Hybrid Computing in Electronic Auction

Cornel Resteanu
National Institute for Research and Development in Informatics (ICI)
8-10 Averescu Avenue, 71316 Bucharest 1
Romania
resteanu@ici.ro

Abstract – ***OPTCHOICE*** **is a package consisting in: a software capable to define and solve in remote regime, using the Internet, optimal choice problems, a technology to enclose, in e-business applications, the ready-made modules for optimal choice of a decisional alternative, and finally, a library containing technology's applying samples. The paper presents one of the samples build to illustrate optimal choice models fast implementation in advanced e-business application. This sample is called *Tele-AUCTION*. By its agency, the Investments Department employees of a plant can organize electronic auctions for goods / services / works of high values purchasing. The optimal choice is made upon mathematical criteria. The focus is on this last aspect. One uses a Multi-Attribute Decision Making model. The model is general, with more than one decision-makers and states of nature, the attributes being of cardinal, ordinal, Boolean and fuzzy type. It benefits from knowledge-based computing for inconsistency avoiding. For optimal choice problem solving, there are five generalised solving methods and one procedure to get a unique optimum.**

I. INTRODUCTION

In many European countries, the laws in force, or at least the deontological norms, are stipulating that goods and services acquisitions as well as works contracting using public funds must be made in the auction regime. In Romania, Communications and Information Technology Ministry owns a free of charge site for electronic auctions. The site is an *m*-1-*n* site, a conjunction site, which joins together *m* acquisitors, 1 mediator, in this case the General Inspectorate for IT&C, and *n* suppliers. The public administration, the national companies, the institutions or enterprises that benefit from public funds for their procurement activities, must use this site for the checklist of products, services and works specified by law. Automatically, a great number of goods suppliers and services / works performers are involved in the system. This establishes a propitious climate for electronic auctions in Romania.

It is easy to understand that, for the exceptions from the official checklist, all the above institutions and enterprises must use complementary software as their own *e-procurement* tool. Private companies, which are always functioning on the maximization profit principle, are also interested to use this kind of software for good quality products / services / works acquisition at lowest prices [1], [2]. The production supply chains can be well served by regular *e-procurement* tools but a special one must assist the supply chain involved by significant investments [3]. *Tele-AUCTION* software is designed to fulfil this special need [4]. With this specification, it is obvious that this software will equip 1-*n* sites, namely sites of 1 acquisitor that attracts *n* suppliers for diverse acquisitions characterised by large values.

II. *TELE-AUCTION* PRESENTATION

The technical platform was defined as follows: PC equipped with Windows NT / 2000, SQL Server 7.0 Enterprise Edition, MSVC 6.0, CLIPS and ASP. *Tele-AUCTION* has two functional blocks. The first block addresses the site owner and, consequently, works on the Intranet. By means of four functions, namely *"Investments objectives"*, *"Object classes"*, *"Object classes attributes"*, *"Objects ranking and auction decisions"*, the staff of Investments and Commercial Departments creates the information base necessary for developing auctions. The second block addresses the potential goods / services / works suppliers and, consequently, works on the Internet. The suppliers possess two functions, namely *"Competitor registration"* and *"Participation"*. The last function is a time polymorphic one and maintains a friendly user interface, for every auction, from beginning to end. For all users, context sensitive help is available. The most important function, the core of *Tele-AUCTION*, is a hidden function that dynamically ranks the competitors for each *open* auction. This is made using a mathematical method belonging to the Multi-Attribute Decision Making (MADM) class. A supervisor program, developed in the dormant technique, automatically runs, at a given tact, the rankings as well as other actions such as auctions closing / deciding / deleting.

The security is a very serious problem, solved in an elaborate manner. For exterior, there is the PKI component that assures access control, user authentication, non-repudiation, integrity of data transfer, digital signature, etc. For interior, a special component manages the database integrity. Every unauthorized access, even those made by programmers directly on the database tables, provoke system blockage until the system automatically regains its integrity. The supervisor also runs this function. Therefore, the competitors can trust that they compete in an environment characterized by correctness and loyalty. The business is based, as always, on partners' honour.

In the following, the steps sequence for an electronic auction (preparation, registration, bidding, re-bidding, closing and deciding) using this software is presented. Will be obvious for everybody that *Tele-AUCTION* supports auctions organized upon a mixture from the Anglo-Saxon and Dutch methods.

A. Auctions Preparation

Auction preparation is a process developed at two levels. The first level is represented by the investment objectives definition, made by the managing staff of the Investments Department. The second is represented by the statement and definition of object classes that will be purchased for each investment objective. The technical staff from different departments accomplishes this task.

An investment objective is well defined if and only if the following information is presented: objective code and name, allowed money amount and financing mode, announcing date and deadline. In response, the system will calculate and / or visualize, at any moment belonging to the interval defined by the objective announcing date and the objective deadline plus a month, the amount of money resulted, from all pending auctions, as necessary to accomplish the investments objective. This is very important information for decision-making.

An object class, belonging to a fixed investments objective, is well defined if and only if the following information is presented: first, object code and name, measure unit, planned price, planned quantity, auction announcing date and auction deadline, and second, all object attributes, specified by attribute name, measure unit, min / max (the good choice sense), lower and upper admissible limits, weight (the importance in the framework of all attributes set). It is to notice that, for every object class, the attribute "price" automatically appears at the top of the attributes' table, being always the first attribute. It cannot be erased. Therefore, every object class has at least one attribute, the implicit one. Always it is specified whether the quantity must be equal to planned quantity or can be a part of it. In response, the system will calculate and / or visualize, at any moment belonging to the interval defined by the auction announcing date and the investments objective deadline plus a month, the bidden quantity and the amount of money necessary to buy the bidden objects, as resulted from the auction.

The software is realized upon large-scale systems' principles. The system can manage a large number of "investments objectives" containing "object classes". In addition, it is prepared to support a substantial participation and the size of the business is not a limitation.

B. Bidding and Re-bidding

At this moment, for the potential suppliers it is possible to access the *e-auction* site using Microsoft Internet Explorer or Netscape browsers. They must register in the system and become auction competitors. If they are not members of a PKI community, then the required formalities are necessary to do.

The competition procedure is very simple. The investment objectives and object classes to buy, with their required quantities and attributes, are shown by *Tele-AUCTION* in a friendly manner. A competitor must fill-in: his object name, the bidden quantity and all required object attributes. He must pay great attention to his object description. Every attribute must be specified with accuracy because the mathematical model for competitors dynamic ranking will be constructed from this kind of information. A facility to guide the attributes' description is present. On the Internet, every attribute is sensitive; by clicking on it, a descriptive text, prepared by specialists in the field, does not allow any involuntary mistake. The incredible situations are pointed out. On the Intranet, at any time, it is possible to visualize the values of current attributes for every proposed object.

During the auction, for a fixed object, the system gives information about its attributes in comparison with the attributes of the first three ranked objects, other than the fixed object. Therefore, the competitor can improve the object attributes, hoping that his object increases its competitiveness. This facility is not valid for the attribute "price". Only five sessions with attributes updating are allowed, but the bidden quantity and the price are free for unlimited re-biddings. One day before the auction closing, for the proposal that has the bidding price greater than the planned price (considered as an upper limit price), an e-mail informing about this situation is launched and from now a single price updating, is permitted. In the case that, during the auction, the organizer has stated new limits for the object class attributes, some object attributes may become out of limits and, in order to stay in competition, the attributes must be updated. Updates made in response at organizer demand are not counted. Retiring from the auction is possible at any moment. This fact is a normal one and does not influence the competitor credibility for other / future auctions. In conclusion, the auction procedure is very stimulant and a true fait between competitors is expected to take place.

C. Auction Closing and Deciding

When the auction status becomes *closed*, no more updates are possible. For the bidden object, its final competition characteristics are done. The competitor must wait for the auction result, which appears when the auction status becomes *decided*.

The function "Objects ranking and auction decision" shows to investments managing staff, at any auction moment, the objects (competitors) ranking. For a pair of investments objective - object class: the planned values (therefore the planned expenses) and the resulted values (therefore the real expenses) are presented. In this context, the current ranking is given in a table containing: object name, offering company, merit, price, bidden quantity, value and ordered quantity. With one exception, all the fields are read-only. During three days, the period that is allowed for *closed* status, ordered quantities column is set free for human intervention. In order to make some corrections, considered of great importance, the managing staff from Investments Department can intervene in the automatic given results. Therefore, it is possible to ignore the automatic auction decision and make a human one, but the price paid for this action is revealed by the system. It is to notice that all human corrections are registered in a special guarded database table, the envisaged elements being: operator name and position in firm, partner company, bidden good / service / work, quantity and price, auction time and code.

When the auction status becomes *decided*, the competitors are informed about final auction results. A complete panoramic view is given. The winner or winners are invited, by automatically launched orders, to sign the economical contracts. It is possible that some potential suppliers, although invited as auction winners, ignore this fact. The next ranked suppliers are called. However, the lack of earnestness is penalized. A sophisticated penalty will be computed. This penalty depends on the value of the ignored auction weighted with the amount and value of transactions carried on in the past, the promptness in making due payments, and other elements that prove the competitor's reliability. For the next auctions, their merit will start from a negative value. Only new winning auctions will erase, in time, this handicap. Wrong specifications of object attributes, in flagrant with the reality, will exclude for good the competitor from the partners list.

III. DECISIONAL MATHEMATICAL MODEL

In this section, which is the core of the paper, will be shown the mathematical model and the choice problems generated over this in order to gain optimality in auctions. The model with its associated database, the modules for automatically generate and solve the choice problems and the transferable IT knowledge in this field belongs to the technology developed to enclose in e-business application a such kind of mathematical tool. Having available this technology, the software presented above was realized in four months!

The decisional process is a multitude of human activities consisting mainly in the realization of the existence of more than one possible course of action in a certain given context, the analysis of their consequences with respect to the envisaged goal, the choice and implementation of the action that is considered optimal in the axiological perspective that has been adopted. The Optimal Choice Problem (OCP) is of utmost importance in this process. The OCP can be easy handled by the MADM theory.

A.. MADM Model

The MADM framework involves the following elements:

- A set of decision-makers $D = \{d(l) \mid l = \overline{1, l}\}$, ($l$=card($D$)), whose elements are the persons with assignments in the process of defining and solving the OCP;

- A set of states of nature $S = \{s(k) \mid k = \overline{1, k}\}$, ($k$=card($S$)), each one of them synthetically signifying the totality of circumstances that determines, for a specific OCP, variations in its formulation;

- A set of objects $O = \{o(i) \mid i = \overline{1, i}\}$, ($i$=card($O$)), containing the decision alternatives;

- A set of attributes $A = \{a(j) \mid j = \overline{1, j}\}$, ($j$=card($A$)), consisting in those characteristics which are evaluated for every decision alternative. An attribute may be expressed in a Boolean, cardinal, ordinal or fuzzy (by trapezoidal membership functions) manner, but this expression must be unique for a fixed attribute. Each attribute $a(j)$ has an associated variation interval [*lo_a*(j), *up_a*(j)] (according to its type) and an associated interval of standard values [*stlo_a*(j), *stup_a*(j)]. Also ones consider an indicator, the *sense_a(j)*, which may take two values, "max" or "min", depending on the fact that $a(j)$ the greater it is the better is considered or the smaller it is the better is considered respectively.

Considering the above four sets as support, the following functions are constructed:

- $(\forall) X \in \{D, S, A\}$, $I^r_X : X \times X \rightarrow (0, +\infty)$, defined by $I^r_X(x(m), x(n)) = w_{mn}$, where w_{mn} represents the relative importance of the element $x(m)$ with respect to the element $x(n)$, i.e. that positive number which expresses how many times $x(m)$ is more important than $x(n)$. However, most of the practical situations use instead of the relative importance an absolute importance, $I^a_X : X \rightarrow (0, 1]$, defined by $I^a_X(x(m)) = w_m$. The absolute importance has the property $\sum_{m=1}^{\text{card}(X)} w_m = 1$. Moreover, for a fixed set X, each of the above functions may be constructed from the other one;

- $C : O \times A \times S \times D \rightarrow H$, where $C(o(i), a(j), s(k), d(l)) = c_{ijkl}$ represents the evaluation of the attribute $a(j)$ for the object $o(i)$, in the state of nature $s(k)$, in the opinion of the decision-maker $d(l)$. This function is usually known as characteristics matrix. It has a hybrid character, being divided, intuitively speaking, into two areas: the first is the *well-defined area* of the matrix, in which every attribute has a well-defined value for every object, for every state of nature and in the opinion of every decision-maker; the second is the *ill-defined area*, meaning that the values of certain attributes in relation to certain objects in certain states of nature are unknown or that they cannot be expressed by some of the decision-makers, possibly, by most of them. Ones can speak of a well-defined area and an ill-defined area because it is up to the human factor to give the matrix elements.

Taking the above structured information as factual base, a productions set P (expressed in the general format *IF* $cond_1 \wedge cond_2 \wedge .. \wedge cond_m$ *THEN* $act_1, act_2, .., act_n$) for unstructured information modeling, is also considered.

The alternative goals of OCP are: 1) To determine an optimal object, without providing reporting information to other objects; 2) To achieve an objects hierarchy; 3) To evaluate each object in von Neumann - Morgenstern sense. From a practical point of view, these goals are equivalent but the quality of global information increases from the first goal to the third goal.

B. OCP Generating and Main Difficulties in Solving

Auction database is the generating source for OCPs. These are generated after any auction-significant data transaction.

A particular problem regarding one auction, generated starting from the MADM model, may be solved by using one or more MADM methods (there are more than 25 different methods or methods classes [5] applicable in conjunction with several normalization methods). For *Tele-AUCTION* has been chosen five of them, namely: the scores / Pareto / Saphier-Rusu / Topsis / Todim methods. They had been extended for more states of nature and decidents because the auctions often require this.

These methods obviously work with the well-defined area of the attributes' matrix and so no entire information is used. It is also possible that part of the processed information contradicts the reality and the respective methods do not perform any model validation. On the other hand, since every method is based on a different point of view of the OCP solving, it is clear that applying different methods to the same set of data, will often lead to different solutions. The potential drawbacks of traditional OCP generating and solving technology, namely inconsistent (incomplete / incorrect / incredible) definition and multiple solutions respectively, were overcome using, a specific rule-based computing technique.

B. OCP Classical Multi-solving

Here is in pseudocode, as an example, one instance of the Pareto methods class. Ones present the classical version in the first column with the extension in the second one.

```
FOR l=1,l
  FOR k=1,k
    FOR j=1,j
      d_a(j)=up_a(j)-lo_a(j)
      IF d_a(j)=0
         d_a(j)=1
      ENDIF
      FOR i=1,i
         c(i,0,k,l)=0
      ENDFOR
      FOR i=1,i
        IF sense_a(j)="max"
           c(i,0,k,l)=c(i,0,k,l)+
          I^a_A(j)*(up_a(j)-c(i,j,k,l))/d_a(j)
       ELSE
         c(i,0,k,l)=c(i,0,k,l)+
         I^a_A(j)*(c(i,j,k,l)-lo_a(j))/d_a(j)
       ENDIF
      ENDFOR
    ENDFOR
  ENDFOR
ENDFOR
FOR l=1,l
  FOR i=1,i
     c(i,0,0,l)=0
  ENDFOR
  FOR k=1,k
     FOR i=1,i
        c(i,0,0,l)=c(i,0,0,l)+
       (1-I^a_S(k))*c(i,0,k,l)
     ENDFOR
  ENDFOR
ENDFOR
FOR i=1,i
   c(i,0,0,l)=0
ENDFOR
FOR l=1,l
  FOR i=1,i
     c(i,0,0,0)=c(i,0,0,0)+
      (1-I^a_D(l))*c(i,0,0,l)
  ENDFOR
ENDFOR
SORT ASC (1-c(i,0,0,0))i=1,i
GIVING
(o(σ(i)),1-c(σ(i),0,0,0))i=1,i
```

Remarks:
- This algorithm, as every implemented algorithm, computes, for each object, an indicator that was named "merit". This term is appropriate to auction domain;
- The merchandise ones divide in three categories: goods, services and works. *Tele-AUCTION* can completely approach all three types:

1) For the first two categories, $k=l=1$ is a covering modeling hypothesis;
2) For auctions concerning the last category, $k, l \geq 1$ is a modeling hypothesis stringently necessary mostly.

C. Knowledge-based Computing for OCP

Two Knowledge-based Computing (KbC) modules, distinct as functionality but unitary as achieving technology, solve the problems of the inconsistency and multiple optimum. In the first module, domain specific production rules expressed by experts can emphasize, for certain objects, the existing non-concordances between the values of their attributes and can also extend the well-defined area in the prejudice of the ill-defined area by filling up gaps with values computed on the basis of the current existing data. This way the model gains in completeness and correctness. In the second module, the procedure of determining the global optimum is, in its turn, based on a system of production rules that adequately deals with the initial factual context enriched with new facts supplied by the mathematical solving methods.

Facts Accumulation

A first category of facts is implicitly supplied by the mathematical model, pre-eminently emphasizing those facts defined by the characteristics' matrix and by the importance of the model entities. It is important to specify that the first KbC module uses the characteristics' matrix in its original form while the second KbC module uses the normalized characteristics' matrix (where each entry belongs to [0, 1]). The second category of facts is generated by the OCP solving mathematical methods. These methods can be separated into two categories: 1) Methods that produce explicit *evaluations* or *rankings* of objects, and as a result determine an optimal solution. By running a set of such methods, every object $o(i)$ has an associated evaluation vector $U(i) = (u(i,m))_{m=\overline{1,m}}$, where m is the number of used methods; 2) Methods that produce *objects' characteristics* without determining an explicit optimal solution. These analysis methods associate with every object $o(i)$ a new characteristics' matrix $V(i) = (v(i,p,q))_{\substack{p=\overline{1,3}\\ q=\overline{1,6}}}$, where its entries have the significances:
- $v(i, p, 1)$ = the minimum / maximum / average number of out-of-standard attributes for the object $o(i)$;
- $v(i, p, 2)$ = the minimum / maximum / average number of attributes thereby the object $o(i)$ is best placed;
- $v(i, p, 3)$ = the minimum / maximum / average number of attributes thereby the object $o(i)$ is worst placed;
- $v(i, p, 4)$ = the minimum / maximum / average number of objects that the object $o(i)$ dominates;
- $v(i, p, 5)$ = the minimum / maximum / average number of objects that dominate the object $o(i)$;
- $v(i, 1, 6)$ = the index of the $o(i)$ object's equivalence class E_n ($O = \bigcup_n E_n$ being obtained by a certain clustering method);
- $v(i, 2, 6)$ = the index of the object that is the class' representative;
- $v(i, 3, 6)$ = the average merit of the $o(i)$ object's class.

In the above definitions, for $q = \overline{1,5}$, the minimum (for p=

1), maximum (p=2), and average (p=3) are respectively computed on the set $S \times D$.

This category of facts may occur during the repetitive optimization process upon end-user's request, or by facts' accumulation, automatically started by the intimate mechanisms of KbC module, in the view of supplying information required by productions processing.

Productions System

The productions system is structured in built-in classes of rules. The following specifications are necessary: a) L_j is a set of attribute values (a list, an interval, etc.); b) *expr* denotes an expression which must agree with attribute type; c) $[lo\_a(j), up\_a(j)]$, $[stlo\_a(j), stup\_a(j)]$ are the restrictive intervals for the attribute $a(j)$; d) O^* contains the objects considered optimal by OCP multi-solving; e) $g(i)$ finally indicates the global optimum.

In a simplified presentation, the generic forms of the rules classes that make up the KbC modules are those presented below.

- The *validation* rules: They detect the occurrence of contradictions in facts base and warn the user, also suggesting appropriate values for the attributes that caused the contradictions. This way, the updating becomes easier.

IF there is an object $o(i)$ for which, in the opinion of expert $d(l)$ and in state of nature $s(k)$ $\langle c_{ij_1kl} \in L_{j_1} \rangle \wedge \ldots \wedge \langle c_{ij_rkl} \in L_{j_r} \rangle \wedge \langle o_i \in E_q \rangle$ *THEN* $c_{ijkl} \notin L_j$ for some $j \notin \{j_1, .., j_r\}$ and so display them, for each wrong attribute value propose appropriate values $c_{ijkl} \in \{ expr(c_{ijkl}$ (for certain $i \in \overline{1,i}$, $j \in \overline{1,j}$, $k \in \overline{1,k}$, $l \in \overline{1,l}$ in which c_{ijkl} are already defined), $v(i, 1, 6)\}$ for (i, j, k, l) - tuples with i, k, l invoked in hypothesis and $j \notin \{j_1, .., j_r\}$, choose one of the proposed values or insert yourself a good one.

- The *filling-up* rules: They can be defined by the end-user or automatically generated according to the factual context. Thus, the filling-up process is not conditioned by the existence of user-defined filling-up rules. Obviously, the end-user rules have a top priority.

IF there is an object $o(i)$ for which, in the opinion of expert $d(l)$ and in state of nature $s(k)$ $\langle c_{ij_1kl} \in L_{j_1} \rangle \wedge \ldots \wedge \langle c_{ij_rkl} \in L_{j_r} \rangle \wedge \langle o_i \in E_q \rangle$ *THEN* $c_{ijkl} = expr(c_{ijkl}$ (for certain $i \in \overline{1,i}$, $j \in \overline{1,j}$, $k \in \overline{1,k}$, $l \in \overline{1,l}$ in which c_{ijkl} are already defined), $v(i, 1, 6))$ for some c_{ijkl} with i, k, l invoked in hypothesis and previously having *NULL* values.

- The *elimination* rules: They have several generic forms, due to possible relations between objects (e.g. dominance) or to constraints imposed on objects' attributes. These rules form a hierarchy that controls the way they are activated, from less restrictive ones to more restrictive ones. So, the rules' firing process is very well served.

IF $o(i_1)$ dominates $o(i_2)$ in the opinion of minimum l ($<$ $\boldsymbol{l}$) experts, in minimum k ($< \boldsymbol{k}$) states of nature, and by minimum j ($< \boldsymbol{j}$) attributes *THEN* eliminate $o(i_2)$, display the corresponding i_1, i_2, j, k, l.

IF there is an object $o(i)$ for which, in the opinion of expert $d(l)$ and in the state of nature $s(k)$ $\langle c_{ijkl} \notin [stlo\_a(j), stup\_a(j)]$ for minimum j ($\leq \boldsymbol{j}$) attributes $\rangle$ *THEN* eliminate $o(i)$, display the corresponding i, j, k, l.

IF there is an object $o(i)$ for which, in the opinion of expert $d(l)$ and in the state of nature $s(k)$ $\langle c_{ijkl} \notin [lo\_a(j), up\_a(j)]$ for minimum j ($\leq \boldsymbol{j}$) attributes $\rangle$ *THEN* eliminate $o(i)$, display the corresponding $i, j\ k, l$.

These parametric rules can also be automatically created (starting from maximum possible j, k, l and decreasing by 1 until the condition part can match, obviously for significant values j, k, l). It is possible, in an unassuming vision, that the global optimum appears at this step.

- The *discrimination* rule: If at this stage the optimum continues to be multiple then a global evaluation function is computed and used in the final discrimination procedure:

$$g(i) = iround(i \sum_{m=1}^{m} g_1(i,m)) + iround(i / j \sum_{q=1}^{3} (-1)^q g_2(i,q)) + iround(i \sum_{q=4}^{6} (-1)^q g_3(i,q)).$$

The first term denote the general score given by OCP multi-solving and the last terms bring a bonus / penalty provided by the new characteristics matrix. Their analytical expressions are:

$$- g_1(i,m) = \begin{cases} 1, \textit{whether } \bar{u}(m) = \underline{u}(m) \\ (u(i,m) - \underline{u}(m)) / (\bar{u}(m) - \underline{u}(m)), \textit{otherwise} \end{cases},$$

where $\underline{u}(m) = \min_i u(i,m)$ and $\bar{u}(m) = \max_i u(i,m)$;

$$- g_2(i,m) = v(i,3,q);$$

$$- g_3(i,q) = \begin{cases} 1, \textit{whether } \bar{v}(3,q) = \underline{v}(3,q) \\ (v(i,3,q) - \underline{v}(3,q)) / (\bar{v}(3,q) - \underline{v}(3,q)), \textit{otherwise} \end{cases},$$

where $\underline{v}(3,q) = \min_i v(i,3,q)$ and $\bar{v}(3,q) = \max_i v(i,3,q)$.

IF card(O^*) > 1 *THEN* calculate $g(i)$ for $o(i) \in O^*$, rank O^* by $g(i)$, display the final ranking.

All the above rules are predefined and benefit from end-user friendly interface. For each of these rules, the system provides a syntax validation and type-checking procedure. This procedure behaves like a 'compiler', flagging syntax errors and signaling contradictions in the type of the attributes (for instance, an attribute was defined to be fuzzy type on the left hand side of a rule, but it has been defined to be of some other type in the database).

The KbC modules use the CLIPS ("C" Language Integrated Production System) expert system shell, tailored to the requirements of the OCP. If the user has working knowledge of CLIPS, he / she can extend the system's rules base by adding rules of his / her own, as conceived for the specific problem which the user wishes to apply to. In this case, the user must provide his syntax validation and type checking procedure.

D. Processing and Control Mechanism

Forward chaining performs the productions system processing guided through the hierarchy just defined in the rules classes' presentation. The underlying strategy controlling the order in which the rules are fired is the default depth strategy. The user can change this strategy by choosing one of the other six implemented in CLIPS: breadth, complexity, simplicity, LEX, MEA and random. When solving an OCP, the choice of the strategy should be irrelevant (the optimal decision should be the same under any strategy governing the firing of rules of equal salience). Therefore, in this case, changing the strategy is not a method of exploring new solutions, but rather of validating the robustness of the choice made.

E. OCP Solving Automation

The Investments Department staff, to whom some IT people will join, will take the responsibility for watching the system and answering to the partners electronic letters. The plant computer automatically solves even the OCPs that present problems like ill characteristics matrix. The function that ensures the man-machine interface on the Intranet is analogous with the function that works on the Internet. In addition, a function manages the suppliers' section of the database. The main goal of this function is to compute, in time, based on statistical data, the suppliers' allowance. As ones can see in this paper, the designer preoccupation was the optimization process automation. Only the economic contract signing is out of the system, mainly because of the bureaucracy accepted as necessary in this field.

One could easily imagine what might happen if optimizations are executed on the "supply server". Provided many suppliers would simultaneously require a status report of their overall business with the plant, the task to fulfil would surpass the computer power. For easily executing this task, the software uses a special-purpose computer, which optimizations will run on. The plant Intranet configuration is essential for well implementing the design solution.

IV. CONCLUSIONS AND FURTHER DEVELOPMENTS

Extending worldwide the business of an industrial plant is one of the globalisation commandments. Another, very important too, is to promote mutual advantageous business. To support these, the Internet created the base for a new range of applications. In our days, *e-applications* undergo a fast development. Web enabled optimization is a new trend in treating the complex industrial problems. Efforts have steadily been made as to design information systems meant to contribute to the industrial plants reengineering. In the authors' opinion, elaborate *e-procurement* applications will soon become facts on the IT market.

Tele-AUCTION belongs to the software developed for I.C.I.'s new line of products for industrial plants. *Tele-AUCTION* will be capable to support mutual advantageous business. This is possible by making use of advanced optimization techniques. The strong point of *Tele-AUCTION* software consists in the fact that the competitors ranking is automatically made using a MADM mathematical model.

Tele-AUCTION software is under final testing; launching it is thought to be a real event and to have a significant impact. It will really contribute to the modernization of the procurement activity. Its capabilities related to genuine business make it suitable to contribute to the invigoration of the commercial climate. With this software, industrial plants may become more active on the world market. Savings in the acquisition process may represent appreciatively 25 –30 % from the total cost. *Tele-AUCTION* interface is very "human"; people without a special training in mathematics and informatics can easily use the software. Please remark that although the mathematical model shows high complexity, Internet developed interface with partners is a narrow one, because it concerns a reasonable demand, namely the suppliers' products and their characteristics. *Tele-AUCTION* delivery conditions and services included are: software and documentation on CD, auto-demonstration, on-call / on-site assistance in use and short time training course (16 - 40 hours) for initiation in electronic procurement.

Further developments refer to extensions for other kind of plants. One supposes that the Internet modules and the optimization mechanism will be the same, only the Intranet modules will change. Therefore, a lot of programming work will be save with good consequences for delivery time and software cost. Moreover, the designing team preoccupation is to extend the facilities of treating the concurrent optimizations by using GRID solutions.

V. REFERENCES

[1] Grieger, M.: "Electronic marketplace: A literature review and a call for supply chain management research". In *European Journal of Operational Research*, Volume 144, Issue 2, 16 January, (2003), pp. 280-294.

[2] Amor, D.: *The E-business ®evolution*. Prentice Hall, Hewlett-Packard Professional Books, (1999).

[3] Resteanu, C., Andrei N., Mitan, E.: "Continuous process plant as a system open to business". In: Dietmar P.F. Moller Ed., *Proceedings of the ESS 2000, 12-th European Simulation Symposium, Simulation in Industry*. Hamburg, Germany, September 28-30, (2000), pp. 260-264.

[4] Resteanu, C.: "Tele-AUCTION: An advanced e-procurement tool". In *New Opportunities for Operations Research, 5th EURO/INFORMS Joint International Meeting,* Instanbul, July 6-10, (2003), pp.200

[5] Hwang, C-L. Yoon, K.: *Multiple attribute decision making*. Springer-Verlag, Berlin-Heidelberg, New York, (1981).