UNIVERSITY of CRAIOVA

Faculty of Automatics, Computers and Electronics

DOCTORAL SCHOOL "CONSTANTIN BELEA"

DOCTORATE THESIS

Design and development of a class e-Metrology for calibration of the tanks in the oil industry

Summary

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Craiova, 2015

Summary

R. 1 Category, thesis framing, content

This thesis is devoted to study integration methods, techniques and principles of calibration of the tanks used in the oil industry in an integrated ERP namely SAP getting an useful application / fully achieved SAP namely using environment ABAP programming - WebDynpro. Recent years have seen a remarkable emphasis on the place and role of measurement in line with the evolution of society, which every day brings new challenges increasingly larger in the science of measurement. As intended, the measurements must be as accurate, even if we discuss the role of identifying, measuring, monitoring, so that they have the main focal point a mutually recognized system of references.

The proposed goal, over time, was to find new methods and standards that are capable of performing increasingly better, to feed-back the increasingly diverse requirements, in order to be demonstrable and appropriate to the mission for which they were created. So the main challenge of the metrology institutes and organizations was the discovery of new methods and standards, adapted to different requirements from those environments that use the measurements in daily purposes.

This thesis with the title ***"Design and development of a class e-Metrology for calibration of the tanks in the oil industry"*** wants an approach and an analysis of methods and calibration techniques used in oil and gas industry, the purpose of this thesis consisting of the achievement of an application, integrated into an informatics system like SAP, that is ERP [1], [2].

So, after studying the specific literature and analyzing / researching the existing documentation in our country, using information from specialty materials, we concluded that there is not an integrated application that should provide the possibly of a more precise analysis, to calculate and store data with reference to the calibration performed in our unit and not only (in our case the existing vertical and horizontal calibration of the tanks in the oil industry) [3], [4], [5].

This thesis refers also and envisages the collecting all the preliminary data necessary for a calibration using methods approved by the relevant institutions (BRML) having applications in metrology, using and establishing metrological and technical

requirements and implementing rules (legal) into the tanks for the storage of petroleum-liquids.

This doctoral dissertation contains a succinct breakdown and in the same time it scopes out all operations of used measurement and calculations that result from performing specific operations of calibration to determine the quantities of fluid inside the tank that are the object of the research, using specific standards and procedures.

Such calculation (results) can be used to determine the management inventory and to achieve commercial transactions.

In figure R.1.0 I detail the dependencies and how to share information in the context of the research theme calibration approach tanks integrated in mechatronics, the using of control loop (automatic) being the main source of information that exists:

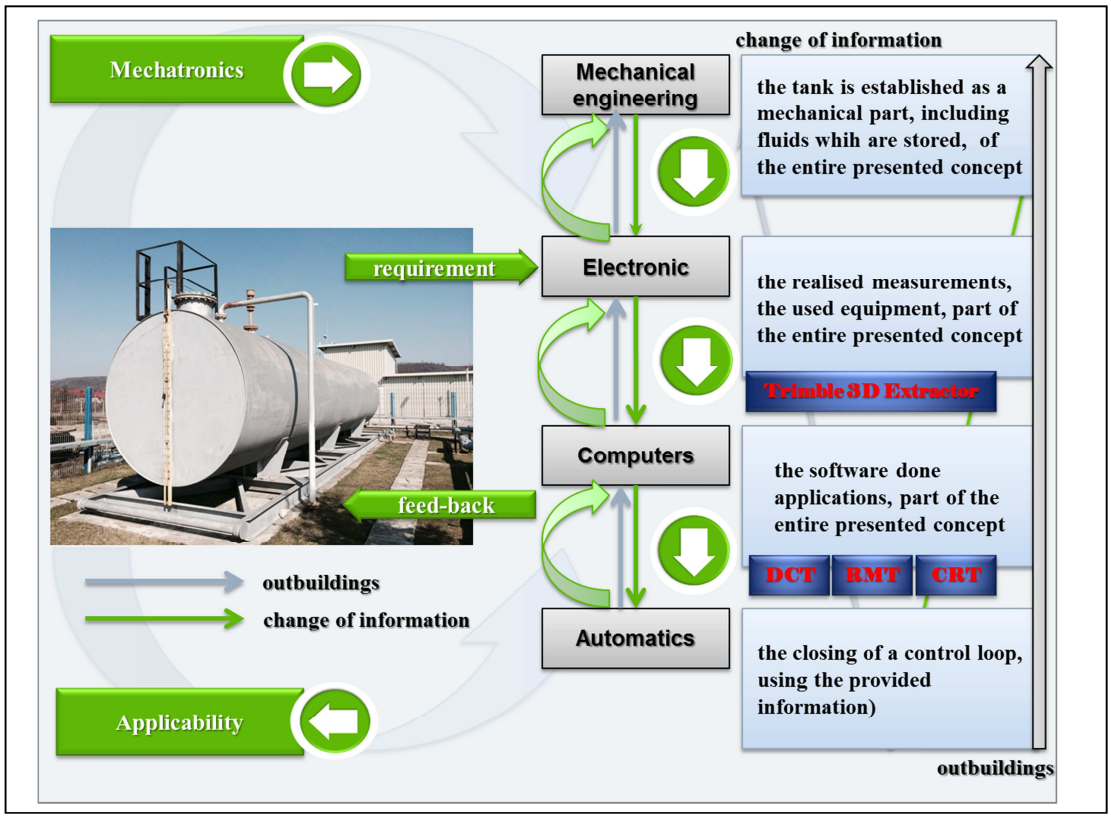


Figure R.1.0 Dependencies/An information exchange in the activity field

One of the problems that were encountered by me in the research that I have undertaken was that of the lack of software to centralize the existing technical data and metrological data in the territory. The existence of a world-class ERP has created an expectation of an "in-house" development, a soft adapted to typical oil requirements. Of

course the techniques used were supervised by experts in the field which examine and certify a calibration namely BRML (Romanian Office of Legal Metrology). The steps that led to a careful and detailed analysis of metrological phenomenon in which I work have been closely monitored by specialists in the field [6], [7], [8].

A particular problem I encountered when I had to centralize national data, collected in the territory, this can be done only online, the existing infrastructure allowing us to access the system using the existing equipment. Where this was not possible, loading Data were loaded locally on a laptop, so that in time the infrastructure has enabled, those data to be downloaded-loaded in the reference system, in our ERP systems, SAP [1], [9].

Performing a software (module) integrated in an ERP system (Enterprise Resource Planning - Planning Resources of the institution), particularly in SAP (Systems of Purchasing and Products), in order to centralize / store / calculate / release the paper of calibration based on data gathered from across the country and to provide a flexible way of working for users not very familiar with IT technology, it required the design of an integrated module ("software design"), a documentation, an implementation, a continuous improvement of the approach for the existing problems in the field of metrology, particularly in the oil and gas industry [10], [11].

They were obtained immediately various advantages, such as:

- data are saved in a single environment (single database), which is in turn attached to a centralized system of "backup";
- the access toe stored data is done online from our country territory;
- can do more analysis of various types (historic performance, KPIs, etc.) on calibrations performed over time;
- the Certificate of calibration is quickly got on the calculations developed on the algorithm set at the starting point of the module;
- the system is adaptable (customizable in terms SAP) and can be easily adapted to changes in the type of legislation;
- the software application (CRT module - Reservoir Calibration Tool) is integrated in an ERP system, giving those who use it the opportunity to read / display / validate technical and accounting data about the asset (in this case tanks);
- another advantage is the possibility, at some moment, to be displayed, the existing stock in a production park (a filling station, a store storing oil

products) if calibration is achieved all into existing storage specified location.

What I have proposed in this thesis is to elucidate the redundancy of collected data, storing them in one safe environment (one database - in our case DB6) and the possibility of accessing data online anywhere in the world where there is internet, using a software (module) integrated in an ERP system that helps the metrology / calibration of existing oil tanks - making calibration electronic file.

Moreover, I wanted to be able to manage using the software created - CRT national achievement of all calibrations, so, cooperating with the multitude of existing software products(which actually performs the calibration by various working methods) to be obtained the electronic calibration file for each asset separately, wherever they are.

In this way you get a centralized situation, on-line, on the work of metrology - in our case the calibration of tanks, regardless of their type.

The electronic calibration file (including calibration certificate, interpolation table, the sketch location of means they undergo calibration) is provided by the system (more it can be prepared a complete file - electronic metrology, comprising all necessary legal documents) CRT SAP module, based on data gathered through the calibration process.

R. 2 Research Methodology

The prototype proposed by me, involves the development of a common database from which they can validate and issue on-line calibration file (including calibration certificate) in electronic format. It was one of the strengths analyzed and thought points by me, in my approach to achieve, as stated above, a software application / module integrated within SAP, in order to solve this shortcoming existing now in this area, and some sticking points encountered frequently in the active, the storage and electronic tracking of calibration is carried out throughout the country in conjunction with the legal metrology activities.

Speaking about this area has not been easy, knowing that there is a significant gap in this sector, metrology –the calibration of the tanks, the measurement technology being used in all sectors of human practical activity.

What made me to propose this prototype (the realization of this software module SAP (integrated with other standard modules in SAP), metrology) was my desire and those who use it to identify, quantify, monitor and manage all specifically, the results should be

compared and linked to a mutually recognized system of references, using various levers currently existing in the company where I work.

The main goal, the basic aim of this paper is to highlight the contributions that we have to integrate a software (how ZMETROLOGY) metrology with an integrated ERP - SAP, in the calibration of existing storage in oil and gas .

R. 3 The purpose and objectives of the research

With the completion of the purpose in this thesis, in the process of documentation and its realization, I investigated and researched the issues and requirements for developing an architectural framework required to manage all the information needed to use the processes needed to achieve all types of calibrations in the industry oil, using techniques approved by the competent people in the field.

Regarding the purpose in the present research, it offers information on techniques, tools needed, entities involved, the components used, the necessary methodology , approved and applied in the oil field development, methods and processes necessary for the integration envisaged in the decisional - check on the calibration of the tanks used in this field.

To achieve the aims set out below, we undertook a comprehensive literature search by bibliographic study, consisting of books, scientific papers, statistical databases, periodicals, analysis BRML studies in the field of some national and international bodies, discussions with experts in the field, in the company where I work and beyond.

Thus, along this research to the calibration, we pursued a number of objectives, which are detailed below, Figure R.1.1:

Objectives	Description
O1	Analysis of historical landmarks and prospects of development of Romanian oil and gas industry,
O2	Identification and quantification of the contributions on the state (petrol, distribution, tanks);
O3	Identify the main changes in management performance measurements made with the introduction of software that monitors this area;
O4	Identification of integrated metrology module efficiency of implementing the SAP ERP system;
O5	Identify changes to the information system implementation management shall be conducted using the existing calibration, conduct a study case.

The analysis and research in the unit belong, aimed as final research the modality of implementation of an integrated ERP system SAP, which is installed in the

unit and which has as its domain of applicability metrology - calibration of the existing storage production parks and beyond, by closely analyzing the benefits of integrating the module into the existing complex computer system.

As the society evaluate , confronting new technologies is becoming stiffer, so the desire for integration of existing software systems in various areas, is a priority for existing IT in various production units. Increasingly more, as shown by different studies and of the statistic, integration of different types of software can result in an analysis and distributive costs much easier to achieve more, the cost with IT asking to be increasingly smaller.

As shown in the studies done by myself, the global context (international) highlights the fact that the concerns of dealing with software development is to integrate as many fields in complex systems data management for a better connectivity between existing departments, in the complex retail units and production , in the case discussed here the oil and gas.

When we talk of challenges in terms of "in-house" software development at the expense of purchasing one on the free market, with the integration of the various bodies and international organizations ,it is related to the adoption of new concepts and theories to fit in the current context , the increasing information security.

Most of the major companies operating in the oil and gas, aim the installation of new types of software, certified in terms of information security, stable and responding promptly and to the many demands coming from the business, which is becoming more demanding with the results obtained after the data entered in headquarters and the production facilities related to the responsiveness of the installed system , the diversity of reports obtained in real time and with the obligation to provide the safe results.

Another requirement increasingly invoked by departments that contribute to the financial support of the IT division, within a large company, is integrating the group of existing IT solutions, so it is appropriate to provide 'datacenter-e "in different locations to be installed in the form of farms, existing solutions separate the various features, the main parameters being the country, geographical situation, climate, etc., clearly defining these criteria, the security of data stored in the existing software systems.

The search for effective software solutions, ERP ,which fully meets current requirements included in a complex architecture of enterprise, provides to those who have decision, means necessary to query and see solutions that respond to a multitude of requirements, here taking to: rapid response to business requirements, efficiency,

responsiveness, fairness, quick access, advanced connectivity, networking opportunity with a variety of peripheral systems of the same type and more.

The desire of IT departments was, is and will be, to provide solutions for all kinds of business requirements existing in the corporation he operates and largely, to be able to create / develop applications (such as their "own development - in -house '), integrated into the existing ERP solution (if there is a solid base of data recorded / stored / stored - most of them being entered by users with clear goals) to solve a series of requirements / problems "arising in-house "so that no call / wait a settlement from the company that offered the solution ERP (supplier).

One of the major advantages of this type of development: is performed together with experts working in the field and thus, it is not the possibility that the resulted reports not to offer everything that was originally requested.

In this thesis, I tried to bring more in the development in SAP, namely developments on the technical and metrology - calibration of the tanks is one of the branches that still have no counterpart IT, particularly in the ERP system [9], the storage, management, calculation models and types of actual calibration and reports are to be submitted and approved by the control bodies in the area, namely BRML.

R. 4 Structure and organization thesis

The research on metrology, targeting administration / management of the calibration of the existing tanks in the oil industry, will be divided into six chapters that will address issues related to achieving calibration of the tanks using methods agreed by the Romanian Bureau of Legal Metrology - BRML.

Thus we have identified the advantages / disadvantages of these (methods used), the benefits brought by the realization of an application, integrated into an ERP system SAP, for the administration (management software) of the types of the performed calibrations and of the calculations required for calibration and the results.

All chapters that make up this research (with the purposeful application / module / proposed prototype) contribute and add value to the field in which it analyzed and documented throughout the study years.

The structure of this work can be highlighted in Table R.1.2 :

First part INTRODUCTION	**Introduction Chapter 1 Current state in area**		
Second part THE STUDY OF THE SPECIFIC LITERATURE	**Chapter 2 Oil-an important source of energy**	**Chapter 3 The conceptual frame**	**Chapter 4 Techniques and technologies used in the calibration field**
Third part THE RESEARCH METHO DOLOGY AND THE ANALYSE OF THE RESULTED DATA	**Chapter 5 The application design for the tank calibration**	**Chapter 6 Applications used in data processing using SAP**	
Forth part CONCLUSIONS	**Conclusions**		

The methods used in carrying out this study are:

- Volumetric method;
- Geometric method;
- Mixed method (volume + geometrical);
- Optical method.

The paper is structured in three main parts:

- The first part is aimed at highlighting and theoretical aspects related to metrology, especially the calibration of the tanks using existing legal methods;
- The second part will highlight the research results, the application / the achieved module SAP ERP system, application Z funded internally;
- The third part will present research findings, results from testing conducted in the ZMETROLOGY module using WebDynpro ABAP.

The practice is to provide an application framework, integrated into an ERP system, aimed at managing calibration performed in our country, an active company in the oil industry, the research was based on the types of legal proceedings (legal norms) existing in the Romanian Bureau of Legal Metrology. The objective of this research was the assimilation of the used methods by BRML within an integrated ERP namely SAP.

The first chapter aims to analyze the framing of this thesis in the chosen field to be studied, metrology, finding everything needed to be highlighted with reference to the use of different methods and calibration techniques found during documentation and individual studies on literature in this field.

After a detailed analysis of the field it has been demonstrated the need to create a software to be able to calculate and store to a complex level, the necessary data for the calibration of existing fixed assets in the database of multinational companies, in this case oil tanks (horizontal and vertical) using calibration techniques approved by the National Institute of Metrology - Romanian Office of Legal Metrology (BRML).

We identified prospects of using such a soft, so that its implementation will bring extra work metrology / calibration in the company that made the study.

The second chapter proposes a route out of the current state of the field, carefully assessing the ,contributions over time on the measuring methods used for oil field, closely analyzing the fixed assets named tanks (horizontal and vertical) used for storage petroleum products resulted from the operations performed on condensate extracted from the production wells (we are dealing here with oil, gas and salt water).

The tanks, horizontal and vertical, help at the storage of the resulting compounds, will be inspected (draft, revision, new tank construction) so that the necessary calibrations every 12 years according to existing laws in our country. These assets are part of the existing assets in sections / manufacturing sectors and parks related to these sections / sectors. In this chapter we will make a reference to the fixed assets, namely tanks, and existing outlets petroleum products (gas stations PECO), here having to do with different tanks, underground and above-ground, vertical and horizontal.

In the third chapter I conducted a survey of the history of oil and gas in Romania, analyzing historical and actual data, found at documenting and individual study on specialized literature and also a variety of specialty items considered for this research carried out with the final goal, this thesis. I tried to collect information from oil history in Romania, the formation of oil over time, the composition of oil - analyzing in detail in terms of chemical composition, the oil exploitation, leading ultimately to the processing of oil in our country, taking into account all aspects of techniques, technologies, advantages and possibilities, extraction-processing arrangements existing in time and now.

Chapter four proposes the conceptual description of the theoretical framework, scientific and practical realization of a software application integrated with an ERP system

- in this case SAP, the ultimate aim being to be able to achieve the management of all calibrations performed within the multinational company where I work. Everything that has been achieved so far has been a result of research work carried out by me, starting from a well thought and analyzed scenario.

Under this scenario the performing of a calibration occurs under certain conditions, selecting the architectural model that will be used to achieve what we wanted and concluding with using a particular type of workflow (Steps) designed and approved.

This type of workflow is so necessary in order to standardize the type of calibration used, so procedurally speaking to be a clear criterion regarding calibration performed for tanks (horizontal or vertical), taking into account its use in the multitude locations in the departments of existing production ,in the branches of multinational oil production in the company where I did this research [12], [13], [14].

They considered here several basic principles underlying the conceptual framework for software, which is the subject of this thesis, namely [15], [16], [17], [18]:

- all realized measurements were made taking into account the procedures, rules and legal framework in terms of metrology (BRML rules), working principles and guidelines;
- there were used calibration methods accepted and agreed nationally, here taking into account two basic components: volumetric component and the geometric one;
- it was taken into account the fact that the knowledge acquired by our specialists, to be kept internally for better organization in the future of other calibrations that will take place in our company;
- the monitoring and management of measurements used to achieve calibration, to be done centrally;
- the optimization of purposed resources ;the management of commissioning, after being calibrated the asset (in this case the tanks), to be centralized;
- the significant support of the approved projects of calibration, that will be performed.

Conceptually, the description of what we managed to raise as scenario can be described as shown above, Figure I.1, that details in a graphical way, the basic principles which underpin the state and achieving calibration tanks and more [12], [13], [14].

The fifth chapter proposes an overview and also a description of the techniques and technologies used to achieve calibration tank (horizontal and vertical), aiming their application in the oil, using it to develop software, platform SAP like environment.

So, the developing of applications that help collection/management/processing of all collected data used to calculate the values from the territory, will be made / tested in the working environment SAP namely ABAP software, so that the use of modules and own libraries SAP being a key factor in the uptake of programs implemented in integrated ERP system existing in the unit .

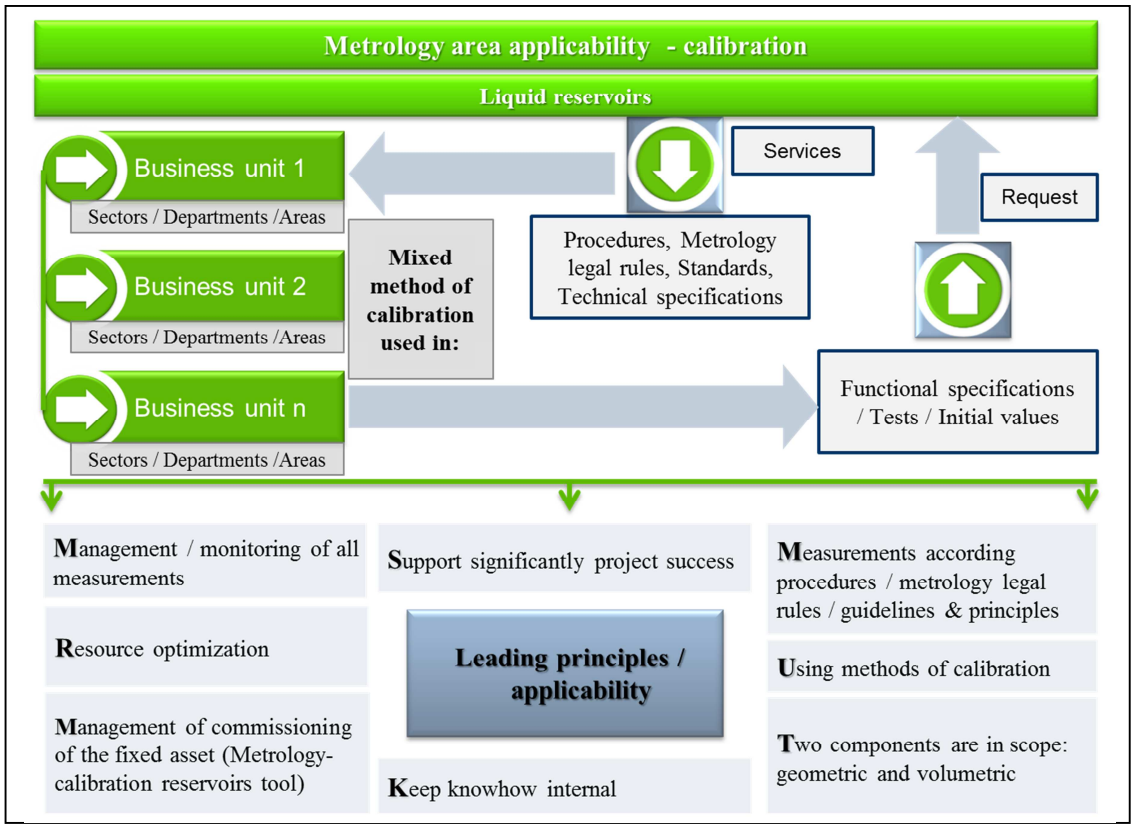


Figure I.1 Used steps for the calibration of a fixed device (tanks)

The algorithms used are based on documents collected within BRML, using theories, equations and diagrams for each type of calibration in part, chosen to be used. The application itself was performed using one of the latest web technologies used by SAP Web Dynpro namely (WD).

This technology is based on optimizing the connection in terms of response time, not being very user-friendly and helps to achieve in SAP business applications on the server side. What is new in this technology, the user interface, which is done in a declarative way, which leads to a much more friendly applications , using this technology.

The sixth chapter is an overview of several applications made in SAP, pointing the issues that will be shared, on the final target ,that is, the practical part of this thesis, namely CRT "Reservoir Calibration Tool".

Thus it follows step by step the realization of software metrology, which is the subject of this thesis, starting from the design of its used models , the principles behind this development in SAP (using ABAP as motor development) and the development of the application itself.

Calibrations are part of their maintenance and maintenance of existing fixed assets in a unit, more, they (the tanks) are part of the activity of regularly check by the units legally enabled (BRML) and the other companies agreed to make metrological checks, whenever needed, thus verifying the integrity of metrological point of view of their storage capacity.

In this chapter we do a breakdown of the steps needed and used to perform a calibration, starting from reporting the territory (production facilities) a problem on a tank (this requirement being made by Service Manager or Project Manager - given that it is building a new tank), the decision taken by the steering committee in the area of production (several production departments included), the decision made by the steering committee at E & P Headquarters (where decisions are made for all territories with areas of production, in compliance with legal requirements BRML) and inviting for supervision of a specialist who will act BRML accredited to certify calibration can be performed under conditions imposed by law. This chapter will make a breakdown of these steps, and workflow used in every type of calibration chosen to be used, depending on established tank.

Also in chapter six I will make a breakdown of all developed applications using the SAP (development of environment ABAP-Advanced Business Application Programming), these applications being made conceptual, to answer the requirement of the business environment in which I work, having connotations with all which means procedures, methodologies, the implementation of the so large extracting and processing of oil in our country.

The first development that I dealt with is the application that performs the storage and management of gas distributed in the territory via own gas distribution and supplier's national gas (so that there will be highlighted everything that means amount of gas

extracted and sold to own consumers - here there are a number of advantages arising from contracts concluded under the company and by those outside our network).

Here I highlighted the integration with the ERP equipped system SAP and the possibility of interdependence of existing data in the system with those introduced from the territory, after readings performed by our employees, responsible for this activity of data collection (from existing meters at each distribution point).

All that is added, as a registration, in the made application, is supervised by ANRE (National Authority for Energy Regulation) using all regulations and rules imposed by the institution of control. This will be taken into account also by the type of contract signed, making a distinction between domestic and industrial consumers (shipping prices depending on the type of consumer to another type of consumer).

At the end of each month, the application sends a situation of registered consumers to ANRE (making clear evidence of consumers - registration criteria varying according to several criteria, one important being the value added tax VAT collected by the state).

The second application I speak about, makes reference to the management of all the developments made in the department performing Z-ABAP development in-house multinational companies.

Here we have a very well established record of all developments that have been requested by our customers - business (from gas application to application of calibration gas reservoirs - the latter application is our main research topic).

This application - module was made in SAP Solution Manager, a SAP system that is used as CUA (Central User Administration - central management of users of SAP), which has links / connections to all SAP existing systems existing (here we are talking about a farm of approximately 30 production systems - which in turn, have two attached SAP systems, development and quality DEV QAS).

This allowed us to control and keep evidence of all the developments made, moreover, a major benefit of these applications is as follows: application / development carried out in a SAP system, fit to be transferred to another SAP system very easy and without any additional cost. Another development that was performed using ABAP environment, is Release Management module (controlling all changes that leave the software development system DEV and QAS get the quality system, the system used by the business such as production PRD). This module makes a reference and has a connection with the module Development Center, recording all other applications made.

This may indicate that the importance of developing a management system of all developments made by the team of ABAP developers, has a major impact on two important issues in a large oil and gas companies:

- a first aspect relates to the organization, planning and improvement of all activities inside the department that provides technologies and applications;
- the second aspect concerns the organization and improving processes for implementing new applications created and their management when they are moved between development systems, quality and production; it is a major impact on all technologies used in the oil and gas company.

The indirect beneficiaries of the control modifications instrument in business are both consultants and those who work in our Competence Center SAP [2].

The application - module developed to answer metrology namely calibration of the tanks is the development target of this thesis, which is created on the basis of a requirement within the department that deals with the control and integrity of the legally fixed assets subjected to periodic checks of the control bodies in our country, here discussing the BRML. Here I will discuss three types of performing a calibration, depending on the approved project , the existing plan of inspections and repairs and also planning after the type of reservoir, of a calibration as the stage of verification of the certification and control bodies.

To achieve a flow of documents and approvals based on well-established criteria by the organization which made this research, but also in line with the bodies of supervision and control [3], we defined the application made in SAP, more types of models to fully answer the calibration process defined as:

- the first model is "dispatcher model" (the most-used model calibration, it involves making their own specialists - certified experts, in collaboration with external certified specialists);
- the second model "body-leasing model" (it is the model which, based on an approved project, is rented from the market (external) certified experts BRML (company agreed) to carry out calibration of the tanks owned by the company, they will work according to rules laid down by us in accordance with existing legal requirements in this area;
- the third model "calibration given outside (fixed price - fixed price)" (is the model that is implemented when an external firm will engage, certified in achieving

calibration data, rules are provided by us, and the final assessment will be made in the presence of a specialist at BRML.

All these models will be checked by certified control bodies in accordance with rules and procedures approved by the relevant institutions. One of the main features that have been accentuated over the past decade has been that of the place and role of measurements in the society we belong [12], [13], [14].

The achieving of the integration of a field in an ERP existing system in a business functional unit, was a long time one of the most exciting issues / developments / achievements for an architect of systems, this making possible the meeting of architectures, programmers, business people. Such an achievement brings by itself more challenges, the purpose of the product to be used in bringing extra business which is put into practice.

I wanted to make a specific contribution in the field of metrology, namely manage, using an ERP system, that is SAP, calibrations carried out throughout the country in the oil group in which I work. This is a prototype that is based on research carried out in two essential parts: one in the industry of oil and gas and another within BRML (here the discussions were constructive using some of the most actual processes) [16].

What is new with this module is, in addition to the fact that is attached to the largest worldwide ERP system SAP and to the possibility of accessing it, using the internet, wherever this operation is possible to be performed. The proposed architecture system facilities the access, the development and proposal of solutions fit to any business environment in part [1]. The developed module is adaptable (customizable), so modeling the processes used in the calibration process can be adapted to any environment , my desire being to exist the possibility of adding / deleting / modifying / archiving for each process, the programmer contribution wishing to be minimal [19].

Another wish of mine has been to be able to collect online data from systems that perform data storage needed for calibration of a fixed asset (tank) using 3D technology (capture images then used for calibration) using web technology in WebMethods case. I realized a few tables inside the module that will collect this data, they will shape tem and then will transfer within the system, this data will then be used to define the calibration process and management.

What will be found in this paper is that it can be made a connection between a computer system ERP (several functions from accounting, human resources to production)

and other satellites in different situations in the field of calibration. The management of calibrations can be made transparent, auditable and safely, with strict rules of security, laid coherent linked to the legislation. The proposed large enterprise architecture can be adapted to the current vision of calibration processes used in this area. Another strength proposed point would be to align national objectives, principles, skills and processes involved in the calibration parties.

Information exchange can be done now easily, the data access is done on-line, the verification steps required for calibration can be achieved in the time agreed, the specialists involved in collecting data can make various comparisons, research, having a web platform of addition / modification / verification of existing data in the system [8], [20], [21], [22].

From the very beginning I defined the basic terms used and also the understanding of the key concepts that form the theoretical background of the thought concept, which is the base of practical developments subsequent to the analysis of the domain itself, the result is an enterprise architecture used in metrology, malleable to any type of system.

The explosion and development of information and communication technologies, the existence of the Internet offer new opportunities in the development and redesign of applications / existing modules in various areas of activity all with one common point, namely metrology, so that the existing processes can be easily adapted to new trends.

This thesis proposes several enterprise architecture that can be adapted to the possibilities and requirements, to the businesses field that is intended to be implemented, so I was focused very much on the side directed towards the business environment, by those who are participating in the calibration process, being connected all the time in the company's strategy, objectives and existing legislation, actual at the completion of this work.

When I chose the topic and the research I had in mind my concerns with respect to systems and their application in practical environment. How these concerns led me to realize this prototype integrated system with a world-class SAP as I've outlined in the following aspects, step by step, to achieve this prototype.

In this thesis, the personal contributions are evidenced by achieving "functional specification + technical specification" for the following applications / modules developed using the SAP ABAP programming environment, some modules have benefited from the latest technology used by SAP WebDynpro namely [23], [24], [25], [26], [27]:

- the realization of SAP module **"DCT - Tool Development Center"** in the SAP Solution Manager, this module serving to make the administration of all SAP objects changes in all systems development within the company where I work;
- the realization of SAP module **"RMT - Release Management Tool"**, is intended to manage all changes made through DCT, to arrive in good condition productive systems;
- the realization of SAP module **"FGT - Gas Billing Tool"** performing sales management of natural gas;
- the realization of SAP module - **"CRT - Reservoir Calibration Tool"** company managing calibrations carried out on the basis of data provided by our specialists. The aim of these applications is to provide electronic calibration file. This file shall consist of all the data needed to control, if any, from the competent bodies. This application / module is subject to audit community.

The aim of this thesis, the achievement of management applications of calibrations performed in a unit belonging to the oil and gas within an integrated system, in our case SAP has generated various discussions regarding the approach and came to conclude that such a module made by own forces / internal (low costs in terms of implementation / application development) will be really useful the department that deals with metrology activities.

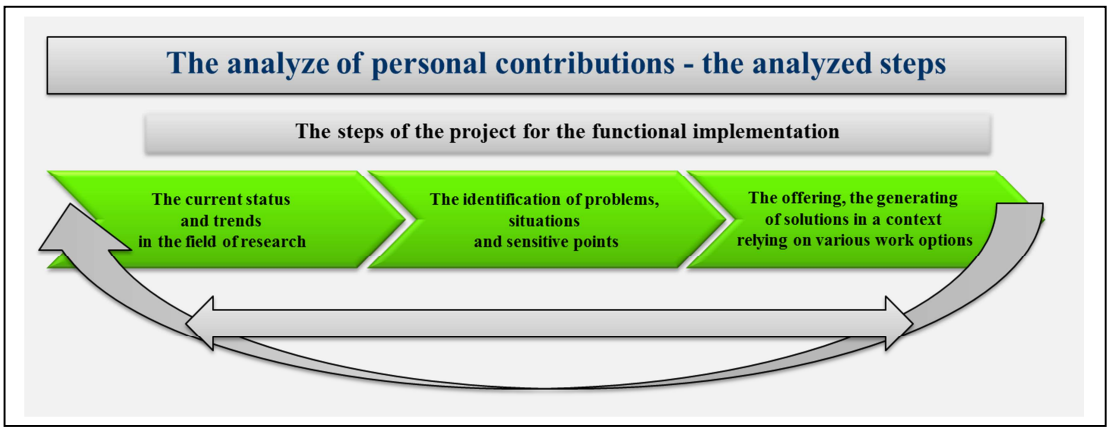


Figure R.2.1 Personal contributions-steps

The detailed analysis, the heated discussions held with experts in the field, the ideas collected from the business in which I work have led me to propose solutions to solve the found problems, related to management of calibrations carried in the oil industry (proposal flow - workflow - to be put into practice and to solve performing a calibration of the

proposal, carrying, storage in database, e-Metrology class proposal, the part with the Internet) in Figure R.2.1 observing the process itself [23], [25], [27].

There were a few things that led me to realize design, development and integration of these applications / how SAP:

- my experience as programmer in various programming environments, my years as a software architect, analyst programmer, the development of the first integrated with existing ERP system in the company where I work;
- the existence of an integrated world-class SAP, with the possibility of a detailed analysis of a way that implies programming and the possibility of developing an integrated module with it and that also benefits from an existing experience, together with a detailed analysis of business processes [28], [29], [30].

In the same line of continuous research I will analyze aspects related to the interoperability in order to design the Cyber-Physical Systems-Systems the conceptual model being shown in Figure R.2.2, [19].

The adaptation of offered possibilities by SAP connection with Cyber Physical Systems would open the doors for using the concept of "Internet of Things", which solved many problems, coming up with solutions for business [31].

This concept "Cyber Physical Systems" has been defined by the "National Science Foundation" as "engineered systems is based on the synergy that of computational and physical components" - based systems engineering and computing synergy physical components [31].

A link between what I have achieved through Cyber Physical Systems [11], could be a solution for future methodologies for calibration and not only the possibility to perform measurements and to react in time to a variety of problems in various activity areas, possibly using this design.

Moreover using systems design using class e-Metrology, the creation of a centralized system for the management of the calibrations carried out throughout the country, using SAP as a "backbone" system, whatever the activity area, would be a great thing for my work in this area

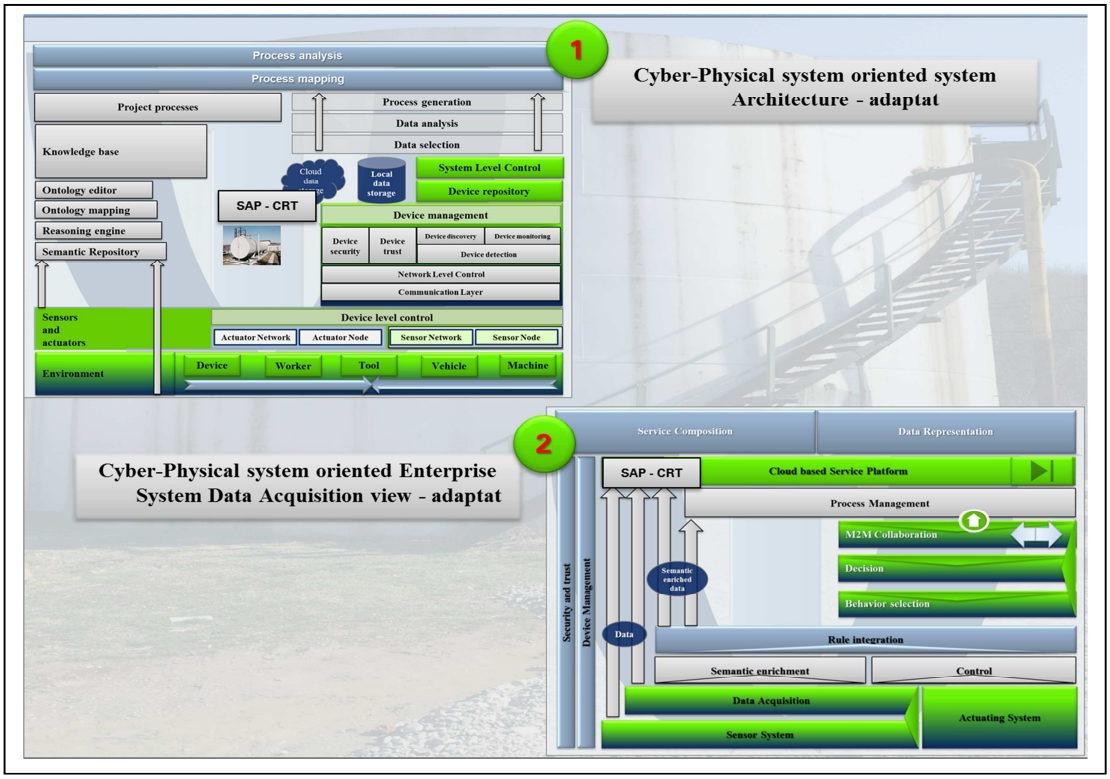


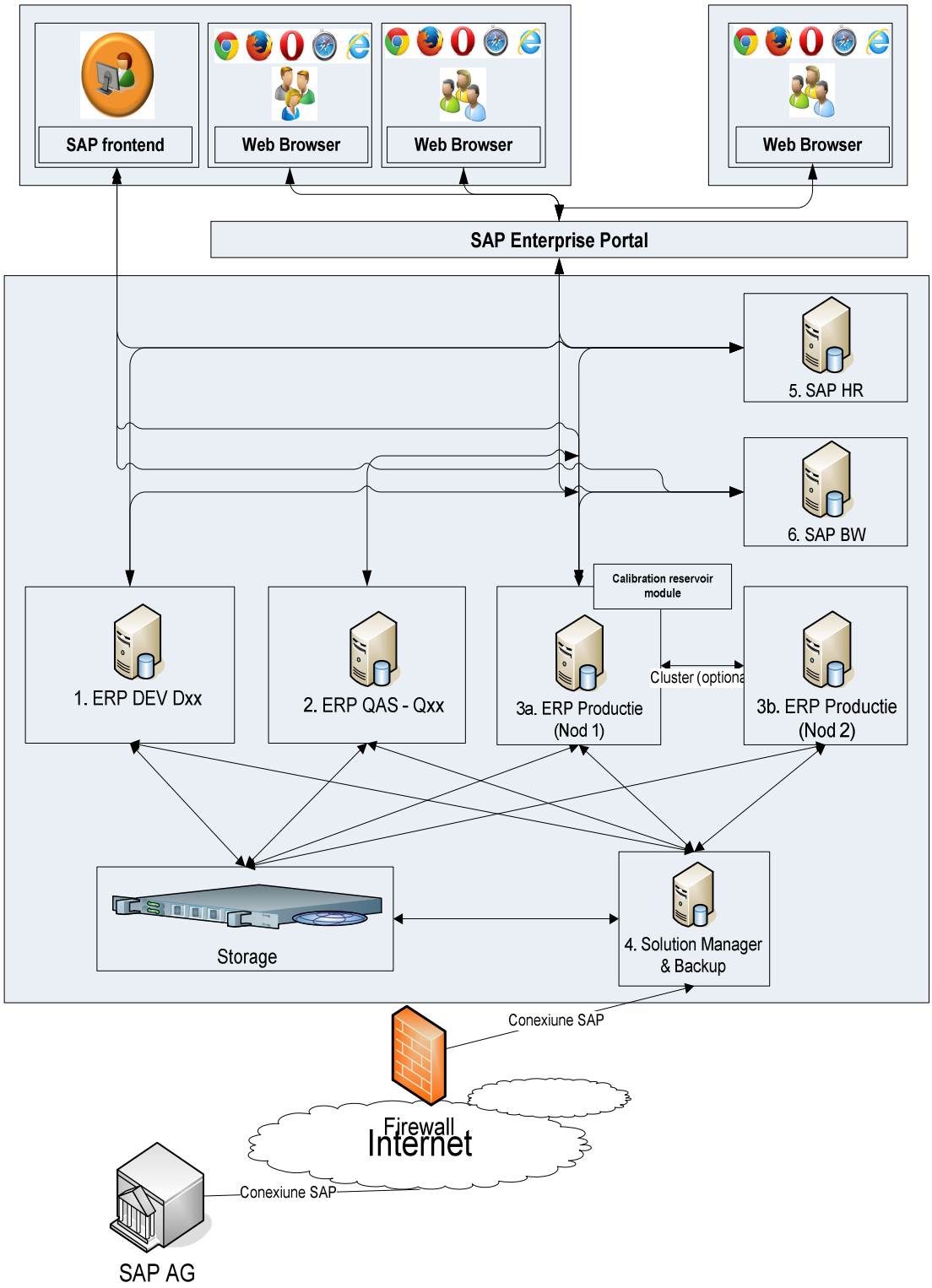
Figura R.2.2 Cyber-Physical system – adaptation

I wish in the future a development of such enterprise architecture adapted (e-Metrology + Cyber-Physical System) in which to be assigned the realized application-CRT, in the Romanian Bureau of Legal Metrology in order to create the good environment for the development of a knowledge base unique in Romania with reference data for calibration performed throughout the country.

In the future, I will continue my research, studying several components that I would want to be part of a future configuration adapted metrology, here listing architecture technologies and equipment, architectural applications and data (information systems), infrastructure architecture, management all existing knowledge, research in this field, various actors schooling activity in this area, cooperation between specialists in the field.

Appendix 1 shows the general architecture required to deliver the CRT module - Reservoir Calibration Tool.

Appendix 1 SAP System Architecture - GUI user presentation layer / SAP Portal



Bibliografie selectivă

[1] E. Callaway, "ERP-The Next Generation: ERP is WEB Enabled for E-business," *South Carolina, Computer Technology Research Corporation,* 2000.

[2] P. Kræmmergaard and C. Møller, "Evaluation of ERP implementation: A case-study of an implementation," *Orlando, Florida, USA, 5th World Multi-Conference on Systemics, Cybernetics and Informatics,* 2001.

[3] F. IACOBESCU and M. BUZOIANU, "Cercetare europeanain domeniul metrologiei," *METROLOGIE, vol. LIV (serie noua),* pp. nr.1-4, 2007.

[4] P. Kræmmergaard and C. Møller, "A Research Framework for Studying the Implementation of Enterprise Resource Planning systems," *Uddevalla, Sweeden, Proceedings of the 23rd Information Systems Research Seminar in Scandinavia,* 2000.

[5] A. Classe, "Business - Collaborative Commerce - The emperor's new package," *Accountancy Nov,* 2001.

[6] ISO, "A global standard for the requirements of process-oriented quality management systems (ISO9000:2000)," *www.iso.ch/iso/en/prods-services/otherpubs/Qualitymanagement.html,* 2000.

[7] I. ISO_4269_:_2001, "Petroleum and liquid petroleum products -- Tank calibration by liquid measurement -- Incremental method using volumetric meters," *ISO/TC 28/SC 2,* 2001.

[8] ISO_International_Organization_for_Standardization, "the Guide to the Expression of Uncertainties in Measurement ISO/IEC Guide 98-3:2008," *http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=50461,* 2008.

[9] S. Chen and Y. Lin, "Performance analysis for Enterprise Resource Planning systems, IEEM 2008, pp. 63 – 67," *IEEM 2008,* pp. 65-67, 2008.

[10] Z. Yao and S. Chen, "Deformation Identification and Tank Capacity Table Calibration of the Storage Tank," *Applied Mechanics and Materials Vols. 184-185,* pp. 110-113, 2012.

[11] M. Yeandle, "Calibration of storage tanks," *International School of Hydrocarbon Measurement ISHM,* 2011.

[12] J. Miao, "Research of measurement system of oi1 tank liquid level based on differential capacitance sensing," *Proceedings of SPIE, (4997),* pp. 547-558, 2002.

[13] E. c. i. l. m. WELMEC WG11, "Measuring Instruments Directive 2004/22/EC, Common Application for utility meters," *WELMEC 11.1, Issue 4* , 2010.

[14] E. c. i. l. m. WELMEC, "Guide for Measuring Instruments Directive 2004/22/EC - Gas Meters Corresponding Tables OIML R 137-1 2006 - MID-002 I," *WELMEC 8.12-1, Issue 1,* 2008.

[15] BRML, "Procedura de verificare - Metrologica a rezervoarelor de stocare pentru lichide PIV 017-05-03 BRML," *BRML Ed. 1/Rev.0/31.10.2008,* 2008.

[16] BRML, "Procedura de verificare - Rezervoare de stocare pentru lichide PIV 017-05-02 BRML," *BRML Ed.1 / Rev.0 / 25.03.2008,* 2008.

[17] BRML, "Procedura de verificare - Rezervoare de stocare pentru lichide PIV 017-05-04 BRML," *Ed.1/Rev.0/31.10.2008,* 2008.

[18] BRML, "Procedura de verificare - Rezervoare de stocare pentru lichide PV 017-05-01-07," *Ordin nr.99 / 16.05.2007 BRML,* 2007.

[19] A. Mihnea, I. Ș. Sacala and D. Repta, "Towards the Development of the Future Internet Based Enterprise in the Context of Cyber-Physical Systems," *Control Systems and Computer Science (CSCS),* pp. 405-412, 2013.

[20] W. Norbert, "Successful Sap R/3 Implementation: Practical Management of ERP Projects," *Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA ©1999* , 1999.

[21] Wikipedia, "Sistemul internațional de unități," *https://ro.wikipedia.org/wiki/Sistemul_interna%C8%9Bional_de_unit%C4%83%C8%9Bi,* 2015.

[22] N. Costetchi, "Abordarea holistica in proiectarea conceptuala a arhitecturii unui sistem de monitorizare din clasa e-Health," *Universitatea Politehnica Bucuresti,* 2014.

[23] V. C. Banta and D. Cojocaru, "Calibration Oil Reservoirs - A Software Application for Metrology," *18th International Conference on System Theory, Control and Computing Joint Conference ICSTCC 2014, SINTES 18, SACCS 14, SIMSIS 18,* 17-19 October 2014.

[24] V. C. Banta and D. Cojocaru, "Development Center Tool a Software Application for Change Request Management," *17th International Conference on System Theory, Control and computing Joint Conference ICSTCC 2014, SINTES 17, SACCS 13, SIMSIS 17,* pp. 42-44, 11-13 October 2013.

[25] V. C. Banta and D. Cojocaru, "Enterprise system based on customer integrated ERP using enabled learning organization in metrology area," *19th International Conference on System Theory, Control and Computing (Joint conference of SINTES19, SACCS15, SIMSIS19),* 14-16 October 2015.

[26] V. C. Banta, D. Cojocaru and R. T. Tanasie, "A Software Application for the Gas Transport and Distribution Management," *Annals of the University of Craiova, Series: Automation, Computers Electronics and Mechatronics, Vol. 10 (37), No. 2,* pp. 1-6, 2012.

[27] V. C. Banta and D. Cojocaru, "Methods, Models and Workflow used in Calibration Oil Reservoirs Software," *Annals of the University of Craiova, Series: Automation, Computers, Electronics and Mechatronics, Vol. 10 (37), No. 2, 2013, ISSN 1841-0626,* pp. 1-7, October 2014.

[28] V. C. Banta, D. Cojocaru, M. A. Moisescu and I. Ș. Sacala, "Release Management Tool - A Software Application for Release and Deployment Management," *the 5th edition of the IACSIT / SCIEI / UASTRO International Conference on Optimization of the Smart systems and their Application in Aerospace, Robotics, Mechanical Engineering, Manufacturing Systems, Biomechanics, Neurorehabilitation and Human Motriciti,* pp. p524-534, 24-27 October 2014.

[29] R. H. Bishop, "Mechatronic System Control, Logic and Data Acquisition," 2008.

[30] C. B. C. Lupsoiu, "Modelarea si proiectarea bazelor de date," *Ed. Sitech,* 2008.

[31] V. C. Banta, D. Cojocaru, M. A. Moisescu and I. Ș. Sacala, "Software Design for Oil Industry Metrology Systems," *Studies in Informatics and Control, ISSN 1220-1766, vol. 23 (4),* pp. pp. 359-371,

2014.