COMPUTER SYSTEM FOR DATA AND INFORMATION MANAGEMENT IN GEOPHYSICAL ACQUISITION COMPANIES

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Abstract

This work presents a data and information management model applied to the acquisition of geophysical data in terrestrial environment, implemented in the form of a computerized system, facilitating access to the acquisition products, information and knowledge generated by the process.

Introduction

A geophysical data analysis can be divided into three parts: data acquisition, processing and interpretation (YILMAZ, 2000). The data acquisition step can be performed in different environments, through various geophysical methods. This work has a specific focus on the acquisition of seismic, magnetic and gravity data on earth environment, and the management model of the large amount of data and information generated by these processes. It is also presented how this model is being implemented in the form of a computerized system and how it can help to create and capture value for the business of GEORADAR Levantamentos Geofísicos S.A. - Data Acquisition Company (DAC). For this, it is important to know the process and understand basic concepts of organization very well, exchange and availability of information and knowledge within the DAC.

Methodology

In recent decades, organizations have realized the importance of learning focused on the acquisition, storage, processing, and especially on the dissemination and use of information and knowledge (DE BEM, 2009).

Often the success of a company is linked to a factor dependent on knowing the difference between data, information and knowledge, and know how to use them correctly and at the right time, even if this seems like a trivial task, as cited Davenport and Prusak (1998).

Data are unit records of a transaction (DAVENPORT and PRUSAK, 1998), without meaning if considered in its raw form, for example, the amount of shot points drilled on a seismic program. This fact, by itself, does not describe fully what happened during drilling or provide us with a basis necessary to make critical analyses of the process.

Information is the result of treatment, combination and organization of correlated data (ZIVIANI, 2012), which allows to solve problems or make decisions and actions taking the operation or process into consideration. As an example of information, we can mention the average time taken to carry out the drill of a shot point in the project-specific conditions. This information can be obtained from the correlation between the amount of shot points drilled in a period and the total time spent in the activity.

As to knowledge, it is the information analyzed and applied to action, built from the experiences gained from that information. It is the knowledge gained by experience of a drilling crew coordinator that lets him know and scale their teams and their equipment in order to optimize productivity. This tacit knowledge exists because of information that were available for them to develop such learning. (Figure 1)

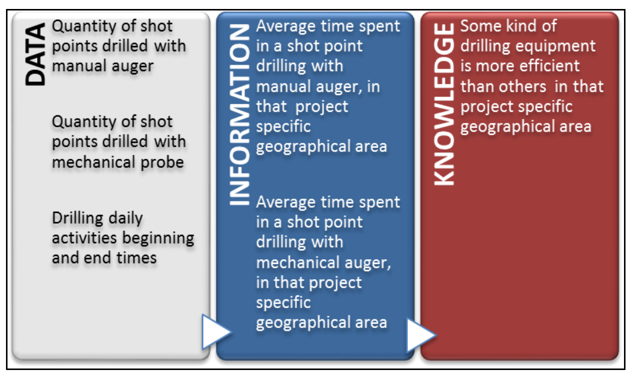

Figure 1 - Example of data, information and knowledge on the seismic data acquisition process

Poor management of data and information generated by the organization directly impacts knowledge they originate, and, consequently, the difficulty of transfer between employees and maintenance of knowledge assets, which are relevant properties of an DAC.

Every company has three levels of management and decision-making: the strategic, tactical and operational ones - these levels define long, medium and short term actions and objectives, respectively.

Then, the data and information management on each of its levels was proposed for the DAC, in order to organize and facilitate the acquisition, exchange and maintenance of knowledge within them.

The closer to the operational level, the greater the amount of data to be managed. And as it approaches the strategic level, the greater the volume of information received and generated for analysis. (Figure 2)

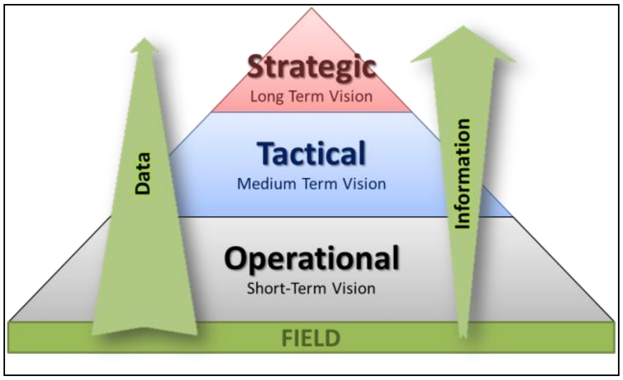

Figure 2 - Data and information on entrepreneurial levels

The information system under development by GEORADAR comprises three main modules, with their features and characteristics aimed at each of its business levels.

This work has focused on the development of the operating module, which has the function to collect and store most of the process data (about 80% to 90%), providing support of the relevant information about the control of the operating level, as well as of the tactical and strategic levels.

The description of the most important events involved in the acquisition process can be obtained from the produced data and generated metadata. The quality of both products as the process can only be guaranteed with proper organization, storage, processing and availability of such data. Commonly, process data are found in decentralized basis, whether of specialist systems for each operation or of monitoring and control spreadsheets, making it difficult to rescue the information and to quantify the volume of data, besides generating errors and rework, due to redundancies.

The area of Planning and Production Control (PPC) has a key role in production management in the acquisition of geophysical data from the point of view of process data collection, definition of operational goals and how to achieve them by controlling the executing (RUSSOMANO, 2000). For this, it is the PPC's responsibility the registration and planning all the inputs of the process, such as equipment, tools and explosives, as well as the management of data and information regarding the plans and execution of production orders. There should also be made comparative analyzes between the planned and carried out, as a basis for correction of deviations.

Furthermore, PPC should help sectors and make arrangements to have all the resources necessary to production in time.

From these concepts, the integrated system module facing the operating level is being developed as a project-oriented PPC function. One of the main functions of this module is to collect and store, the most efficiently possible, production data, whether from manual input via system interface, other databases belonging to specialized process sub-operations systems, spreadsheets or control files of operating fronts and fronts of support and further data and metadata produced and treated in the acquisition, storing them in a separate structure, with necessary robustness and security. From there, the discrete, historical and statistical information about the process can be generated in the form of graphs, tables, reports and maps through a web interface. Through this same interface, public and non-exclusive products (data, metadata, coordinate files, documents and reports) submitted by acquisition services provided by GEORADAR may be sought, revalidated and indexed and securely viewed. Figure 3 illustrates a functioning generic architecture described for the operating module.

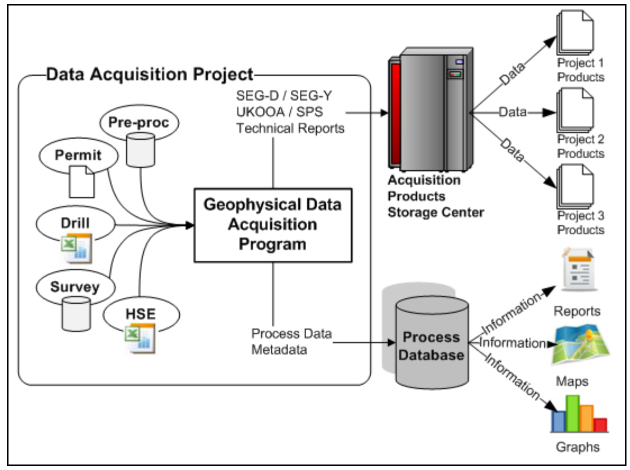

Figure 3 - General architecture of the system

The process flow that describes the basic sequence of activities to be performed in the execution of a seismic, magnetic and gravimetric acquisition project is presented in Annex, in addition to the main process data stored by the system for each operating front.

The operating fronts or project production steps are: Operating Planning, Permitting Phase, Survey, Acquisition and Pre-processing of Magnetic Data, Acquisition and Pre-processing of Gravimetric Data, Drilling, Charging of Explosives into Blast Holes, Seismography, Treatment and Validation of Seismic Data and Area Recovery.

Some flow process attention points should be noted. Permitting early stage depends on the completion of at least three predecessor activities and, therefore, presents a higher risk of generation of production bottlenecks. On the other hand, the acquisition and calculation of final coordinates, whose successors are other four sub-processes (gravity reading, magnetic reading, probing the shot points and scattering of seismic equipment), this may result in difficulty in providing and managing information, such as reacquired displacements and coordinates. Thus, production and rework in the process (e.g. Reacquisition and re-drilling) need to be very well recorded and that information be disseminated quickly and effectively among operating fronts to avoid divergences in the process.

Infrastructure and system development

As the projects are carried out in areas considered distant form company's executive office, it has been proposed a web server architecture and decentralized project-oriented databases, where there is a periodic synchronization of all of them with a central database server, located strategically, since this depends on Internet signal, often difficult in the economic and technological environment of the Brazilian market. Data related to a specific project are first stored on their local database, and in due course in a predefined frequency, are synchronized with the central database, so that the information of all projects can be acquired from it. (Figure 4).

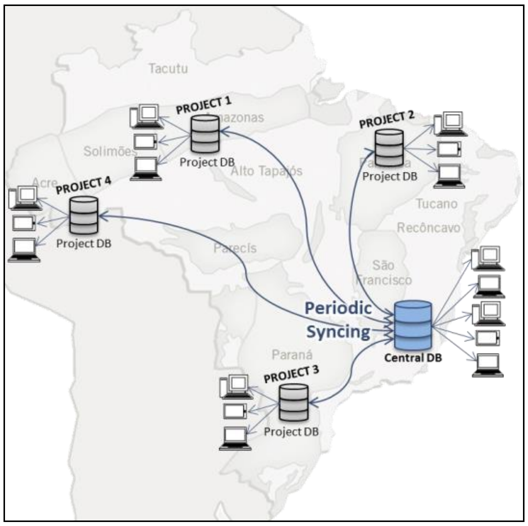

Figure 4 - System Infrastructure (map without scale)

For ease of access and distribution of web systems, the software is being developed in this type of platform, including WebAPI's, which are application programming interfaces aimed to provide a set of business rules and specific services for each of the system modules, thus facilitating the changes to be made in software and requiring less traffic on the network.

Features of the system

Relevant information to PPC in acquisition projects are easily obtained from the correlation of data of the process performed through the system. Some examples are presented below.

The amount of recorded shot points and the number of records validated by the front of Treatment and Validation (Quality Control) can be related to the purpose of defining the percentage of loss or rework occurring in production.

The amount of explosive material in the deposit and the amount of shot points already charged, of shot points already blasted and of those ones yet to be charged can be followed in order to avoid that the production has stoppages due to lack of inputs or even for control of the destruction and restoration of charges left in the ground.

Another key information obtained from the system, is the amount of rework generated due to, for example, failure in placement or in acquisition of the coordinates of a stake which impacted the impossibility of drilling and charging of a shot point, or any another stage of production.

One can also mention the possibility of facilitating the production information flow among operating fronts, through the quick and easy generation of reports that can be sent to the field with the most relevant data and information that have been collected by the previous front referring to the points that will be produced at this stage.

Such information, obtained at an operating level can be processed considering several projects, with the objective of generating general analyzes and conclusions about the process, which will be treated in the module faced to the tactical level. For example, the average cost of producing a shot point or a mileage unit and also what the representative of each type of cost in this total can be easily obtained based on historical data of projects, thus enabling corrective action or improvement based on these analyzes.

As basic features of PPC stands out that the system allows, from geo-referenced data, create, edit and view the history of pre-plot changes and compare them to the coordinates of materialized points, including relevant calculations on placement and altitude variations errors, for example. Also using a spatial data infrastructure (SDI), the release of production of each of the operating fronts can be accomplished with the help of maps and tables, calculating automatically quantitative, mileage and production estimates.

Geographical and geodetic information relevant to Permitting and Survey are also found in the system, such as shapes and coordinates of landowners' properties, man-made obstacles and hydrography and can link them to the lines of the acquisition program (Figure 5) and generate information or alerts on these intersections as a way to assist in the planning of the deviations to be performed. These data have the option to be collected directly from other specialized systems of these sub-processes, such as Topograph, GPSeismic® or GPS TrackMaker® or to be manually included via user's interface.

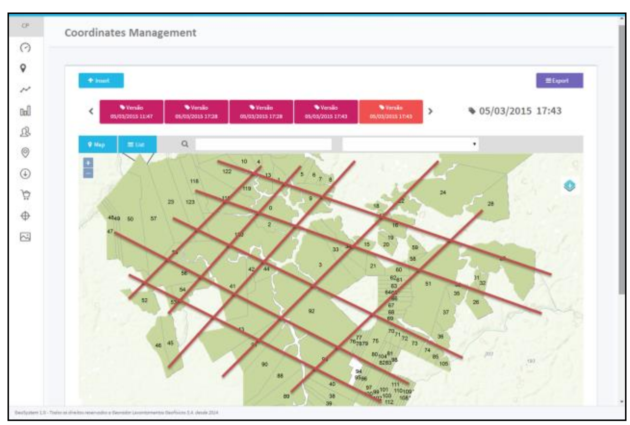

Figure 5 - Project coordinate management screen

To assist the PPC per operating front, it is possible to visualize the history of the works and reworks and also the situation of each planned point and each materialized point in the survey, by step of operation (Figure 6). From this information, support reports to field activity will be generated via system, including information that the coordinator or team leader deems necessary to facilitate the daily work of operators.

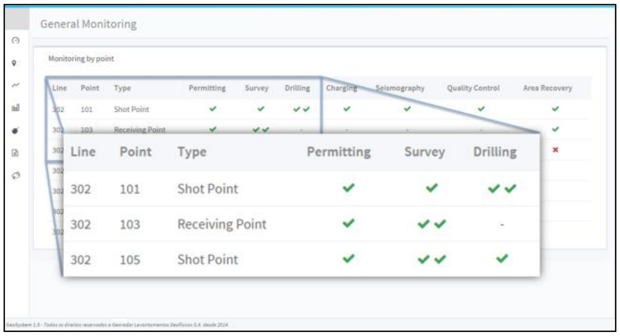

Figure 6 - Production monitoring general screen, per each project point

In the case of seismic, displacement and reduction of holes and charge rules are registered as a way to control the record of these eventualities, considering that these are essential information to data processing and quality control of the entire project, and, in that way, it permits to avoid inconsistencies in seismic records or even reduce the number of reworks during the process.

The system also provides daily monitoring of all inputs (equipment and materials) available, including the record of human resources allocated to each operating team, for each of the operating fronts and involved sectors, in order to anticipate the needs for acquisition of materials or staff hiring.

The control of explosive materials is made in a dedicated feature, since its importance in the process in terms of safety and environment. The amount of materials available by the deposit is correlated with the production of charging and blasting fronts and with the recovery of charges carried out by the HSE sector, so as to always guarantee the absence of charges left on the ground. Such information can also be analyzed in maps, graphs and reports, in order to help monitor of this control, which involves different sectors within the project.

In addition to functions aimed PPC, the data validation and treatment steps, either seismic data or magnetic and gravimetric ones, have sub-modules applied to assist in the validation, either formatting or of the information contained in the data produced and pre-processed (Figure 7), also allowing the statistical analysis performed by the organization of files and metadata, thus enabling the screens, maps and reports displaying, which quantify sensor problems, environmental noise, anomalous amplitude and frequency, stretches not materialized or points without gravimetric and magnetic reading (Figures 8 and 9).

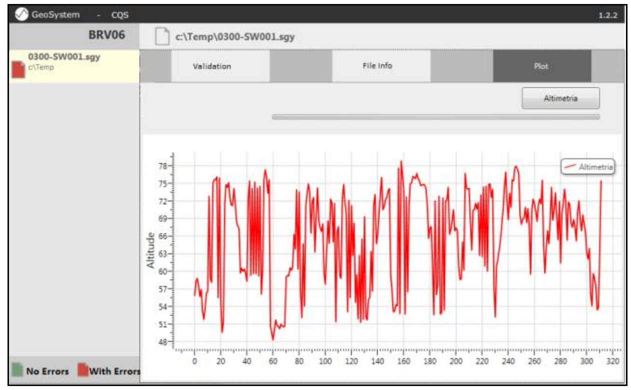

Figure 7 - Treatment and validation of seismic data sub-module

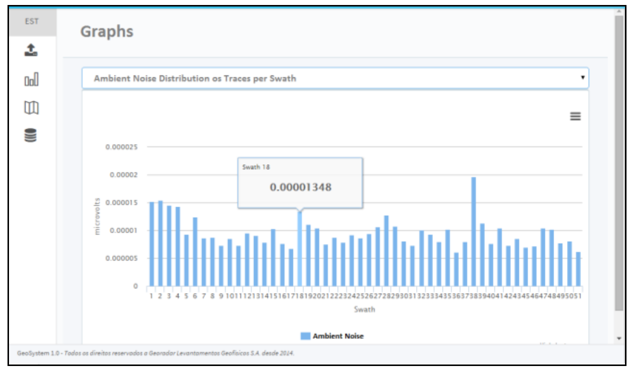

Figure 8 - Statistical graphs screen on problems caused by environmental noise

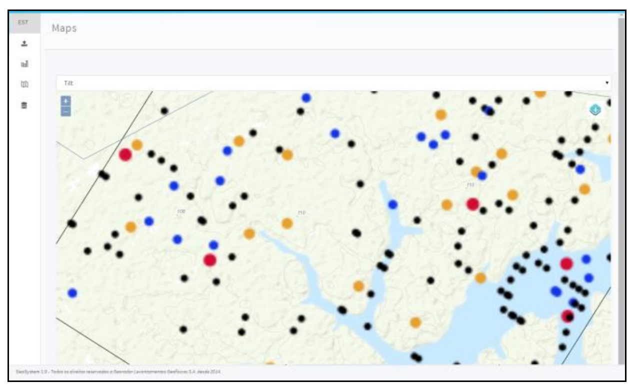

Figure 9 – Statistical maps screen

Another sub-module, linked to the delivery control of acquisition data, is dedicated to the organization of the products of each project, enabling its safe and quick search. Each delivery made, whether valid or invalid, is recorded and reported in the system, and this information is linked to production data.

Results

As the implement is deployed in modules and sub-modules, each one with its specific WebAPI, modifications and adaptations will become more uncomplicated. The current phase of construction is the integration of these sub-modules of the operating part. At this step, the system has demonstrated effective in storing the data and control the most important information for the smooth running of its projects.

The use of the presented data and information management model, wherein means and applies the difference between these two concepts, brought remarkable improvements in the productive process, such as:

- Decrease in the number of man-hours required to PPC in the projects;
- Increased accuracy of information submitted in internal and external reporting;
- Reduction in the number of decentralized information sources on the same project;
- Increased success rate in the first delivery of data sent to the Brazilian exploration and production database – *Banco de Dados de Exploração e Produção* (BDEP), being around 80%;
- Improve and facilitate communication among operating fronts within projects;
- Makes the focus change easier in the Quality Control sector for monitoring and supervising the process from the beginning, taking more preventive and less corrective measures.

Future developments

Certainly the processes that involve the acquisition of geophysical data in GEORADAR are susceptible to constant improvements, and, with this in view, the data and information management system must also be in accordance with the changes that occur. Therefore, close monitoring of the development needs is crucial to maintain the adopted model.

Several new features, primarily focused on the areas of support to operation, such as logistics, transport and HSE sectors, are current system demands, so that the operating databases allow generating information even more consistent to the process.

These are also future developments: modules geared to tactical and strategic levels, which include features aimed at business intelligence and control of overall objectives of the company, respectively. All these modules need to be aligned and must complement each other in order to organize optimally the data and information necessary to the work of each enterprise level.

Conclusions

This work has as one of its goals to demonstrate how the knowledge of the process, the clear definition of the difference between data and information and the systems technology can assist in a more efficient management of DAC's on all their internal and external supply chains, generating productivity gains and appreciation of knowledge assets, which, although intangible, have tremendous value.

The recording and the analysis of non-conformities of the process serve as the first step for taking more assertive decisions about projects. However, the main objective of the system is to generate information with consistency and avoid redundancies that generate inefficiency, both in operation and in its administration, and enable the rapid and effective rescue of the necessary information and products of each project in an organized way.

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Annex - Standard process flow of an acquisition project of geophysical data by GEORADAR