MINISTERUL EDUCAŢIEI ŞI CERCETĂRII
UNIVERSITATEA PETROL-GAZE DIN PLOIEŞTI
B-dul. Bucureşti nr. 39, 100680 Ploieşti - România
www.upg-ploiesti.ro
Telefon +40 244 573 171 Fax +40 244 575 847

INSTITUȚIA ORGANIZATOARE DE STUDII UNIVERSITARE DE DOCTORAT UNIVERSITATEA PETROL-GAZE DIN PLOIEȘTI
DOMENIUL FUNDAMENTAL – ȘTIINȚE INGINEREȘTI
DOMENIUL DE DOCTORAT – Mine, petrol Și gaze

TEZĂ DE DOCTORAT

CONTRIBUŢII LA MANAGEMENTUL DE ZĂCĂMÂNT ŞI OPTIMIZAREA EXPLOATĂRII ZĂCĂMINTELOR DE HIDROCARBURI

Autor: **ROSTAMI DEHKA MOHAMMAD**

Conducător științific: **Prof.dr.ing. IULIAN NISTOR**

Ploiești 2021

MINISTERUL EDUCAŢIEI ŞI CERCETĂRII
UNIVERSITATEA PETROL-GAZE DIN PLOIEŞTI
B-dul. Bucureşti nr. 39, 100680 Ploieşti - România
www.upg-ploiesti.ro
Telefon +40 244 573 171 Fax +40 244 575 847

INSTITUȚIA ORGANIZATOARE DE STUDII UNIVERSITARE DE DOCTORAT UNIVERSITATEA PETROL-GAZE DIN PLOIEȘTI
DOMENIUL FUNDAMENTAL – ȘTIINȚE INGINEREȘTI
DOMENIUL DE DOCTORAT – Mine, petrol Şi gaze

TEZĂ DE DOCTORAT

CONTRIBUŢII LA MANAGEMENTUL DE ZĂCĂMÂNT ŞI OPTIMIZAREA EXPLOATĂRII ZĂCĂMINTELOR DE HIDROCARBURI

CONTRIBUTIOS TO REAL TIME RESERVOIR MANAGEMENT AND PRODUCTION OPTIMIZATIAON OF HYDROCARBON RESERVOIRS

Autor: **ROSTAMI DEHKA MOHAMMAD**

Conducător științific: **Prof.dr.ing. IULIAN NISTOR**

Nr. Decizie 89 din 27.01.2021

Comisia de doctorat:

Președinte	***Prof.univ.dr.ing. Lazăr AVRAM***	de la	Universitatea Petrol-Gaze din Ploieşti
Conducător științific	***Prof.univ.dr.ing. Iulian NISTOR***	de la	Universitatea Petrol-Gaze din Ploieşti
Referent oficial	***Prof.univ.dr.ing. Ion MĂLUREANU***	de la	Universitatea Petrol-Gaze din Ploieşti
Referent oficial	***Prof.univ.dr.ing. Ioel Samuel VERES***	de la	Universitatea Tehnică din Cluj - Napoca
Referent oficial	***CSP I dr.ing. Dumitru Gherghiceanu***	de la	OMV PETROM

Ploiești 2021

Summary

Digital Oil Field (DOF) project in OMV Petrom was initiated to automate wells and facilities and remotely monitor, troubleshoot and optimize operations and maintenance data and activities, in a modern manner and to foster value creation through integrated and reliable data to skilled professionals in order to facilitate the right decisions.

DOF Project started as a pilot in an oil field, covering a large area of automated wells and facilities. The first pilot project was kicked off in a field operating around 400 wells equipped with PCP and more than 70% automated facilities consisting of: 14 MPSs (Meter Point Skids), 2 PMANs (Production Manifolds) and 1 OMS (Oil Metering Station), all connected to SCADA systems.

Operating mainly in a mature environment, where field performance management, optimum well and facilities intervention and preventive maintenance, make the difference to be "best in class" and to compete in a low oil price market environment. In today's world of compressed margins, E&P companies are pressured more than ever to make the leap from the original design of Digital Oil Field to its full implementation in order to position themselves for the future. The Digital Oil Field is essentially bringing data to life, simplifying operations, helping to make the right decisions at the right time and thereby ensuring safe and efficient low cost operations of oil and gas fields. Below is the summary of each chapter in the main Thesis:

Chapters 1 and **2**, introduced and described the concept and key elements of the digital transformation. SPE Real-Time Optimization Technical Interest Group (RTO TIG) involve three critical components, technology, people and process as well as Organization as the fourth element. The change management is considered as one of most important milestone in digitalization process to drive the transformation, organizational and operational efficiency and excellence.

Digital Oil Field aims to remotely monitor, troubleshoot and optimize operations and maintenance data and activities, in a modern and autonomous manner. The aim is to create value through increased integrated and reliable performance data availability to skilled professionals in order to facilitate the right decisions, known also under the term "Data Enabled Operations Excellence". The digital transformation has been started its journey back in 2007 going from pilots to more than 4000 automated wells and 80+ facilities by end of 2016.

Chapter 3 focused more on subsurface automation and digitalization. This includes artificial lift selection, installation, surveillance, troubleshooting and optimization especially for brown mature fields producing through multiple artificial lifting systems, SRP, PCP, ESP, LRP, GL, etc. A new well optimization flowchart was described in terms of roles and responsibilities of different operational parties for each system and activity.

Variable speed drives are employed to remotely optimize well gross production rate boosting oil production without the need of costly pump design changes. Mean time between failure related surface and downhole equipment was more than doubled since 2010, in part, due to the proactive approach of remote well parameter monitoring and preventive actions taken before equipment failure occurred.

A new technology (MURAG) is implemented to conduct reservoir measurements in many wells and artificial lifting units for fluid level, bottom-hole pressure and casing head pressure measurements. The goal is making these measurements with minimum personnel

effort, decreasing HSE risks in the fields and operational locations, and providing high flexibility and consequently great levels of mobility.

The physical and virtual flow metering technologies investigated, screened and implemented during the digital transformation program have also been elaborated and discussed. The chemical injection skid technology was also introduced in the project for the automation of downhole corrosion inhibitor injection. The system that is able to automatically inject the correct dosage of inhibitor to increase the life time of the downhole equipment.

SAWOCS (Smart & Automated Workover Candidate Selection) solution and workflows were developed to assist workover candidate selection and increasing the technical and economic success rate of workovers. The fundamental logic is the enabler for identifying a complete list of well integrity and deliverability issues for currently producing and shut-in (waiting WO/WI) wells.

Chapter 4 is about Production Management Framework (PMF) which is another major milestone in upstream digital transformation. It is a set of six elements to support and implement the mission statement to “Understand, Measure, Monitor, and Realize” production and the minimum requirements for understanding, forecasting, managing deferments & losses and optimizing production. This framework with four main and two supporting standards developed certain workflows, dashboard and visualization and analytics capabilities to address production related topics. Production system capacity is being calculated in a systematic way which triggers most likely and more reliable production forecast. The difference between these two, production system capacity and forecast, is considered as deferment which is also tracked and calculated more transparently to address root cause analysis and mitigation measures. All new opportunities are captured in a single register with estimated incremental production gain and/or cost saving to through opportunity lifecycle.

Chapter 5 is about the design and implementation operational hub or operations control room in combination with SCADA integration and alarm management. The main objective of operational hub is to develop and implement a process based on remote monitoring of operational and maintenance data and mobile teams intervention in all onshore oil and gas fields. All automated production systems including subsurface and surface were integrated into operational hub through SCADA systems. The alarm management philosophy was implemented to ensure that effective alarm management systems (based on best practices for alarm management) are implemented and maintained at all upstream onshore automated wells and production facilities. Real time data from wells and production facilities are being transmitted through SCADA system to control rooms and are monitored in the operational hub.

This enhanced operational set up delivers significant benefits:

- Safe operations through real time online monitoring of wells and plants
- Reduced onsite exposure and windshield time for field staff
- Minimized production losses/ deferments

- Improved production potential utilization and efficiency
- Avoidance of damage of subsurface/surface equipment through monitoring and optimization
- Increased run life of equipment, energy consumption per boe of oil produced, optimized oilfield chemical usage and thereby significant reduction of operating costs

Chapter 6 discussed the first implementation of Advanced Process Control (APC) in upstream which is a mathematical model that optimizes plant performance. It works by determining the best operating point for the objective function outputs. The purpose of an APC solution is to keep key process operating parameters within the bounds of a target objective by controlling the CV's (Control Variables) and monitoring the MVs (Manipulated Variables) within the controller algorithm; to achieve the objective function for the most optimum plant operating mode; determined from the mathematical process model. The APC implementation has been started in 2019 in two pilot assets to maximize C3+ production, sales gas production in one asset and to increase the throughput of TEG & LTS facilities in another asset.

Chapter 7 elaborated Control Loop Performance Optimization (CLPO_PID) to maintain the main process operating constraints of proportional integral derivative controllers inside narrow limits of a target reference criteria or set-point. Process control loops has a major influence in how a disruption can be assessed, analyzed, controlled and eventually regulatory measures implemented. In fact, even though PID controllers are relatively simple to use, they are able to provide good performance in most process control applications found in Oil & Gas Upstream.

Chapter 8 is about data management, integration and analytics. Data is acknowledged as one of the main technical asset in any industry. Data drives digital transformation, changes and operational excellence. Therefore, data management approach is defined and established as one the key components of digital transformation initiative to address the data driven decision and data driven production in a fast and more reliable way by using clean and accurate information. On the other hand, data integration has an important role in DOF environment as it is a key to establish connections between sensors, operational technologies, data sources, enterprise platforms, advisory systems, etc. to ensure that companies make the most out of the technology stack. This is possible through hybrid integration platform which is a framework of on-premises and cloud-based integration and governance capabilities that enables differently skilled personas (integration specialists and non-specialists) to support a wide range of integration use cases.

Data assurance and quality is another important dimension that is addressed in the digital transformation process. The purposes of data quality management are as follows:

- ✓ Create a global system for check, report and monitor data quality rules
- ✓ Provide the current state of data quality
- ✓ Identify data quality & consistency based on defined rules
- ✓ Simple overview on pending data issues for correction in all source systems

- ✓ Management of issues in the data located in existing databases and monitor the corrections
- ✓ Create a knowledge database for data quality rules

Mohammad Rostami Dehka