Design & Development of Integrated Information Management System for Drilling Operations Abroad

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Abstract—Due to the limitation of cooperation contract period, logistics supply and regional conditions, the number of drilling rigs and drilling operation procedures need to be arranged scientifically and reasonably for drilling operations abroad. According to the characteristics of this foreign drilling operation, we design and develop an Integrated Information Management System (IIMS) including intelligent planning and integrated management system including well site data management, office work planning and cost control, operation management, statistical query and logistics support.

1. Introduction
Drilling plays an important role in the exploration and development of oil and gas fields. The improvement of drilling engineering management level is conducive to the overall improvement of drilling engineering quality and service life of oil and gas wells, and has a very important impact on the overall realization of oilfield exploration and development business objectives[3]. With the continuous advancement of oil exploration and development process and the increasing demand for oil in China, more and more foreign drilling operations are carried out outside China. These drilling projects have fixed and strict operation time requirements. At the same time, due to the limitation of local conditions and long distance from home, foreign drilling operations have their own characteristics and difficulties. In order to improve the scientific management level and collaborative decision-making level of foreign drilling operations, It is necessary for us to improve the informatization level of drilling operations, and ensure the safety of drilling operations in aboard blocks[1]. We have designed and developed a set of integrated management system which including the functions of data acquisition& management, drilling design management, drilling operation logistics management, drilling scheduling, directional well calculation, well control and overflow calculation[2].
The purpose is to solve the problem of foreign drilling projects within the scope of their own network to realize the integration of well site and base office. Finally, improve the information construction level of foreign drilling projects.

2. Integrated Information Management System (IIMS) Design

2.1. IIMS Final Goal
With the most advanced programming environment, we are aimed at developing a set of drilling information management system and build an integrated office platform, achieving digital management of the drilling information, various types of reports and documents as well as optimized management of the production and office work. Our final goal is to improve the working efficiency, reduce the workloads and lower the comprehensive cost. We guarantee the accurate, complete and prompt transfer of our project to our users.

The highlights of our design of IISM are as follows.
Automatic tabulate statistics of report data: with the automatic logical relationship among data, users need not to re-input the data, and thus to economize manpower and speed report submission.
The reporting system will compose and complete the reports automatically with the format (EXCEL\WORD\CRYSTAL REPORT) users require, and send mails or cautions to designated users.
Visual drawing tools of drilling, based on object-oriented technology, will bring visual demonstrations of wellhead equipment, casing program, 3D well track, construction progress, completion pipe string, and stratum pressure etc. The modularized graphic unit management supports such operation as dragging, copying, pasting, and zooming. The intelligent computer-aided drawing functions in automatic label, composition and addition of annotation. The graphs generated in the system can be stored in various formats such as vector-graphs, PNG, BMP, GIF, and JPG.
The examination and approval of documents simulate the actual procedure. With its function of retention (trace reserve), the system can record the complete process of examination and approval and it also support electric signature. Classification and access control of the data limit the users to specific data access\[4\]. At the same time, version control of the system functions to code and archive automatically according to the inner control of the documents.

2.2. IIMS Network structure
Acceding to the network environment of the wellsite and oilfields, wellsite drilling data management and office working system will be developed in B/S pattern, so that the users can visit them via IE. Compared with the conventional C/S model, the system has the following conveniences and advantages\[5\]:
(1) No software installation to the clients: every client can visit IIMS via the browser and there is no limit to the number of users.
(2) Convenient installation and maintenance: the system will upgrade automatically, with no need of the users’ operation in version renewing.
(3) Excellent data safety: via hierarchical authorization, a user can only operate on the data and functions within the authorization, and the data have no residence in the client, which greatly reduces the risk of blow gaff.

Based on our survey on the users’ network environment, the following network structure diagram of the system has been drawn.
2.3. **IIMS architecture**

The system structure is mapped out (Show in Fig2) according to the system function, the user level, the environment of the user and our previous work. It includes 3 parts.

1. **Wellsite Drilling Data Management** including DDR, DMR, DCR data input, cementing, coring, bit and well completion reports, and data upload. The potential users are drilling supervisors, service engineer and drilling engineer.

2. **Office working system** including company files (regulations, contracts and business documents), drilling data (well completion reports) and classified database management of various reports and statements. The potential users are all staff of the drilling department.

3. **Common Drilling Software Package** used to carry out the calculation of related stratum pressure, survey of the directional wells, anti-collision scanning, wellbore trajectory control, directional well three dimension display etc. All the calculation modules read the original data directly from the database and various tools library via data sharing, avoiding repeated data entries.

2.4. **User classification**

Based on our understanding of the user organization, this system classifies the users into 3 categories:

1. department manager level, such as the drilling department manager;
2. oil field office engineer level,
such as the chief drilling inspector, material engineer, drilling engineer, well completion engineer, planning and cost control engineer and document controllers; (3) well site engineer level, such as well site drilling supervisor, drilling crew engineer, and service engineer (in casing, cementing, directing, logging etc.). The organization structure chart of the drilling department is as follows:

Figure 3 Organization of Drilling Department

3. INTEGRATED INFORMATION MANAGEMENT SYSTEM (IIMS) development

(1) Well Site Drilling Information Management System (WSDIMS)

Well Site Drilling Information Management System mainly provides an information management platform for the drilling supervisors in such operations as drilling, mudding, logging and cementing. To satisfy the drilling supervisors’ need in the management of the materials and costs in the well site, WSDIMS is designed to include such 7 main functions as data input, daily reports, end well report, other regular reports, material management, operational analysis, supervisor’s instruction and visualization, according to the drilling operation process and the responsibility of the inspector in the well site.

Figure 4 The function list of Drilling Information Management System at the well site

Figure 5 Main Interface of Drilling Information Management System at the well site
Drilling office management subsystem, a work platform for the relevant drilling personnel, is one of the three major parts of the IIMS consisting of 5 categories of function modules as is shown in Fig. 6:

(3) Drilling Engineering Software Toolkit
Drilling Engineering Software Toolkit integrates mature calculation models and design algorithms relating to drilling engineering so that it can provide various convenient engineering calculation for the drilling engineers on site. It is composed of 3 subsystems: Data Management, Engineering Calculation, and System Maintenance.

Figure 6 Structure Chart of Office Working System

Figure 7 Home page of Office Working System

Figure 8 Structure Chart of Drilling Engineering Software Toolkit

Figure 9 Main Interface of the Toolkit
Data Management Subsystem provides the input of all the data relating to engineering calculation. Data can be put in quickly via copy, paste etc. All the data put into the subsystem will be stored for subsequent engineering calculation to avoid unnecessary re-input.

![Basic Data Interface](image)

Figure 10  Basic Data Interface

Engineering Calculation Subsystem provides convenient and practical aided design calculation tools for the directional well engineers. It is composed of 2 main modules: Directional Well Planning and Kick Killing Calculation.

Directional Well Planning Module is used in the conventional 2- dimension directional well trajectory design, mainly including Target Data Input, Directional Well Planning and Anticollision Calculation.

![Min Distance Scanning Result](image)

Figure 11  Min Distance Scanning Result

Kick Killing Calculation Module provides 3 methods of calculation simulation for kick killing construction: engineer’s method, driller’s method and multistep round-robin method, and it can monitor the safety construction pressure in the kick killing construction. The module is mainly composed of such sub-modules as Kick Killing Data, Kick Drillstring, Surge/Swab Pressure Calculation, Kick Killing Calculation and Kick Killing Simulation.
System Maintenance Subsystem provides a unified management of the coding tables adopted in the software toolkit (mainly including the pipe, collar, downhole motor, joint, HWDP and stabilizer). Users can add, delete or modify the codes in the toolkit.

4. conclusions
Integrated Information Management System for Drilling Operations Abroad consists Wellsite Drilling Data Management, Office Working System and Common Drilling Software Package. These three parts operate in a unified software and hardware environment, which can realize remote transmission of drilling data and real-time transmission of operation instructions from well site to office, and realize the integration and unification of drilling design, drilling operation, logistics management, contract management and other operation. The construction and functions of the system are expatiated in detail. The system has been applied on the site and got a good effect.

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