OPTIMIZATION MODEL FOR AN OIL WELL DRILLING PROGRAM: MEXICO CASE

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This document provides an overall of the oil well drilling in PEMEX Exploración y Producción (PEP), it presents a diagnosis of the current situation which finally constitutes the grounds for a "model for the optimization of an oil well drilling program". This model is an application of the optimization techniques and, specifically, of the binary integer programming.

Key Words: b*inary integer programming, oil well drilling and maximization of economic value*

INTRODUCTION

The approach and commitment of commercial relations between Mexico and the industrialized countries, characterized for comprising highly competitive companies, have caused in our country a growing trend of the companies towards the modernization of their work plans in order to achieve higher productivity [1] and easier access to the international markets.

Petróleos Mexicanos [2] complying with its social commitment of guaranteeing the supply of hydrocarbons to the nation started an integral transformation of the company several years ago, seeking to reach a place in the competitivity worldwide context. Therefore, it has been implementing actions aimed to offer its hydrocarbons at competitive prices [3] but without significantly sacrifying the profits of the company by means of the rationalization and efficient use of its resources.

Pemex faces great challenges at short and medium term: efficiently administration of the declension of the main oil fields; substitution of this declension with hydrocarbons from other basins; sustainment the production platform at medium term; productivity increase and improvement of its operation performance; proved reserves increase in order to keep the production levels at medium and long term [4]; in order to achieve the above, it needs, among other things, planning and administration of its complete well drilling process which starts by selecting the technology and finishes by the incorporation of reserves or the administration of the production.

Likewise, Petróleos Mexicanos, pursuant to this new economic situation has reconsidered its main purpose such as the maximization of the economic value at long term [5], hence, Pemex Exploración y Producción currently faces the challenge of contributing in the attainment of this purpose by the identification of all those operations subject to be optimized and the start-up of applicable correction actions.

One of said operations is identified in this work: Wells drilling and an optimization mathematical model is presented by means of which the available drilling equipment is assigned to the different geologically detected locations with the possibility of storing hydrocarbons in such a way that the maximization of the economic value is guaranteed.

It is important to highlight that both in Mexico and in the rest of the world, the oil companies dedicated to the exploration and exploitation of hydrocarbons apply approximately 60 % of its budget to the investment of its wells drilling program.

This document presents a mathematical model which is theoretically grounded on the Binary Integer Programming Model corresponding to the Operations Research field [6] and to the use of specialized software [7].

This model enables obtaining different scenarios on the optimum assignation of drilling equipment of oil wells [8], it may influence on the decisions making and support the maximization of the economic value of the companies dedicated to the exploration and exploitation of hydrocarbons.

BACKGROUND

During many decades the Oil Industry has considered the Wells Drilling field as an “art” instead of considering it as “ENGINEERING”. At the beginning of oil wells drilling said statement could have been true. However, since the beginning of 20’s through the end of 40’s, the Drilling Technology of Oil Wells lived a development period and during the two following decades (1950-1970) exhaustive research was made, both in the lab and in the field on all aspects related to the drilling process; thus entering in its automation period by the end of 60’s [9].

During said period, the problem of selecting the suitable technology for the wells drilling when the geological conditions of the area were known was also present [10].

As from the 90ŕs real efforts began for building drilling equipment as environmentally clean as possible [11]. The primary purpose was successful drilling of wells minimizing the impact to the ecology [12, 13].

During this decade, the processes related to the oil wells drilling have been substantially modified, since the planning process which includes the total analytic accounting through lessons of technology transference learned for a continuous improvement [14], observing emphasis on the administration of drilling fluids.

Likewise, considering the increasing trend that the oil prices have experienced during the recent years, the economic analysis of the wells drilling and its planning in general, represents one of the most important activities of the oil countries [15].

DIAGNOSIS

Currently, in order to be in the position of resolving the challenges for Pemex, the most important probable reserves, located in the Tertiary Oil of the Gulf Project (Chicontepec), must be developed. This project implies a huge challenge, mainly due to the geological characteristics of its stratified fields with low pressure which requires additional energy and a reduced recovery factor 42, and because of the significant social and environment challenges related to their exploitation. In order to develop this project, it will be necessary to approximately drill 15,000 wells during the next 15 years, namely, 1,000 per year only in this area which is compared with the current drilling level of all the basins which totals 675 Wells average per year during the last 5 years.

Likewise, for the exploitation projects, the challenge is to increase the recovery factor of the ripe fields by means of actions such as the massive drilling of non-conventional wells, namely, horizontal and multilateral wells.

Drilling equipment for shallow water (water ties lower than 500 meters) has proved technology in the industry with more than 30 years of development. In general, this equipment is installed in platforms denominated self-lifting platforms.

However, using self-lifting or fixed platforms for deep waters (water ties higher than 500 meters), is not technically or economically feasible. Then, it is necessary to use *floating platforms* also known as *semi-submersible drilling platforms* or specialized drilling ships.

Facing these challenges requires expert operation knowledge since higher risks and costs are present during the exploration drilling and development. In addition, once the technological requirements are established for the drilling of these environments, some of these fields are located under salt-subsalt formations; therefore, specialized technology is required for their identification and drilling in order to break through these salt formations.

Six exploration wells were finished during the period 2002 - 2008. The reduced number of exploration wells drilled in Mexican deep waters is due to different causes, among which the most important causes which may be highlighted are that they require more time for their drilling due to their complexity and high cost, that the drilling equipment is few and expensive and that Pemex has limited experience in this type of drilling.

During 2007, Pemex assigned its resources regarding the exploration and exploitation fields, mainly to drilling works, infrastructure and maintenance of all oil basins. Investments in exploration were mainly focused on the purchase of 11,849 square kilometers of tridimensional seismic and termination of 50 exploration wells. As to what regards exploitation, 610 wells were finished and 2,357 interventions in wells were made. All of the above enabled to produce 1,053.2 millions of barrels of crude oil equivalent and reclassify 806.2 millions of barrels of crude oil equivalent. Despite this, the annual production and net reserves decreased.

Challenge established by deep waters regarding the most important marine oil field of Mexico (Cantarell in shallow waters), also implies: longer drilling times, 200 days vs. 120 days per well; higher costs, cost per well higher for at least 100 millions dollars; more drilling needs, more than ten times the number of total meters to drill; and, less exploration success, in Cantarell is about 90 %, while in deep waters it is estimated almost 10 % (see table 1).

Table 1

Drilling costs

Description	Cost per well	Risks	Development Time
Shallow waters	10 million dollars	10%	3 years
Deep waters	100 million dollars	90%	8 years

Fortunately, Pemex has at this time, more than 300 exploration locations from which 100 are in the ground and two hundred in shallow waters, ready to be drilled (see figure 1).

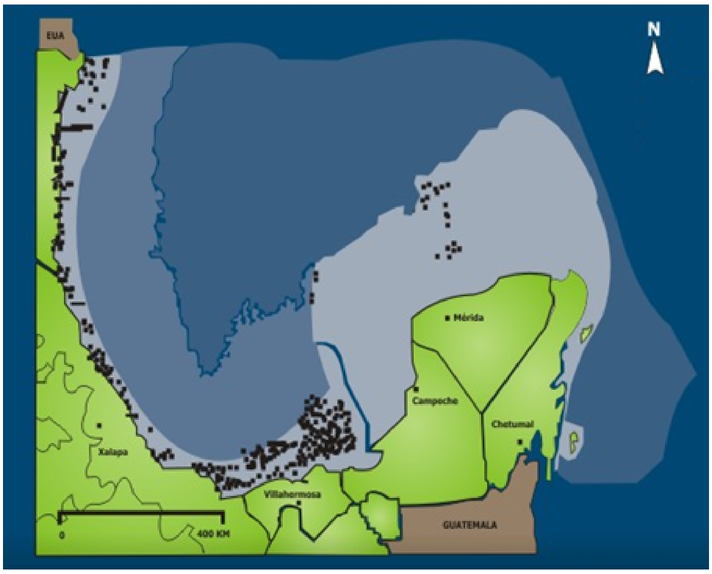

Figure 1. Gulf of Mexico
Source. Pemex, PEP

It is worth highlighting that less than 30 percent of the domestic territory with oil possibilities has been studied, thus forecasting about 54 thousand millions of barrels. These resources are assumptions, analogies or hypothesis which assume the existence of hydrocarbons (see table 2). In order to turn them into possible reserves, they require drilling and studies. Sequential certainty takes these reserves up to proved developed reserves [16].

Table 2

Reserves

Resources or reserves[1]	Quantity [2]	Commercial exploitation feasibility
Prospective[3]	53.8	0%
Possible[4]	14.6	10-15%
Probable	15.3	50%
Proved without development	5.5	95%
Developed proved	10.0	100%

[1] As of January 1st. 2007.
[2] Thousands of millions of barrels of oil equivalent. Partials are not included in the total.
[3] Potential resources assumed with geophysical studies and analogies with adjacent fields.
[4] Prospective resources with drilled and volumetric well; characterized field; use of mathematical simulators to determine commercial potential.

What it is unquestionable is that Pemex must start a series of actions to be in the position of facing future challenges. The company must start the exploitation of oil fields in deep waters and establish since now the programs that lead to their accomplishment.

DRILLING

For every company aimed to the exploration and exploitation of oil fields, the wells drilling constitutes the basic or primary activity guaranteeing its existence in the market. This activity may be divided into two great fields, drilling of exploration wells and exploitation of oil fields.

While the drilling of exploration wells is basically aimed to gain the knowledge of the geological structures and determine the possibility that hydrocarbons may be found therein, the purpose of drilling of exploitation wells is to increase or maintain the hydrocarbon production volumes.

Drilling equipment is without any doubt the most valuable and most expensive resource in this activity. Its availability is limited and its assignation is a very complex task [17].

MODEL

In order to attain the assignation of equipment to the Investment projects, first, the equipment availability must be determined by classifying it according to its capacity which involves both the depth at which it may be drilled and its technological complexity. This information is shown in a table as the information shown in table 3.

Table 3

Drilling equipment

Equipment class	Capacity	Availability
1	Cap_1	Dis_1
2	Cap_2	Dis_2
:	:	:
k	Cap_k	Dis_k

where: k = number of equipment classes
Cap_k = drilling capacity of class k equipment is pent
Dis_k = number of available class k equipment.

In addition to the above-stated information, it is necessary to consider the costs associated with the use of the drilling equipment in the economic analysis of the different assignation scenarios.

It is possible that the availability of the equipment is not permanent throughout the considered study; for instance, the fact that certain equipment is not available for its assignation during the first five months, may be taken into consideration or else, that the equipment is scheduled for maintenance works for 6 weeks by half of the analysis period. The way in which this type of situations may be considered upon making the assignation of equipment will be described herein below.

Once the equipment availability is known, it is necessary to identify the requirements of each investment project and its main economic indexes. An index such as the Net Present Value (NPV) shows the convenience of each project and it enables to determine the way and time in which the assignation of drilling equipment to the considered investment projects must be made to integrate with it a projects portfolio which provides the maximum economic value.

In order to obtain the NPV of each project, it is convenient that the cash flows be calculated considering equipment movement based on the estimation of the number of wells to be drilled and on the drilling equipment required by the project to offer the most attractive economic value.

From all existing indexes, the NPV is considered as one of the most suitable ones because it considers all the income and expenses shown in the investment Project and the relative value of money through the time. The NPV of an investment project is nothing but its value measured in money. It is the opportunity value.

Programming of drilling equipment requires an approach for investments selection [18] wherein the resource intended to be efficiently used is the group of drilling equipment either own or leased with which Pemex-Exploración y Producción may count during a fixed period of time, in a way that the economic value of the wells drilling is maximized.

Traditionally, the information about the equipment movement of a Project is presented as shown in table 4.

Table 4

Typical movement of drilling equipment

required equipment	capacity (meters)	2008											
		jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
100	*5000*												
130	*3500*												
Total Equipment		2	2	2	2	1	1	1	1	1	1	1	1

It may be observed that this Project has five wells. One of them requires equipment with a drilling capacity of 5000 meters and four months for its drilling and termination, the other four wells may be drilled and terminated with equipment of 3500 meters, upon moving it from one well to the other every three months.

This equipment movement for the Project exclusively depends on the studies required for the development of the oil field. Cash flows are estimated based on them and the NPV is calculated upon the beginning of the analysis; January 2008. The same process is applicable to each project competing for the assignation of Drilling Equipment.

As the purpose is the integration of an investments project portfolio [19] providing the highest economic value permitted by the restrictions on the availability of drilling equipment, it is worth beginning the analysis of the problem by responding to this question: Which would be the ideal situation in which a projects portfolio may be attained with the maximum economic value? This ideal situation would be evidently the absence of restrictions.

In the case of Mexico, this would be equivalent to have a number of drilling equipment so great, of different capacities, as for enabling that all the considered projects could be simultaneously begun upon the beginning of the study. The economic value of the portfolio would be the same as the total of the NPV's of all the considered projects. The above-mentioned ideal situation could be illustrated as shown in table 5.

As it may be observed all the projects begin during the first month. There is enough drilling equipment to satisfy the needs of each project.

Table 5

Ideal situation for the obtaining of the maximum value

project	capacity (meters)	2008											
		jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
project 1	*3600*	*1*	*1*	*1*	*2*	*2*	*2*	*2*	*1*	*1*			
project 2	*5000*	*2*	*2*	*2*	*1*	*1*	*1*	*2*	*2*	*2*			
project 3	*3600*	*3*	*3*	*3*	*3*	*2*	*1*	*1*					
:													
project n	*5500*	*1*	*1*	*1*	*1*	*2*	*2*	*2*					

$$NPV = NPV_1 + NPV_2 + ... + NPV_n$$

NPV = Economic value of investment projects portfolio

Unfortunately, this is not the case and the presence of restrictions on the drilling equipment availability will usually oblige to differ some of the projects until those periods in which there is the convenient equipment, in sufficient quantity, to cover their needs. This will occur when the equipment is no longer used or else, when its availability increases (arrival of new leased equipment, for instance).

While the situation about differing projects would be as shown in table 6.

Table 6

Situation of differed projects for obtaining the maximum economic value

project	NPV	Capacity (meters)	2008												2009
			jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	jan
project 1	NPV_1	3600	1	1	1	2	2	2	2	1	1				
project 2	NPV'_2	5000								2	2	2	1	1	1
project 3	NPV_3	3600	3	3	3	3	2	1	1						
. .	. .	. .													
project n	NPV'_n	5500						1	1	1	1	2	2	2	
equipment availability			4	4	4	4	4	4	4	4	4	4	3	3	1

$$NPV = NPV_1 + NPV_2' + NPV_3 ... + NPV_n'$$

NPV = Economic value of investment projects portfolio

It is observed that in Table 6 an additional line has been included with information about the monthly availability of equipment. It has been established that during the first ten months of the analysis 4 ground drilling equipment will be available and that this figure decreases to 3 during the following two months (maybe because the expiration of a leasing agreement for two equipment). This restriction forces to the differing of projects. Due to this reason, it may be observed that project 2 and project n must have been differed until the months of August and June, respectively and that their NPV'k have experienced a decrease in their value upon considering the value of money through the time, by means of the NPV's updating at a corresponding monthly discount rate (updated NPV's are highlighted as NPV'k as shown in table 6).

Decrease of NPV's of projects 2 and n consequently causes that the NPV of the portfolio for the example shown in Table 6 results lower than the NPV of the portfolio of table 5. Therefore, it may be concluded that the problem consists in determining which projects must be differed (if necessary) and the priorities in order to sacrifice the economic value of the portfolio, the least possible.

Even when only 20 projects and an analysis of 2 years (24 months), the number of combinations in which the projects could be arranged throughout this analysis, in a way that the monthly demand of equipment does not exceed the existing monthly offer, may be enormous. Finding the multi-period portfolio of investment projects offering the maximum economic value, with trial and error tests would practically be impossible. This without considering that in addition to the constraint of the drilling equipment, it could be necessary to consider some of other nature.

Consideration situations as the above, make the problem about selection of projects, be a complex problem which solution requires an analytic model.

The integer binary programming model for the optimization of a wells drilling program considers all the possible combinations so that as from the solution derived from said model (the optimum values of decision variables) the best of them is found which maximizes the economic value.

The decision variables in a model this nature are binary type (1 or 0). In the model the decision binary variable considering the possible forms in which the assignation of drilling equipment to the considered investment projects may be made, will be defined as x_{kji}, where i is the project number, j is the month during which the project starts and k is the number of the equipment class assigned to the project I (equipment class will be at least of the drilling capacity required by the project).

In this optimization model, the maximization of the economic value is sought considering both differing projects and the possibility of assignation of equipment with higher capacities to those required by the projects, in case their economic value was sufficiently attractive.

The information corresponding to the investment projects may be observed in table 7, in a presentation which helps to the better understanding of the model structure.

Table 7

Investment Projects

Project Number	Project Name	Depth to Perforate	Equipment Class	NPV			Requirement		
				Mes 1	…	Mes S	Mes 1	…	Mes S
1	$Proj_1$	$Depth_1$	1	$npv_{1,1}$	…	$npv_{1,s}$	$req_{1,1}$	…	$req_{1,s}$
2	$Proj_2$	$Depth_2$	1	$npv_{2,1}$	…	$npv_{2,s}$	$req_{2,1}$	…	$req_{2,s}$
:	:	:	:	:	…	:	:	…	:
$L_1 = l_1$	$Proj_{L1}$	$Depth_{L1}$	1	$npv_{L1,1}$	…	$npv_{L1,s}$	$req_{L1,1}$	…	$req_{L1,s}$
$L_1 +1$	$Proj_{L1+1}$	$Depth_{L1+1}$	2	$npv_{L1+1,1}$	…	$npv_{L1+1,s}$	$req_{L1+1,1}$	…	$req_{L1+1,s}$
$L_1 +2$	$Proj_{L1+2}$	$Depth_{L1+2}$	2	$npv_{L1+2,1}$	…	$npv_{L1+2,s}$	$req_{L1+2,1}$	…	$req_{L1+2,s}$
:	:	:	:	:	…	:	:	…	:
$L_2 = L_1 + l_2$	$Proj_{L2}$	$Depth_{L2}$	2	$npv_{L2,1}$	…	$npv_{L2,s}$	$req_{L2,1}$	…	$req_{L2,s}$
:	:	:	:	:	…	:	:	…	:
$L_{k-1} +1$	$Proj_{Lk-1+2}$	$Depth_{Lk-1+2}$	K	$npv_{Lk-1+2,1}$	…	$npv_{Lk-1+2,s}$	$req_{Lk-1+2,1}$	…	$req_{Lk-1+2,s}$
$L_{k-1} +2$	$Proj_{Lk-1+2}$	$Depth_{Lk-1+2}$	K	$npv_{Lk-1+2,1}$	…	$npv_{Lk-1+2,s}$	$req_{Lk-1+2,1}$	…	$req_{Lk-1+2,s}$
:	:	:	:	:	…	:	:	…	:
$n = L_{k-1} + l_k$	$Proj_n$	$Depth_n$	K	$npv_{n,1}$	…	$npv_{n,s}$	$req_{n,1}$	…	$req_{n,s}$

where:
l_k = number of projects requiring class k equipment,
$npv_{i,j}$ = net current value of the project *i* if starts during month *j,*
$l_1+l_2+\ldots+l_k = L_K = n$ = total number of considered projects,
$Proj_i$ = project *i* number,
$req_{i,j}$ = requirement of project $_i$ equipment, during the month *j,*
$Depth_i$ = depth of deepest well of the project *i.*

Description of the model of mathematical programming designed to resolve the assignation of drilling equipment problem is presented here in below.

Coefficients of the function to be maximized as defined as:

$npv_{i,j}$ = net current value (expected monetary value may be considered if the project is evaluated in a risk way) calculated for project *i* if started during the month *j*.

It is also important to define the requirements coefficients of the drilling equipment and its availability as follows:

$req_{i,j}$ = equipment requirements of project *i*, during the month j,

DIS i = equipment class *i* availability, with *i = 1,…,k.*

Once the decision variable is defined, the coefficients of the target function and those corresponding to the requirements, the generalized mathematical approach of the model may be presented.

Objective function:

$$Max\, npv \sum_{k=1}^{K} \sum_{j=1}^{T} \sum_{i=1}^{L_1} npv_{i,j} x_{k,j,i} + \sum_{k=2}^{K} \sum_{j=1}^{T} \sum_{i=L_1+1}^{L_2} npv_{i,j} x_{k,j,i} + \sum_{k=K}^{K} \sum_{j=1}^{T} \sum_{i=L_{K-1}+1}^{L_K} npv_{i,j} x_{k,j,i}$$

Monthly constraints on the equipment class 1:

$$Month\,1:\sum_{i=1}^{L_1} req_{i,1}\,x_{2,1,i}\le DIS_1$$

$$Month\,2:\sum_{i=1}^{L_1} req_{i,2}\,x_{1,1,i}+\sum_{i=1}^{L_1} req_{i,2}\,x_{1,2,i}\le DIS_1$$

$$\vdots$$

$$Month\,T:\sum_{i=1}^{L_1} req_{i,T}\,x_{1,1,i}+\sum_{i=L_1+1}^{L_1} req_{i,T-1}\,x_{1,2,i}+\ldots+\sum_{i=1}^{L_1} req_{i,1}\,x_{1,T,i}\le DIS_1$$

Monthly constraints on equipment class 2:

$$Month\,1:\sum_{i=L_1+1}^{L_2} req_{i,1}\,x_{2,1,i}+\sum_{i=1}^{L_1} req_{i,1}\,x_{2,1,i}\le DIS_2$$

$$Month\,2:\sum_{i=L_1+1}^{L_2} req_{i,2}\,x_{2,1,i}+\sum_{i=L_1+1}^{L_2} req_{i,1}\,x_{2,2,i}+\sum_{i=1}^{L_1} req_{i,2}\,x_{2,1,i}+\sum_{i=1}^{L_2} req_{i,2}\,x_{2,1,i}\le DIS_2$$

$$\vdots$$

$$\begin{aligned}Month\,T:&\sum_{i=L_1+1}^{L_2} req_{i,T}\,x_{2,1,i}+\sum_{i=L_1+1}^{L_2} req_{i,T-1}\,x_{2,2,i}+\ldots+\sum_{i=L_1+1}^{L_2} req_{i,1}\,x_{2,T,i}\\&\sum_{i=1}^{L_1} req_{i,T}\,x_{2,1,i}+\sum_{i=1}^{L_1} req_{i,T-1}\,x_{2,2,i}+\ldots+\sum_{i=1}^{L_1} req_{i,1}\,x_{2,T,i}\le DIS_2\end{aligned}$$

Monthly constraints on equipment class k:

$$Month\,1:\sum_{i=L_{k-1}+1}^{L_k} req_{i,1}\,x_{k,1,i}+\sum_{i=L_{k-2}+1}^{L_{k-1}} req_{i,1}\,x_{k,1,i}+\ldots+\sum_{i=1}^{L_1} req_{i,1}\,x_{k,1,i}\le DIS_k$$

$$\begin{aligned}Month\,2:&\sum_{i=L_{k-1}+1}^{L_k} req_{i,2}\,x_{k,1,i}+\sum_{i=L_{k-1}+1}^{L_{k-1}} req_{i,1}\,x_{k,2,i}+\sum_{i=L_{k-2}+1}^{L_{k-1}} req_{i,2}\,x_{k,1,i}\\&\sum_{i=L_{k-2}+1}^{L_{k-1}} req_{i,1}\,x_{k,2,i}+\ldots+\sum_{i=1}^{L_1} req_{i,2}\,x_{k,1,i}+\sum_{i=1}^{L_1} req_{i,1}\,x_{k,2,i}\le DIS_k\end{aligned}$$

$$\vdots$$

$$\begin{aligned}Month\,T:&\sum_{i=L_{k-1}+1}^{L_k} req_{i,T}\,x_{k,1,i}+\sum_{i=L_{k-1}+1}^{L_k} req_{i,T-1}\,x_{k,2,i}+\ldots+\sum_{i=L_{k-1}+1}^{L_k} req_{i,1}\,x_{k,T,i}+\\&\sum_{i=L_{k-2}+1}^{L_{k-1}} req_{i,T}\,x_{k,1,i}+\sum_{i=L_{k-2}+1}^{L_{k-1}} req_{i,T-1}\,x_{k,2,i}+\ldots+\sum_{i=L_{k-2}+1}^{L_{k-1}} req_{i,1}\,x_{k,T,i}+\\&\sum_{i=1}^{L_1} req_{i,T}\,x_{k,1,i}+\sum_{i=1}^{L_1} req_{i,T-1}\,x_{k,2,i}+\ldots+\sum_{i=1}^{L_1} req_{i,1}\,x_{k,T,i}\le DIS_k\end{aligned}$$

Multiple choice constraints:

$$\sum_{k=1}^{K}\sum_{j=1}^{T}\sum_{i=1}^{L_1} x_{k,j,i} \leq 1$$

$$\sum_{k=2}^{K}\sum_{j=1}^{T}\sum_{i=L_1+1}^{L_2} x_{k,j,i} \leq 1$$

$$\sum_{k=3}^{K}\sum_{j=1}^{T}\sum_{i=L_2+1}^{L_3} x_{k,j,i} \leq 1$$

$$\vdots$$

$$\sum_{k=K}^{K}\sum_{j=1}^{T}\sum_{i=L_{k-1}+1}^{L_K} x_{k,j,i} \leq 1$$

with $x_{k,j,i} = 0/1$; $k = 1, 2, 3,\ldots, K$; $j = 1, 2, 3,\ldots, T$; $i = 1, 2, 3, \ldots, L_k$.

As it may be observed, this model is at great scale, its basic structure corresponds to the pure binary integer programming and it is resolved by using CPLEX in a Digital Alpha Server, which has four mathematical processors to work in parallel.

CONCLUSIONS

This paper has presented the mathematical model enabling the optimization of the planning and programming of oil wells drilling under limited resources conditions which is successfully used in Pemex Exploración y Producción.

Scenarios which may be obtained with this model offer advantages to negotiate the contract of drilling equipment since substantial reductions may be obtained in the costs upon executing medium term agreements. Namely, costs vary if equipment is contracted to drill a well during three months or nine wells during two years.

Another advantage derived from this model is the continuous and optimum updating of the wells drilling program which presents a dynamic behavior since not all the wells being drilled are productive and since the frequent budget reductions directly affect the number of equipment available for drilling.

Operations research enabled to prepare a mathematical model to represent the problem of assignation of drilling equipment to locations previously studied by geologists and which have great possibilities of turning into oil fields. Mainly, the problem is reduced to a set of available activities (locations to be drilled) competing for the limited resources (drilling equipment), therefore, upon deriving a solution from this model, said limited resources may be efficiently assigned among the competitive activities.

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