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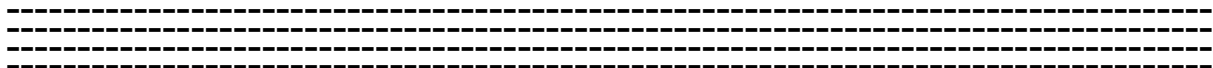
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Address for correspondence:

Vladimir RĂSVAN
University of Craiova
Faculty of Automation, Computers and Electronics
Al.I. Cuza Street, No. 13
RO-200585, Craiova, Romania
Phone: +40-251-438198, Fax: +40-251-438198
Email: vrasvan@automation.ucv.ro

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Methods, Models and Workflow Used in Calibration Oil Reservoirs Software

Viorel Costin Banța*, Dorian Cojocaru**

**PhD Student, Mechatronics Department, University of Craiova, Romania*

*** Mechatronics Department, Faculty of Automation, Computers and Electronics, University of Craiova, Romania (e-mail: bantaviorel@gmail.com, cojocaru@robotics.ucv.ro)*

Abstract: The scope of the present article is to present a proposal regarding the integration methods, models and workflow used in the metrology field with the Enterprise Resource Planning (ERP) systems. One of the main topics of the author's PhD research is the development methodology and the implementation of a metrology software application for the calibration of oil tanks. The developed application is integrated with an existing Enterprise Resource Planning (ERP) system used by important Oil & Gas Company. The software application was developed in the SAP (System and Applications Products) programming environment ABAP (Advanced Business Application Programming), using the latest Web Dynpro WD technology. The development methodology includes the analysis, implementation and testing of the software application.

Keywords: metrology, workflow, enterprise resource planning, advanced business application

1. INTRODUCTION

Enterprise Resource Planning or ERP is software business solution that helps integrating all divisions across a company onto a single computer system serving all needs in the company. Enterprise resource planning (ERP) software business solutions are designed for companies that work in a wide variety of areas. ERP is business process management software that allows an organization to use a system of integrated applications to manage the business and automate many back office functions related to technology, services and human resources. This concept, ERP "Enterprise Resource Planning", was introduced in 1990 by the Gartner Group, in order to define a new generation of manufacturing resource planning (MRP II) software, which later came to fill up the gap reflected by the evolution of application integration beyond manufacturing. The Gartner Group its client's oriented company which has as a main field of activity, IT solutions consultancy. For companies, MRP II is a method which helps, to involve the planning of all the regular resources, including without limitation, software applications, users skills and abilities, design of specific databases, and any other computer resources [3].

In order to manage accurate the resources we use the concept purpose, to increase the performance and most of the productivity of the company [1], [2]. For developing activity in a company, initially for each division where used separate software, accounting, business intelligence (BI), human resources (HR), inventory management (IM), planning, manufacturing (PP), sales and distribution (SD), marketing, later came the ERP concept and his final target were to integrate all these software applications in one

single software product [4]. Overall the ERP has improved the process management of a business activity; he integrated and managed applications for all areas. SAP, Oracle and Microsoft are the more well-known companies which deliver ERP software for large enterprises. SAP started in 1972 in Germany, is the largest inter-enterprise software company in the world, and one of the largest independent software supplier. The initial purpose of SAP was to provide to his customers the possibility to interact with a common corporate database for a broad software application. ESR it's a new trend in SAP evolution, "Enterprise Services Repository is the central repository, which is part of SAP NetWeaver platform, where enterprise services, business objects, and business processes and their metadata are stored" [6].

More or less ESR is the central repository information used in entire SAP NetWeaver Platform and if we want to make our application callable by services and integrated with other applications or business partners we have to use the principles of ESR [7]. From this paper's point of view, the interesting aspect is that we create a z-homemade application inside our installed enterprise resource planning software (SAP) [8].

2. CALIBRATION OIL TANKS - METHODOLOGIES

Using Enterprise Services Repository as a new software technology, is part of daily activity inside oil companies, which try to automate processes, in order to have an accurate visibility of their innovations and to adapt several changes shortly and with better results [5], [6]. In order to achieve this, many companies create development teams dedicated to solve the problems of each specific activity. In entire group, the development team (inside Technology

Department) is dedicated for developing and providing best practices for internal processes, in order to help the daily activity of their colleagues from other departments. We store all developments in SAP Solution Manager – in fact in Development Center tool [9]. In order to have an accurate integrated database with all measurements regarding calibration of oil reservoirs, test results, conclusions after measurements, we initiate a process / case study in order to create an internal development application for metrology area, calibration reservoirs inside SAP system.



Fig 1. Vertical reservoir / tank

Our case study full fills all legal requirements regarding this subject. In exploration and production area we can use two types of reservoirs: vertical and horizontal (Figure 1 and Figure 2). In order to realize a calibration of an oil reservoir a mixed method is used. The method is based on two components: a volumetric one and a geometric one [13]. This method is used to calibrate a vertically cylinder

reservoir with fixed roof. This reservoir cannot have a nominal capacity greater than 40 cubic meters [12]. In order to implement this method for the calibration purposes, two components are used:



Fig 2. Horizontal reservoir / tank

- geometric components are used for direct measurement reservoir dimensions based on measuring tapes, the final result regarding entire capacity of reservoir being determined based on measurement performed [12],[13];
- geometric components are used for direct measurement reservoir dimensions based on measuring tapes, the final result regarding entire capacity of reservoir being determined based on measurement performed [12],[13].

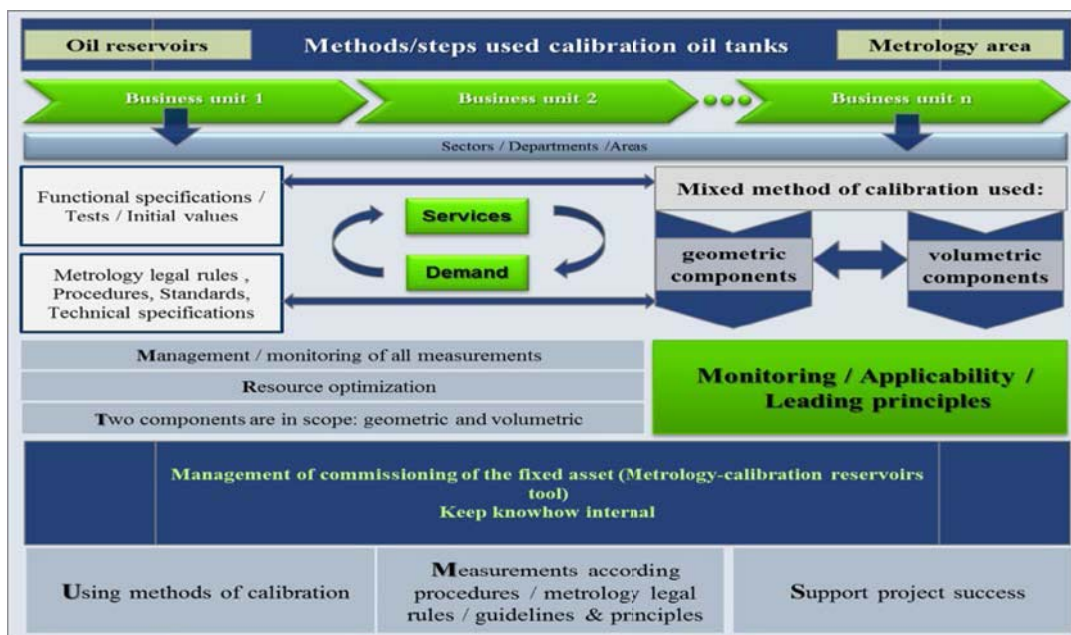


Fig.3. Example metrology procedure / connection between business areas

Mixed method cannot be applied to tanks with obvious deformity and to tanks which do not have a circular horizontal section. In order to verify and calibrate a reservoir it's used a different metal measurement unit (with overflow): 100 dm³ (cubic decimeter), 200 dm³, 500 dm³ or higher than this value. If is needed to measure with other standard fraction, then we will use, a measure of 50 dm³ [12], [13]. In order to see the underlying principles to create a software application, the Figure 3 illustrated this, so, we take into consideration the metrology standard rules, guidelines, principles, standards and indications from the internal metrology team. In the application all recorded information is stored in order to be analyzed and to be part of the mathematical computations. When the collecting measurements process is started, it is needed to create a calibration table for each reservoir. For each value of partial capacity from the reservoir, and for each integer value expressed in centimeter of the filling height of the tank, the reference temperature will be 20⁰ C [10]. We notice that V_H is partial capacity, corresponding to the higher fill H (integer number recorded in centimeter), between consecutive two measured heights, h_{i-1} and h_i, and will be obtained using the linear interpolation, using the following formula [12], [13]:

$$V_H = V_{i-1} + v_i \times \frac{H - h_{i-1}}{h_i - h_{i-1}}, (i = 1, 2, \dots, n) \quad (1)$$

where:

- $k = 1, 2 \dots i$ - order number of ratio water introduced;
 $h_0 = 0$;

- v_0 = dead stock of reservoir,

- $v_1, v_2 \dots v_i$ -ratio water volume which are placed in reservoir, successively, to the height h_i,

h₁, h₂ ... h_i- each measured height, after ratio water placed.

$$V_{i-1} = \sum_{k=0}^{i-1} v_k, \quad (2)$$

For each measurement we have to take into consideration the outside temperature. In this case, regarding v_k, there are two cases:

- when it is not considered, then the amount of sum of all capacity, will be equal with all ratio water introduced in reservoir;
- or we have to adapt our calculation with one correction factor, equal with (1-e)/100 (e is the corrected error, in percentage, of the working flow meter) [12], [13].

Regarding the avoidance of water expansion effect, there are also two cases:

- when the water temperature is between 5⁰ C and 10⁰ C and the difference between average measure volume and the reservoir does not exceed 2⁰ C,
- when the water temperature is between 10⁰ C and 25⁰ C and the difference between average measure volume and the reservoir does not exceed 1⁰ C.

For some different water ration at t_k temperature, the relation (1) can be corrected, using the following formula [12], [13]:

$$v_k(t_k) = v_k(20) \times [1 + \beta_e(t_k - 20)], \quad (3)$$

where:

k - is the order number of ratio water,

$v_k(t_k)$ - is the ratio water volume on t_k temperature;

$v_k(20)$ - is the amount of the real conventional capacities for the water measure, which is used for the achievement water ratio;

β - is the coefficient of expansion in volume of the material volume ratio of which is made.

These corrections are also made for the dead stock v₀. In order to calculate water mass, m_k, taking in consideration volumes v_k(t_k) we can use the following formula:

$$m_k = v_k(t_k) \times \rho(t_k), k=0, 1, \dots, i, \quad (4)$$

where: $\rho(t_k)$ - the density of water at the t_k temperature.

The following formula is used to compute the water mass M_{i-1} till high h_{i-1}:

$$M_{i-1} = \sum_{k=0}^{i-1} m_k, \quad (5)$$

In order to calculate the water volume of our reservoir, V_i, at h_{i-1} and t_{i-1} the following formula is used:

$$V_{i-1}(t_{i-1}) = M_{i-1} / \rho(t_{i-1}), \quad (6)$$

where: $\rho(t_{i-1})$ - is water density at t_{i-1} temperature.

The capacity of reservoir, V_{i-1}(20), for height t_{i-1} and reference temperature 20⁰ C, will be calculated [12], [13]:

$$V_{i-1}(20) = V_{i-1}(t_{i-1}) \times [1 + \gamma_r(20 - t_{i-1})], \quad (7)$$

where $\gamma_r = (2/3) \times \beta_r$ is the dilatation coefficient of the reservoir material. A correction for temperature could be applied during the calibration of a reservoir if the water height h_i is considered. This correction could be ignored if the height is lower than 2 m or if the height is upper than 2 m and water temperature into the reservoir is between 15⁰ - 25⁰ C.

The following formula is applied:

$$h_i(t_i) = h_i(20) \times [1 - \alpha(t_i - 20)], \quad (8)$$

where:

$h_i(t_i)$ - is the height at the temperature t_i, which is measured in the reservoir;

$h_i(20)$ - is the height read from measuring tape, according with the calibration certificate which is attached to the measuring tape; α - the material coefficient of linear dilatation; In order to perform the calculations, the following dilatations coefficients are used: the mild steel

– 3,3 x (10⁻⁵)⁰ C; stainless steel: 5,1 x (10⁻⁵)⁰ C; aluminum alloy - 3,3 x (10⁻⁵)⁰ C; brass: 3,3 x (10⁻⁵)⁰ C. In each measurement the calculated value of height is rounded on integer value [10], [12], [13]. As a conclusion, the calibration sheet will include the ratio water number, the reservoir/tank height water, the cumulative volumes of water rations, the volume of water ratio, the size of range, the volume/mm, the height and the corresponding volume of height as is described in the Figure 4.

3. METROLOGY SOFTWARE APPLICATION DESIGN

SAP focuses on existing integrated processes in the company, from the collecting, planning process, development/production tracking and to the purpose of managing the relationships with customers, suppliers or other business partners. SAP (System and Applications, Products) is the largest ERP (Enterprise Resource Planning) system in the world [15] [16]. SAP is based on client/server architecture and it is used in developing integrated systems. The benefits for the company, when choosing to use SAP, are as following: an integrated system (there is a single database, all components are interdependent); an open system (independent from the hardware platform and database used, allowing the correlation with other software; modification including new functions created by the user; a comprehensive system that, from an economic perspective, can cover any sector activities; a real-time system including tools and providing information based on data analysis from operational flow; a lower cost for company based on automated tools and preconfigured functionality; an integrated industry-specific solutions inside business

processes; easy to integrate operations into one software in order to meet the corporate needs for standardization and control. As it was used for the application WebDynpro, other benefits come with this new technology for SAP landscapes, like: the model is used for develop professional Web UI's (Web User Interface) for business applications; the WD tools can support the application development during all phases (implementation, testing and design); a clear separation layout data and business data, thus it is possible a clear separation between layout data and business data, thus it is possible to develop WD applications with the same programming model, both for conventional PC's and mobile devices; different languages are supported; the time for implementation and the effort implementation is significantly reduced; a structured design process is supported by WD; it's easy to use the Model View Controller concept obtaining a strict separation of layout data and business data; it has more UI elements as compared to other technology; run on multiple platforms; support web service and data-binding.

In the Figure 5 is explained the WD concept and his benefits. In another train of thoughts the concept of WD are based on MVC (Model View Controller) architecture and is composed of three particular elements: model, controller and view. The MVC architecture is described in the figure below, Figure 6. As it is plotted in this figure, the MVC architecture design pattern contains a clear distinction between processing control (controller), data model (application data, connection to business functionality), and the display of the data (view) in the interface according with clear rules. As described in the

	A	B	C	D	E	F	G	H
	Ratio water number	Reservoir heigh water	Cumulative volumes of water rations	The volume of water ratio	The size of range	The volume / mm	The height	The coresponding volume of H height
	i	h_i	$\sum v_k$	v_i	$h_i - h_{i-1}$	$\frac{v_i}{h_i - h_{i-1}}$	H	
		mm	dm ³	dm ³	mm	dm ³ /mm	mm	dm ³
1	Dead stock	0,00	21,00	21,00	0,00	0,00	0	21
2	—	—	—	—	—	—	10	31
3	1	—	—	50,1	49,40	1,01417004	20	41
4	—	—	—	—	—	—	30	51
5	—	49,40	71,10	—	—	—	40	62
6	—	—	—	—	—	—	50	75
7	2	—	—	50,1	32,90	1,522796353	60	90
8	—	—	—	—	—	—	70	105
9	—	82,30	121,20	—	—	—	80	121

Formula will be: $H2 = C1 + D3 \times ((H2 - B1) / E3)$

Figure 4 The result of a calibration