation of a EU financed project through the Increase of Competitiveness Operational Program

Flexible and modular equipment for the numerical control of technological processes	POS-CCE	200.000 euro	Structural funds 2008/9	Priority axis 2 – Competitiveness through research, technological development and innovation	DMI 2.3 – Facilitating the access of enterprises to research, development and innovation – The Ministry of Education and Research, second place in the country

3.2.2.1. Application's interface

Statistics indicate that over 80% of the testing, measurements and data collections are computer controlled. These automatic testing systems generally use a PC computer or a specialized computer with dedicated software for data acquisition. Both hardware and software are interdependent and equally important.

The best solution for the software necessary for the collection of data according to specific parameters depend of a large number of factors, among which: the type of computer used, the operating system, the programmers' abilities and the type of applications used. While some factors are subject to personal preferences, some other are established by the company's strategy, financial aspects, compatibility with other software, etc. Computers with an other than Windows OS can be used successfully for data acquisition but the programmer must take charge of the development of application and hardware control. This is one reason for which the users of non-Windows computers often discover that for economic reasons as well as for the ease-of-use it is recommended to switch to Windows for the development of data acquisition applications.

The block diagram is presented below:

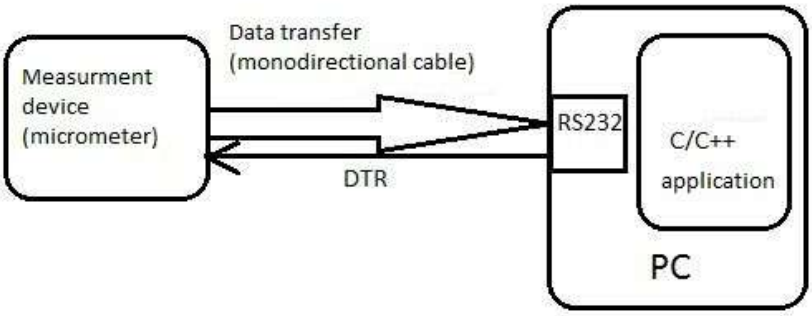

Fig.3.2.2-1. Block diagram

The measuring device is a digital micrometer IP54 manufactured by Schut Geomatrical Metrology :

Technical data:

- Measuring range; 0-30mm
- resolution : 0.001mm
- Data output supports bidirectional transfer
- precision : +/- 0.004mm

Fig. 3.2.2-2. Measuring device (digital micrometer)

Data transfer cable (47.61046 model) is an optical cable connecting through RS232 computer serial interface. This cable model is monodirectional.

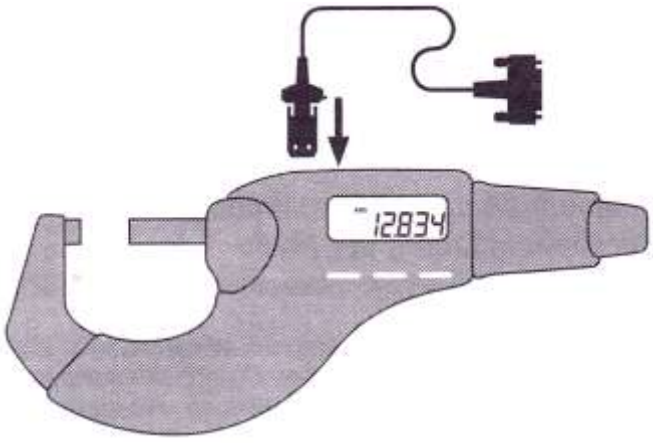

Fig. 3.2.2-3. Data transfer cable

Measuring device communication:

Parameters:

Transfer speed: 4800 b/s

Parity: even

Start byte : 1

Stop byte : 2

Number of data bytes: 7

Transfer mode: mono-directional.

For receiving data must be sent a signal on the DTR line

The application – in C and C++ based on Win32API (which represents the entirety of the Windows functionality that are open to developers in order to create Windows applications. In fact, it is a totality of the Windows dll functions grouped on the type of function).

3.2.2.2. Operations used

The applications manages the acquisition of data provided by the micrometer at the application's request as well as at the request sent by the device (when the button is pressed).

For creating the application the following Win32 API operations were used:

Opening a serial port (RS232)

The CreateFile function opens the communication port. There are two ways of calling the function: overlapped and non-overlapped. The method described below it is the best method for opening a communication source for the overlapped operation:

```
//////////////////////////////////////////////////////////////////
HANDLE hComm;
hComm = CreateFile( gszPort,
                    GENERIC_READ | GENERIC_WRITE,
                    0,
                    0,
                    OPEN_EXISTING,
                    FILE_FLAG_OVERLAPPED,
                    0);
if (hComm == INVALID_HANDLE_VALUE)
  // error opening the port
//////////////////////////////////////////////////////////////////
```

The Non-overlapped method I/O is used in multithread applications, because while a thread is blocked in a port operation, other threads can function normally. The application must prioritize the access to the port correctly. If one thread is blocked waiting for an operation to finish, all other threads that subsequently call communication operations will be blocked until the initial operation is finished.

The Overlapped method I/O – a port opened for overlapped operations allows multiple threads to execute port operations simultaneously and other instructions can also be implemented as the port operatons are pending.

Reading the serial port

The **ReadFile** function realizes the reading operation. In the code sequence listed below it is detailed how the reading request is handled. It can be noticed that a subsequent operation can be performed only if the ReadFile functions returns TRUE (1). Also, it can be noticed that the signal fWaitingOnRead, defined in the code, indicates if the operation is overlapped or not. It also prevents a new reading operation while the first one is processed.

```
//////////////////////////////////////////////////////////////////
DWORD dwRead;
BOOL fWaitingOnRead = FALSE;
OVERLAPPED osReader = {0};
// Creates an overlapped event. Must be closed before the exiting operation
osReader.hEvent = CreateEvent(NULL, TRUE, FALSE, NULL);
if (osReader.hEvent == NULL)
  // Error on the creation of the overalapped event. Exiting sequence.
if (!fWaitingOnRead) {
  // Reading operation.
  if (!ReadFile(hComm, lpBuf, READ_BUF_SIZE, &dwRead, &osReader)) {
    if (GetLastError() != ERROR_IO_PENDING)  // The reading is delayed?
      // Communication error. Report
    else
      fWaitingOnRead = TRUE;
  }
  else {
    // The reading has finished succesfully
    HandleASuccessfulRead(lpBuf, dwRead);
//////////////////////////////////////////////////////////////////
```

The second part of the overlapped operation is the detection of the operation finishing. The event in the overlapped structure is transferred through WaitForSingleObject function that will wait until the event will be signaled. As soon as the event is signaled, the operation will finish. That does not mean that the operation finished successfully, just that the operation has finished. If an error appears, GetOverlappedResult returns FALSE and GetLastError

returns an error code. If the operation finished successfully, GetOverlappedResult will return TRUE.

```
//////////////////////////////////////////////////////////////
#define READ_TIMEOUT      500      // milisecunde

DWORD dwRes;

if (fWaitingOnRead) {
  dwRes = WaitForSingleObject(osReader.hEvent, READ_TIMEOUT);
  switch(dwRes)
  {
    //The reading is finished
    case WAIT_OBJECT_0:
      if (!GetOverlappedResult(hComm, &osReader, &dwRead, FALSE))
        // communication error. Report
      else
        // The reading has finished successfully.
        HandleASuccessfulRead(lpBuf, dwRead);
      // Reset the signal to perform another operation
      fWaitingOnRead = FALSE;
      break;
    case WAIT_TIMEOUT:
      // The operation is not finished. fWaitingOnRead has not changed.          // The loop will start again; a new reading cannot start because the first // has not finished
        // Background operation can be performed here//
      break;
    default:
      // error in WaitForSingleObject; Exiting sequence
      // a problem in the structural event is signaled
      // OVERLAPPED.
      break;
  }
//////////////////////////////////////////////////////////////
```

Writing in the serial port

Writing in the serial port is implemented in the application but it is not used because in the one-way communication only readings from the measuring device (the micrometer) can be made.

The function to realize the writing in the serial port is WriteFile().

Setting-up the serial port.

Setting the DCB structure

It is the most important part of the serial port's programming. Most programming errors emerge from the incorrect initialization of the DCB structure.

There are three (3) methods for the initialization of the DCB structure. The first one uses the GetCommState function. This function returns the current values of the DCB structure:

```
////////////////////////////////////////////////////////////////
  DCB dcb = {0};

  if (!GetCommState(hComm, &dcb))
    // Error in obtaining current settings for the DCB
  else
    // DCB can be used.
////////////////////////////////////////////////////////////////
```

The components of the DCB structure.

The values for the initalizatons of the DCB components are:

```
  dcb.BaudRate = BAUDRATE(TTYInfo);
  dcb.ByteSize = BYTESIZE(TTYInfo);
  dcb.Parity   = PARITY(TTYInfo);
  dcb.StopBits = STOPBITS(TTYInfo);
  dcb.EvtChar = '\0';
  dcb.fDtrControl     = DTRCONTROL(TTYInfo);
  dcb.fRtsControl     = RTSCONTROL(TTYInfo);

  dcb.fOutxCtsFlow    = CTSOUTFLOW(TTYInfo);
  dcb.fOutxDsrFlow    = DSROUTFLOW(TTYInfo);
  dcb.fDsrSensitivity = DSRINFLOW(TTYInfo);
  dcb.fOutX           = XONXOFFOUTFLOW(TTYInfo);
  dcb.fInX            = XONXOFFINFLOW(TTYInfo);
  dcb.fTXContinueOnXoff = TXAFTERXOFFSENT(TTYInfo);
```

```
dcb.XonChar         = XONCHAR(TTYInfo);
dcb.XoffChar        = XOFFCHAR(TTYInfo);
dcb.XonLim          = XONLIMIT(TTYInfo);
dcb.XoffLim         = XOFFLIMIT(TTYInfo);

dcb.fParity = TRUE;
////////////////////////////////////
PORT( TTYInfo )         = 1 ;
BAUDRATE( TTYInfo )     = CBR_4800 ;
BYTESIZE( TTYInfo )     = 7 ;
PARITY( TTYInfo )       = EVENPARITY ;
STOPBITS( TTYInfo )     = TWOSTOPBITS ;
DTRCONTROL( TTYInfo )   = DTR_CONTROL_ENABLE;
RTSCONTROL( TTYInfo )   = RTS_CONTROL_ENABLE;
XONCHAR( TTYInfo )      = ASCII_XON;
XOFFCHAR( TTYInfo )     = ASCII_XOFF;
XONLIMIT( TTYInfo )     = 0;
XOFFLIMIT( TTYInfo )    = 0;
CTSOUTFLOW( TTYInfo )   = FALSE;
DSROUTFLOW( TTYInfo )   = FALSE;
DSRINFLOW( TTYInfo )    = FALSE;
XONXOFFOUTFLOW(TTYInfo)  = FALSE;
XONXOFFINFLOW(TTYInfo)   = FALSE;
TXAFTERXOFFSENT(TTYInfo) = FALSE;
```

Data flow control

This delay allows for the pending operations to finish.

In serial communication flow control ensures a mechanism for suspending communication when one of the devices if busy or, for some reasons, cannot communicate. There are two types of flow control: hardware and software.

Serial communication is realized between two devices. In the present case, the devices are a PC and a measuring device. The PC is identified as DTE (Data terminal equipment). DTE-ul is sometimes called “host”. The measuring device is identified as DCE (Data communication equipment), sometimes also called “device”

Closing the serial communication port.

In order to close a serial port, the CloseHandle function must be used. The function has a single parameter that is the same (handle) as the one returned by the CreateFile function when the opening of the port was requested. There is a two seconds delay between calling the CloseHandle function to the actual closing of the port and the freeing of resources

3.2.2.3. User interface.

The main window:

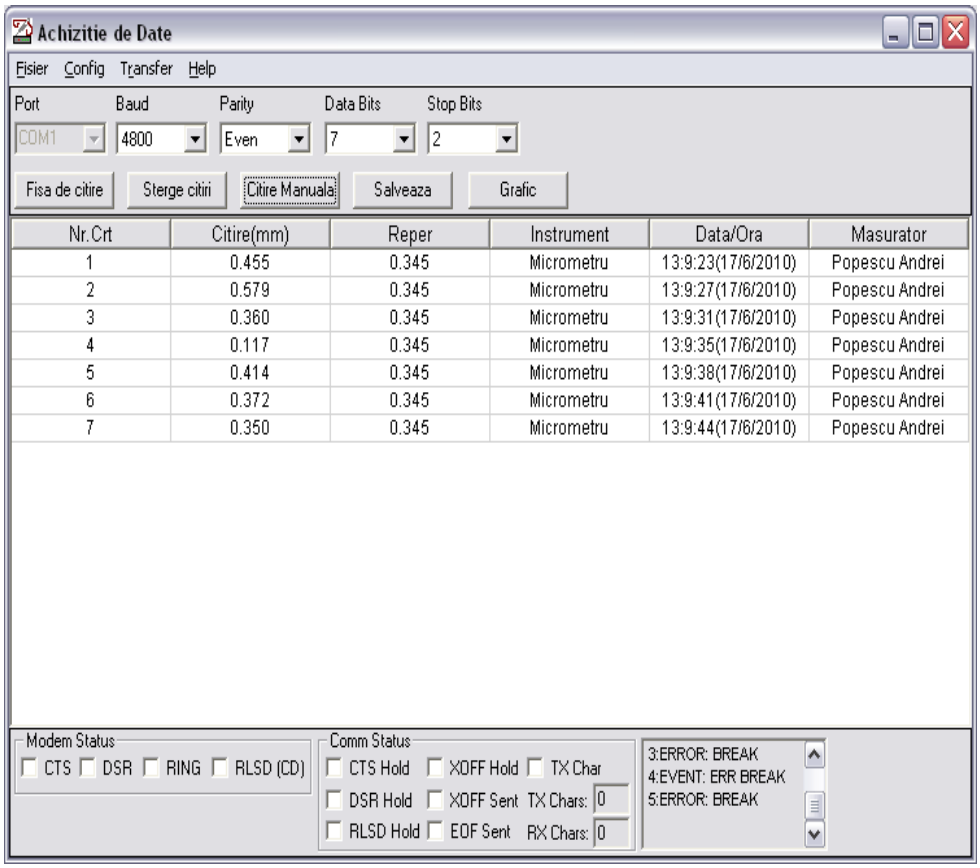

Fig.3.2.2-1. *Main window*

The main window has 5 area (up to down):

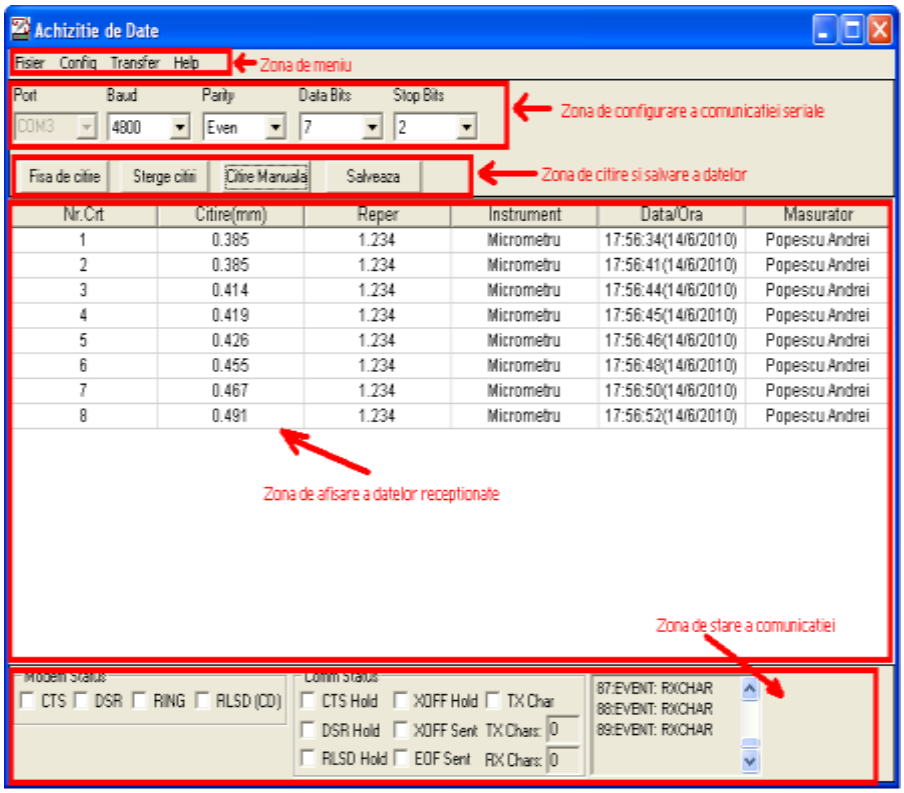

Fig.3.2.2-2. *The areas of the main window*

1. Menu area
2. Communication setting area
3. Reading and saving data area
4. Reading display area
5. State of communication area

Menu area

Includes:

- connect/disconnect serial port options

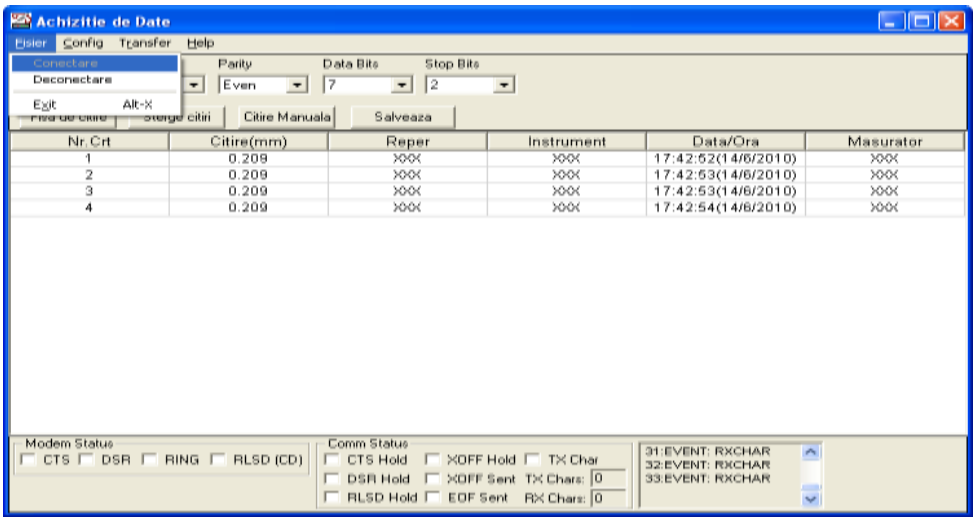

Fig.3.2.2-3. *Menu area*

- Communication events setting:

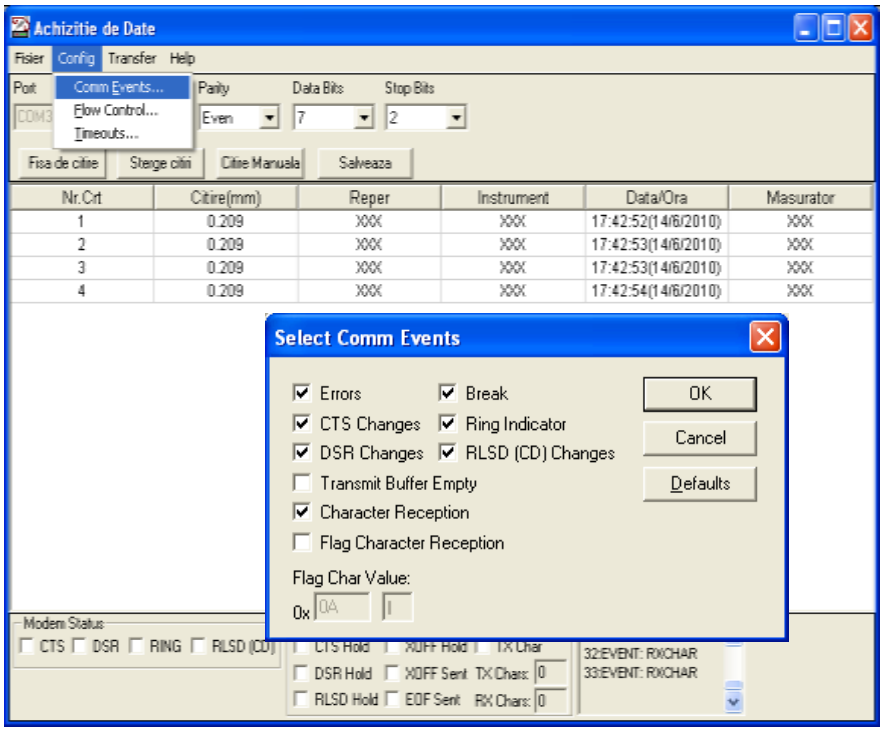

Fig.3.2.2-4. *Setting communication events*

- configuring data flows:

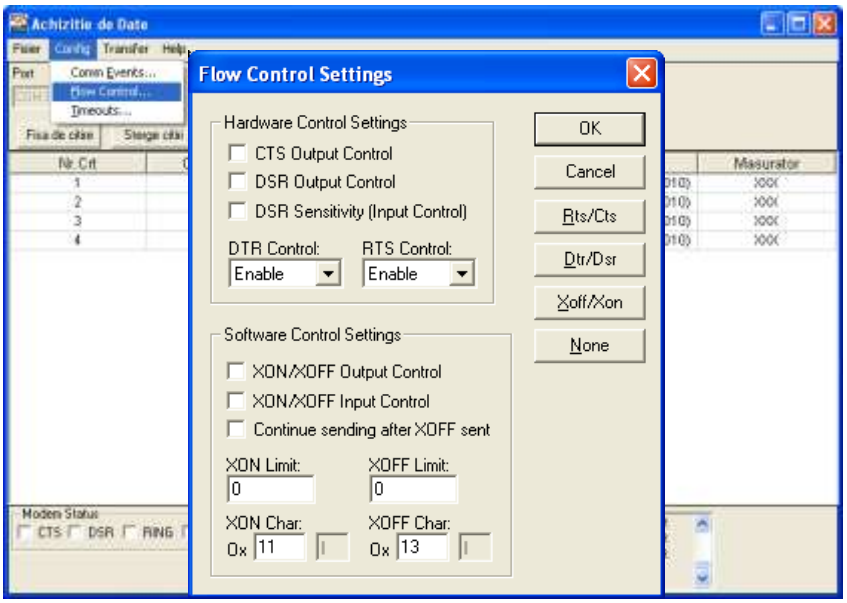

Fig.3.2.2-5. *Configuring data flow*

- configuring Timeouts:

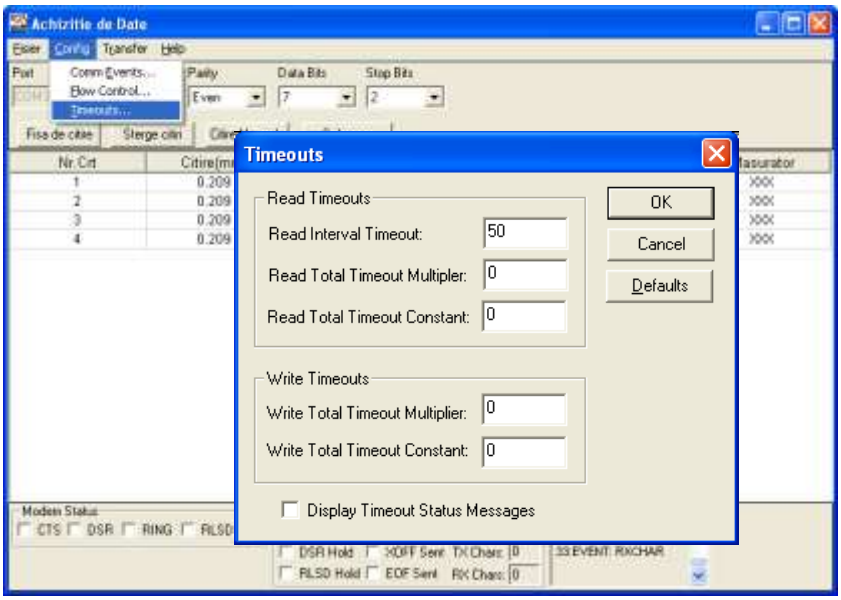

Fig.3.2.2-6. *Configuring timeouts*

- the sending and receiving files procedures

Transmission can be used only with a bi-directional connection.

By selecting „receiving file” data (only read values) will be saved directly to a .txt file

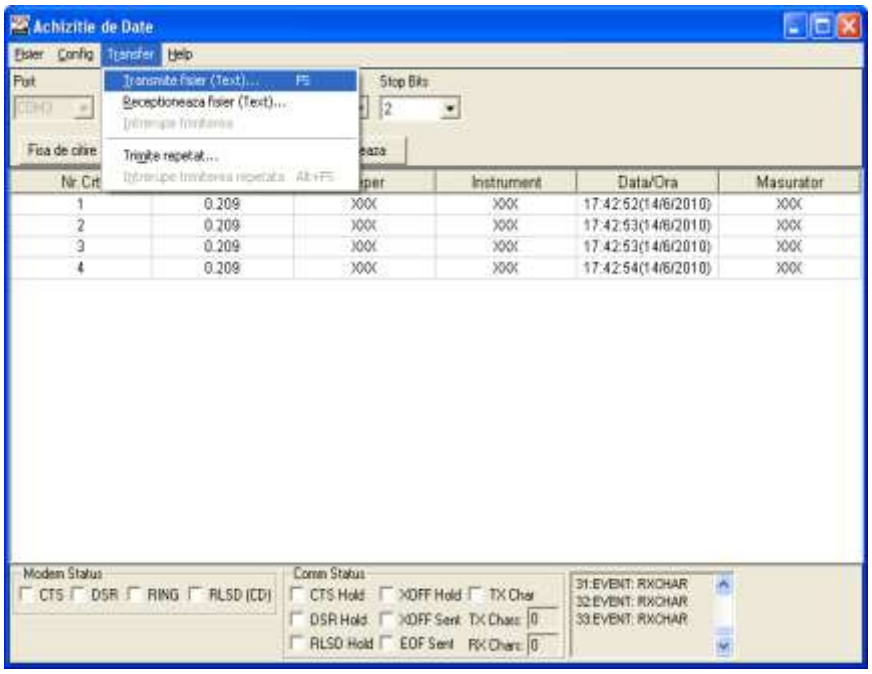

Fig.3.2.2-7. *Sending and receiving procedure*

Setting up communication

In this area will be configured: the communication port; communication speed (baud), parity, data bits, stop bits. These will be configured according to the specifications of the measuring device.

Reading and saving data

Includes:

- the „reading sheet" option in which can be included: the measuring device used, the reference value, and the name of person performing the measurement.

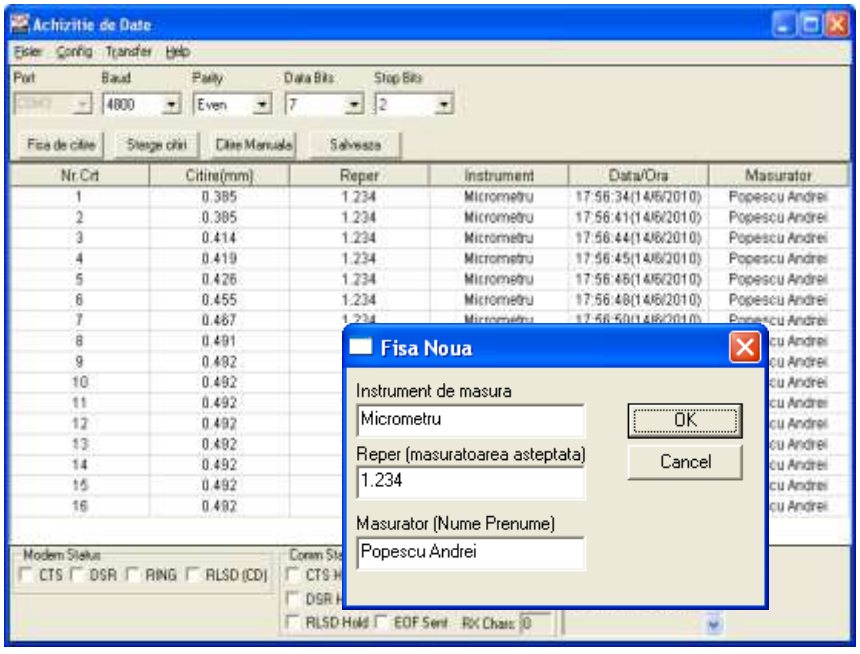

Fig.3.2.2-8. *Reading sheet*

- the option „delete reading” that deletes all readings recorded in the reading window and starts a new sheet (see the previous option)

- the option „manual reading” that sends a request to the measurement devices in order to obtain the current reading (change on the DTRS pin – see the description of the measuring devices)

- the „Save” option that allows the saving of the reading window in .xls format.

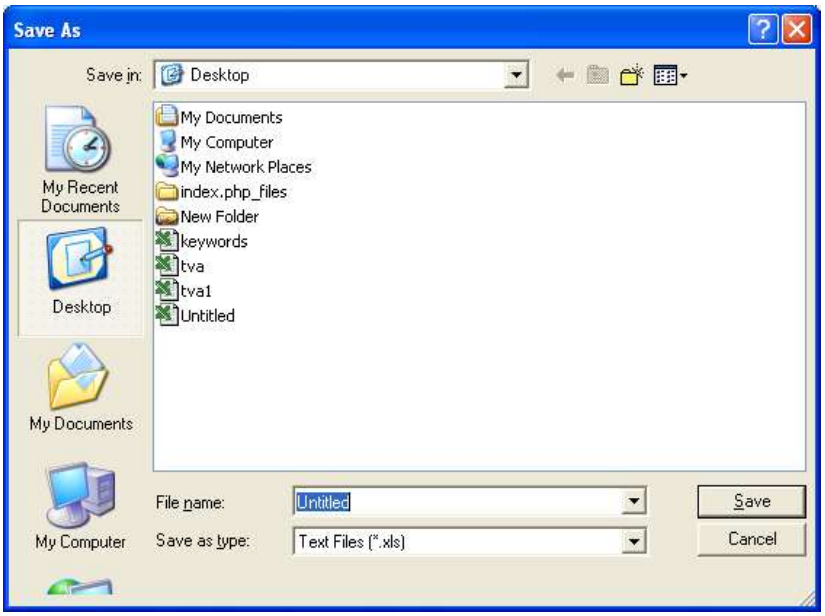

Fig.3.2.2-9. *Saving reading in .xls*

- the „Graphic” option that displays a graphic of the measurements in relation with the initial values; also, the minimal and maximal measured values are highlighted.

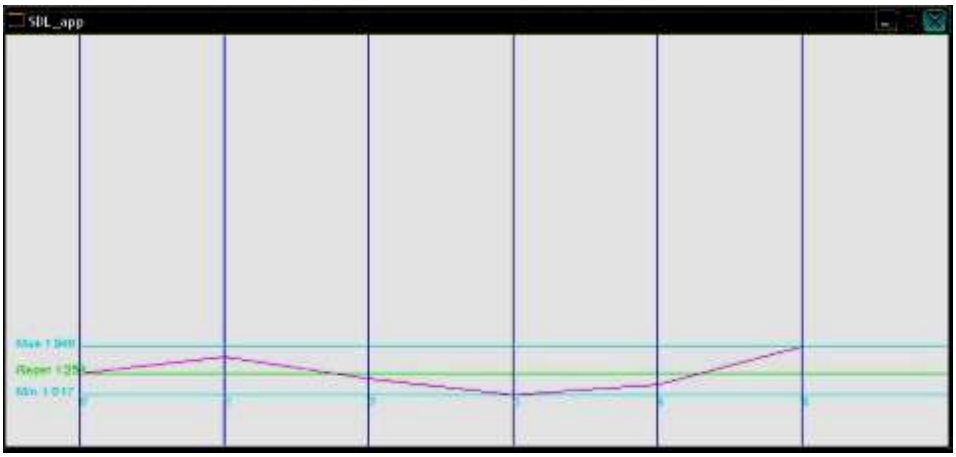

Fig.3.2.2-10. *A graphic of measurements taken*

3.3 Scientific research planning using specific statistical methods. Aplyig ANNs to estimate best results [27], [58], [62], [64], [71]

3.3.1 Introduction. Combining scientific research with usage of artificial neural networks

In this paragraph we should underline the extraordinary collaboration with professor Eugen Cicala, a world-class specialist [21] [22], in the field of scientific planning as well as the utilization of the pionieering works of professor A.Nichici [22]. As a novelty element it is underlined the combination of statistics in a complementary mode with using artificial neural networks in previsioning the results such that the efficiency of the research should be improved by minimization of the number of experiments to be effectuated [62]. Thus, there are continued the research from the second PhD Thesis, i.e., T. Slavici, Optimising the financial management using artificial intelligence methods, obtained at the West University of Timisoara, in 2006.

The databases used in this paragraph are from the chemical domain, and obviously are not part of the author activity domain. The actual research was performed by a pluridisciplinary team at the scientifical and technological park "Tim Science Park" Timisoara, being finalized with publication in ISI journals [27], [58], [64] with non-zero IF and SRI. The research team was composed of chemists, computer scientists, mathematicians, economists. The contribution of the undersigned to the research is related strictly to the increasing of the economic efficiency using artificial intelligence and cybernetics methods and does not concern the fundamental research in the domain of chemistry. This is the reason for which the part describing the chemical technological processes is presented at a minimum necessary to understand the text.

a) In the following are sketched some principles applied in the subsequent paragraphs, related to the planning of scientific research.

1. In many situations, the development of a scientific research follows empirical algorithms, these situations leading to a waste of human resources, time resources and material resources, leading in the end to an inefficient utilization of financial resources. Through a scientific planning it is aimed to identify and realize the experiments (samples) with the most quantity of informations; thus, it is possible that, through a scientific planning, to extract more utile information from 16 experiments than the information extracted from 50 random palnified experiments. All these researches are usually performed for determining the values for the influence factors (xi) which ensure extreme values for the objective functions (yi)

2. Dispersional analysis – is a statistical method used to analyse the measured data (for the objective function) which depends on one or more factors with simultaneous action, in order to establish the signifiance of these factors on the analysed objective function.

3. The strategy of modelling through factorial experiments. The problem of establishing the necessary and sufficient volume of the experiment reduces to a compromise between the necessity of analyzing a larger number of parameters which could be identified as influence factors xi and their study on domains of larger span. The reduction of the total number of experiments leads to the reduction of time and costs. Thus, the notion of optimal experimental program arises.

4. In some situations, even this empirical planning could be considered as a starting point for a future scientific planning, being considered as preliminary research. These results could be exploited as:

- elimining the coupled factors (with interdependencies); obviously, through this reduction the number of influencing factors (xi) decreases and thus the number of experiences decreases, leading to a decrease in the total cost of research

- the compatibility between the proposed levels for the influencing factors and their physical (actual) realization; for instance, the molecular mass could not take any value, but certain discrete values, corresponding to physical existent substances

- in case there exist more discreet variables (included in the program matrix using codes), the general experiment could be disconnected in more specific experiments around some discrete values of the influencing factors

- the empirical and qualitative determination of a maximum area for the objective functions and the concentration of the values for the influencing factors in the respective areas

b) Also, in each example, various topologies of artificial neural networks were utilized, along with scientific planning, in order to predict the results.

The following figures present the main architectures (topologies) utilized.

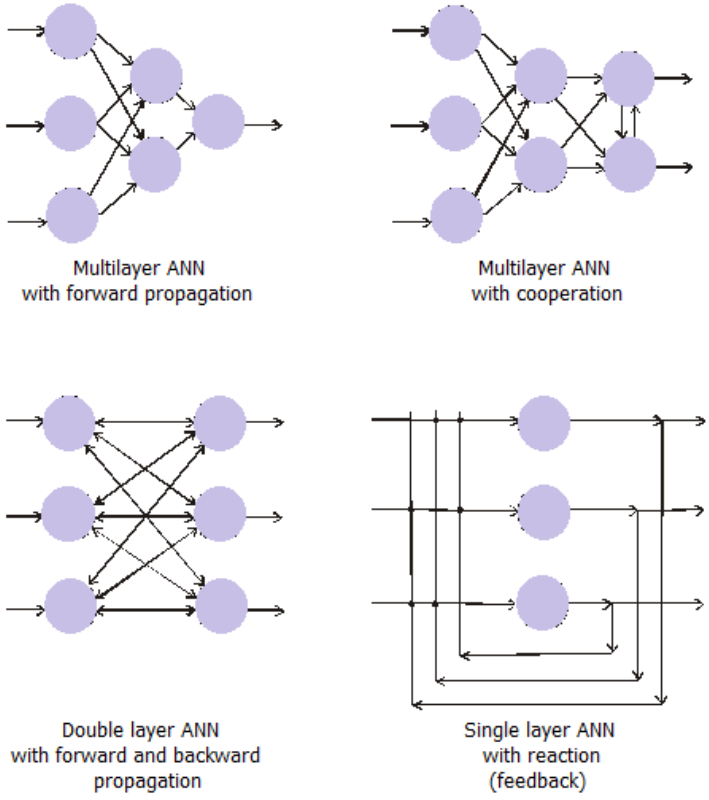

Fig.3.3.1-1 Various ANN architectures

I appreciate that this strategy, complementary to the strategy previously described (i.e., scientific planning of research) is a second factor which leads to the reduction of costs for an experimental research. According to the description provided in the paragraph which treats the optimization of the artificial neural network, by improving the network architecture could

be obtained a forecast accuracy of 95%-98%, thus could be realized important economies in the realization of an experimental research. The shortcoming of this method is, in this case, the necessity of a reasonable number of training epochs (replicas) in order to obtain a certain accuracy of the forecast.

3.3.2 Using scientific planning and artificial neural network in order to and Develop of Mixed Reactive Carbonates for Peptide Synthesis [13], [58], [62], [64], [70] , [71]

3.3.2.1. Introduction. Peptide Synthesis

In chemistry, the underlying principles of sustainable chemical development (green chemistry) imposed the necessity for the identification of new methods concerning the reduction of reagents and energy consumption in the chemical processes, the reduction of emissions of toxic chemical products into the environment, the extension of the use of renewable resources.

Peptides and proteins have many important therapeutic applications, such as in the treatment of cancer, infectious and viral diseases, AIDS-related diseases, heart disease, respiratory diseases, autoimmune disorders, transplantations, skin disorders, diabetes, genetic disorders, digestive disorders, blood disorders, infertility, growth disorders, and eye conditions. These peptides are present in numerous physiological and biochemical processes of life where they play major roles. Peptides allow for communication between cells through interactions with receptors and are involved in different biochemical and metabolic processes, including pain, reproduction and immune response.

During the synthesis of peptides, the incorporation of amino acids that retain optical activity is a key factor in obtaining compounds that are identical to natural peptides. For this reason, alkoxycarbonyl-type (carbamate) groups are preferred

The reactive organic carbonates are an ecological alternative to halogenated compounds, reagents like phosgene and its reactive chlorinated derivatives (chloroformates, diphosgene, triphosgene) in alkoxycarbonylation and carbonylation reactions .

The reactive organic carbonates have numerous applications in fine organic chemistry: intermediates in the synthesis of other derivatives of carbonic acid (asymmetric carbonates, polycarbonates, carbamates, ureas) and in peptide synthesis. There are many fundamental and applicative scientific studies on the physical and chemical properties (reactivity, stability of molecule) of reactive organic carbonates

3.3.2.2. Optimisation of the Scientific Research

In many situations, the development of the scientific research uses empirical algorithms that are a waste of human resources, time, and money. To follow the economic impact of how material resources are used for conducting experiments and calculating the specific cost per experiment, the costs for each experiment must be analysed separately. Direct costs for each test performed can be approximated from the sum of the material costs, utility costs and human resource costs. This approximation omits administration costs, building use and equipment depreciation. Therefore, considering that scientific planning can

lower the number of experimental tests necessary to obtain the best objective function values and empirical planning requires a large number of experimental tests, a direct cost reduction of approximately 88% can be realised.

The goal is to convert empirical planning of scientific resources into scientific planning. For this purpose, only experiments that were relevant and contained a wealth of information were used. For example, it is possible to obtain more information from 16 scientifically planned experiments than from 50 empirically planned experiments. This study sought to identify the influencing factors (xi) that assured maximal objective functionality. In many situations, empirical planning can even be considered preliminary research and serve as a starting point for future scientific planning. The second step consisted of scientific research planning, and the optional final step involved improving research planning to reach the optimum cost/benefit ratio.

3.3.2.3. Scientific Planning of the Experiment

The major objective of experimental modelling is to obtain more accurate experimental models for technological purposes. The achievement of this objective is supported by a rational program of experiments. The first step is to perform preliminary experiments to determine the most significant factors that influence the technological process of interest. Based on the developed experimental models, influencing factors (xi) capable of improving the objective function in terms of optimisation criterion are selected.

The multifactorial space proposed for investigation included five influencing factors: X_1, the nature of the substrate with two levels: 1 (DSC), 2 (DPC); X_2, the alcohol with twelve levels: R_1-R_{12} (Table 1); X_3, the catalyst type: C_1 (TEA) and C_2 (tri-n-butylamine [TnBA]); X_4, catalyst quantity; and X_5, reaction time. Among the influencing factors are discrete variables (substrate (X_1), alcohol (X_2), and catalyst (X_3)) and continuous variables (reaction time (X_5) and catalyst quantity (X_4)). Assuming the assignment of two levels of variation (minimum and maximum) for the two continuous factors, the number of theoretically possible combinations for a complete experiment would be 192 (2x12x2x2x2). However, only part of the experimental points that correspond to a systematic exploration of the multifactorial space is feasible.

The preliminary experiment consisted of the selection of six reactants from a total of twelve reactants, and the generation of the most convenient experimental method from this set was performed. This assumption resulted in twelve preliminary experimental methods, which are shown in Table 3.3.2-1

Table 3.3.2-1. Preliminary results

No. exp.	Substrate	Alcohol	Catalyst	Catalyst quantity [ml]	Reaction time [h]
	X1	X2	X3	X4	X5
1	DSC	1	TEA	0.2049	26
2	DSC	2	TnBA	0.524	5
3	DSC	3	TnBA	0.93	5
4	DSC	4	TnBA	0.93	5
5	DSC	5	TnBA	0.93	5
6	DSC	6	TnBA	0.93	5
7	DPC	1	TEA	0.38	24
8	DPC	2	TEA	0.395	24
9	DPC	3	TnBA	0.212	24
10	DPC	4	TnBA	0.212	24
11	DPC	5	TnBA	0.212	24
12	DPC	6	TnBA	0.212	48

Legend: DSC = N,N'-disuccinimidyl carbonate; DPC = N,N'-diphthalimidyl carbonate; TEA = triethylamine; TnBA = tri-n-butylamine

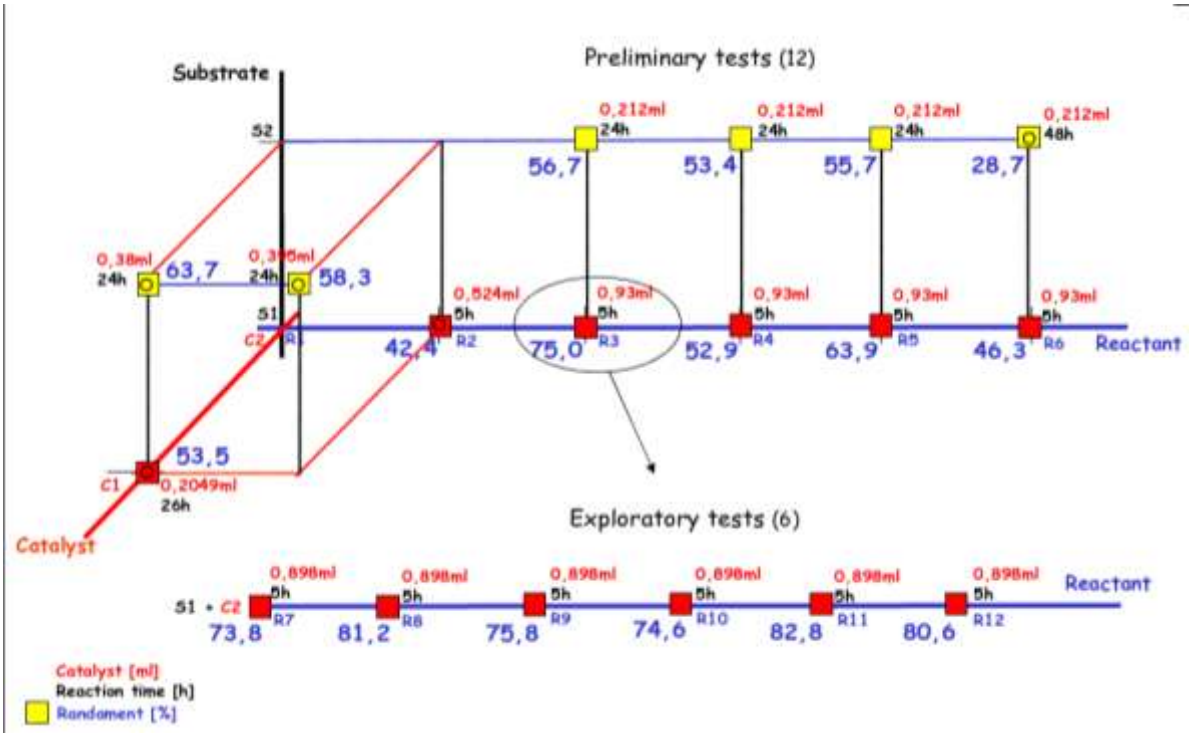

Fig. 3.3.2-1 Number of tests

From the results of the preliminary analysis, the most convenient combination was *N,N'*-disuccinimidylcarbonate (DSC) as the substrate, 2-phenyl-ethyl alcohol as the reactant, and tri-n-butylamine as the catalyst. A series of conclusions can be drawn from the preliminary analysis. The best performance was obtained using DSC as the substrate in combination with 2-phenyl-ethyl alcohol and tri-n-butylamine (*TnBA*) as the catalysts.

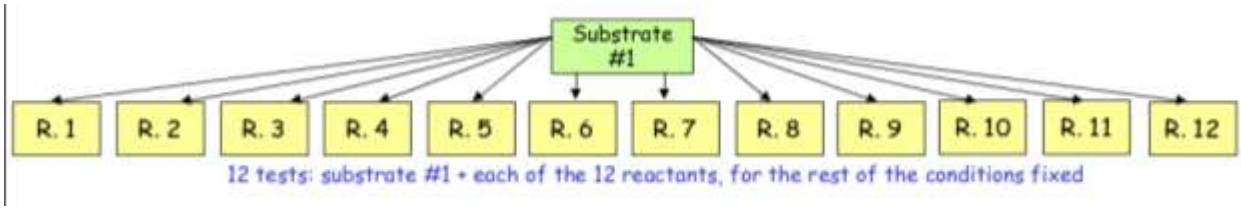

Fig.3.3.2-2 Number of tests for each substrate

These results represent a starting point for the analysis of the performance of the other six alcohols (alcohol 6–12, Table 3.3.2-1) not used in the preliminary experiment. Similarly, there was performed another test, which helped to obtain a final classification of the reactants. Specifically, the yields could be increased by approximately 78% by carefully selecting the type of reactant used.

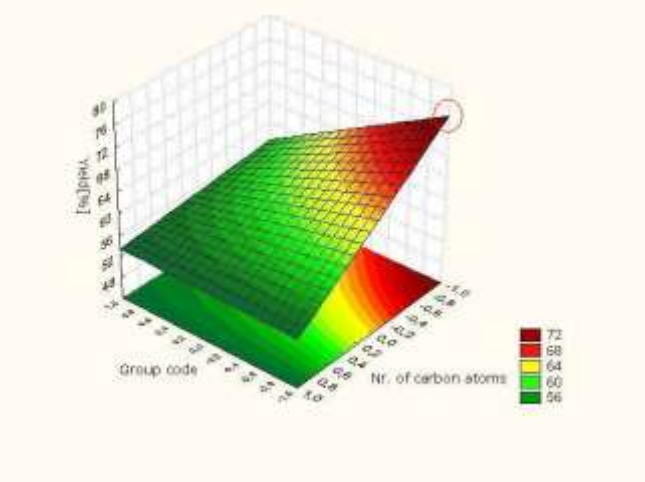

Figure 3.3.2-3 *Response surface revealing the influence of the factor groups*

Analyzing the preliminary data led to the isolation of a point (factor combination) with the best results (Figure 2.3.2-3) around which we can develop an additional analysis. A supplementary study investigated the effects of reaction time and catalyst quantity on the objective function to determine the possibility of further improving the reaction results. Based on this study, an optimized set of reaction conditions were proposed for maximum efficiency.

3.3.2.4 Using of artificial neural network

The improvement of the chemical processes is an issue of major importance in the current concept of green chemistry which require the energy and the raw materials savings and also the reduction of the dangerous reactants and co-products. Using traditional, empirical algorithms of laboratory experiments programming, without making use of a number of factors that may interfere in their number reduction, unnecessary lead to an unjustified consumption of energy and materials.

The systematic scientific planning of the laboratory experiments for the synthesis of the intermediates (carbonates), which can be extended to any type of experiments, has allowed the substantially reducing both of their number and involved cost and the improvement of the cost/ benefit ratio, by identifying discrete and continuous variables that influence the reaction process and by choosing the best combination between the reactants type, substrate and catalyst.

Thus, using artificial neural networks, a forecast accuracy of 93% was obtained.

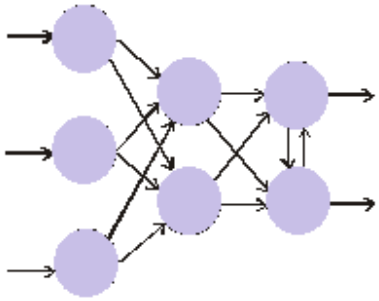

Figure 3.3.2-4. Multilayer ANN with cooperation

This problem is developed in paragraph 3.5 and 3.6.

3.3.3. Aspects regarding the economic study of the bioethanol obtained by development of a new environmentally friendly pretreated method

3.3.3.1. Introduction

Studies carried out on the chemical composition of the atmosphere showed a continuous change, especially due to human activities which generate significant quantities of gaseous pollutants. The European environmental policy has paid particular attention to transport because this economic sector, with a continuous growth (approx. 2% annually), is the main responsible in terms of gaseous pollutants emissions. The road transport generates the majority (approx. 84%) from the total of transport generated carbon dioxide emissions. In the European Union, transport uses over 30% of the total energetic consumption, while oil represents 98% of the total fuel used. [51]. To reduce the negative environmental impact the European Commission approved, in December 2005 an action plan (Biomass Action Plan) designed to increase the use of wastes from agriculture and forestry in order to produce energy. [35]

Lignocellulosic biomass represents the raw material for the large scale production of ecological biofuels or other chemical compounds, being a cheap and abundant source of renewable energy. Its components are 40-50% cellulose, 25-35% hemicelluloses, 15-20% lignin and small quantities of proteins, lipids, acids and mineral salts. The cellulose and hemicelluloses represent two thirds of the biomass dry weight.

The bioconversion of lignocellulosic raw materials to bioethanol consists of four major operations: pretreatment, hydrolysis, fermentation, and separation/distillation [53].

Usually, the lignocellulosic biomass that will be pretreated has to be subject to a preliminary stage in order to remove all the impurities (non-wood materials, metals, stones, earth, glass, plastic, etc.).

The lignocellulosic biomass resulted from this preliminary stage was subjected to a grinding process using a mill for grinding wastes from different processes and parts scrapped for recycling. The wastes resulted from the production process could be leaves, branches, pieces of wood or thermoplastic materials: the high and low pressure polyethylene, PVC, ABS, polyamide, etc.

Usually, the biomass pretreatment is achieved by *chemical*, *physical* (heat, pressure, acid hydrolysis, basic medium tratment, ammonia fiber expansion, steam expansion, oxidation in alkaline medium, ozone treatment, different solvents) or *biological methods*

The role of fractionation (pretreatment) is to maximize the in yield fermentable monosaccharides from cellulose and hemicellulose structures, thus increasing the growth rate of the hydrolysis

Pretreatment stage is absolutely essential for obtaining bioethanol by fermentation of biomass because it represents approximately 30% of the total cost of ethanol.

3.3.3.2 Experimental

The quality of the biomass is directly influenced by two factors: humidity and total solid mass. These two characteristics were experimentally determined for three types of lignocellulosic biomass and are presented below:

Table 3.3.3-1. Biomass characterization

Type of lignocellulosic biomass	% total solide	% humidity
Fir	94.89	5.11
Oak	91.42	8.58
Hemp	92.19	7.51

3.3.3.3 Economic issue regarding the bioethanol production from lignocellulosic biomass

Even if they represent a current trend, biobased products, including bioethanol, must be made at competitive cost. Otherwise, there will be no market for the biobased products even though they are made from renewable resources.

Cost-benefit analysis is an evaluation method of a policy which quantifies in currency terms the value of all its consequences over society members. The net social benefit expresses the value of this policy. The difference between the social benefits (B) and the social costs (C) represents the social net benefits (BSN).The main purpose of the cost-benefit analysis (CBA) is to help policy-makers ensure an equitable distribution of resources. In order to provide and prove the efficiency of such measures given by a governmental intervention, the specific action has to be compared to the alternatives, including the status-quo. In this view, the role of CBA is important. There are two types of CBA: ex-ante and ex-post. The ex-ante analysis is made before a project or a policy measure takes place. The ex-post analysis is made at the end of the implementation of the project or policy measure. The value of the ex-post analyses is higher as the given information creates a learning framework for the policy-makers or project developers.

Financial analysis takes into account the benefits and costs of the investment project in measurable, monetary terms, in order to reach unitary indicators expressing the value of the investment. The calculations are made according to the analysis required for European project funding. Thus, in this section the economic aspects of bioethanol production are approached from a European funding point of view.

In the present case study, the investment costs refer to the amount invested to produce bioethanol, for a plant capacity of 100 kg of biomass. The calculations have been performed in EUR, the effect of monetary erosion due to the inflation being integrated to the exchange rate. For example, these are forecasted at a monetary value of 10000 EUR. However, the complexity of the project requires the investment costs to be the highest; this investment will be made only once (Table 3.3.3-2).

Operating costs occur in the operation of an investment, including cost of routine and maintenance, but excluding depreciation or capital loss. Here only the cash flows are considered, the non-cash depreciation being left out.

Table 3.3.3-2. Total investment costs, operating costs and revenues

No.	Budgetary lines	Year				
		1	**2**	**3**	**4**	**5**
1	Equipment	-10000.00	-	-	-	-
2	Residual value	-	-	-	-	5000
3	Total fixed assets (1+2)	-10000.00	-	-	-	5000
4	*Total investment costs*	*-10000.00*	-	-	-	*5000*
5	Raw materials	-2682.45	-2462.12	-2462.12	-2462.12	-2462.12
6	Labour	-1500.00	-1500.00	-1500.00	-1500.00	-1500.00
7	Electric power	-187.75	-187.75	-187.75	-187.75	-187.75
8	Maintenance	0.00	-200.00	-200.00	-200.00	-200.00
9	Administrative costs	-200.00	-200.00	-200.00	-200.00	-200.00
10	*Total operating costs (5+6+7+8+9)*	*-4570.00*	*-4550.00*	*-4550.00*	*-4550.00*	*-4550.00*
11	Output - Bioethanol	6563.79	6563.79	6563.79	6563.79	6563.79
12	*Total operating revenues*	*6563.79*	*6563.79*	*6563.79*	*6563.79*	*6563.79*
13	*Net operating revenues (10+12)*	*1993.79*	*2013.79*	*2013.79*	*2013.79*	*2013.79*

The financial indicators, Financial Present Net Value (FNPV) and Financial Rate of Return (FRR), which indicates the project's capability to be financially efficient from both perspective of the analysis, i.e. that those of the sponsor and those of the beneficiary, are calculated in a balanced manner for the 5 year period (Table 3.3.3-3).

Table 3.3.3-3. Financial indicators

No.	Budgetary lines	Year				
		1	**2**	**3**	**4**	**5**
1	Total operating revenues	6563.79	6563.79	6563.79	6563.79	6563.79
2	*Total inflows*	*6563.79*	*6563.79*	*6563.79*	*6563.79*	*6563.79*
3	Total operating costs	-4570.00	-4550.00	-4550.00	-4550.00	-4550.00
4	Total investment costs	-10000.00	-	-	-	5000
5	*Total outflows (3+4)*	*-14570.00*	*-4550.00*	*-4550.00*	*-4550.00*	*450.00*
6	*Net cash flow (2+5)*	*-8006.21*	*2013.79*	*2013.79*	*2013.79*	*7013.79*
7	*Financial rate of return on investment - FRR(C)*	*17.95%*				
8	Discount Rate for FNPV(C)	5.00%				
9	*Financial net present value of the investment - FNP(C)*	*3093.58*				

The FNPV is positive, the value being estimated to 3093.68, and the FRR is 17.95%. being higher than 5% (the used financial discount rate). Thus, it can be noticed that such an investment is feasible; in addition, the lignocellulosic materials, as sawdust hemp, oak or fir have much more favorable utilization potential for biobased industrial products because of their quantity and competitive price.

3.3.3.4 Using of artificial neural networks

Using artificial neural networks, a forecast accuracy of 93% was obtained.

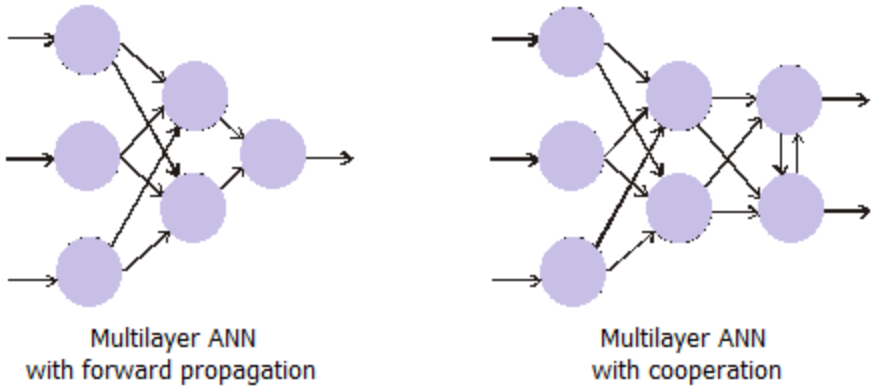

Figure 3.3.3-1. Multilayer ANNs

This problem is developed in paragraph 3.5 and 3.6.

3.4 A general point of view about possibility of using IA in management of industrial engineering and agribusiness [33], [66]

Modern agricultural economics became more and more related to the economics of development. This is mostly due to the necessity of provisioning the commercial and technological growth with a continuous level of farm surplus. However, the relative importance of agriculture tends to decline with the economic development of a country, as shown by Ernst Engel in the 19th century. The primary reason for this tendency is that as incomes increase the proportion of income spent on food declines (Encyclopedia Britannica). A major issue of this economic model is that most of the increase in farm output remains concentrated in certain geographic areas, rather than extending to a homogeneous national (and global) coverage. Subsequently, most of the income gains become related to certain specific geographical areas, leading to the impoverishment of farmers in areas where the production could not be increased to support the decline of farm prices.

While gross income from agriculture varies with smaller amplitude than individual farm prices, net income may vary more than prices. This is why a small agricultural company is in most of the cases unable to compensate for a drop in prices by reducing its payments for machinery, fertilizer, or labor, even if agriculture costs are currently relatively stable.

Thus, efficiency is a must for a small agricultural enterprise to be viable. This requires adequate fertilizers, machinery, and equipments, which are accessible through adequate sources of credit. But the financial securities required by the credit institutions should use additional new tools of forecasting economic development.

An efficient tool of forecasting economic development of a certain company should use adequate evaluation criteria. These criteria should be related not only to the specifics of a certain company (agricultural or not), but also to the time factor.

3.4.1 Methods of IA in agribusiness

To use an ANN, one must cover, progressively, three phases: the training phase, the validation phase and the testing phase. The training phase consists in “feeding the network”,

i.e., introducing known associations between inputs and outputs in the program. The validation phase consists in checking the outputs generated by the ANN against known values of the outputs, corresponding to certain known input data. The testing phase consists in obtaining unchecked answers from the ANN, i.e., forecasts associated to certain inputs, for which the result is not apriori known. This way, while the first two phases are related to the construction of the ANN, the last phase actually represents its usage.

While the fundamental feature of a neural network is its learning capacity, modern algorithms and computers are essential to emulate this feature [57].

The particularities of financial management problems which highly recommend ANNs as efficient tools are: too much complexity of an eventual mathematical model, associated with insufficient accuracy (in the cases when this model could be determined); incomplete available data, noise- and bias-affected; too many restrictions to be applied and simultaneously optimized in the process.

Economic areas suitable for the use of ANN include, but are not limited to [62]:

- verifying the authenticity of documents (including verification of signature specimens);
- credit opportunities fund;
- market response for marketing problems, based on historical databases;
- forecasting of exchange rates and indices;
- forecasting firms' productivity;
- assessment and diagnosis of certain elements of the firms' structure;
- predict firms and banks bankruptcy;
- computing the optimum investment portfolio within financial institutions;
- optimization issues (scheduling optimization, minimizing losses, and so on).

There are several reasons that may explain why economic theories haven't had a fully successful implementation in economic reality. First, the economic theories are formulated using classic logical terms (yes/no, true/false). This is not a realistic approach in financial management, mainly due to the uncertainties on which human thinking and decision. Moreover, classical mathematical and logical rules are not able to express the human preference for complex choices. Second, the existing economical models could not improve their level of accuracy without a correspondingly increase of complexity. In reverse, any simplification of a model leads to a decrease of the forecasting accuracy.

In order to face these challenges, in the mid 1960s, the concept of fuzzy logic was created. In contrast to a classical system, which operates with discrete values (yes/no, true/false, 1/0), a fuzzy system operates, based on fuzzy logic, with logical variables which take continuous values between 0 (no, false) and 1 (yes, true). Thus, a logical expression could also be "partially true", not only, "true" or "false".

A fuzzy system has four elements: the rule base, the inference mechanism, the fuzzification interface and the defuzzification interface. The rule base is a set of IF-THEN rules that contains a fuzzy logic qualification of the expert's linguistic description of how to achieve a good control on a given process. The inference mechanism emulates the expert's decision making in interpreting and applying knowledge about how best to control the process. The fuzzification interface converts the controller inputs into information that the inference mechanism can use to activate and apply rules. The defuzzification interface converts the conclusions of the inference mechanism into actual outputs.

The most used examples of fuzzy system are the knowledge-based expert systems.

3.4.2. ANNs used to asses the financial state of a company

In order to illustrate the methods proposed above, we discuss two examples: first, an ANN constructed to recognize the evolution of the financial state of a company, and second, an expert system used to forecast the net profit of a Salix viminalis plantation. The general term "company" refers not only to small agricultural companies, but also to any company with connections to the agricultural environment (e.g., grocery stores, agricultural association, bakery companies, etc).

The ANN constructed to recognize the evolution of the financial state of a company was proposed by Tucu and Rotarescu [77]. The input data consists in a representative sample of 55 Eastern European companies. According to Tucu and Rotarescu [77], the four relevant factors regarding the financial states of a company are: revenue rentability rate (i.e., the ratio between the total profit and the total revenue, expressed as a percentage), coverage rate of liabilities with cash flow, asset leverage and payment period of obligations. In addition, for small agricultural companies, the actual harvest (measured in tons per hectare and compared to the average multi-annual harvest) should be taken into account.

The implementation of the ANN was made using the Neural Network Toolbox of Matlab [6] [8].

From the 55 firms considered, 49 were used in the training process, 3 in the validation phase and 3 for the test phase. The output of the ANN is a function A, whose range of values are presented in Table 3.4.2-1.

For the training phase the accuracy was 98.0%. For the validation phase the accuracy was 100%. The test phase had an accuracy of 100%. Thus, the overall accuracy is 98.2%, corresponding to 28 true positive, 1 false negative, 0 false positive and 26 true negative marks. This result is compared to the actual prediction marks, which has an overall accuracy of 92.0%.

Value of A	(less than 0)	0	(between 0 and 2.05)	2.05	(higher than 2.05)
Economic meaning	Certainty of economic failure (bankruptcy)		The uncertainty area		Certainty of economic stability (non-bankruptcy)

Fig. 3.4.2-1. Possible outputs of the ANN

3.4.2. Expert systems used to forecast productivity

In order to illustrate how an expert system works, let us consider the database used by Untaru et al [80]. It was constructed by administering, from 2008 to 2010, yearly questionnaires in three Eastern European countries (Romania, Hungary and Serbia) corresponding to the DKMT Euroregion (as described on the official website), to a statistical sample of 120 agricultural firms. From that database, we only consider the entries reffering to Salix viminalis plantations. Salix viminalis (energy willow) plantations represent a sustainable solution for the European economy, but are relatively new in the DKMT region. Hence, the need to offer accurate forecasts for a Salix viminalis plantation is explained by the need of the (potential) investors to know the outcome of such a plantation in the region. Accordingly to the data collected, the profit of a Salix viminalis plantation will be computed given 7 input variables: year of observation relative to planting year; rainfall amount during the observation year; economic state during the observation year; presence and number of natural disasters during the observation year; yield per hectare during the observation year; demand/supply market elasticity relative to the observation year; detailed costs per hectare (plantation, soil preparation, maintenance, harvesting, depositing, drying and total costs) during the observation year; income per hectare during the observation year.

The implementation of the expert system was performed using Exsys Corvid [5].

An example of the input fed into the system is:

IF	year of observation is 2
AND	rainfall amount is 637
AND	state of economy is good
AND	the amount of natural disasters is absent
AND	the demand/supply market is 1.48
THEN	the profit is 1340 €/hectare

After assigning scores to each type of activity involved in the agricultural process (plantation, maintenance, harvesting) and computing the profit (with and without transportation to each potential client), the user could get the following output:

GIVEN	Year of observation is 2
AND	Rainfall amount is 637
AND	State of economy is good
AND	The amount of natural disasters is absent
AND	The demand/supply market is 1.48s
THEN	the profit is 1100 €/hectare

For the output obtained by the expert system, the signed percentage error is between -80.95% and 27.27%, with an average of -18.79%, and thus the accuracy of the expert system is 81.21%.

3.4.3. Cost-benefit analysis performed using Artificial Intelligence

When starting a new agribusiness investment project, the potential entrepreneur is bound to perform a cost-benefit analysis in order to properly evaluate the future outputs of his

investment. But, in order to avoid the risk of bankruptcy, the analysis should be performed using modern, computer-aided tools, rather than classical tools in evaluating the project's feasibility.

Cost benefit analysis (CBA) is a technique used to determine the monetary social costs and benefits of a given investment project [52]. From this point of view, the execution of a CBA is an action that should be performed by any manager before starting a new project. This is done by evaluating the potential costs and revenues that will occur during the completion of the project. Hence, cost-benefit analysis is a decision-making process whose result is to determine whether a certain project is financially feasible, or not.

Any cost-benefit analysis should take into account several key phases, which will be briefly presented below.

Step 1. Context analysis and project objectives The first step to be taken when establishing a new project should be the understanding of the socio-economic and institutional context of the project. A project is considered to be feasible, if the social costs are exceeded by the social benefits. Last but not least, an investment project should be related and consistent to larger frameworks (regional, national, international).

Step 2. Project identification This second phase of CBA requires a sound knowledge on the activities, services and specific methodologies which are needed during the implementation of the project. After having correctly identified the framework of a project, this next step requires to define the boundaries of the analysis and its impact. An issue in the phase of impact analysis, which is very important, is to determine whose costs and benefits really count. This phase should be performed properly, in order to achieve a realistic image of the project.

Step 3. Feasibility and option analysis The next step to be performed, once identified the socio-economic context and the social demand for the project's output, is to identify various actions and measures leading to the achievement of the objectives. As a result, a project is declared feasible if it respects the technical, legal, financial and other constraints relevant to the nation, region or specific area. In order to cover most of the practical situations that could arise, a good feasibility analysis should consider at least three scenarios: "do-nothing", "do-minimum" and "do-something". Often, the "do-nothing" scenario leads to important and obvious damages to the investment, and thus it can be neglected. A simplified CBA should be performed for each feasible "do-minimum" and some alternatives for the "do-something" scenarios. This leads to a classification of the available options by the expected benefit.

Step 4. Financial analysis The main purpose of the financial analysis is to compute net return indicators of a given investment project as a function of cash flow forecasts. Among the net return indicators, there are two particularly important ones: the Financial Net Present Value (FNPV) and the Financial Internal Rate of Return (FRR). The following data should be processed in order to obtain a good financial analysis: total investment costs; total operating costs; total operating revenues; sources of financing.

Step 5. Economic analysis The project's contribution to the economic welfare of the region is estimated by the economic analysis estimates of the project.

Step 6. Risk assessment The risks involved during the project duration should be taken into account in the process of elaboration of an investment project. The project's performance is measured in terms of FRR or NPV. Thus, risk assessment consists thus in the evaluation of the probability that the project will achieve a satisfactory performance.

Sensitivity analysis is a tool frequently used in the risk assessment. Basically, this means to determine the 'critical' variables or parameters of the model. A specific form of sensitivity analysis is scenario analysis. Unlike sensitivity analysis, which evaluates the influence of each variable on the financial and economical performance of a certain investment, the scenario analysis evaluates the combined impact of sets of values assumed by the critical variables. Further, the probability distributions of the critical variables are used in the process of computing the probability distribution of the FRR or NPV of the project.

During the risk assessment analysis, a typical source of mistakes in project appraisal is optimism bias. This optimism bias has its cause in the human tendency to be over-optimistic about the estimation of the key project parameters: investment costs, works duration, operating costs and benefits.

In order to minimize the level of optimism bias, one can use classical tools or modern tools. Among the classical tools are increased cost estimates and decreased, or delayed, benefit estimates. Modern tools include specific software, such as Artificial Intelligence methods.

Cost-benefit analysis is an important tool in starting new financial investments in any business. However, in the specific area of agribusiness, there are some specifics that should be taken into account, such as: natural disasters, climatic and geographical conditions, long-term impact on the environment, and so on.

A serious challenge is represented by the natural disasters. Their impact on agricultural projects increases as the economic vulnerability of the region or country increases. European Union is subjected mostly to floods and droughts. However, other natural disasters like fires, prolonged frost and ecological accidents should also be considered. Measures for reducing the disaster risk consist both on policy planning (such as risk insurances) and physical components (such as infrastructure to prevent natural hazards).

All the various risks which could affect an agribusiness project can not be properly evaluated by human mind, due either to the optimism bias or, more likely, to the volume of information that has to be processed, which is very large. These are the main reasons to use Artificial Intelligence tools in evaluating agribusiness projects.

In this point of view, expert systems represent the most affordable solution to use. Expert systems, also known as knowledge-based expert systems, are specific Artificial Intelligence softwares that emulate the knowledge of real experts. The decision of an expert system is comparable to the most competent decision of a real expert (Collopy et al., 2001).

An expert system contains three parts: the inference engine, the knowledge base and the dialogue interface. The inference engine produces reasoning based on logical rules and the knowledge base supplied by the user. The knowledge base is usually a collection of rules of the form "IF condition THEN result." The dialogue interface is used either to input the rules that form the knowledge base, or to interrogate the output of the inference engine, based on the rules available in the knowledge base.

The advantage of expert systems is that any data amount could be processed. The reasoning is based on previous experience, which was quantified and fed into the computer, rather than on some subjective, optimistic basis. Moreover, a graphical user interface could be constructed, such that the typical end-user (which, supposedly, has not expertise in the domain of Computer Sciences) doesn't need to concentrate on too detailed technical problems, but rather on the practical importance of the forecast. Such expert systems could be implemented using Corvid Exsys.

More complex than usual cost-benefit analysis, cost-benefit analysis of an agricultural investment project represents a challenge that must be taken in agribusiness. The complexity of the cost-benefit analysis increases as the number of environmental issues that should be considered increase. Moreover, there are natural disasters that are hard to envision and have effects that are very hard to forecast. The human tendency of over-optimism produces also errors in the human rationalism. On the other hand, computer analysis, performed with expert systems, provide objective evaluation of the costs, risks, benefits and the rate of attraction of the project, for any scenario.

3.4.4. Conclusions

Artificial Intelligence provides versatile tools, which can be successfully used in the process of business management. [81]

The expert systems have a more user-friendly interface, the programming of such a tool using natural language and IF-THEN rules. However, the lack of information could lead to potentially disastrous results, as shown by the accuracy of only 81.21% of the constructed expert system.

ANNs prove to be a powerful tool for all the financial institutions involved in the process of sustaining agribusiness. The forecast accuracy of an ANN being over 95%, well superior compared to traditional methods, ANNs represent one of the best modern methods to evaluate the profit of a certain agricultural company and even its evolution in time.

But the most important feature of Artificial Intelligence tools is that there is no need to have a strong financial or agricultural knowledge in order to use them and interpret the generated outputs. Thus, both farmers without economic knowledge and economists without farming knowledge could take advantage of and at consequently for sustainable development and even avoiding failure.

3.5 The usage of artificial neural network in bankruptcy forecasting [59], [62]

3.5.1 Introduction

Artificial intelligence (AI) is a relatively new branch of computer science. Its origins lie in the mid-1950s, when the growing desire to obtain a machine able to reproduce human intelligence was equaled and surpassed by the development of new technologies. The most challenging AI task was creating an artificial version of the human central nervous system. This goal was achieved by artificial neural networks (ANNs). An ANN is strongly related to the mathematical optimization process, i.e., finding a functional minimized by a given dataset. The obtained functional was claimed to extrapolate any dataset related to the initial data. With the development of computers and computer software, ANNs became increasingly complex and efficient, and found applicability in various domains [57].

The use of ANNs as an economic forecast method regarding companies' evolution dates from 1997. The study developed by Wu [82] in 1997 suggested using an ANN for identifying firms that need more complex auditing investigations and underlined the superiority of AI methods over traditional methods in forecast accuracy.

From an investment perspective, Pinson [54] used AI in 2006 to create a multi-expert approach based on a meta-model for business risk assessment. The advantage compared to a traditional method is an adaptable system capable of giving dynamic resolution strategies to the problems. From a similar business forecast approach, AI methods have been used to predict corporate dividends. In 2008, Kim et al. [42] characterized the viability of Small Manufacturing Enterprises (SMEs) by employing methods such as adaptive learning networks. The main product and management characteristics of SMEs were investigated to establish the main influence factors for their long-term survival. Their overall accuracy was 61.31%.

In 2011, Chen [20] proved the superior accuracy of AI methods over traditional methods in predicting corporate financial distress. The AI methods used were principle component analysis, decision trees and logistic regression. The Eastern European economic climate is still influenced by the political development of the region in the second half of the twentieth century. Immediately after 1990, there was a widespread enthusiasm for starting new private companies. This enthusiasm is measured at an economical level through entrepreneurial indicators. In the short term, the number of private companies increased, but, as the enthusiasm was not always a good substitute for managerial skills and experience, many new-founded companies faced bankruptcy [55]. Moreover, the actual state of economic crisis severely affected the young Eastern European private companies. The uncertainty of the medium- and short-term situation of a company caused unwanted market blockages. The need for a good forecasting tool for the bankruptcy of Eastern European companies thus arises. Several authors used neural networks to meet this need, including Dorneanu et al [32] and proposed strategies for local use. [45]

Within the framework of European competitiveness policies, developing specific instruments for firm viability is a necessity, especially in the context of economic crisis. There is currently a push to rebuild the trust of economic agents to re-establish normal business trends [30] . The present economic crisis led to the bankruptcy of an important part of the SMEs. Moreover, this decline led to a recession of the global economy, especially in Eastern Europe, as shown by Kim et al. [42] and Dorneanu et al. [32]. Such a negative economic event reflected upon less-developed regions, influencing entrepreneurial behavior [45]. According to the Directorate General of Economic and Financial Affairs [4], the economic sentiment indicator in the EU has decreased from a value of 106.4 in December 2010 to 92.8 in November 2011. In this view, elaborating more accurate instruments for firm viability and risk assessment gained importance [42].

In response to the need for an efficient instrument that could predict firms' viability, we create an optimized neural network. The network considers four relevant factors regarding companies' financial states and returns a forecast of their bankruptcy state. Our work thus offers valuable information applicable to Eastern European SMEs and potentially beyond.

3.5.2 Methodology

Based on the available data, the present work chooses a representative sample of 55 Eastern European companies and computes four relevant factors regarding their financial states: revenue rentability rate, coverage rate of liabilities with cash flow, asset leverage and payment period of obligations, described by Tucu and Rotarescu in 2006 [77]. An ANN is constructed and trained to recognize the state of bankruptcy. The influence of the network parameters is next studied and the ANN is optimized to obtain a high level of forecast accuracy, over 95%.

The learning capacity is probably the fundamental feature of a neural network, as modern algorithms plan to emulate this characteristic within computers. The fundamental ANN features can be divided into two categories: architecture and properties. An ANN's architecture defines the structure, giving the number of neurons and their connections; other features are the Input/Output (I/O), synapse intensity, deviations and activations. An ANN's properties concern the learning method, synapse reactivation, continuous associations and comparisons of the new information with the existing information, and how the new information is categorized.

Instruction vectors are sequentially presented in an ANN and the synaptic weights, which memorize the entire knowledge of the network, are adapted to extract the information contained in these vectors [28]. The issue thus regards the most efficient use of a neural network in those applications that would fully exploit their specificity. Based on the literature and empirical evidence, it can be stated that ANNs are generally used in the types of problems that present the following features:

- the mathematical model of the process is unknown, has a too high complexity associated with an insufficient accuracy or cannot be determined in certain cases;
- the available data are incomplete in certain cases or are affected by noise and turbulence; or
- there are a number of restrictions applied to the process that must be simultaneously optimized [59].

3.5.3 ANN use in forecasting bankruptcy

3.5.3.1 The structure and topology of the ANN

The neural network developed is a classification (pattern recognition) network. It is implemented using the neural network toolbox of Matlab. Figure 3.5.3-1 depicts the network topology, training algorithms and network progress.

The network topology contains one input layer of four units; one, two or three hidden layers of 10 or 20 units; and one output layer with a single output [71]. The four units of the input layer are financial rates, chosen from the classical forecast methods: revenue rentability rate (X1), coverage rate of liabilities with cash flow (X2), asset leverage (X3) and the payment period of obligations (X4) [79]. The economical meanings of these units are the following:

X1 =Net profit/Income

X2 =Cash Flow/Active

X3 =Liabilities/Assets

X4 =Liabilities/Turnover x 360

The algorithms used are presented in the following.

Data division (i.e., the selection mode of the 3 types of samples - training, validation and test - from the initial input set) is performed randomly. The ratios of the input data are 90% for the training set, 5% for the validation set and 5% for the test set.

For the training phase, a scaled conjugated gradient back-propagation algorithm is used, for which the maximum number of epochs to train is set to 1000. To improve network performance, early stopping of the training algorithm is also used.

The training algorithm ends in one of the following situations: the maximum number of epochs is reached (in our case, this value is set to 1000), the maximum time is exceeded (which is not our case, as the process is static), performance is minimized to the goal (in our case, the default goal is 0), the performance gradient falls below a predefined value (in our case, the default value is 10^{-6}) or validation performance has increased more than a predefined number of times since the last time it decreased (in our case, the default value 5). In our case, the training algorithm ends because the validation performance increased above the maximum value.

The performance of the training algorithm is measured by the mean squared normalized error function. The derivative is the default derivative and in our case, it returns the performance gradient needed for the training algorithm.

3.5.3.2 Training, validation and test of the neural network

To evaluate network performance, the confusion matrices and error rates were studied. According to the ANN features, two steps were taken.

Step 1 Training the network using 49 companies.

Step 2 Checking the network forecast accuracy using another 6 companies (3 for the validation phase and 3 for the test phase).

Figure 3.5.3-2 shows the confusion matrices corresponding to the training and validation testing phases of the neural network build-up procedure, respectively, as well as a global confusion matrix embedding the three matrices, as computed above. The matrices are structured such that the rows contain the network's output and the columns contain the desired targets. The red tiles represent the false positive and false negative results, the green tiles are true positive and true negative output, the gray tiles contain the total marginal percentages and the blue tile contains the overall classification percentage.

For the training phase, from 49 total subjects, 24 were marked true positives, 1 as a false negative, 0 as false positives and 24 as true negatives, leading to an overall accuracy of 98%.

For the validation phase, from 3 total subjects, 2 were marked true positive and 1 true negative, leading to an overall accuracy of 100%.

The test phase considered 3 subjects, 2 marked as true positive and 1 as true negative, with an overall accuracy of 100%.

The overall accuracy is thus 98.2%, corresponding to 28 true positive, 1 false negative, 0 false positive and 26 true negative marks (Figure 3.5.3-3).

This result is compared to the actual forecasting marks, which has an overall accuracy of 92.0%, corresponding to 48 true positive, 1 false negative, 8 false positive and 55 true negative marks.

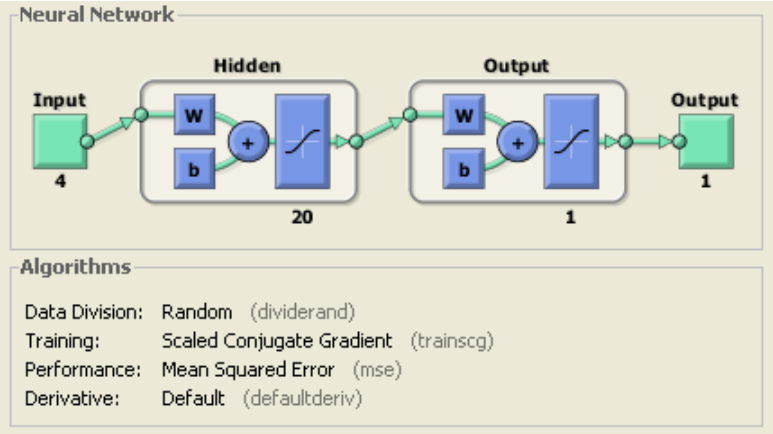

Fig. 3.5.3-1. Neural network (Source: authors' elaboration with Matlab Program)

Figure 3.5.3-4 shows the overall evolution of the training phase. Two aspects were monitored: the performance gradient (i.e., the backward derivative of the performance with respect to weights and biases) and the validation test (i.e., the number of times the error on the validation set increased since the last decrease). In our case, the error on the validation set increased during the last six epochs. This situation means that for the last six epochs, the network begins to overfit the data, memorizing the training data rather than learning to generalize from the training set, leading to the necessity of stopping the algorithm early to obtain a network with good generalization properties. The early stopping technique states that the parameters assigned to the network are those for which the validation error is minimized. In our case, these parameters are those corresponding to the 38th epoch (Figure3.5.3-5).

Figure 3.5.3-5 displays the error evolution during all 44 training epochs. The training error (shown in blue) and, even more important, the test error (shown in red) and the validation error (displayed in green) are represented. A small training error shows that the model fits the training data well, while a lower testing error signifies that the neural network displays good performance on real-life data that differs from the training set. In our case, the best validation error was obtained for the parameters corresponding to the 38th training epoch.

To compare the accuracy of the forecast from the two methods, the same input data has been used both for network and Score A methods. Tables 3.5.3-1, 2 and 3 gather the obtained results.

Table 3.5.3-1 presents training data, Table 3.5.3-2 presents validation data and Table 3.5.3-3 presents test data. The first four columns contain the first four input variables. The fifth column represents the forecast given by the network, using the following coding: 0 for bankruptcy and 1 for non-bankruptcy. The sixth column is the Score A function computed by classical methods, for which a negative value signifies that the firm is in bankruptcy, a value over 2.05 signals a non-bankruptcy state and a value between 0 and 2.05 signifies uncertainty regarding the bankruptcy state. The seventh column is the real situation of the (non-) existence of the bankruptcy and the eighth column is the accuracy of the forecast.

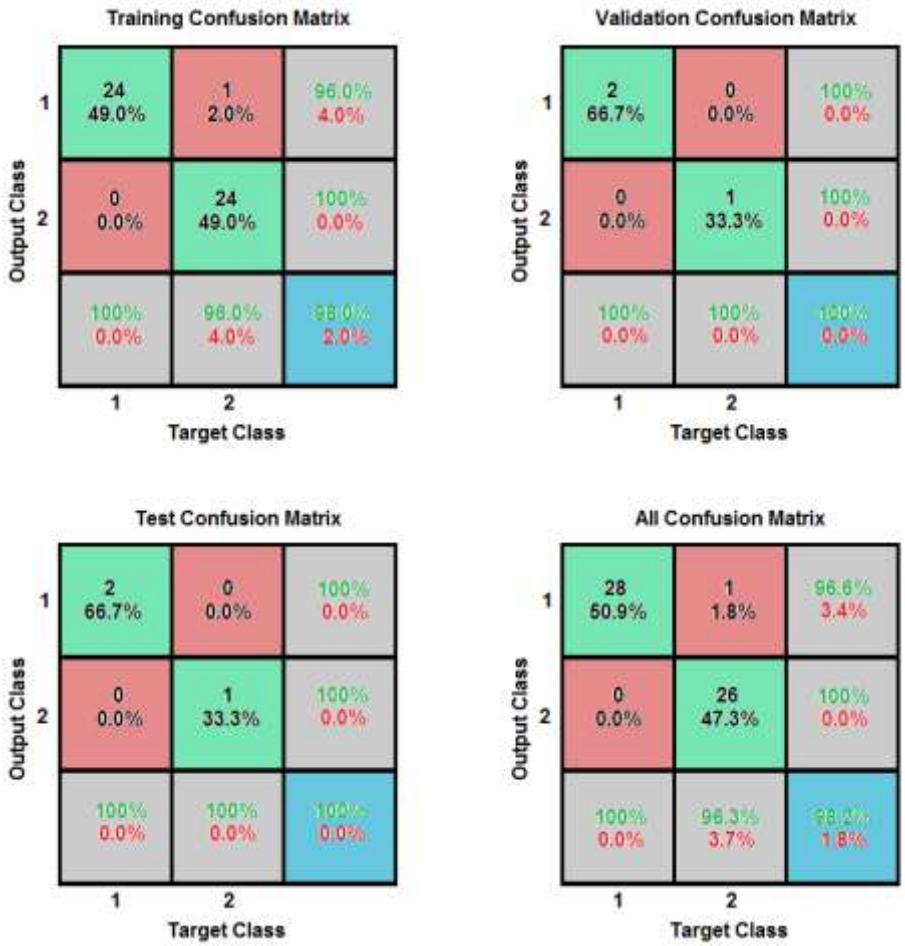

Fig. 3.5.3-2. The confusion matrix during training, validation and testing phases

Fig. 3.5.3-3. The confusion matrix corresponding to the actual forecasting marks

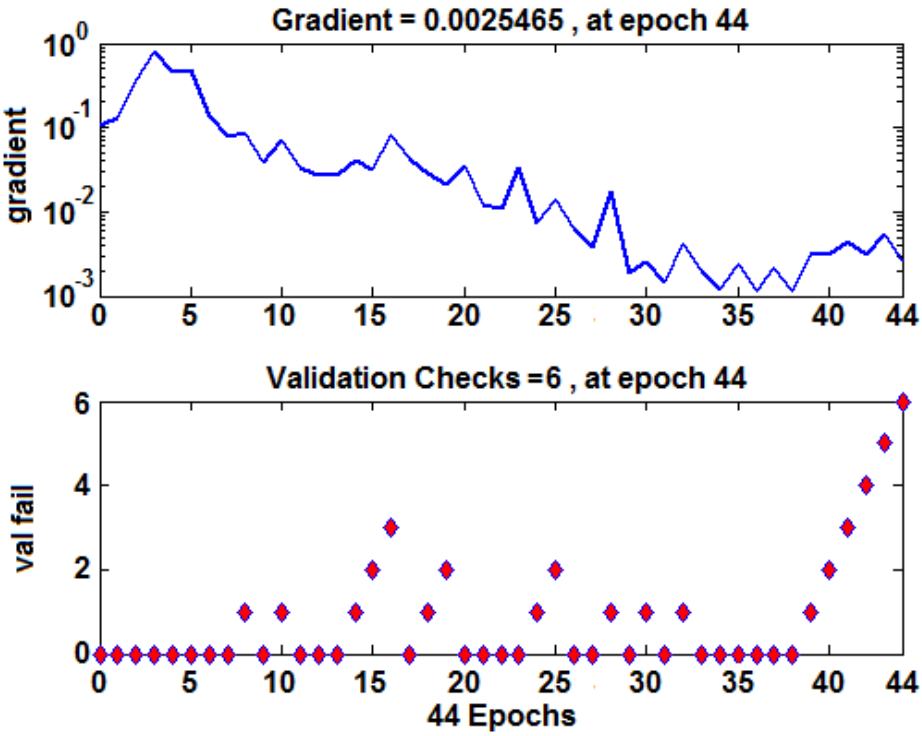

Fig. 3.5.3-4 Evolution of the training phase

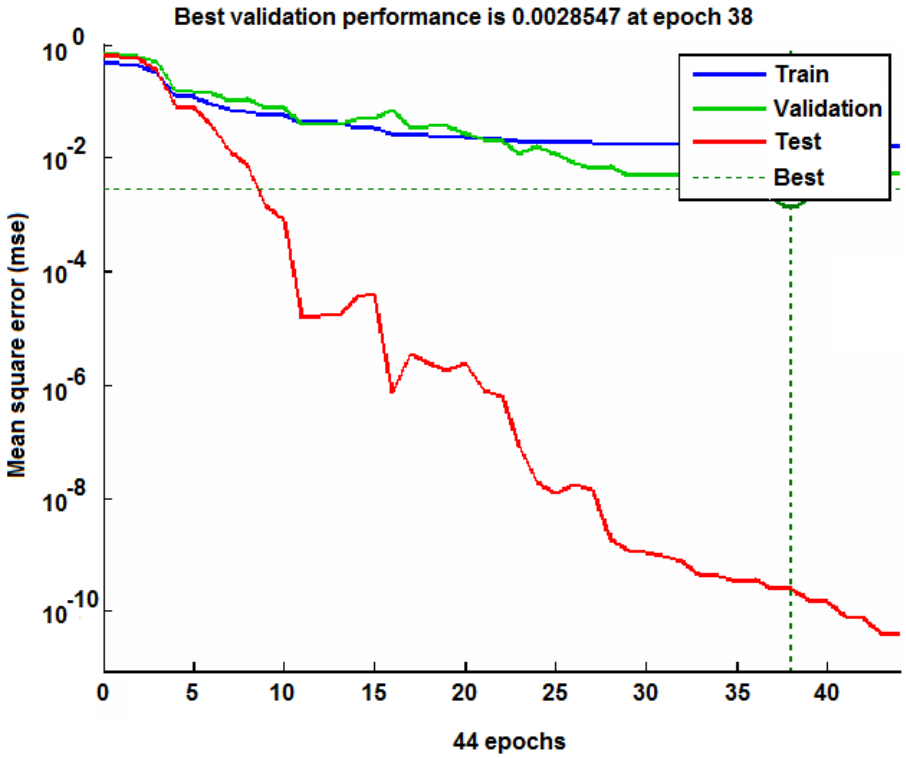

Fig. 3.5.3-5. Error evolution during all training epochs

Table 3.5.3-1. Sample training data

X1	X2	X3	X4	Y network	A	Y real	True/ false
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
7.10	17.60	41.00	215.00	1.00	2.71	1.00	True
5.20	459.00	0.40	6.00	1.00	30.68	1.00	True
18.20	-9.10	4.20	39.00	0.00	3.40	1.00	FALSE
1.20	8.40	38.40	172.00	1.00	2.42	1.00	True
0.10	0.30	16.00	302.00	1.00	1.70	1.00	True
2.00	13.00	10.60	215.00	1.00	3.70	1.00	True
0.20	50.60	9.30	38.00	1.00	7.54	1.00	True
1.20	6.50	32.60	476.00	1.00	-0.57	1.00	True
0.10	21.80	12.60	143.00	1.00	4.71	1.00	True
14.60	242.60	13.10	26.00	1.00	18.74	1.00	True
-12.00	-35.20	34.70	117.00	0.00	-0.00	0.00	True

Table 3.5.3-2. Sample validation data

X1	X2	X3	X4	Y network	A	Y real	True/ false
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
2.30	9.00	78.20	54.00	1.00	1.72	1.00	True
18.30	144.00	13.40	90.00	1.00	12.97	1.00	True
-5.10	-6.10	55.10	113.00	0.00	1.00	0.00	True

Table 3.5.3-3. Sample test data

X1	X2	X3	X4	Y network	A	Y real	True/ false
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
4.50	17.10	59.50	106.00	1.00	2.71	1.00	True
8.70	33.20	67.90	99.00	1.00	3.49	1.00	True
-2.70	-6.10	56.90	111.00	0.00	1.08	0.00	True

3.5.4 Optimization of ANN

The network developed in the previous section can be optimized to obtain forecastings of a higher accuracy. The optimization can be made using two classes of methods: empirical and statistical methods.

3.5.4.1 Optimization of the neural network architecture using quasi-empirical method

According to Slavici, [62], [71] six relevant factors influence the network's architecture: network topology, learning method, the nonlinearity function used, number of hidden layers, neuron number of each layer and number of training epochs. At this stage, all six factors are considered to be *a priori* determined. If only four different values are considered for each factor and no additional lines are made for a given set of values, 4^6 = 4096 experiments would be required. Using a statistical method for experiment planning is thus necessary.

A first quasi-empirical experiment plan was elaborated and presented with the preliminary conclusions by Slavici [62], [71]. From the variety of existent neural networks

typologies (architectures), the achievement of four topologies has been made using Matlab functions (in other cases, conflicts in network exploitation have occurred). The best results obtained corresponded to a feed-forward type of neural network. This topology will be used below for the statistical study of the obtained results.

3.2.4.2 ANN optimization using scientific research and statistical methods

Statistical studies have been performed to model process accuracy and establish the influencing factors. Among the factors considered with quasi-empirical methods, the most influencing ones are the number of training epochs (e) and the number of layers (s). The number of neurons per layer (n) is also considered a parameter.

The values for these factors are

for the number of epochs (e): 50, 100, 200 or 500;

for the number of layers (s): 3, 4 or 5;

for the number of neurons per layer (n): 10 or 20.

The early stopping condition was not imposed, so the experiments ended when the maximum number of training epochs was reached.

Tables 3.5.3-4 and 5 present the intermediate results of the dispersion bi-factorial analysis performed successively for the two factors (epochs and layers). The Fischer criterion value - one of the strongest tools in appreciating the significance of a variable - is thus established. The computed value is compared with the value in the lookup tables. If the computed value is higher than the corresponding lookup table one, the correspondent variable is considered significant for the analyzed objective function.

Table 3.5.3-4

STAT. GENERAL MONOVA		MAIN EFFECT: NO EPOCHS (t1. Sta) 1 - No. Epochs, 2 - No. Layers			
Dispersion source	Square sum	Freedom degrees	Estimated dispersions	Fischer criterion	Level
Error effect	2055.222 76.000	3 24	685.0741 3.1667	216.3392	000000

Table 3.5.3-5

STAT. GENERAL MONOVA		MAIN EFFECT: NO EPOCHS (t1. Sta) 1 - No. Epochs, 2 - No. Layers			
Dispersion source	Square sum	Freedom degrees	Estimated dispersions	Fischer criterion	Level
Error effect	24.05556 76.000	2 24	12.02778 3.16667	3.7982246	036887

Figure 3.5.4-1 shows the forecast accuracy depending on the number of training epochs, the number of neurons per layer being considered a parameter (10 or 20 neurons per layer). It can be observed that a better accuracy is achieved using 10 neurons per layer than using 20 neurons per layer. The accuracy obtained for 500 training epochs is also slightly higher than that obtained for 200 training epochs.

Figure 3.5.4-2 illustrates the forecast accuracy as a function of the number of training epochs, with the number of layers considered a parameter (3, 4 or 5 layers). These values are computed based on the data included in Table 3.5.3-6. Table 3.5.3-6 reflects the forecast accuracy obtained for a specified number of training epochs and layers. For each pair of values (s,e), three repetitions of the experiment were performed and the mean values were computed. While a lower number of training epochs (50 or 100) requires 4 layers for better accuracy, 3 or 4 layers are required for better accuracy for a higher number of training epochs (over 200). The best accuracy obtained is for 200 training epochs and 3 layers.

Table 3.5.3-6

Number of epochs	Number of layers	Forecast accuracy	Mean value	Dispersion
50	3	70.000		
50	3	72.000	71.66666	1.527525
50	3	73.000		
50	4	70.000		
50	4	75.000	74.00000	3.605551
50	4	77.000		
50	5	71.000		
50	5	72.000	70.00000	2.645751
50	5	67.000		
100	3	80.000		
100	3	81.000	80.33334	0.577350
100	3	80.000		
100	4	82.000		
100	4	83.000	82.66666	0.577350
100	4	83.000		
100	5	81.000		
100	5	82.000	81.00000	1.000000
100	5	80.000		
200	3	90.000		
200	3	92.000	91.66666	1.527525
200	3	93.000		
200	4	91.000		
200	4	92.000	90.66666	1.527525
200	4	89.000		
200	5	90.000		
200	5	88.000	88.33334	1.527525
200	5	87.000		
500	3	90.000		
500	3	91.000	89.66666	1.527525
500	3	88.000		
500	4	90.000		
500	4	91.000	90.33334	0.577350
500	4	90.000		
500	5	88.000		
500	5	91.000	90.33334	2.081666
500	5	92.000		

Figures 3.5.4-1 and 3.5.4-2 depicted the discrete dependence of the forecast accuracy on two given sets of data: the number of training epochs and the number of either layers or neurons per layer. These dependences give information about the forecast accuracy value for

specific values of the parameters (n,e), respectively (s,e). To obtain more accurate answers about these dependences, two continuous functions describing the evolution of the forecast accuracy on the parameters (n,e), respectively (s,e), are required. The maximum value of these functions is then computed to obtain the values of the parameters for which the forecast accuracy is highest. Based on the least squares method, two objective functions have been constructed, describing the dependence of the forecast accuracy on its most influencing factors. The first objective function describes the dependence of the forecast accuracy on the number of neurons per layer n and epochs e and it has the following expression:

$$P(n,e) = 21.648 + 5.92 * n + 0.194 * e - 0.201* n^2 + 0.0001 * n* e$$

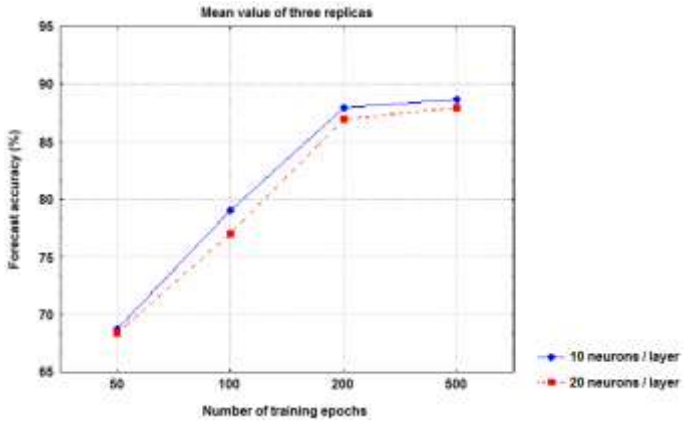

Fig. 3.5.4-1. Forecast accuracy versus number of neurons per layer

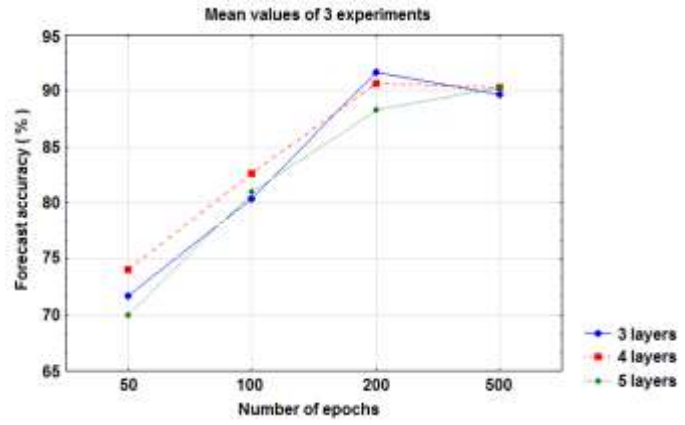

Fig. 3.5.4-2. Forecast accuracy versus number of layers

The second objective function describes the dependence of the forecast accuracy on the number of layers s and epochs e and it is given as:

$$P(s,e) = 43.543 + 11.501 * s + 0.182 * e - 1.542* s^2 + 0.002 * s* e$$

Figure 3.5.4-3 shows the forecast accuracy for the first objective function. Good forecast accuracy for the first function (over 97%) can be achieved using a number of neurons per layer close to 15 and a number of training epochs close to 350. Figure 3.5.4-4 shows the forecast accuracy for the second objective function. In this case, the best accuracy (over 95%) can be achieved for a number of training epochs close to 350 and the number of layers has

little influence on this maximum value. A good forecast accuracy, over 95%, can be achieved with a neural network having the following structure: close to 350 training epochs, close to 15 neurons per layer and close to 4 layers.

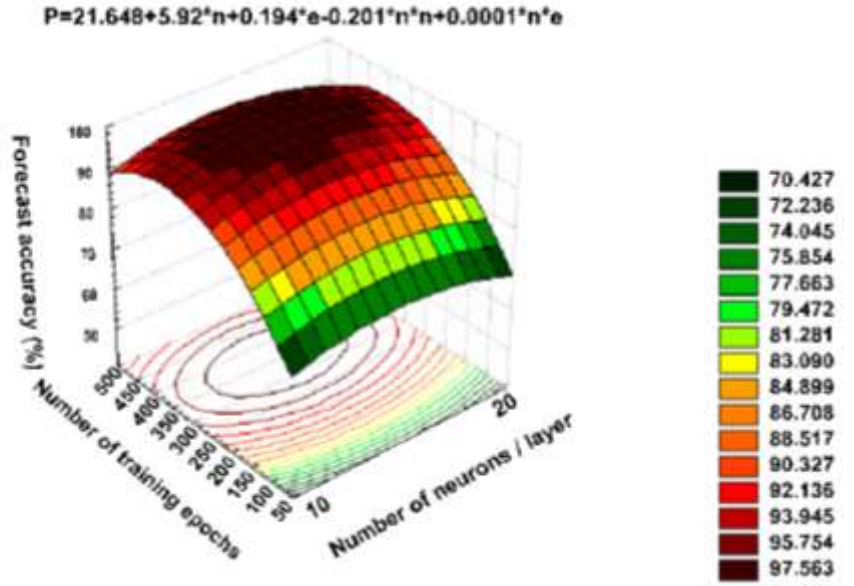

Fig. 3.5.4-3. The forecast accuracy of the first objective function

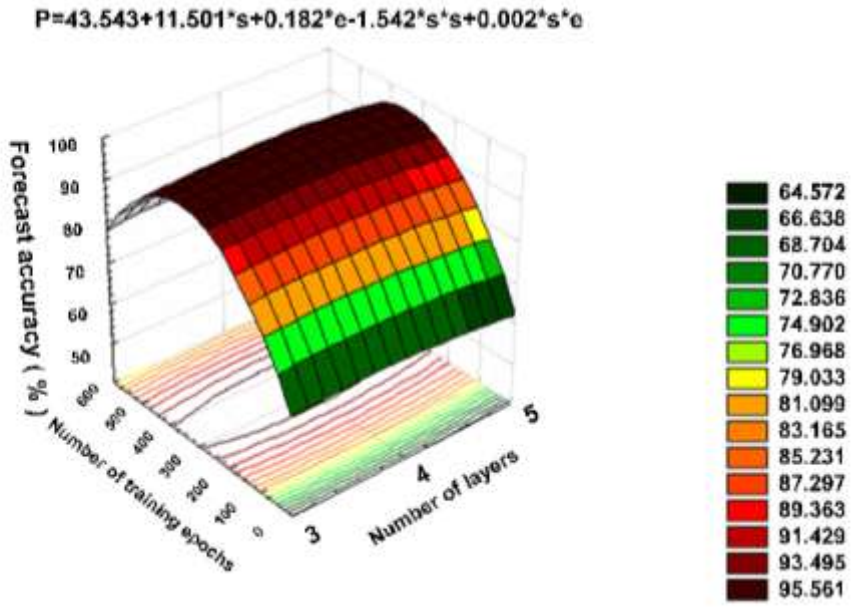

Fig. 3.5.4-4. The forecast accuracy of the second objective function

3.5.5 Conclusions

Using ANNs to predict company bankruptcy is extremely efficient, as the forecast accuracy is higher than in traditional methods. A data volume higher than the network training set can thus be considered. The data processing has been made using AI methods and not mathematical modeling (with statistical tools) for the following reasons:

a) a mathematical model of the process is either unknown or too complex and is associated with insufficient accuracy; it cannot even be determined in some cases.

b) the available data are incomplete or subject to noise in some cases.

c) there are a number of constraints applied to the process that require being simultaneously optimized.

By studying the dependence of the forecast accuracy on the network topology, an optimized structure with a forecast accuracy over 95% has been developed. This forecast, obtained by AI methods, is superior to those obtained by traditional methods and does not require statistical tests or research planning with factorial type tests.

The benefits brought by ANN and expert systems compared to the classical economic forecast and decision making methods include: higher forecast accuracy, faster decision making and the possibility of dynamical update of the wide databases constructed. The increasing use of AI methods is thus justified and represents an added value for the financial environment.

3.6 Optimization of Artificial Neural Network architecture [23], [60], [62], [71]

Optimality is a common problem for all the sections describing the usage of ANN, so it is developed here only one time, using the data base from bankruptcy (section 3.5, and especially subsection 3.5.4). These considerations can easily be extrapolated for all other sections.

3.6.1 ANN structure and parameters optimization training in order to increase forecast accuracy of company bankruptcy. Quasi-empirical methods

The purpose of this subparagraph is that of improving forecast accuracy by optimizing ANN structures of the various parameters specific to ANN and to parameters of training.

It is estimated that it is one of the most difficult problems in the implementation and use of ANN, in many works being considered an art; increased difficulty of this problem is the large number of parameters that can be changed, some of them can not even be quantified, so the choice of the network structure (topology) and chosen training method is about the experience in the field of user, experience that have to be gained by applying the ANN to the most varied cases [23].

Further will be presented in the author's opinion the main parameters that could compete to optimize the forecast, being removed from the beginning ("in common sense") those considered irrelevant. Obviously it requires a statistical study, using specific methods of removing the relevant parameters:

- network topology (spread before perception, radial ...)
- learning method;
- non-linearity adopted function;

- number of hidden layers;
- number of neurons in each layer;
- number of training epochs;
- nonlinearity function
- training function

If each of the six factors considered aprioristic determinants would be considered only four different levels and would not make additional replicas for a given level of required parameters would be $4^6 = 4096$ experiments, and therefore would be required the use of statistical methods for planning the experiment.

Within this paragraph will be presented a first organizing of the experiment, being elaborated a quasi-empirical planning, followed by a developing of the first set of preliminary conclusions. There are displayed in the tables, obtained experimental results, indicating that generally have been made three replicas (the successive experiments for each line were kept the same with input parameter values).

3.6.2 (Scientific) analysis and synthesis of experimental data [71]

In the previous section the input data were presented and their appliance in the case of a quasi-empirical experiment planning regarding the ANNs usage to forecast the small firms bankruptcy.

Based on the knowledge gained in the above mentioned section, this section aims to scientifically plan the experiment, using specific statistical tools in order to optimize the construction and usage of the ANNs.

The analyzed situation is encompassed in the general field of dispersion analysis. Dispersion analysis is s statistical method of analyzing the measurement data, values obtained for an objective function (in this case, forecasting accuracy in percents), which depend on one or more factors with simultaneously action. The purpose is to establish the significance of these factors on the analyzed function.

The main idea of dispersion analysis follows from a theorem regarding some dispersion properties, according to which if one estimates the dispersion of a sequence of measurements on a objective function in two different ways, by taking into account two or more different influencing factors and eliminating their influence in order to compare the two values of the dispersion, then one could obtain information on the influence of the analyzed factor on the objective function. The influencing factors could be qualitative or quantitative for the studied phenomenon, and could take different levels (values), controlled by the experimenter.

The general principles of dispersion analysis were implemented using the facilities provided by the software Statgraphics Centurion [9].

In particular, the factors influencing the forecasting accuracy and the correlations between variables were studied in two situations:

The dependent variable, forecasting accuracy and the independent variables the number of training epochs and the number of layers.

The dependent variable, forecasting accuracy and the independent variables the number of training epochs and the number of neurons in the inner (intermediary) layer.

Since the two situations are similar with respect to the utilized algorithms, in the following only the first case will be detailed. The selection of the two input variables (number of epochs and number of layers) was performed using variable relevance criteria (e.g., Fisher test) which are not the subject of the present study.

For the two input variables, the following levels were considered:

For the number of epochs, 4 levels, i.e. 50, 100, 200, 500

For the number of layers, 3 levels, i.e. 3, 4, 5

According to these input data, the experiment was planned and organized as detailed in Table 3.6.2-1.

Table 3.6.2 -1. Experiment details

STA BAS STA	**Form: t1. Sta (10v * 36c) Variabiles: 1-3, cases: 1-36**		
	NR.EPOCHS	**NR.LAYERS**	**PRECISION (%)**
	50.000	3.000	70.000
	50.000	3.000	72.000
	50.000	3.000	73.000
	50.000	4.000	70.000
	50.000	4.000	75.000
	50.000	4.000	77.000
	50.000	5.000	71.000
	50.000	5.000	72.000
	50.000	5.000	67.000
	100.000	3.000	80.000
	100.000	3.000	81.000
	100.000	3.000	80.000
	100.000	4.000	82.000
	100.000	4.000	83.000
	100.000	4.000	83.000
	100.000	5.000	81.000
	100.000	5.000	82.000
	100.000	5.000	80.000
	200.000	3.000	90.000
	200.000	3.000	92.000
	200.000	3.000	93.000
	200.000	4.000	91.000
	200.000	4.000	92.000
	200.000	4.000	89.000
	200.000	5.000	90.000
	200.000	5.000	88.000
	200.000	5.000	87.000
	500.000	3.000	90.000
	500.000	3.000	91.000
	500.000	3.000	88.000
	500.000	4.000	90.000

	500.000	4.000	91.000
	500.000	4.000	90.000
	500.000	5.000	88.000
	500.000	5.000	91.000
	500.000	5.000	92.000

After processing the results, according to previously mentioned algorithms were achieved the following drawings.

Figures 3.6.2-1 and 3.6.2-2 present graphically and in an objective way the function variation (forecast accuracy in percents), according to the two variables considered in this first phase: the number of training sessions and number of layers. Moreover, by applying the least squares method for the experimental data, a second degree model of the following type was obtained for the forecast accuracy:

$$Prec = 43.543 + 11.501 * s + 0.182 * e - 1.542 * s^2 + 0.002 * s * e$$

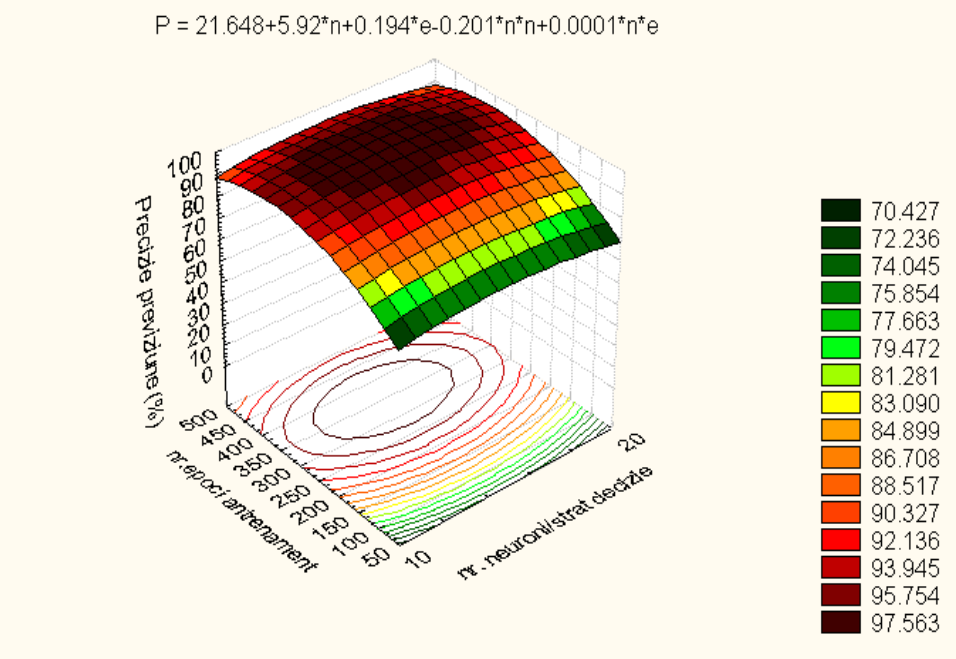

Fig. 3.6.2-1. Forecast accuracy

Figures 3.6.2-1 and 3.6.2-2 depict the same dependence, the difference being in the origin of the z axis, corresponding to the forecast accuracy: in Figure 3.6.2-1 the origin is considered at 0% and in Figure 3.6.2-2 at 50% level.

Figure 3.6.2-4 illustrates graphically and comparative the dependence of the objective function on the number of training epochs, the number of layers being considered as parameter.

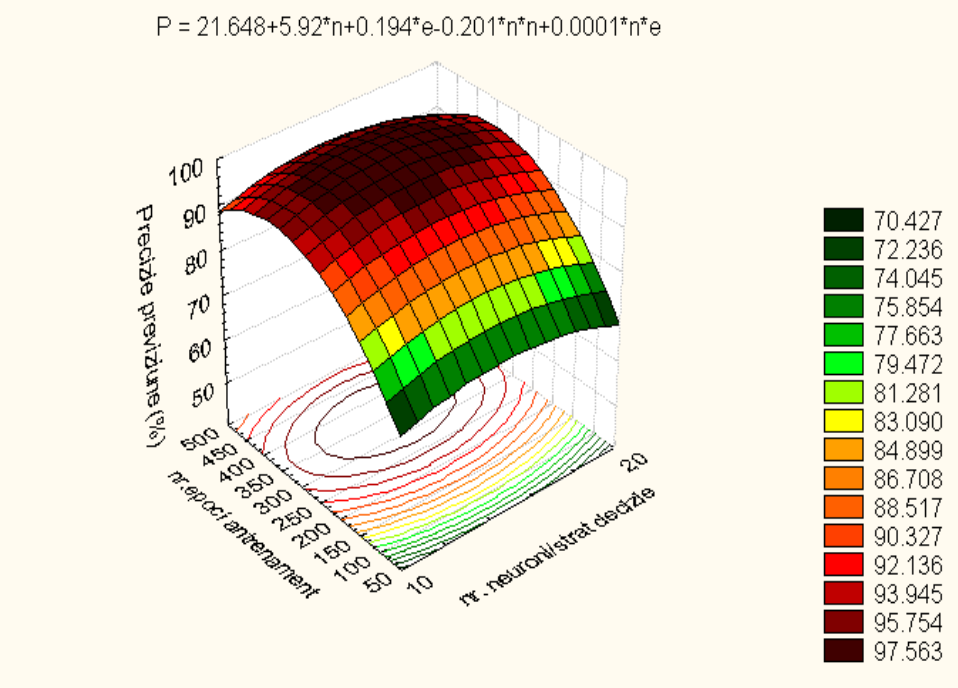

Fig. 3.6.2-2. Forecast accuracy

Figure 3.6.2-3 represents the result distributions.

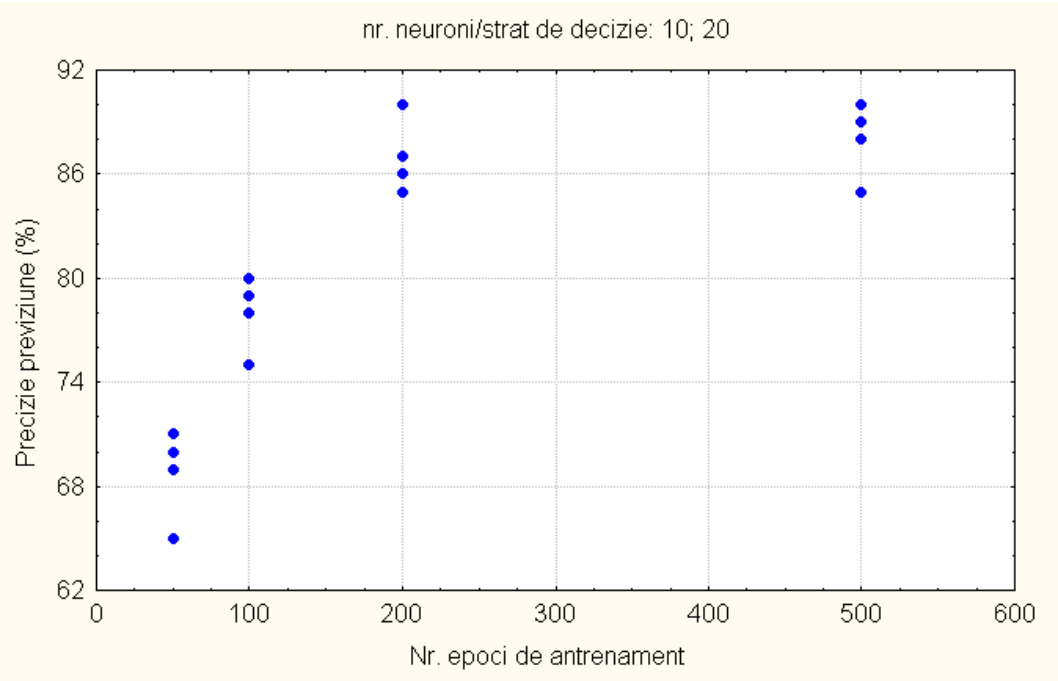

Fig. 3.6.2-3 The result distributions.

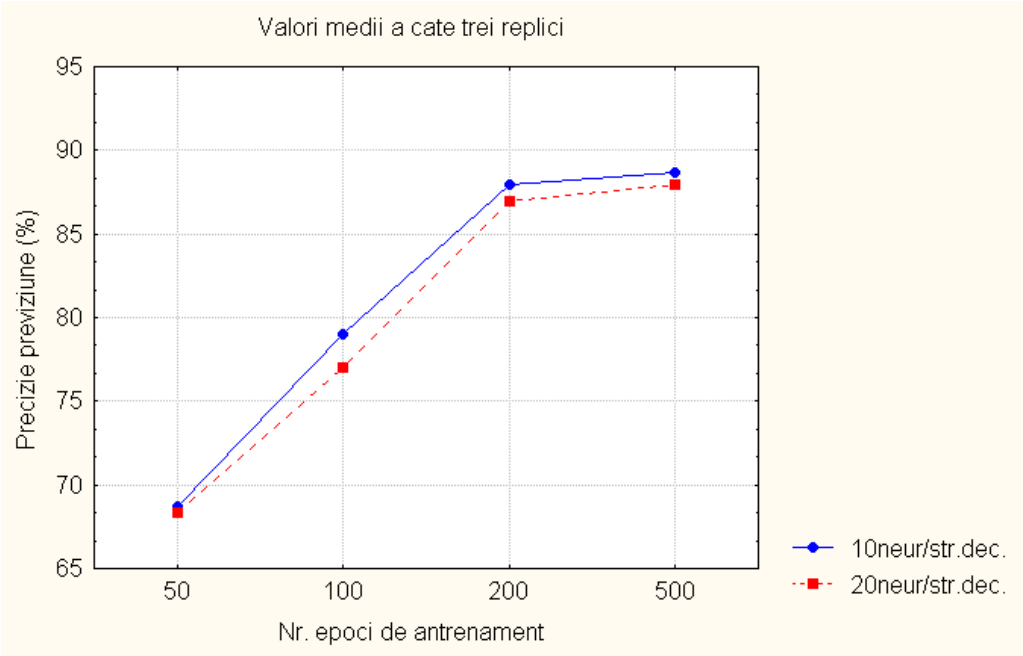

Fig. 3.6.2-4 The objective function dependence on the number of epochs.

Figures 3.6.2-5, 3.6.2-6 and 3.6.2-7 are depict the most important statistical quantities used in undertaking research using the following conventions of representation:

- point marks the average position;
- rectangle marks the standard error;
- the difference between the two horizontal segments marks the standard deviation.

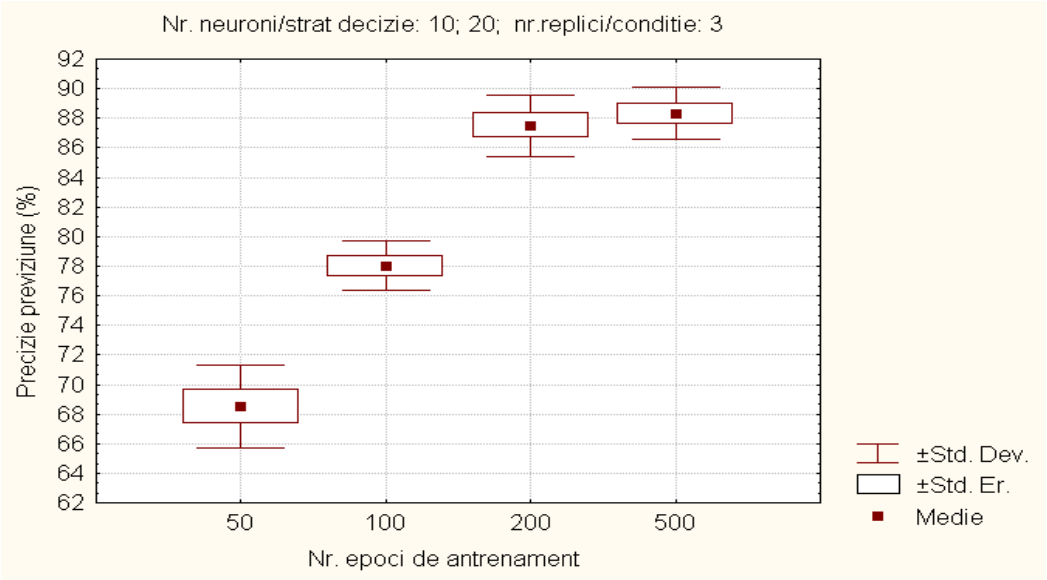

Fig. 3.6.2-5. Statistical quantities used in undertaking research

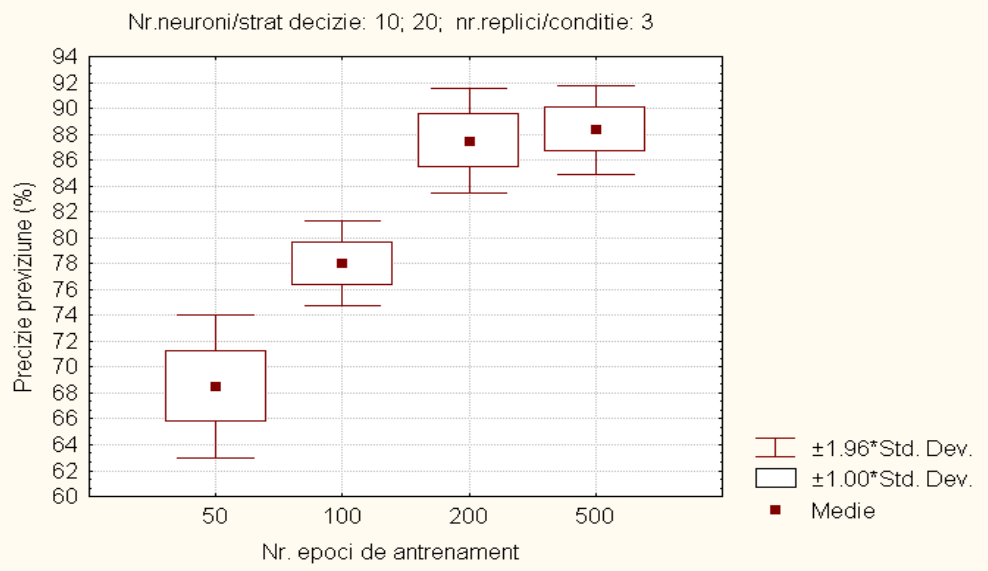

Fig. 3.6.2-6. Statistical quantities used in undertaking research

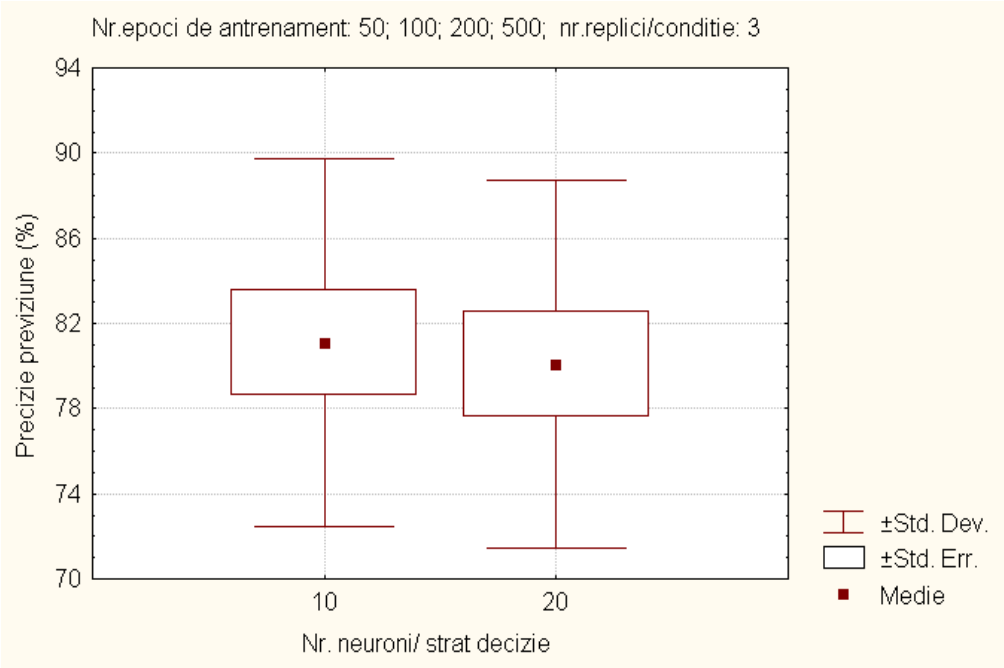

Fig. 3.6.2-7. Statistical quantities used in undertaking research

IV. SCIENTIFIC ACHIEVEMENTS (PROFESSIONAL AND ACADEMIC) UPON THE INDUSTRIAL ENGINEERING PROJECTS MANAGEMENT OPTIMISATION

4.1 Grants, projects development, accessing. Is this a scientific achievement?

4.1.1 Projects and grants' framing within the certification thesis [2], [3], [10]

In accordance with European and national stipulations and tradition, a certification thesis must emphasize the scientific, professional and academic achievements, on thematic disciplinary and pluri disciplinary directions, which cannot be assimilated as a new doctorate or a continuation of the existing ones, and must present the candidate's personal evolution on a large scale of capacities and availabilities, being thus not reduced to the scientific achievements. It is hard to be framed within scientific, professional or academic achievements; the author provides arguments for its framing in all the three categories:

a. Arguments for framing as scientific results:

- The emergence of the specific field, as a branch of project management;
- The development of special evaluation techniques related to project's social benefits;
- The development of quantification techniques related to non financial benefit, providing algorithms and specific procedures;
- The setting of technologic and scientific parks as centeres for scientific emulation;

b. Arguments for framing as professional results:

- every modern CV contains as a mandatory key element the accessing of some grants, projects;
- the accesing of grants stimulates the research and lab development, as well as the organizing of scientific events;
- it allows the set up of modern institutions, like Technological and Scientific parks, industrial parks, spin-off or start-up companies, generating the premises for the development of research teams, and even research directions; one of the missions of a true doctorate leader is to create or develop new research directions.

c. Furthermore, the projects can be regarded as academic achievements, because in the context of the new antreprenorial University concept, a competitive financing of a university is hard to imagine without project or grant resources; project development and accessing favourizes team building and the development of new branches or directions of research under the leader's coordination.

4.1.2 European projects – an interdisciplinary field of expertise for the regional development [2], [3], [10]

In developing a project, the starting point is made by the establishment of objectives which will be pursued during the timeframe of the project. These objectives are categorized as general and specific.

The general objective regards the sustainable interest of the economic agent more at a qualitative level, while the specific ones sustain the previous ones at a more quantitative and detailed level. Following the establishment of objectives, the next stage is the detailed planning of the activities to be developed. These activities along with the other steps of the project are in strong connection to the horizontal principles (eg. sustainable development, etc).

The outcomes of the project are in the end measured through result indicators, which are determined by ex-post analysis. [3] These instruments are established from the beginning with two different types of values: the initial value (before the actual project) and the target value (the value planned). These indicators are actually measuring the degree in which the economic agent achieved its commitment of sustainable positive action in the economic environment in which activates. Some of these indicators are compulsory and have a standard form and other can be created in order for the beneficiary (the economic agent) to have the freedom to measure the added value brought by its project in any form that is more related to the specificity of its actions. [30]

In this view, the beneficiaries often do not take the time of reading the entire documentation and therefore, do not posses a high comprehension of the logic of the program itself and its objectives. Consequently, the level of real qualitative impact of the won projects is lower than the targeted one. Moreover, this main factor is catalyzed by low interest in regional convergence research for the correspondent region or absence of key data in elaborating such studies, considering the fact that local development agendas or other compulsory development plans often do not present the competitive advantages of the regions and focus mainly on the disparities. In consequence, the first objective is based on more targeted objectives than empirical facts.

4.1.3 Implemented projects within national and international call for proposals

In all the bellow mentioned projects I was manager, or at least manager for Romanian part in international projects, and in project number 17 only financial manager [83].

Project title	Project ID	Amount	Programme	Priority axis	Key area of intervention	Action
Cross – border projects						
1.Joint partnership and joint sustainable scientific research quality management development with Nyregyhaza University [93]	HURO/ 0801/066	50.000 euro,	RO-HU Cross – border Cooperation Programme 2007 -2013	2. Cross-border cooperation area economic and social cohesion strengthening	2.2. RDI cooperation promotion	2.2.3 RD sectors cooperation

Project title	Project ID	Amount	Programme	Priority axis	Key area of intervention	Action
2.Towards a new quality dimension within Romanian and Hungarian University Education – Cross – border quality implementation and monitoring center – Lead Parner ISF, partner Szeged University – [92]	HURO/ 0801/036	150.000 euro, from which 107.500 Euro ISF contribution	RO-HU Cross – border Cooperation Programme 2007 -2013	2. Cross-border cooperation area economic and social cohesion strengthening	2.3 Labour market and education cooperation – joint development of knowledge and competences	2.3.1 Labour market and education cooperation – joint development of knowledge and competences
3.Quality in education, college and universities, using innovative methods and new laboratories – Lead Parner FIS- [96]	IPA 117 Cod MIS-ETC 488	117.270 Euro	Romania-Serbia IPA Cross-Border Cooperation Programme	3. Promoting "people to people" exchanges	Measure 3.3 Increase educational, cultural and sporting exchange	-
4.Cross-border initiative for research and development activities, (and) cooperation between economy and scientific educational institutions, in Serbian and Romanian historical Banat, as contribution to competitiveness improvement and regional identity, according to EU standards – [97]	IPA 136 Cod MIS-ETC 507	297.636 Euro total / 80.310 Euro FIS	Romania-Serbia IPA Cross-Border Cooperation Programme	1. Economic and Social Development	Measure 1.4 Support increased levels of R&D and innovation in the border region	-
5.Train and win in HU-RO style- [94]	HURO/ 1001/148/ 2.3.1	63.034 Euro	Hungary-Romania Cross-border Co-operation Programme 2007-2013	2. Strengthen social and economic cohesion of the border area	2.3. Co-operation in the labour market and education - joint development of skills and knowledge	2.3.1. Cooperation between educational institutions
6.Romanian – Serbian joint business planning, hosting and supporting – Cross border center for SME's planning, hosting and supporting within Timis County and Southern Banat District [104]	RO 2006/018-448.01.01.10	110.000 euro	2008/2009 In partnership with Development, Public Works and Households Ministery and RO CBC Office from Timisoara			
POSDRU projects						
7.West Region new labour market integration opportunities	POSDRU/ 103/5.1/G/ 79077	1.170.535 lei	POSDRU 02.10.2010-30.06.2012	5 Active measure for	5.1 Development and	

Project title	Project ID	Amount	Programme	Priority axis	Key area of intervention	Action
[100]				employment promotion	implementation of employment active measures	
8.Together for success through relevant and actual qualification achievement [101]	POSDRU/ 108/2.3/G/ 83035	1.692.720 lei	POSDRU 01.07.2011-31.01.2013	2. Labour market correlation with active training	2.3. Access and participation within continuous professional training	
9. Student – Future managers [102]	POSDRU/ 109/2.1/ 81666	751.000 lei	POSDRU 03.01.2012-31.06.2013	2. Labour market correlation with active training	2.1. Easing the transition from school to active life	
10 Labour market correlation with active training through relevance, interactivty and accessibility [103]	POSDRU/ 109/2.1/ 82583	938.600 lei	POSDRU 03.01.2012-31.06.2013	2. Labour market correlation with active training	2.1. Easing the transition from school to active life	
LEONARDO projects						
11.ARTTOWN project [84]	2010-1-IT1-LEO04-00983 4	25.000 euro	Lifelong Learning Programme	Sub-programme : Leonardo Da Vinci	Action type: partnerships	Leonardo Da Vinci Partnerships
12. Developing Intercultural Competences for Enterprises – DICE [98]	LLP-LdV/PAR/2013/ RO/096	25.000	LIFELONG LEARNING PROGRAMME	LEONARDO DA VINCI	Action type: partnerships	LEONARDO DA VINCI Partnerships
GRUNDTVIG projects						
13.Labour inclusion for personal autonomy of women [90]	GRU-09-P-LP-89-TM-IT	15.000 euro	Grundtvig			
14.Partnership for education [91]	GRU-11-P-LP-200-TM-SK	15.000 euro	Long term and active education - Grundtvig			
Scientific research contracts – SPIN OFF						
POS CCE Start-up and SPIN OFF projects						
15 Flexible and modular equipment for numeric management of the technological processes [89]	POS-CCE	200.000 euro	Structural Funds 2008/9	Priority axis 2 – RDI competitivity	ID 2.3 – RDI access for companies - Education and Research Ministery , second place in	

Project title	Project ID	Amount	Programme	Priority axis	Key area of intervention	Action
					the national contest	
16. ISF broadband access improvement [99]	POS-CCE SMIS *CSNR* 37278	122.710,40 lei	Communication and Informational Society Ministery	Axis 3. Public and Private sectors ICT	ID 3.1. – Suporting the use of informational technology O311. Broadband and afferent services access supporting	Grant application 410/21.12.2010
Technological Park projects						
17. Technological parks for Innovation and Trans-European Cooperation – Comisia Europeană Bruxelles [83]	135741-RO-2007-KA3-KA3MP	80.000 euro	2008/2009 Lifelong Learning-Comenius, Grundvig, ICT and Languages			Financial Management
18.INFRATECH [95]	Contract 4/ 08.11.2004	180.000 ISF contribution	2004-2006 Education and Research Ministery			
Rural development projects						
19. Bread and pastry unit set up Cenei, Timis County [86]		Total : 265.193 eur Cofinancing 53.492 eur	FEADR	Axis I – Agriculture and Silvic sectors competitivity increasing	Measure 123 Increasing the added value of agriculture and forest products State aid scheme N578/2009	
20. Rehabilitation, modernisation and set up of production line [88]		Total : 198.491 Euro	FEADR	Axis III – Life standard and economy diversification in rural areas	Measure312 Support for SME's set up and development	
21 Leisure area set up [87]		Total: 160.002 Euro	FEADR	Axis III – Life standard and economy diversification in rural areas	Measure313 Support for SME's set up and development	

4.2 Using cost-benefit analysis in project assessment

4.2.1 Introduction [2], [10], [31]

Cost-benefit analysis is a method whose main purpose is to help decision-making. The difference between social benefits (B) and social costs (C) represents social net benefit (SNB):

$$SNB=B-C$$

There are two main types of cost-benefit analysis:

- *ex ante* cost-benefit analysis, which is standard cost-benefit analyse in the usual sense of this term; it is performed when a project is still subject of study, before its starting or implementation.

- *ex post* cost-benefit analysis is carried out at the end of the project. In this moment all the costs are "allocated", in the sense that all resources have already been used in the project. The value of ex post analysis is more comprehensive, but less direct because it offers information not only for a certain intervention, but also for "cataloging" of such interventions.

Other cost-benefit analysis is developed over the duration of a project, namely *in media res*. Some elements of such studies are similar to those ex ante analysis, while others are similar to ex post analysis.

Ex ante analysis is useful in the resources reallocation decision-making for a certain project being studied. For ongoing projects, a *in media res* can be also useful in decision-making process when the modification of resources reallocation for other uses is justified.

The main phases of cost-benefit analysis are:

- specify the set of alternatives
- identify subjects who will receive the benefits and those who will bear the costs.
- Clasify the impacts and select the measuring indicators.
- Quantitative estimation of impacts over the life of the project.
- Monetary evaluation of all impacts.
- Update the value of costs and benefits in order to obtain real values.
- Partly calculation of net present value (NPV) for each alternative.
- Sustainability analysis
- Formulate recommendations based on NPV and sustainability analysis.

4.2.2 Cost-benefit analysis of investment projects [2], [10]

In accordance with the type of projects, will be applied the provisions of specific regulations, namely:

- Regulation (EC) no. 1083/2006 of 11 July 2006 laying down general provisions on the European Regional Development Fund, European Social Fund and Cohesion Fund and repealing Regulation (EC) no. 1260/1999 – Articles 37, 39, 40, 41, 55;

- Corrigendum of Commission Regulation (EC) no. 1828/2006 of 8 December 2006 laying down detailed rules for implementing Regulation (EC) no. 1083/2006 laying down some general provisions concerning European Regional Development Fund, Social European Fund and Cohesion Fund and Regulation (EC) no. 1080/2006 of European Parliament and Council of the European Regional Development Fund - annex XX; annex XXI (The application form for infrastructure investments); Annex XXII (The application form for investments);

- Commission Regulation (EC) no. 718/2007 of 12 June 2007 implementing Council Regulation (EC) no. 1085/2006 establishing an instrument of pre-adheration assistance (IPA) - Article 157.

- Guidelines on the methodology to achieve cost-benefit analysis, Working document no.4 of European Commission.

4.2.3 Evaluating process of investment projects includes the following steps [2], [10]

Presenting socio-economic context and project's objectives: the first step in achieving the evaluation is represented by a qualitative presentation of socio-economic context and objectives expected to be achieved through investments to be achieved, both directly and indirectly. In this first step should be also taken into account the relationship between objectives and priorities set out in the framework of Operational Programme, National Strategic Reference Framework, the coherence and objectives of EU Funds;

Project identification: all project essential characteristics should be included in the evaluation.

Project feasibility analysis and alternatives: feasibility analysis should determine if the local context is favourable for the project (for example, if there are physical, social or mandatory institutional requirements), to estimate the evolution of labour demand, to justify the project implementation (scale, location and so on) compared with alternative proposed sceneries.

Financial analysis (fig. 4.2.3-1) is based on updated cash-flow estimation. EC suggests as a reference financial term, a discount rate of 5%. In this respect, in accounting should be maintain a clear record of cash inflows and outflows related to:

Total cost investments;

Total operating costs and revenues;

Financial profitability of investment costs: net present value of investment (FNPV/C) and internal rate of return of investment (FRR /C);

Sources of funding;

Financial sustainability;

Financial profitability of domestic capital: net present value of capital (FNPV/K) and internal rate of return of investment (FRR/K): this takes into account the impact of EU subsidy on national (public and private) investors.

The time horizon must be consistent with the economic life of main assets. The residual value must be included in accounting at the end of the year. However, inflation variation and price relative changes should be treated in a coherent way. Generally, the

internal rate of return on investment (FRR / C) may be very low or negative for public sector projects, but for private sector the internal rate of return (FRR / K) should normally be positive.

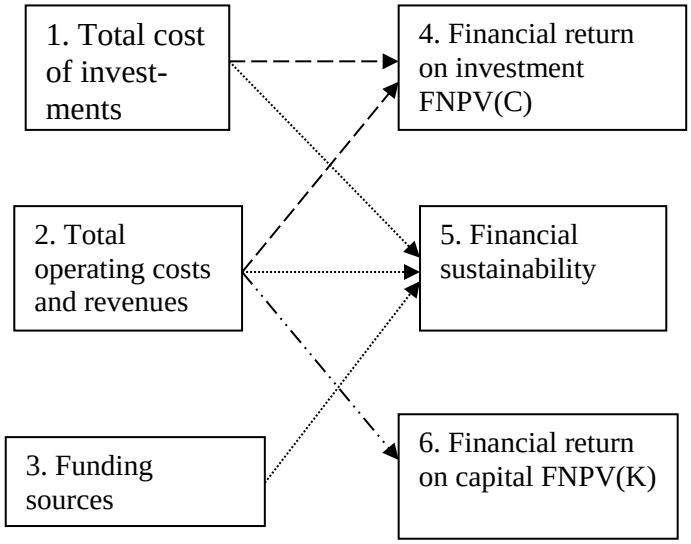

Fig. 4.2.3-1 *Financial analysis structure*

Economic analysis: cost-benefit analysis also involves project assessment of economic welfare. In order to achieve this aim is followed the following five steps:

- observed prices and public charges are converted into shadow prices, which better reflect social opportunity cost of asset.

- externalities are taken into account and are assigned a monetary value;

- indirect effects analysis;

- the costs and benefits are updated at a real social discount rate (for cohesion countries and IPA, as well as for convergence regions is 5,5 %, but for competitive regions is 3,5%);

- indicators calculation of economic performance economic net present value (ENPV), economic rate of return (ERR) and benefit-cost ratio (B / C).

Risk assessment: project assessment risk is achieved as economic analysis in five steps (fig 4.2.3-2), as follows:

- sustainability analysis: identification of critical variables, eliminating deterministic dependent variables, elasticity analysis, the choice of critical variables, the scenario analysis;

- assumption of a probability distribution for each critical variable;

- calculating of performance indicators distribution (usually FNPV and ENPV);

- assessment results and acceptable level of risk;

- establishment of some risk reduction measures.

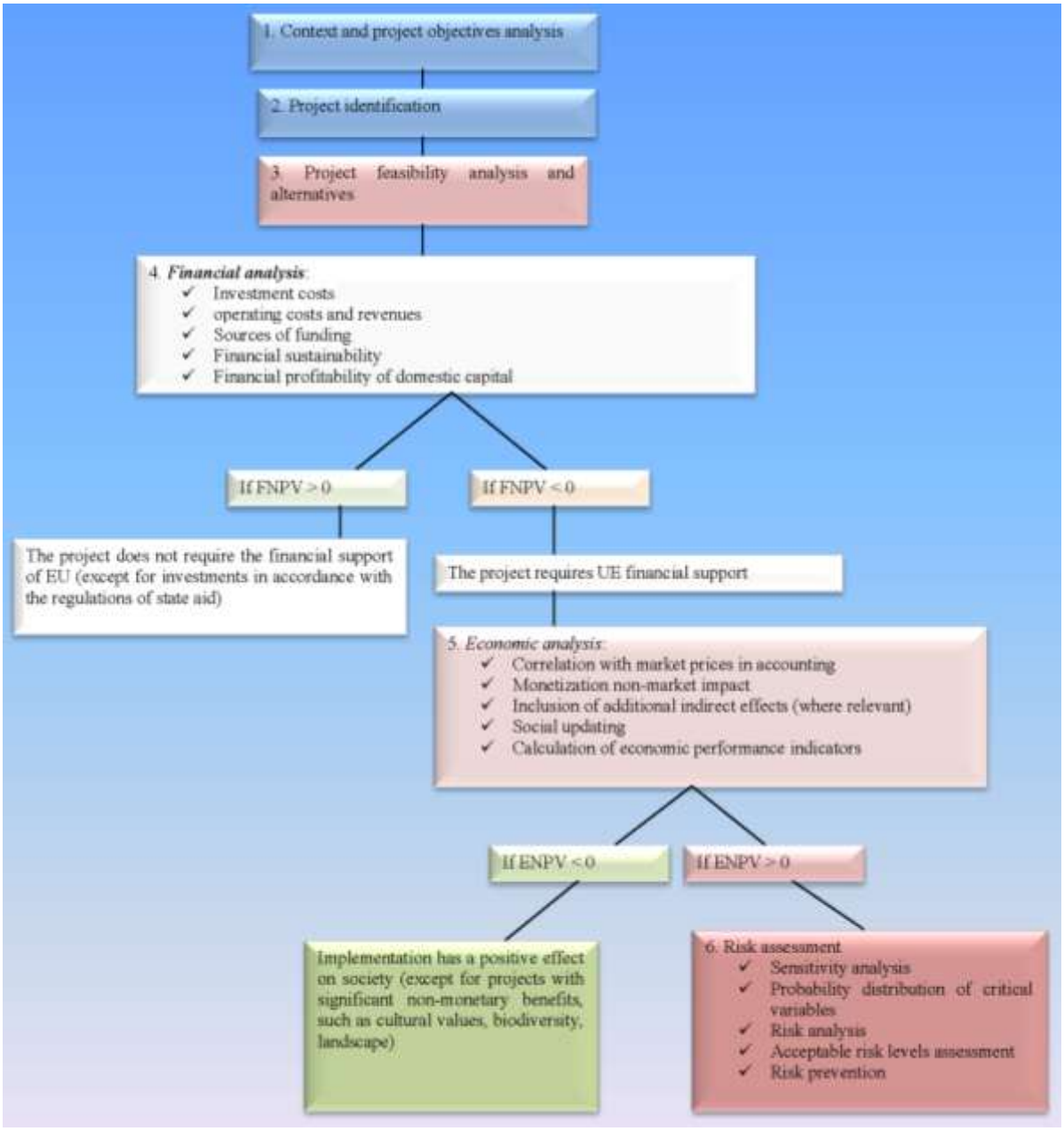

Fig 4.2.3-2 *Project assessment stages*

4.3 Case study for cost-benefit analyses [10] [85], [93]

4.3.1 Project description

Cross-border cooperation programme Hungary-Romania 2007-2013.

Priority axis: 2. Strengthen social and economic cohesion in the border region

Key areas of intervention: 2.1. Supporting cross-border business

Action: 2.1.1. Business infrastructure development

According to Operational Programme, the overall objective is to offer to people and institutions from the cross-border area joint development facilities, which will constitute the key development in the region, aiming at developing businesses according to sustainable development principle. So, it will be incubated under more favorable conditions those

companies that conduct research for implementing the most efficient renewable technologies (solar, wind, biogas, renewable resources) or a combination of thereof, depending on the energy potential and the zone specific, transferring the already existing good practice, but also developing new practice as result of research. The entire infrastructure is created within the sustainable development principles set out by the European Commission documents.

The overall objective of the present project is the creation of a joint business infrastructure (new buildings and renovations, insisting on facilities and utilities specific to some business structures). Activities are divided into five packages containing the achievement of a joint business infrastructure, particularly in sustainable development field (renewable energies), conferences, fairs, exhibitions, publications of some business opportunities bulletins and design a strategic plan to improve business infrastructure.

General objective: Improvement of socio-economic conditions and crossborder business development including construction/modernization of business centers.

Specific objectives:

1. Achievement of a pilot center in Timisoara and the modernization of those from Bekescsaba, Szeged.

2. Achievement of a renewable energies market.

Thus, the project through its objectives, activities and proposed results complies with equal opportunities principle and EU provisions of Council Directive no.1000/78/EC of 27th November 2000, in order to apply equal treatment principle and combat the social exclusion risk. The main idea, the whole project is based on is that of respecting equal opportunities and that of "mainstreaming", in other words valuing gender differences transforming a disadvantage in an opportunity. As for, sustainable development, the project complies with guidelines from framework documents of European Commission, so that in the cost-benefit analysis were determined its specific indicators: B/C, RIR, VAN, but during the project-related conferences were forseen section devoted to environmental protection, as well as dissemination of research-development results, in general, but also from own projects.

4.3.2 Budget and financial analysis

Table 4.3.2-1. Project budget (euro)

	LP		PP1		PP2		PP3		Total
Grant (ERDF+ state cofinancing)	270000	90%	90000	90%	54000	90%	36000	90%	450000
Own contribution	30000	10%	10000	10%	6000	10%	4000	10%	50000
Total	300000	100%	100000	100%	60000	100%	40000	100%	500000

4.3.3 Identification of investments, defining objectives and the reference period

The present cost – benefit analysis has the following main objectives:

To prove project's opportunity from a financial point of view and to show the manner in which it contributes to the regional development indicators, and specifically, to the HU-RO CBC Programme objectives, priority axis 2, and major intervention field 2.2: RDI cooperation promotion, Action 2.2.1 – Joint research infrastructure development.

To provide good arguments for the necessity of the financial support from the Programme in order to ensure project financial sustainability.

Investment identification

The project's overall objective consists in the set up and functioning of a complementary research infrastructure, and its further capacity building through network integration of other universities and RD institutions from the cross – border cooperation area. There are 5 foressen types of activities: RES complementary RD infrastructure set up, lab endowment, cross – border conferences organization in the RD and education fields, RD magazine publication, exchange of good practices, introduction of modern RD methods and the formulation of a strategic plan for the capitalization and the improvement of the joint infrastructure. The target groups are represented by researchers, professors, students, a specific private sector segment with the capacity to use the technologies and solutions created. The project will generate social benefit through creation of jobs and through the development of a new field, with adequate added value.

Defining objectives:

a) The improvement of socio – economic conditions and the development of cross-border infrastructure, including the construction and modernization of research units;

b) Setting up a pilot center in Timisoara (new construction) and modernization of the Arad center.

The overall objective of the infrastructure investment is the set up of a RD center, specialized in RES. The center will be built upon two strategic directions: improvement of the quality of research and continuation of actual research programmes.

On the other side, the future researchers' professional formation, through the ease of access to sustainable working resources, is practically a solution for the development of RES. The professional training and the adequate information of this group of human resources can be considered as the creation of an "intellectual infrastructure".

Specific objectives of the project:

- creating RES innovative elements, for ensuring the increase of their sustainable efficient use;

- Dissemination of results, for the proper promotion of the RD results and the implementation of new technologies in various urban or rural area, considering the specifics of each area;

- Setting up of a pilot center and complementary labs in accordance with the actual needs in the RD field;

- The start up of a joint analysis on the basis of the created infrastructure.

4.3.4 Options' analysis

a) Zero alternative <do nothing > would imply the continuation of the RD process done at the level of project partners, using the actual development level and expertise of each partner. This will cause the stagnation of the RD process due to the lack of some basic demands that are included as objectives in this project. In the meantime the cross-border cooperation is bottlenecked in the absence of a joint RD structure.

b) Minimum alternative <do minimum> implies the modernization of the existing infrastructure, using only own financial resources or some small amounts allocated from public funds (structural, but not only, eventually the set up and endowment of some spaces for cross-border events and partnerships), a situation in which the cross-border cooperation is initiated on a small scale. Due to the lack of specific and sufficient infrastructure no meeting point for the RES interested RD institutions will be provided, thus not reaching one of the project main purposes. Timisoara's existing RD infrastructure will include the main investements for renewal of RES technologic lines at the level of the research endowment.

c) Maximum alternative <do something> proposes the integral creation of the new infrastructure, as well as its endowment using the structural funds attracted through this project, and its financing in accordance with the schemes and the percentages stipulated in this project. The infrastructure's endowment means equipments for specific technologies, office equipments and stationery, specific furniture.

4.3.5 Financial analysis

Financial analysis models

The financial analysis takes into consideration the project's benefits and investment costs, expressed as measurable, monetary units, in order to obtain common indicators in expressing the project value.

In the case of public infrastructure projects, the investment process is carried out within an adequate time period that is required for building design and engineering documentation, for the execution of the works and for the operationalization of the invesmtnet, according to the legislation in force.

Furthermore, there is a gap between the moment of the actual spending of the investment funds and the period in which the economic effects of the investment are reaped. In order to provide a real comparison between effects and efforts it is necessary that they are presented under the same reference moment, which is realised by updating the costs and benefits of the investement.

The updating is based on the fact that 1 spent leu at the beginning of the investment will bring - at the end of the period - "i" lei profit, namely that after "t' years will produce $(1+i)^t$ lei profit. In practice, for transferring the sums from future to present, an updating coefficient is used:

$a = \frac{1}{(1+i)^t}$; $t = 1 \rightarrow n$ a = update coefficient; t = number of years.

The main input variables of the financial analysis are the investment costs, the operational costs, investment's lifetime, the updating coefficient, the interest rate, the

investor's generated revenues (including their reschedueling over time), the rates of the main taxes and contributions.

The development of the cash – flow, which includes all these elements, will determine the financial sustainability (project's sustainability is verified through cumulated cash – flow which must be positive in every year of the investement's lifetime). In the meantime, the Internal Revenue Rate and Financial Net Actualised Revenue are estimated, in order to indicate the project's capacity for being financial efficient from both perspectives, the one of the beneficiary, and the one of the financing unit.

The cost – benefit analysis' minimal indicators that must be considered are:

VNAF/C – actual net revenue estimated from the total investment cost;

VNAF/K – actual net revenue estimated from the total of the beneficiary's contribution;

RIRF/C – internal revenue rate estimated from the total investment cost

RIRF/K - internal revenue rate estimated from the total of the beneficiary's contribution;

Rb-c – cost –benefit report.

Other supplementary indicators that can be used within the cost – benefit analysis are:

Amortization time (Tr);

Specific investment (Is).

The financial actual net revenue is defined as:

$$\text{VNA (S)} = \sum_{t=0}^{n} a_t * S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + ... + \frac{S_n}{(1+i)^n}$$

where S_t is the net cash flow in moment t, and a_t is the updating coefficient for the time moment t.

The financial internal revenue rate is defined as the interest rate (updating rate) which determines a zero value for the investment financial actual net revenue:

$$\text{VNA (S)} = \sum_{t=0}^{n} \frac{S_0}{(1+IRR)^t} = 0$$

The cost – benefit report is determined through the report between the actualized benefit sum and the costs actualized sum:

$$\text{B/C} = \frac{\sum_{t=0}^{n} a_t * B_t}{\sum_{t=0}^{n} a_t * C_t}$$

Amortization rate (Tr) is determined through the identification of the moment in which the cumulated cash flow reaches the 0 value.

The specific investment (Is) is estimated through reporting the total investments value at the investements physical units.

The main hypothesis considered for evaluating the operation scenarios of the investment projects are:

The estimations are realized in Euro and lei, the monetary depreciation caused by inflation being integrated in the currency;

The financial and economic estimations are based on the general breakdown of costs;

The operational previsions are made for a 15 years interval after the project implementation;

The project falls into the category of infrastructure investements not targeted at financial revenue, but focused on the social and economic impact, for which the EU grant awarded;

The activities portfolio for the operation stage of the project was determined on the basis of current responsibilities and professional competences of the beneficiary and its staff;

The modification rate of the parameters is in accordance with the sectorial and macroeconomic estimations;

The guide for the cost – benefit analysis of investment projects states that "the residual value is taken into consideration within the sustainability table only if it corresponds to a real flux for the investor". Taking into account the investment's destination - of the created infrastructure after the project ending - at the end of the analysis period the residual value will be 0 for the 25 years considered in the analysis;

The investment's financing from own contribution and non reimbursable assistance provided through Ro – Hu CBC 2007-2013 Programmes, Axis2;

Financing of the operational costs within post implementation period from own resources;

The standard updating rate recommended within the financial analysis is r = 5 %;

The standard updating rate recommended within the economic analysis: r = 5,5 %;

Substantiation of the financial analysis' indicators:

a) –"without project" scenario (zero alternative <do nothing >)

This scenario considers project non implementation and the development of an analysis starting from this point of view. Practically, under these circumstances, the existing costs are only the operational costs estimated for 15 years.

b) – „ minimum project" scenario (minimal alternative <do minimum>)

In accordance with the guidelines of the Cost-Benefit Analysis guide, this alternative consideres the project implementation without infrastructure investments.

c) –„project" scenario (maximum alternative <do maximum>)

In accordance with the guidelines of the Cost-Benefit Analysis guide, this scenario involves the execution of the project in accordance with the Feasibility Study.

It must be stated that, apart from the basic investment costs detailed in the budget breakdown, management, promotion and expertise costs must be also considered, as incumbered during project's implementation. Also, it must be considered that the project will be implemented during a 2 years period, and the financing programme also allows for the

reimbursement of preparatory costs. In this aspect, and for the beneficiary of the present Feasibility study, the project implementation costs, scheduled for 2 years, can be observed in the following table:

Table 4.3.5-1

	Project implementation costs	1	2	3
1	Project management team costs	0 €	12,560 €	12,541 €
2	Promotion costs	0 €	7,650 €	13,600 €
3	External expertise costs	0 €	2,400 €	2,400 €
4	Investment costs	10,026 €	298,704 €	284,119 €
	Total costs	10,026	321,314	312,660

In regard of operational costs it can be stated that for the new proposed construction the following costs categories were identified: wages costs, for permanent staff and also for researchers' staff, administration costs, maintenance costs, overall repair costs. These costs are presented within the table below:

Table 4.3.5-2

	Operational costs	1	2	3	4	5	6	7	8
1.1	Experts wages			2,700 €	10,800 €	10,800 €	10,800 €	10,800 €	10,800 €
1.2	Permanent staff wages			9,120 €	36,480 €	36,480 €	36,480 €	36,480 €	36,480 €
1.3	Utilities costs			3,488 €	13,950 €	13,950 €	13,950 €	13,950 €	13,950 €
1.4	Administrative costs			270 €	1,080 €	1,080 €	1,080 €	1,080 €	1,080 €
1.5	Maintenance costs			88 €	350 €	350 €	350 €	650 €	650 €
1.6	Overall repair costs								
1	Total costs	0	0	15,665	62,660	62,660	62,660	62,960	62,960

Table 4.3.5-3

	Operational costs	9	10	11	12	13	14	15
1.1	Experts wages	10,800 €	10,800 €	10,800 €	10,800 €	10,800 €	10,800 €	10,800 €
1.2	Permanent staff wages	36,480 €	36,480 €	36,480 €	36,480 €	36,480 €	36,480 €	36,480 €
1.3	Utilities costs	13,950 €	13,950 €	13,950 €	13,950 €	13,950 €	13,950 €	13,950 €
1.4	Administrative costs	1,080 €	1,080 €	1,080 €	1,080 €	1,080 €	1,080 €	1,080 €
1.5	Maintenance costs	650 €	900 €	350 €	650 €	650 €	650 €	900 €
1.6	Overall repair costs							2,000 €
1	Total costs	62,960	63,210	62,660	62,960	62,960	62,960	65,210

In regard of the revenues, the following categories were identified for the present construction: research revenues, expertise and training revenues, classes revenues, other revenues. Their structure is presented below:

Table 4.3.5-4

	Revenues structure	1	2	3	4	5	6	7	8
2.1	Research revenues	0 €	0 €	9,975 €	39,900 €	39,900 €	39,900 €	39,900 €	39,900 €
2.2	Expertise revenues	0 €	0 €	3,000 €	12,000 €	12,000 €	12,000 €	12,000 €	12,000 €
2.3	Training revenues	0 €	0 €	425 €	1,700 €	1,700 €	1,700 €	1,700 €	1,700 €
2.4	Class revenues	0 €	0 €	319 €	1,275 €	1,275 €	1,275 €	1,275 €	1,275 €
2.5	Other revenues	0 €	0 €	350 €	1,400 €	1,400 €	1,400 €	1,400 €	1,400 €
2	Total revenues	0	0	14,069	56,275	56,275	56,275	56,275	56,275

Table 4.3.5-5

	Revenues structure	9	10	11	12	13	14	15
2.1	Research revenues	39,900 €	39,900 €	39,900 €	39,900 €	39,900 €	39,900 €	39,900 €
2.2	Expertise revenues	12,000 €	12,000 €	12,000 €	12,000 €	12,000 €	12,000 €	12,000 €
2.3	Training revenues	1,700 €	1,700 €	1,700 €	1,700 €	1,700 €	1,700 €	1,700 €
2.4	Class revenues	1,275 €	1,275 €	1,275 €	1,275 €	1,275 €	1,275 €	1,275 €
2.5	Other revenues	1,400 €	1,400 €	1,400 €	1,400 €	1,400 €	1,400 €	1,400 €
2	Total revenues	56,275	56,275	56,275	56,275	56,275	56,275	56,275

For the “no project” scenario (zero alternative <do nothing >), the performance indicators of the financial analysis have no significance because they are reffering to an achieved investment. Within this scenario it is considered that the beneficiary has no sufficient resources for developing its own investment.

For „minimum project” scenario (minimal alternative <do minimum>), the performance indicators are estimated in a financial analysis based on what we have previously presented. These indicators can be observed within the table below:

Table 4.3.5-6

	Finacial analysis	1	2	3	4	5	6	7
1.1.1	Total investment costs	0	-46,785	-44,139	0	0	0	0
1.1.2	Residual value	0	0	0	0	0	0	0
1.1.3	Exploitation total costs	0	0	-8,575	-22,150	-17,150	-17,150	-17,150
1.1.4	Project total revenues	0	0	10,175	20,350	20,350	20,350	20,350
1.1	Net revenues (1.1.3+1.1.4)	0	0	1,600	-1,800	3,200	3,200	3,200
1.2	Total inflow	0	0	10,175	20,350	20,350	20,350	20,350
1.3	Total outflow	0	-46,785	-52,714	-22,150	-17,150	-17,150	-17,150
1	Net cash flow (1.2+1.3)	0	-46,785	-42,539	-1,800	3,200	3,200	3,200
	IRR(C)	-13.76%						
	Updating coefficient	5.00%						
	NPV(C)	-61,321						

Table 4.3.5-7

	Financial analysis	8	9	10	11	12	13	14	15
1.1.1	Total investment costs	0	0	0	0	0	0	0	0
1.1.2	Residual value	0	0	0	0	0	0	0	0
1.1.3	Exploitation total costs	-17,150	-17,150	-17,150	-17,150	-17,150	-17,150	-22,150	-17,150
1.1.4	Project total revenues	20,350	20,350	20,350	20,350	20,350	20,350	20,350	20,350
1.1	Net revenues (1.1.3+1.1.4)	3,200	3,200	3,200	3,200	3,200	3,200	-1,800	3,200
1.2	Total inflow	20,350	20,350	20,350	20,350	20,350	20,350	20,350	20,350
1.3	Total outflow	-17,150	-17,150	-17,150	-17,150	-17,150	-17,150	-22,150	-17,150
1	Net cash flow (1.2+1.3)	3,200	3,200	3,200	3,200	3,200	3,200	-1,800	3,200

For project' scenario (maximum variant <do maximum>) the performance indicators are:

Table 4.3.5-8

	Finacial analysis	1	2	3	4	5	6	7
1.1.1	Total investment costs	-10,026	-321,314	-312,660	0	0	0	0
1.1.2	Residual value	0	0	0	0	0	0	0
1.1.3	Exploitation total costs	0	0	-15,665	-62,660	-62,660	-62,660	-62,960
1.1.4	Project total revenues	0	0	14,069	56,275	56,275	56,275	56,275
1.1	Net revenues (1.1.3+1.1.4)	0	0	-1,596	-6,385	-6,385	-6,385	-6,685
1.2	Total inflow	0	0	14,069	56,275	56,275	56,275	56,275
1.3	Total outflow	-10,026	-321,314	-328,325	-62,660	-62,660	-62,660	-62,960
1	Net cash flow (1.2+1.3)	-10,026	-321,314	-314,256	-6,385	-6,385	-6,385	-6,685
	IRR(C)	-10.61%						
	Updating coefficient	5.00%						
	NPV(C)	-524,327						

Table 4.3.5-9

	Financial analysis	8	9	10	11	12	13	14	15
1.1.1	Total investment costs	0	0	0	0	0	0	0	0
1.1.2	Residual value	0	0	0	0	0	0	0	207,201
1.1.3	Exploitation total costs	-62,960	-62,960	-63,210	-62,660	-62,960	-62,960	-62,960	-65,210
1.1.4	Project total revenues	56,275	56,275	56,275	56,275	56,275	56,275	56,275	56,275
1.1	Net revenues (1.1.3+1.1.4)	-6,685	-6,685	-6,935	-6,385	-6,685	-6,685	-6,685	-8,935
1.2	Total inflow	56,275	56,275	56,275	56,275	56,275	56,275	56,275	56,275
1.3	Total outflow	-62,960	-62,960	-63,210	-62,660	-62,960	-62,960	-62,960	-65,210
1	Net cash flow (1.2+1.3)	-6,685	-6,685	-6,935	-6,385	-6,685	-6,685	-6,685	198,266

Based on the estimated indicators, it can be stated that the project needs the support of non reimbursable European financing. The opportunity is given by the existence of the RO-HU CBC 2007 -2013 Programme, Priority Axis2, Major Intervention Field 2.2., Action 2.2.1.

The project can attract a percentage of 95 % of non reimbursable financial assistance, in accordance with the Programme Guide.

4.3.6 Conclusions

From the cost-benefit analysis result and their recording in accounts the following are resulting:

There are differences between the accounting interpretation for the residual value of the building which is represented by the recovered value from the asset out of service at the end of the normal operation period, and residual value according to cost-benefit analysis which represents the total value of the building at the end of the 10 year of project monitoring.

According to the table, it can be noticed that in case of income-generating projects the financial assistance is diminished and the beneficiary's own contribution value is increased.

On completion, it is found that the total expenditure value is higher than that expected in the project, resulting in their sharing of eligible expenses and not - eligible costs according to the financial reports related to grants.

Considered eligible expenses are those forseen and approved, but those not-eligibile are represented by the VAT on the one hand, and financial costs. On the other hand, there are additional costs necessary to complete investments, costs borne by the beneficiary, representing own contribution.

4.3.7. Final results

Name of the Lead Partner	**”Ioan Slavici” University Foundation**
Registration Nr.	

Start date of the project (Year)[1]	2013
Estimated residual value	207.201 €
Financial discount rate	5%
Total investment cost	1.121.700 €
Discounted investment cost (DIC)	990.552 €
Discounted net revenue (DNR)	7.122 €
Funding-gap rate (R=(DIC-DNR)/DIC)[2]	99,28%
Total eligible cost of the project (EC)[3]	1.121.700 €
Desicion amount (DA=EC*R)[4]	1.113.635
Co-financing rate of the project (CRpa)[5]	5,00%
Total grant amount (DA*CRpa)[6]	55.682 €
Own contribution (from the Desicion amount)	1.057.953 €
Financial present net value (FNPV)[7]	-983.430
Financial rate of return (FRR)[8]	1.1%

1 *When indicating the year of the starting date the* preparation activities *have to be taken into account.*

2 *Must be the same as the total elgible cost indicated in the Application Form.*

3 *R = Max EE/DIC*
where Max EE is the maximum eligible expenditure = DIC-DNR

4 *The total eligible expenditure after the financial analysis.*

5 *Max CRpa is the maximum co-funding rate fixed for the priority axis in the Commission's decision adopting the operational programme (Art. 53.6).*

6 *The total grant amount after the financial analysis.*

7 *If this indicatior is not negative the project is considered as in-eligible.*

8 *The project is only eligilbe if this indicator is lower than the used financial discount rate (5%).*

Description	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1. Total cash outflow of the operating costs (Operting costs: sheet nr. 2.)	0	0	22025	88100	88100	88100	88600	88600	88600	89100	89100	89100	89100	89100	99100
2. Total cash inflow (Revenues: sheet nr. 5.)	0	0	19375	77500	77500	77500	77500	77500	77500	77500	77500	77500	77500	77500	77500
3. Residual value															207201
4. Operating net revenue (2-1+3)	0	0	-2650	-10600	-10600	-10600	-11100	-11100	-11100	-11600	-11600	-11600	-11600	-11600	185601
5. Discounted net revenue (DNR) [1]	7.122,04 €														

[1] *DNR is the discounted net revenue = discounted revenues – discounted operating costs + discounted residual value*

Registration Nr.: 0

Description	2012	2013	2014	2015	2016	2017	2018	2019
1. Financial investment cost	10.026 €	479.213 €	632.461 €	0 €				
2. Financial operating cost	0 €	0 €	22.025 €	88.100 €	88.100 €	88.100 €	88.600 €	88.600 €
3. Loan reimbursement								
4. Reimbursement of the interests								
5. Other costs								
6. Total cash outflows (1+2+3+4+5)	10.026 €	479.213 €	654.486 €	88.100 €	88.100 €	88.100 €	88.600 €	88.600 €
7. Financial revenue	0 €	0 €	19.375 €	77.500 €	77.500 €	77.500 €	77.500 €	77.500 €
8. Total grant amount of EU fund		450.000 €	615.615 €					
9. National public contribution (10+11)	10.026 €	29.213 €	19.496 €	10.600 €	10.600 €	10.600 €	11.100 €	11.100 €
10. National co-financing amount								
11. Total own contribution (12+13)	10.026 €	29.213 €	19.496 €	10.600 €	10.600 €	10.600 €	11.100 €	11.100 €
12. Own contribution (i.e cash)	10.026 €	29.213 €	19.496 €	10.600 €	10.600 €	10.600 €	11.100 €	11.100 €

13. Liabilities (14+15)	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €
14. Loans								
15. Other liabilities								
16. Financial residual value								
17. Total cash inflows (7+8+9+16)	10.026 €	479.213 €	654.486 €	88.100 €	88.100 €	88.100 €	88.600 €	88.600 €
18. Net financial cash flow (17-6)	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €

4.4 Industrial Parks and Technological and Scientific parks projects

4.4.1 Juridical and conceptual framework – Technological and Scientific Parks – TSP

The TSP key element is bringing together, in one place, the research institutions directly linked with superior education structures, business and government organisms, and coordinating these groups interrelations. The Parks are economic and technologic complexes that can host scientific research centers, technologic and innovation incubators that can provide continuous training, prognosis services and facilities needed for the expo events, organization of fairs and market development. The TSP concept is internationally adopted, being initiated in the USA after the Second World War and in Europe during 70's and 80's.

TSP characteristics:

scientific and technologic knowledge is considered the basic resource for production process, alongside capital, market, natural resources and other economic growth factors;

the use of knowledge for innovation is not only a natural way of functioning, but also it is a competitive element, alongside with the development of new ideas, assimilation of new technologies, manufacturing of new products and new services;

TSP generates new aspects of functional adaptation through the collaborative involvement of companies, individuals, educational and government institutions. The "running in" of this complex mechanism of various structural and actional elements, leads the way to the emergence of unespected organizational structures, management, investments, training, strategies and norms;

TSP human resources are key development elements.

Principles and practices

TSP provides "hard business services" (the use of space, telecommunications, transport, human resources, proper functioning environment) and "soft business services" (managerial assistance), as well as development services for companies, such as:

Technological transfer from universities or RD centers towards lucrative companies;

Business incubators, to train competent antrepreneurs, provide managerial assistance, financing access, product distribution networking and other facilities that companies need in order to ensure their financial success;

Juridical support for creating bussines ventures, management of taxes and contributions, labour legislation, intellectual property and conflict of interests;

Intellectual property protection;

Financial incentives for attracting investors;

Stimulation of the administrative processes through decrease of birocracy.

4.4.2 Projects realized in the field:

INFRATECH	Contract 4/ 08.11.2004	180.000 euro ISF contribution	**2004-2006 Education and Research Ministery**

TIM SCIENCE PARK Timisoara was set up through this project, the main founders being INCEMC Institute Timisoara and ISF Timisoara. This was one of the first 3 TSP created at national level and had afterwards won a number of first prizes on national level.

Technological parks for innovation and Trans-European Cooperation – Comisia Europeană Bruxelles	135741-RO-2007-KA3-KA3MP	80.000 euro	2008/2009 Lifelong Learning-Comenius, Grundvig, ICT and Languages Programmes

The project was coordinated at European level by Professor Dumitru Tucu Politehnica Timisoara, with the undersigned assuming the financial management of the project.

4.4.3 TSP "Tim Science Park" Timisoara

The stages for the development of this project were:

- Through Minister order no. 4993/13.10.2004 the Education Ministery has authorized the functioning of „TSP TIM SCIENCE PARK"

- The new building works execution was supported by the main partners, in accordance with one additional act.

1. INCEMC Institute Timisoara;

2. ISF Timisoara;

3. S.C. Titus S.R.L.

The park has been awarded as "best scientific and technological park in Romania" multiple times.

4.4.4 Industrial Parks. Juridical and economic aspects

Industrial parks are strictly located areas, in which investments, industrial production and afferent services activities are carryed out, under a specific facilities regime.

The industrial parks are set up for stimulating economic and social development, for increasing technological transfer and attracting investments and for the better use of local human resources. Through the industrial park status, the companies located within the park benefit from access to the utilites and facilities required for their economic activities.

The initiative of creating an industrial park can come from the part of local public administration, chambers of commerce, professional and antrepreneurs associations, as well as from companies having as main activity the administration of industrial parks. The title of industrial park is awarded based on conditions and regulations of the National Agency for Regional Development for a specific period. The functioning duration is at least 25 years, and must be established based on the objectives stated in the national economic development programme.

The economic units located within the Park have access to the following facilities:

- VAT and customs tax exemption for the import of machines, tools, installations, equipments, transport, agriculture endowment, other goods necessary for the ongoing investment;
- VAT and customs tax exemption for the import of materials and stocks, components and pieces needed for the construction, repair and maintenance of the parks objectives;
- Exemption for the reinvested profit contribution in technologies modernization, industrial infrastructure development, investment objectives supporting inside the industrial park, for 5 years after formation;
- Cofinancing, with or without reimbursement, of up to 25 %, of the necessary investement for the continuation of works execution and for utilities provided inside the park perimeter, with the exception of grants;
- Local tax and contributions reduction, as granted by local and county administrations decisions, for a maximum of 5 years;
- The chambers of commerce and industry will actively support the process of getting the necessary permits, authorizations and functioning licenses for the industrial park activities.

4.4.5 Cenei Industrial Park

The process of obtaining the industrial park status is undergoing, the proposed location being the north extremity of Cenei village, based on the infrastructure of the old Agriculture Association, which is now property of the undersigned.

Inside the park's perimeter a number of projects were formulated, submitted and awarded for financing, under the European rural developments financing programmes.

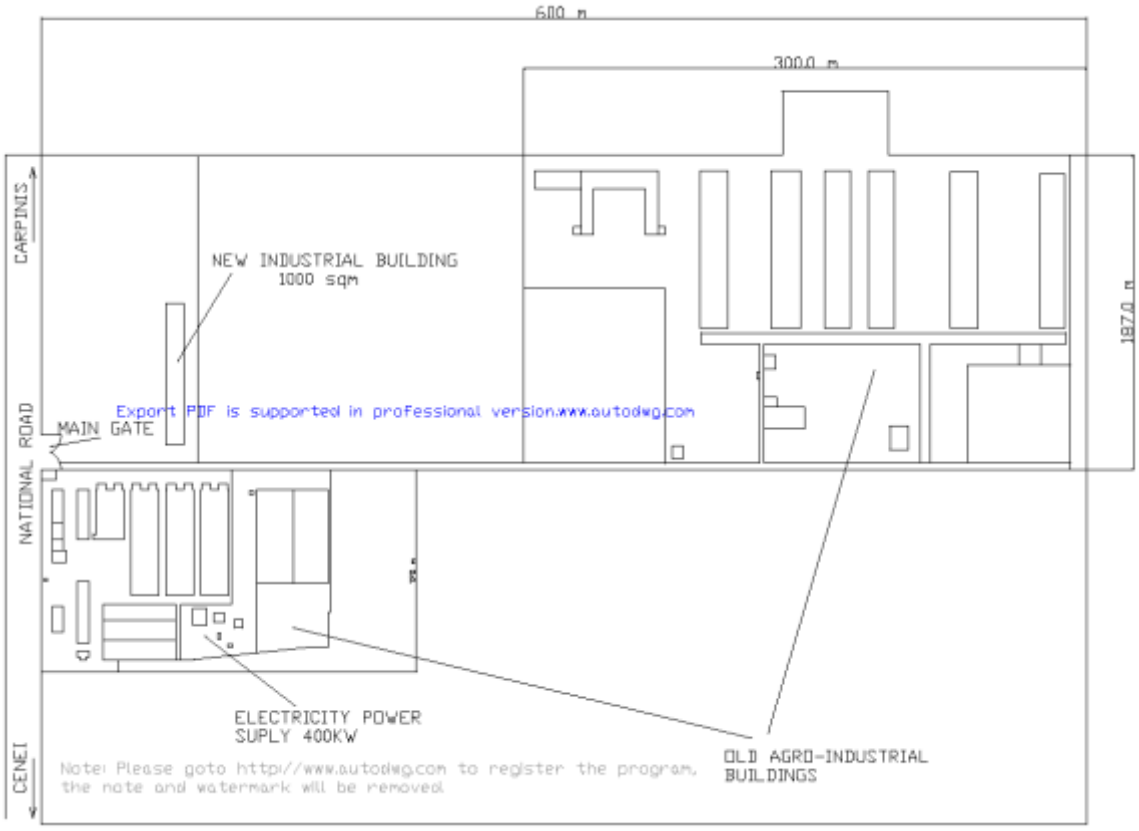

Fig.4.4.5-1 Cenei Industrial Park

Rural development projects						
Platform rehabilitation and surroundings works for the achievement of a production line for pellets and briquettes		Total : 235.284 eur Cofinancing35.293 eur	FEADR	Axis III – Life standard and economy diversification in rural areas	Measure312 Support for SME's set up and development	
Bread and pastry unit set up Cenei, Timis County		Total : 265.193 eur Cofinancing 53.492 eur	FEADR	Axis I – Agriculture and Silvic sectors competitivity increasing	Measure 123 Increasing the added value of agriculture and forest products State aid scheme N578/2009	
Rehabilitation, modernisation and set up of production line		Total : 198.491 Euro	FEADR	Axis III – Life standard and economy diversification in rural areas	Measure312 Support for SME's set up and development	
Leisure area set up		Total: 160.002 Euro	FEADR	Axis III – Life standard and economy diversification in rural areas	Measure312 Support for SME's set up and development	

4.5 Start-up and spin-off projects

4.5.1 Juridical and conceptual framework

The main objective of this operation is focusing on supporting the activities related to the founding and development of spin –off's, more specifically on the development of innovative start – ups (based on RD results), in order to increase the technological transfer from RD institutions towards companies, for the development of new business sectors and innovative activities.

The fundamental entities are defined as follows:

- Spin-offs: recently created or under-creation companies that emerged based upon a recent RD project's result of an public RD organization or of an university;
- Start-ups: microenterprises or small enterprises, with juridical status registered on Law 31/1990 (with its further modifications and completions), which have functioned for at least 3 years prior to submitting a grant or project application and has a maximum of 20 employees. For spin-offs it is accepted that the company is not registered with the Registry of Commerce at the moment of project's submission.

The enterprises to be encouraged are the ones that are or will become (through the project) innovative enterprises. Such enterprises must have already implemented a product on the market, or will manufacture/deliver products or goods on the market that are new or substantially improved using the results of a R&D activity or a patented idea.

Spin-off projects are encouraged because they offer to a researcher or a group of researchers the possibility of branching off from the public institution, in which they have obtained the RD result, for the purpose of implementing their solution, of producing and distributing the results on the market.

These economic activities, based on producing and distributing products and services on the free market, cannot be financed by public institutions like public R&D institutes, universities or hospitals. Through this kind of projects the researcher is stimulated to continue his project in order to capitalize upon his research's results, while respecting the concurential environment, as stipulated by state aid schemes.

Start –ups are innovative only if during recent times have implemented on the market a product or service substancially improved or if through the proposed products they become innovative. In both situations, the proposed project must start from a RD result, from a patent or an intellectual property right.

4.5.2 Field projects implemented

It must be emphasized that the project "Flexible and modular equipments for the numerical leadership of technological processes" – a project with a value of 200,000 Euros, financed in the POSCCE (Sectorial Operational Programme "Increasing Economic Competitivness", Operation 3.1. – Start-up and and spin-off) has taken second place in the national projects competition organized by the Ministry of Education and Research. The project has used the results of previous researches carried out by the "Ioan Slavici" University. Through the project a spin-off enterprises was created in the University – SC

Slavici Spin-off SRL – which is responsible for the commercial use of the research. The society has managed to finalize several commercial contracts with other private enterprises.

Flexible and modular equipment for numeric management of the technological processes	**POS-CCE**	**200.000 euro**	**Structural Funds 2008/9**	**Priority axis 2 – RDI competitivity**	**ID 2.3 – RDI access for companies -Education and Research Ministery , second place in the national contest**

Indicators upon the project

Indicators	**Value at the beginning of the project**	**Proposed value at the end of the project**	**Realised value at the end of the project**	**Comments**
Number of procured equipments	0	4	4 complex equipments 50 fix assets+ 214 inventory objects =264	The realised value is higher because initially the equipment term was used to explain an unitary functional equipment (for example a measuring equipment formed by other specific equipments – micrometer, station, comparator, caliber.
No of patents/ know – how / research results introduced in production	0	3	3	Complex surfaces profiling in case of non ferrous materials manufacturing Algorhythms amd software solutions for data collection from mechanic measurements Applications library for assembling language in order to illustrate the realised functionalities for the lamellas dL8xx-232
Supplementary indicators				
Number of prototypes	0	3	3	integrated measuring assembly integrated handling assembly modules dL8xx-232 (development line class, built around the microcontrollerADuC836)
Number of adapted technologies	0	2	2	Handling technologies (non ferrous) Non metallic handling technologies
Number of management algorhythms	0	4		1 Liniar interpolation algorhythms 2. Circular interpolation algorhythms 3. Non ferrous handling specific trajectories generation algorhythms 4. Non metallic handling specific trajectories generation algorhythms
Results				
Jobs created	0	10	13	Registered working contracts are annexed

Maintaned jobs	NA	NA	NA	
Own contribution lei	0	181 200*	181 200	
Number of patent requests	0	5	5	1. Colision detection system for visual handicapped individuals 2. Assisted locomotion system for visual handicapped individuals 3. HRTF functions generation systems used in virtual acoustic reality 4. Monitoring of locomotion system for visual handicapped individuals 5. HRTF function monitoring and evaluation method and equipments.
Number of spin off clients	0	15	15	

4.5.3 Modular structures of numerical management of processes for the processing of materials and nanotechnologies. Converting the research results into comrcial products inside spin-off company. [7], [48], [60]

4.5.3.1. Introduction

Management structures numerical modular of processes for processing materials and nanotechnologies constitute frequent subjects of their research and / or for providing research stands for other areas.

Research conducted in university labs can help improve the performance of productive structures of companies may have direct effects on industrial modernization, development of new products, improving technologies. However, academic teachers must make a decisive contribution to the development of their materials, ensuring choice applied experimental work more efficient for training students. Thus, in the collective were mixed, teachers, students, master and doctoral students more prototypes.

The prototypes were developed in the idea of using education as a means to work with students from faculties of electronics, computers, automation, etc.. The prototypes are designed either as a complete laboratory work, independent, for some specialized disciplines (electronic circuits, smart sensors, embedded systems etc.) As well as application development tools, useful in work to develop projects year license/dissertation.

In order to achieve these prototypes is necessary and appropriate financing, possibly providing a positive experience in microproduction for to expand.

4.5.3.2 Construction principles

A prototype includes the following components:

- a piece of hardware, usually done as a microcontroller system connected to a personal computer.

- a software component that includes two software applications resident on the system microcontroller and the PC respectively.

- written documentation (ie lab work description of application development tools and how they use).

- additional Software Resources (demo version) used in application development tools.

Microcontroller systems are made using microconvertoarele with kernel 8052/ARM7 supplied by Analog Devices, which include, near microcontroller itself, a number of interface peripherals (CAN 12 biţi/1MSPS, CNA 12 bit/5uS, converter ΣΔ 24-bit, etc.).

Software resident on the system microcontroller is a real-time operating Mini (tiny) for specialized applications indulged acquisition and control. On a PC running software developed in LabView environment, having the main role of a GUI - the user that communication with microconvertor system.

It was made a lot of experimental models based on these constructions principles.

4.5.3.3. Experimental models

The following are some images that illustrate the ideas in the designing the educational means.

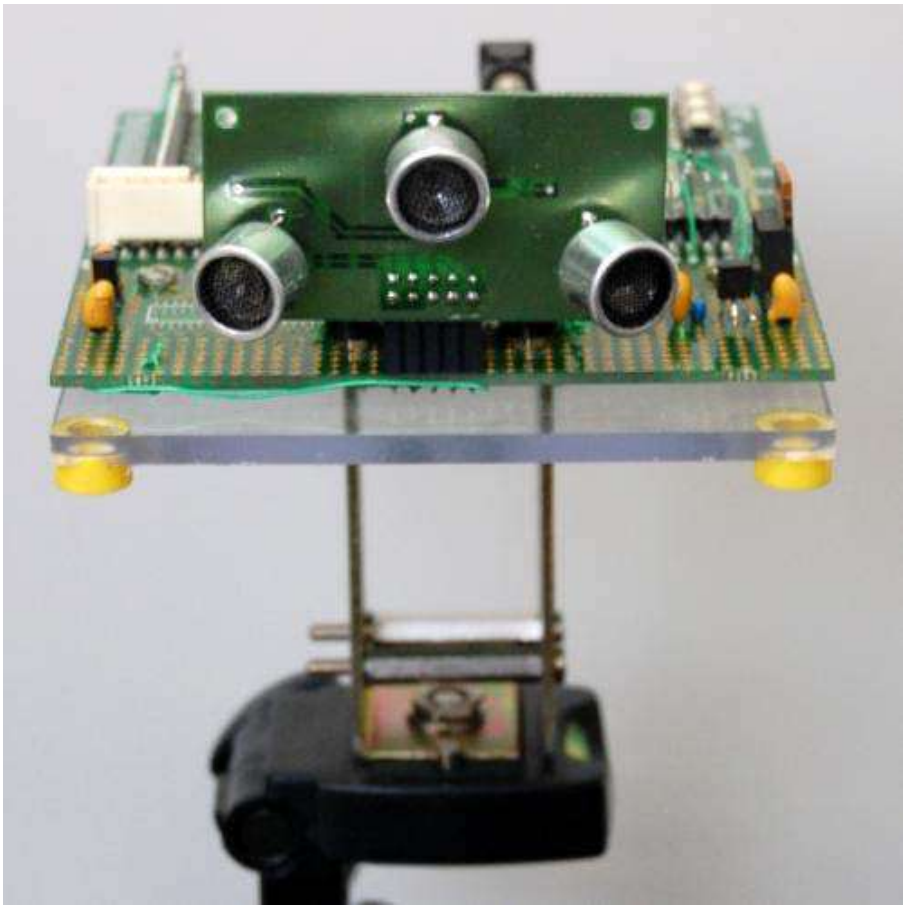

Figure 4.5.3-1 - Laboratory "Study ultrasonic transducer (hardware).

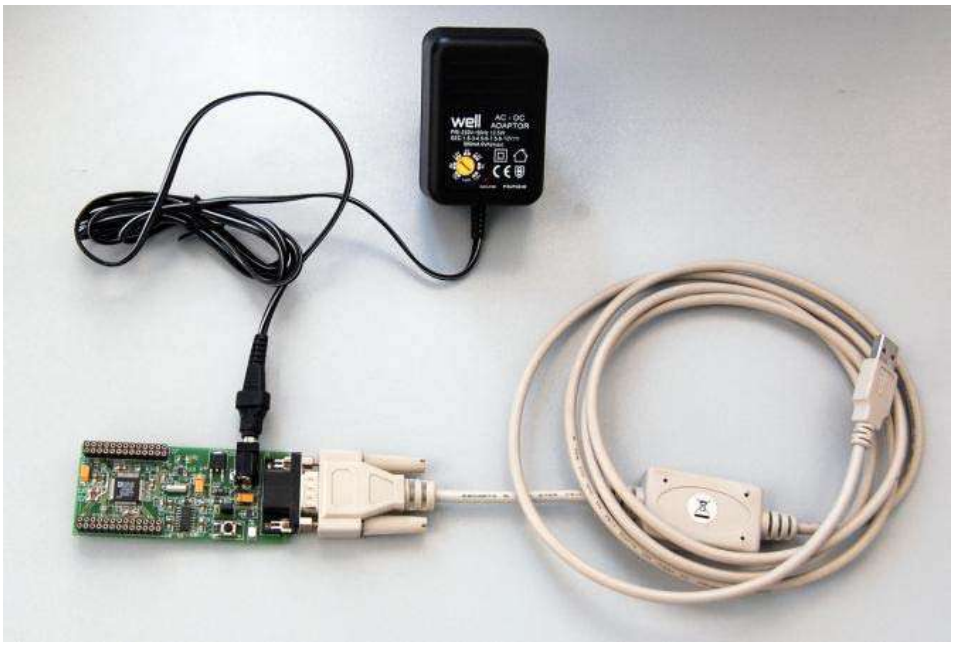

Figure 4.5.3-2. - Application development system with AduC832 microconvertor

Have been developed so far and are in different families Stage of completion following prototypes:

- dL xxx-232 family (Development Line). Micro in this category (see Figure 4.5.3-3) include a minimum of hardware to allow easy inclusion in hardware application developed.

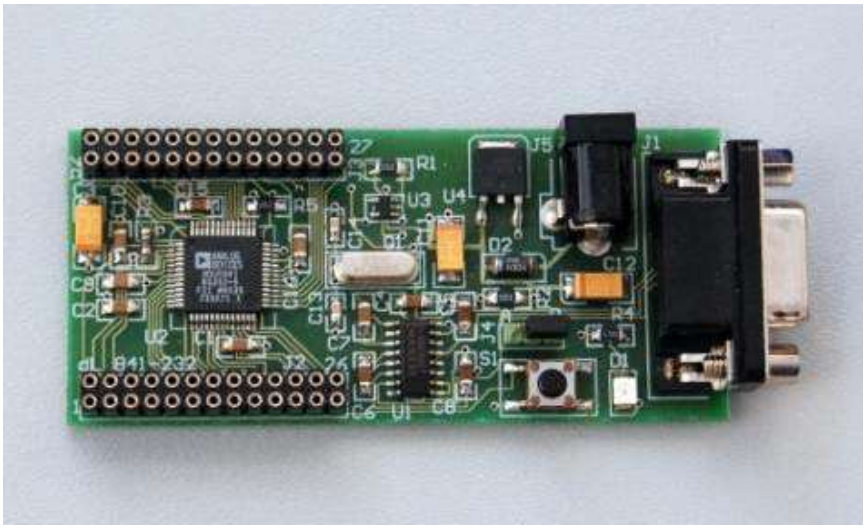

Figure 4.5.3-3 - Family dL xxx-232 (Development Line).

Micro serial port can communicate with a personal computer and can run real-time operating Minisisteme Tiny.

Software development environment IDE can be used uVision available from Keil company. In applications of data acquisition and control is available a specialized GUI (DL-GUI).

There are currently completed micro: Mr 814-232, 836-232 dL, dL 841-232, 842-232 dL, dL 2104-232.

Figure 4.5.3-4. - Family rL xxx-232 (Research Line).

Are in preparation: MR 814-USB, DL-836 USB 841-USB dL, dL 842 - USB-2104 USB dL. Family eL xxx-232 (Education Line).

Micro in this category is intended for carrying out laboratory work in the disciplines of electrical measures, data acquisition systems, etc. Micro communicate on a personal computer serial port and provides all facilities for testing hardware procurement and control signals. Software related to this family includes operating Minisisteme Tiny and a graphical-user interface specialist (el-GUI).

There are currently completed micro: it 836-232, 841-232 eL, eL 842-232. Are in preparation: EL-836 USB EL-841 USB, EL-842 USB.

Family district xxx-232 (Research Line).

Micro in this micro from previous families, they present features hardware / software and an enhanced level of protection in higher use. Tiny micro supports operating Minisisteme and can be ordered through a graphical-user interface-GUI specialist district.

There are currently completed micro: RL 836-232, RL 841-232, RL 842-232. RL 836-232, RL 841-232, RL 842-232.

Are in preparation: RL 836-USB-841 USB RL, RL 842 and RL-USB 836-485, RL 841-485, RL 842-485 (the last connected by an interface 485).

4.5.3.4. SPIN-OFF – from idea to production

Based on that experience it was accsesed some financial program, 2.1 prioritary axis of the operational programme and the major field of interventions: sector operational programme: the increase of economical competitivity, prioritary axis: ap2: competitivity through research, technological development and innovation intervention field: d2.3: the access of companies to activities of research-and-development (rd) and innovation operation: o2.3.1: suppeort for innovative start-up's and spin-off's.

The activities proposed by this project will be performed within the Scientific and Technologic Park called "Tim Science Park" in Timisoara, which is authorized to function

according to Order no. 4993/13.10.2004 of the Ministry of Education and Research, and brings together the inter-disciplinary research of some institutions members of the Park (The National Institute of Research in Electrochemistry and Condensed Matter, "Ion Slavici" University of Timisoara, "Vasile Goldis" University of Arad) and other partners ("Politehnica" University of Timisoara, the company ISEL Germany and its representative in Romania, SC Dr. Kocher SRL).

General objective: Transferring into the productive field of the innovative technological capital, of some individual scientific contributions (paper works, licenses and know-how), regarding the use of microcontrollers in nanotechnology and material processing).

Specific objectives:

1: The creation of a society specialized in the production of didactic equipment in the field of the management by microcontrollers of the technological processes.

2: The diversification of the production of the newly created society by assembling modular equipments, which are flexible and meet the users' requirements in the field of nanotechnologies and material processing. The project fills in the existing gap in the Romanian market, namely the lack of equipments for didactic use; this is achieved by the scientific research and the microproduction, the created spin-off, the works and the ourself licenses.

The newly created company:

- spreads in Romania the modular building of specialized equipments for nanotechnologies and material processing;

-brings contributions to the field of nanotechnologies, which is considered as an advanced field, and also in the methods of equipment management by microcontrollers;

-contributes to the development in the approached field, by the conceiving of modular equipments (flexible in the sense of passing from a processing type to another).

The spin-off is established as a limited liability company and will have three shareholders:

-"Ion Slavici" University of Timisoara

- SC "Titus" SRL from Timisoara

- Mr. Virgil Tiponut, who owns the majority of the intellectual rights over the results of the scientific research that, will be used by the spin-offs [76].

The existing partnership is fully financed by "Ion Slavici" University of Timisoara and, both from the technical point of view and the financial one, it is independent from the extended partnership that will be achieved by means of the implementation of this project, which will receive European funding and private co-financing.

The product will be materialized by modular equipments of processing that, by minimal transformations, can use the following technologies:

- chipping (particularly milling)

- laser fascicle processing

- water jet processing

- oxygen flame processing

- chemical engraving processing

- combined processing, usually successive

Possible future customers of the newly created spin-off:

- education and research institutions from the envisaged area: The "Politehnica" University of Timisoara, "Ion Slavici" University of Timisoara, "Tibiscus" University of Timisoara, The University of the West from Timisoara, "Aurel Vlaicu" University of Arad, "Vasile Goldis" University of the West from Arad, as well as different high-schools with the profile of informatics / computers: "Grigore Moisil" Informatics High school of Timisoara, "Banatean" National High-school, "Ioan Slavici" High-school, "Iuliu Maniu" Highschool.

- the generation of SMC's (small and medium companies) with diversified and flexible production, that need modular equipments. Let us enumerate possible customer companies: Optoelectronica S.A. Bucuresti, Takata Petri S.R.L. Arad, Apellsan S.R.L.Bucuresti, ICPL-CA S.A. Bucuresti, General-numeric S.R.L. Bucuresti.

The target group proposed: the engineering students from the "Ioan Slavici" University of Timisoara, who will be involved in the research activity and will become the selection basis for employers (part-time jobs) within the new spin-off.

4.5.3.5. Conclusions

In conclusion, even from the beginning of the spin-off activity, the process of research and application in production will be conceived so that:

- the company's activity should focus on quality in the framework of applying the principles of sustainable development;

- the company's offer should be defined reported to the interests and expectations of the target groups and the beneficiaries, as well as to the market dynamics.

The general objective of the project is the increase of the Romanian companies' productivity, by ensuring the respect of the principles of sustainable development, and the decrease of the gap between this productivity and the one of the European countries. Also, the objective is similar to one of the specific objectives of the priority axis 2, namely the *stimulation of technological transfer based on the cooperation between the RD institutions and the companies*, and the increase of the national and international visibility of the interdisciplinary research team involved in the project, by means of the largescale result dissemination activities, the participation in scientific events, etc.

The implementation of the project will lead to the performance of an efficient production activity and, in the medium term, to the accumulation of profit, which becomes the financing and supporting source of the research and micro-production activity, as well as of the future investments. The financial analysis included in the business plan reveals the fact that the newly created company will be able to generate sufficient self-funding in order to carry-on its activities for at least 5 years after the end of the project. The accumulated cash-flow is positive for each year, it being the condition necessary for financial sustainability.

V. PROFESSIONAL ACHIEVEMENTS

There are interference areas between the scientific, academic and professional components.

5.1 Professional prestige

It is a result of the professional training, published scientific papers, coordinated grants and projects, creating new specializations and new labs, founding economic units.

5.2 Completion of Professional training

Completion of Professional training was achieved by graduating from more specializations and Bologna cycle stages:

1. Industrial engineering licence –Politehnica Timisoara University 1983
2. Applied informatics licence –Politehnica Timisoara University1994
3. Finances licence – West University Timisoara -2000
4. Management licence – West University Timisoara 2001

5 Industrial engineering doctorate PhD – Politehnica Timisoara University – 1994

6. Finance doctorate PhD – West University Timisoara – 2006

These are part of the fundamental basic training, continuously improved through complementary trainings and educational programmes.

5.3. Permanent publishing activity

As an academic career does not involve only teaching, in the 28 years of my academic activity I have constantly published more than 20 books, as single or first author, all of them ISBN edited and printed. Most of these works are now used as basis for new classes' curricula that have been introduced in educational plans (for example the artificial intelligence in the economic field). Also publications in specialty journals, especially ISI journals, with a relative influence rating more than zero, so combining the scientific component with the professional one.

5.4 Participation in national and international conferences events

As stated in my professional background, the constant involvement and participation in scientific manifestations have transformed in a form of continuous professional training, a chance for cooperation and exchanges of ideas, that are extremely necessary for working in a increasingly globalized world. In the annexes I have presented the papers presented in various events, and participation at conferences held in Spain, Italy, Hungary and Serbia. In some of these events I have acted as chairman (Las-Palmas – Spain, Nyiregyhaza- Hungary), and in some I have been a member in the Organizing Committee (SIPA conferences once in two years).

5.5 Accessing and implementing projects/ grants, focused on professional component

The accessing of some projects in which the professional component stronger than the scientific one, under the Programmes: long life learning (Erasmus, Comenius, Vinci, Grundwig, Monet, sectorial), POS-DRU, POS-CCE.

Chapter 4 presents these projects relevant information.

5.6 Forming new entities from professional component point of view:

5.6.1. The constitution of modern scientific and professional entities:

a. TSP Tim Science Park

The followed stages for the development of this project were:

- Through Minister order no. 4993/13.10.2004 the Education Minister has authorized the functioning of „TSP TIM SCIENCE PARK"

- The new building works execution was supported by the main partners, in accordance with one additional act.

1. INCEMC Institute Timisoara;

2. ISF Timisoara;

3. S.C. Titus S.R.L.

Subsidy contract no. 4/08.11.2004 was awarded, and the maximum financing was 15.750.000.000 lei;

As Lead Partner, at European level, a grant coordinated by Professor Dumitru Tucu was awarded , the undersigned being the project financial manager.

Technological parks for innovation and Trans-European Cooperation – EC	135741-RO-2007-KA3-KA3MP	80.000 euro	2008/2009 Programme Lifelong Learning-Comenius, Grundwig, ICT and Languages

-the best national TSP award was gained in various occasions.

b. The spin off and start-up company constituted – SC Slavici Spinn-off SRL, responsible for research commercial capitalization;

Flexible and modular equipment for numeric management of the technological processes	POS-CCE	200.000 euro	Structural Funds 2008/9	Priority axis 2 – RDI competitivity	ID 2.3 – RDI access for companies -Education and Research Minister , second place in the national contest

Projects selected under POSCCE-A2-O2.3.1-2008- 1- Support for innovative start-ups and spin-off's

POS CCE programme

Priority axis: 2

Field of intervention 3

Operation: 1

Call for proposals: POSCCE-A2- O2.3.1 -2008-1

Table 5.6.1-1

No.	ID	Beneficiary	Project Title	Project type	Score
1	176	S.C. SANOMED G&G S.R.L	CHEMOSENSORIAL MEDICAL EVALUATION CENTER	START-UP	25
2	231	UNIVERSITATEA IOAN SLAVICI-TIMIŞOARA-TITUS SLAVICI	FLEXIBLE AND MODULAR EQUIPMENT FOR NUMERIC MANAGEMENT OF THE TECHNOLOGICAL PROCESSES	SPIN-OFF	23
3	178	UNIVERSITATEA TEHNICA IAŞI-CIOBANU ROMEO	INNOVATIVE RECYCLING	SPIN-OFF	22
4	175	AMD INITIATIVE SRL	MIPORE ABSORBANT PRODUCTS RANGE DEVELOPMENT FOR INDUSTRIAL/ AGRICULTURE USE	START-UP	20

c. Cenei Industrial Park – on-going implementation.

5.6.2. The constitution of Ioan Slavici Foundation for Education and Culture in Timisoara, within which the University was formed.

5.6.3. Creating new labs at the level of Politehnica University from Timişoara (handling and measurements numerically assisted) and at the level of Ioan Slavici University Timisoara (integrated engineering, companies' simulator).

VI. ACADEMIC ACHIEVEMENTS

6.1 Step by step and on the basis of legal contest evolution within academic functions hierarchy

Until present, my academic career has developed gradually, from university assistant to university professor. Every didactic function was gained as a result of a public contest. My daily academic activity took place within Politehnica University from Timisoara and within Ioan Slavici University from Timisoara, where I am the founder and the President of the Administrative Council.

6.2 Academic achievements by completion of more specializations and Bologna cycle stages:

1. Industrial engineering licence –Politehnica Timisoara University 1983

2. Applied informatics licence –Politehnica Timisoara University1994

3. Finances licence – West University Timisoara -2000

4. Management licence – West University Timisoara 2001

5 Industrial engineering doctorate PhD – Politehnica Timisoara University – 1994

6. Finance doctorate PhD – West University Timisoara – 2006

These form the fundamental basic of my academic achievements, continuously ameliorated through complementary trainings and educational programmes.

6.3 Permanent publications activity

As an academic career does not involve only teaching, in the 28 years of my academic activity I have constantly published more than 20 books, as single or first author, all of them ISBN edited and printed. Most of these works are now used as basis for new classes' curricula that have been introduced in educational plans (for example the artificial intelligence in the academic environment)

6.4 Participation in national and international conferences events

As stated in my professional background, the constant involvement and participation in scientific manifestations have transformed in a form of continuous professional training, a chance for cooperation and exchanges of ideas, that are extremely necessary for working in a increasingly globalized world. In the annexes I have presented the papers presented in various events, and participation at conferences held in Spain, Italy, Hungary and Serbia. In some of these events I have acted as chairman (Las-Palmas – Spain, Nyiregyhaza- Hungary), and in some I have been a member in the Organizing Committee (SIPA conferences once in two years).

6.5 Teaching in foreign universities

I consider this type of activity to be an excellent opportunity for establishing contacts with academics from other countries, as well as a chance of developing my working skills in a multicultural and international environment. Until now I have taught classes at the Universities of Novi-Sad, Szeged, and Nyiregyhaza, in the framework of some cross-border projects with Serbian and Hungarian Partners.

6.6 Involvement in student practice activities

This activity was accomplished through:

a) supporting the students in organizing scientific events;

b) Coordinating licence (graduation) works;

c) Recommending students for scholarships and other practical activities during the completion of their higher education process;

d) professional visits organising for students at the level of various public institutions.

6.7 Founding new entities in the academic sector

6.7.1. The founding of Ioan Slavici Foundation for Education and Culture in Timisoara, within which the University was formed.

6.7.2. The founding of 5 university specialization fields (Accounting and Information Management, Finance, Business Administration, Computers, Information Technology), for which I personally have formulated and organized the ARACIS authorization documentation.

6.7.3. Creation of new labs at the level of Politehnica University from Timişoara (handling and measurements numerically assisted) and at the level of Ioan Slavici University Timisoara (integrated engineering, companies' simulator).

SECTION II

CAREER DEVELOPMENT PLANS

VII. FUTURE PLANS FOR THE DEVELOPMENT OF MY PROFESSIONAL, SCIENTIFIC AND ACADEMIC CAREER

7.1 Development of the professional career

For the future I intend to continue the development of my professional career in the interdisciplinary fields I have approached so far, in the area of interference between economy and engineering, as I have now (at 30 years since I have graduated from my first university) gain a larger reference frame. This is one of the reasons for my wish to develop and strengthen my working relationships with colleagues from other universities, and to participate in more juridical activities organized on national and international level.

I intend to continue the introduction of new curricula in the existing teaching plans that are more attuned to the realities of the open market and present academia. In order to achieve this I will develop the syllabus of the new courses and form new educational and research teams.

Creating new laboratories is also one of the directions in which I intend to develop my professional career, especially at the interference area between economy and informatics.

Also, I will continue to apply for financing in projects that encourage the development of professionals more than the development of scientific endeavours, like long life learning (Erasmus, Comenius, Da Vinci, Grundtvig, Monet, aso), and also larger programs like the Development of Human Resources Operational Program and the Increase of Competiveness Operational Program.

Also, as a PhD supervisor is traditionally considered as a leader and creator of new schools in the academic sector, I intend to participate in the development of my younger colleagues as professionals and academics.

Another area of personal and professional development regard my involvement in the development of modern professional and scientific units, like technological and scientific parks, spin-off companies, and start-ups.

7.2 Development of scientific career

Scientific research is essential for the development of an academic career. Scientific career implies a continuous involvement and interest for research, the fields of research being established according to personal interests in the science.

a. My main fields of scientific interest are:

- aplied IA in industrial engineering
- modern forecast methods for industrial engineering processes
- numerical control of manufacturing processes

These areas have been approached in scientific papers published in various ISI marked journals that have an influence score above 1. Following the publishing of these works, I have been asked to act as expert evaluator for several international journals. For example, I have received an Invitation to review Manuscript ERP-2013-0027 - Expert Review of Pharmacoeconomics & Outcomes.

As the economic domain is enlarging by encompassing social aspects, these personal areas of interest are also subject to change course towards an interedisciplinary research. I do

not wish to limit my research areas, as I considered that a good professor and researcher needs to have knowledge from many areas, in order to better understand the economic and technic phenomena.

I intend to increase the quality of my research in the above mentioned area of interest, and also to approach new areas, like:

- optimization of financial decisions by using genetic algorithms

- creating new databases and their applications by using the new expert systems

b. Developing/creating new laboratories.

I also intend to develop or create new laboratories of economic informatics and simulated enterprises.

c. Publishing intentions.

I have presently written or participated in the writing of more than 100 journal articles, studies or reviews. Some articles have been published in English. It is my intention to continue to publish the results of my research in national and international journals. For the future I will try to publish more of my research in international journals, in order to promote also the ideas and achievements of the Romanian school in the fields of economy and engineering. Following the hierarchy accepted worldwide, I have already published several papers in ISI journals with a relative influence factor above 1 and an impact factor above 2 (included in the cited 10 representative papers), and I intend to continue for the future.

Another priority is to increase the value of these papers, in order to be accepted in other ISI rated journals with high influence scores. For one of the published papers, we have received a confirmation from the editor regarding the high reading rate. The letter is cited below:

Dear Prof Slavici,

We thought you might be interested to know how many people have read your article:

Economic efficiency of primary care for CVD prevention and treatment in Eastern European countries Titus Slavici, Claudiu Avram, Gabriela Victoria Mnerie, Adriana Badescu, Doina Darvasi, Florin Molnar-Matei and Mihai Aristotel Ungureanu BMC Health Services Research, 13:75 (23 Feb 2013) http://www.biomedcentral.com/1472-6963/13/75 Total accesses to this article since publication: 1213 Pharmacoeconomics &.. Pharmacoeconomics & Outcomes

d. Research results presented in national and international conferences.

In the future I intend to participate and present papers in more conferences and scientific events. Especially, I intend to participate in conferences and scientific events attended by participants from other universities and other countries. Of course, I will give precedence to conferences for which the proceedings are ISI indexed or on list A or B.

e. Accessing projects that give precedence to the scientific aspects over the professional ones, like : long life learning programs (transversal projects), projects financed in the Increase of Economic Competitiveness Operational Program, FP7, PNII.

f. Creating and developing modern professional and scientific units like : scientific and technological parks, spin-offs and start-ups.

7.3 Development of the academic career

a. Ascending in the academic hierarchy: Step-by-step and competition based process.

Until now, I have ascended the academic hierarchy, all the way up from assistant to professor, without any shortcuts. All obtained academic functions have been the result of competition. Presently, I am attempting to obtain the right to function as PhD supervisor.

b Permanent publishing activity.

As an academic career involves more than teaching the students, in my 28 years of academic activity I have continuously published a number of over 20 books as first or single author.

c. Participating and presenting lectures in national and international conferences.

For the future I intend to participate and present lectures in more conferences and workshops. Especially, I will try to participate in conferences and workshops attended by participants from other universities and countries. Also, I will give precedence to conferences and workshops organized on subjects and themes related to the area of public law in which I intend to specialize.

As it can be seen from my activity up to present, I consider the constant participation in scientific events as a way of increasing my professional abilities, collaborating and exchanging ideas, all of which are very necessary in an increasingly "small" world due to globalization.

d. Presenting lectures in foreign universities.

For the future, I intend to give more attention to presenting lectures in other universities, especially universities in other countries. Such an activity will be a good occasion to contact academics from abroad, and develop my abilities to work and teach in an international, multicultural environment.

e. Involvement in student practice

Practical involvement in students' work can be achieved through:

support given to students to encourage their participation in scientific events and/or in organizing scientific events.

Coordinating and supervising licence works;

Recommending students for scholarships or other practical activities during faculty;

Organizing professional visits for students to various public or private institutions

For the future I will give more attention to these practical activities with the students, to supporting students' academic and scientific efforts. Also, for students in the master stage, I would like to develop the "habit" of inviting various experts – in different areas – to present lectures and talk to students, as "special guests".

SECTION III

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PROJECTS

[83] PR 135741-RO-2007-KA3-KA3MP, Technological parks for Innovation and Trans-European Cooperation – Comisia Europeană Bruxelles, 135741-RO-2007-KA3-KA3MP, Amount 80.000 euro.

[84] PR 2010-1-IT1-LEO04-00983 4, ARTTOWN project, Project ID 2010-1-IT1-LEO04-00983 4, Amount 25.000 euro.

[85] PR Dezvoltarea infrastructurii comune de cercetare si a managementului calitatii in cercetarea stiintifica universitara conform principiilor dezvoltarii durabile.

[86] PR FEADR Axis I, Bread and pastry unit set up Cenei, Timis County, Total: 265.193 eur, Cofinancing 53.492 eur.

[87] PR FEADR Axis III, Leisure area set up, Total:160.002 Euro.

[88] PR FEADR Axis III, Rehabilitation, modernisation and set up of production line, Total: 198.491 Euro.

[89] PR Flexible and modular equipment for numeric management of the technological processes, POS-CCE, Amount 200.000 euro.

[90] PR GRU-09-P-LP-89-TM-IT, Labour inclusion for personal autonomy of women, Project ID GRU-09-P-LP-89-TM-IT, Amount 15.000 euro.

[91] PR GRU-11-P-LP-200-TM-SK, Partnership for education, Project ID GRU-11-P-LP-200-TM-SK, Amount 15.000 euro.

[92] PR HURO/0801/036, Towards a new quality dimension within Romanian and Hungarian University Education – Cross – border quality implementation and monitoring center – Lead Parner ISF, partner Szeged University, Project ID HURO/ 0801/036, Amount 150.000 euro.

[93] PR HURO/0801/066, Joint partnership and joint sustainable scientific research quality management development with Nyregyhaza University, Project ID HURO/ 0801/066, amount 50.000 euro.

[94] PR HURO/1001/148/2.3.1, Train and win in HU-RO style, Project ID HURO/ 1001/148/2.3.1, Amount 63.034 Euro.

[95] PR INFRATECH 4/08.11.2004, INFRATECH, Contract 4/08.11.2004, Amount 180.000, ISF contribution.

[96] PR IPA 117, Quality in education, college and universities, using innovative methods and new laboratories – Lead Parner FIS, Project ID IPA 117 Cod MIS-ETC 488, Amount 117.270 Euro.

[97] PR IPA 136, Cross-border initiative for research and development activities, (and) cooperation between economy and scientific educational institutions, in Serbian and Romanian[.] Project ID IPA 136 Cod MIS-ETC 507, Amount 297.636 Euro total / 80.310 Euro FIS.

[98] PR LLP-LdV/PAR/2013/RO/096, Developing Intercultural Competences for Enterprises – DICE, Project ID LLP-LdV/PAR/2013/RO/096, Amount 25.000.

[99] PR POS-CCE SMIS CSNR 37278, ISF broadband access improvement, POS-CCE SMIS CSNR 37278, Amount 122.710,40 lei.

[100] PR POSDRU/ 103/5.1/G/79077, West Region new labour market integration opportunities, Project ID POSDRU/ 103/5.1/G/79077, Amount 1.170.535 lei.

[101] PR POSDRU/ 108/2.3/G/83035, Together for success through relevant and actual qualification achievement, Project ID POSDRU/ 108/2.3/G/83035, Amount 1.692.720 lei.

[102] PR POSDRU/109/2.1/81666, Student – Future managers, Project ID POSDRU/109/2.1/81666, Amount 751.000 lei.

[103] PR POSDRU/109/2.1/82583, Labour market correlation with active training through relevance, interactivty and accessibility, Project ID POSDRU/109/2.1/82583, Amount 938.600 lei.

[104] PR RO 2006/018-448.01.01.10, Romanian – Serbian joint business planning, hosting and supporting – Cross border center for SME's planning, hosting and supporting within Timis County and Southern Banat District, Project ID RO 2006/018-448.01.01.10, Amount 110.000 euro.

IX. ANNEXES