BASED INCREMENTALITY MEASURMENT PARAMETERS OF CROSS-DOMAIN METHODOLOGIES

*Khaldia LAREDJ and **Mostefa BELARBI and ***Benyamina Abou El hassan
LIM Research Laboratory – Ibn Khaldoun University of Tiaret – Algeria
* khaldialaredj@gmail.com ** mbelarbi@univ-tiaret.dz **
***LAPECI Research Laboratory – Oran 1 benyanabou@yahoo.fr

ABSTRACT
This paper presents methodology for the development of complex real-time systems. The methodology uses incremental mechanisms in order to establish measurement parameters of cross-domain development process. It is an important objective to develop a cross-domain framework that addresses the requirements and constraints of several kind of industrial models. By promoting a strict increment-based design style and identifying increments that can be deployed in different application domains, the design and production costs of new applications can be significantly reduced by reusing components.
We will provide in this paper an overview of parameters measurement of cross-domain development process based on MARTE (Modeling and Analysis of Real-Time and Embedded Systems) and SART (structured analysis real time) using two industrial case studies for development of hydrostatic bearing lubrication system and triaxial apparatus system .

Key-Words: *Incremental approach, cross-domain development process, SART, MARTE, hydrostatic bearing, triaxial apparatus test, parameters measurement.*

1. INTRODUCTION

Along with technological advances, new needs arise in an industrial application and real-time **[7]** induced to add new features keeping up technology deployment already achieved.

The efficiency of any system depends on external and / or internal constraints which it is subjected. Two solutions can be envisaged in this respect to increase this efficiency: either we shall replace the system with a more efficient or improving it. The incremental method embodies the latter. It gives a framework for the development of systems as it integrates tools providing an environment of organic development. Each development in addition to improving the existing system enriches the while avoiding the costs of a new business solution. In addition, staff training time is reduced. As example we find based component technology **[13]** which uses software pieces called component. These components can be used independently or linked to construct new components or new packages. Industrial and academic community interest at first to components models of packages like EJB, CCM et .NET **[15].** Component field applying was extended to low level layers such systems and inter-systems **[13].** The general model of development process was suggested in Across project **[16].** In this kind of project, BIP (behaviour interface process) formalism **[12]** was used to capture behaviour of the studied system and tools are used to translate him to executable platform.

All these platforms need measurement parameters in order to evaluate meeting performance meeting like reliability, maintainability, survivability, etc. **[14].** The objective of this research is to develop a general methodology for designing a real-time application. The methodology is based paradigms such as MARTE, SART **[1,7,17]**. The concept applied uses the notion of incrementality **[2,3,11]**.

In this paper we present the idea based on instrumentality notion in order to measure performance of cross-domain methodologies: two case studies will be studied in the industrial fields: first, rotating machinery is commonly used in many mechanical systems, including electrical motors, machine tools, compressors, turbo machinery and aircraft gas turbine engines. Typically these systems are affected by exogenous or endogenous vibrations produced by unbalance, misalignment, resonances, material imperfections and cracks **[4]**. To damp the vibrations has been proposed several methods: passive **[10]**, active **[8]** and semi-active method **[9]** . Where passive methods are not enough to dampen the vibrations generated, a new smart hydrostatic journal bearing with four hydrostatic bearing flat pads fed by electrorheological fluid, has been designed to control rotor vibrations caused by imbalance and to reduce transmitted forces to the bearing. **[6]**. So bearings are machine elements used to guide the rotating shafts **[5]**. The hydrostatic bearings can be used irrespective of the load and speed. They are used successfully in a large number of machines operating at low speeds and carrying heavy loads. Lubrication of hydrostatic bearings is an important process, but also complex. Because it consists of electronic and mechanical components that operate in a physical world. This is what makes the development process is also difficult.

The second industrial domain consists of test triaxial apparatus. The triaxial test is one of the most versatile and widely performed geotechnical laboratory tests, allowing the shear strength and stiffness of soil and rock to be determined for use in geotechnical design. Advantages over simpler procedures, such as the direct shear test, include the ability to control specimen drainage and take measurements of porewater pressures.

The idea is to apply an incremental approach for incremental specification, and we try to adopt the method of SART, MARTE specifications an incremental way.

This paper is organized as follows: sections 2 present the incremental approach and our proposition, Section 3 shows our case studies with a specification of the SART and MARTE methods Finally, we conclude with discussion how measurements parameters could applied to the case studies.

2. METHODOLOGY

2.1 Incremental approach

The objective with this model is to quantify parts which can be developed from specification to executable code. The development of an increment may follow several approach for example a spiral approach. Incremental development means dividing the requirements into suitable parts during the specification allowing for independent development of the different increments **[3].** The design and coding of one increment are followed by testing of that increment, which makes it possible for the developers to start implementing the next increment while the testers validate, verify or certify the first developed increment. The incremental approach hence allows for a good deal of parallelism between development and testing. The benefit from this parallelism is not only the possibility to work in parallel, but also that the testers really start testing the software to be delivered at an early stage. We propose an incremental approach to the specification stage system based on the methods of specifications such as SART, MART. **[18]**... Figure 1 illustrates the process of our methodology.

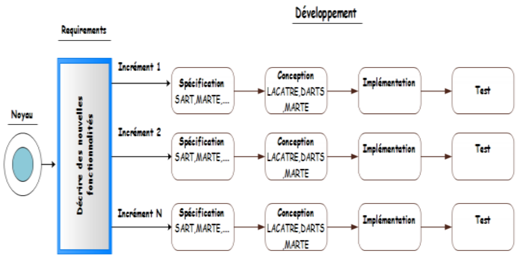

Figure 1: Incremental development approach

It will define the development of an application from first abstract sketches to detailed integrated models that can be verified, simulated and deployed. Key to development process is the use of library of predefined services, which is available to the application developer. These components serve as building blocks for new applications et can be interfaced from a domain specific language. Applications are developed in specific descriptions language (MARTE, SART) **[19]** and translated to the general model, which captures its behaviour in tool language as well as the interfaces and connections. The general model is the starting point for model to model transformation to generate the inputs for later analysis and deployment steps.

In this section, we provide a brief overview of the IK methodology, which aims to develop novel model of life cycle metric, based on incremental model depicted in Fig.1, to improve existing practices in development of complexes real-time and embedded systems. The methodology consists of three essential elements: assets activities (incremental model), New activities (K model), and tools (with the methods and techniques used in each activity). Initially, the left-level system design models are carried out using the Incremental model. When the developers execute the second increment the k model is starting, the third increment execute with IM model, then the K model therefore is carried out, until N increment the IM and K model are affected with consecutive manner.

Algorithm for IK methodology:

I=1; IM
For i=2 to N do
Begin
IM;
KM;
I=I+1;
End

The main activities of this IK methodology are: IM model:

The classical stages for incremental model: Specification, Design, Implementation, and Test.

K model:

1. Collection increments Specification
2. Design
3. Implementation
4. Test

2.2 Measurement parameters

Among metrics applied to software systems contain the following elements: (a) reliability (b) survivability and (c) maintainability. Reliability is a function of how that customer will use the software. Reliability is determined by the interaction between the structure of the code and the user's operation of the system. The **survivability** can identify potential problems as they occur and seek remediation for these problems before the system fail. A system based on principles of survivability will be able to identify new usage patterns by the customer and communicate these new uses to the software developer.

A **maintainable system** is one that is built around the principle of requirements traceability. if it becomes necessary to change the system requirements, this becomes an impossible task when we do not know which code modules implement which requirement. Basically, a maintainable system is one that can be fixed or modified very quickly. These three metrics can be performed using the notion of increments.

3. CASE STUDIES

3.1 HYDROSTATIC BEARING

3.1.1 Presentation

A pump supplies a bearing about 30 % higher than that required flow rate (See figure 2). The excess fluid returns to the reservoir via a pressure regulator. A pressure sensor is used to stop the rotor drive if the pressure reaches a value too low. Non-return valve and the hydraulic accumulator provide food bearing to a stop of the shaft. We can also provide a backup pump. The flow is then derived to each cell on each portion of the circuit. Provision may be a check valve in case of overpressure in a cell. Resistance hydraulic HR should be placed as near the cell to avoid instabilities due to the pneumatic type lubricant compressibility. A pump may be necessary to ensure the return of the lubricant to the reservoir. A thermocouplee to control the temperature of the liquid at the outlet of the bearing and 1 trigger stop if it becomes too large. Finally, a cooling system ensures a constant temperature on the power supply **[6]**.

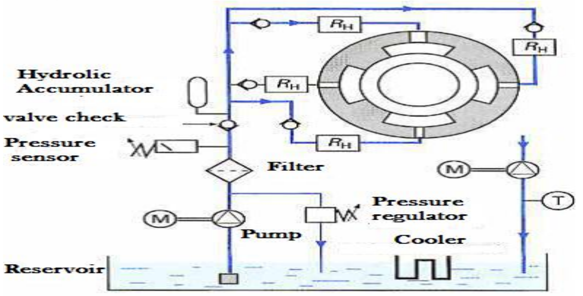

Figure 2: operating principle of hydrostatic journal bearing with four hydrostatic bearing Supply constant pressure scheme: real case

3.1.2 System specification

- Context diagram (figure 3)

First data flow diagram permit to describe the application environment.

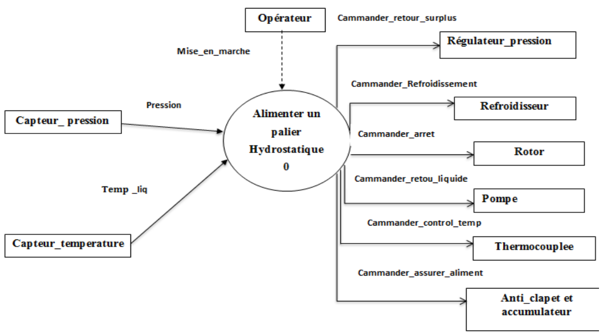

Figure 3: Context diagram

-Preliminary diagram (figure 4)

Data flow diagram showing the first level of functional analysis of the application.

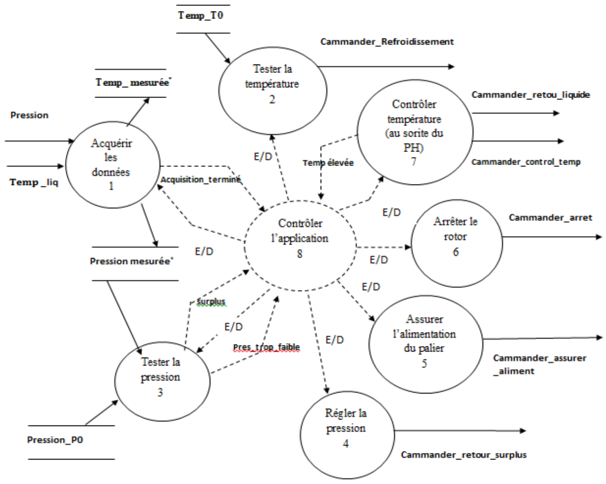

Figure 4: diagram preliminary

For this system we must add two features: (figure 5)

1. One feature to verify the level of fluid reservoir.
2. A feature to manage all previous functionality it functions as an operating system.

Check the liquid level in the reservoir according to our approach is an increment becomes a functional process To achieve this increment, we need to a sensor sends a signal when the low level (eg level b), the sensor is considered a terminal send a data level low = true or level low =false, finally needs an actuator here is that the pump will start.

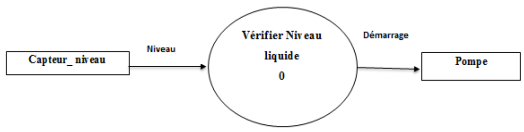

Figure 5 Diagram context (increment)

We now describe the preliminary diagram (Figure 6) :

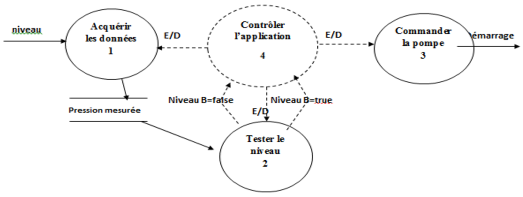

Figure 6: Preliminary diagram (increment)

- **Simulation and test**

Functionality to manage the various previous functions this feature can be illustrated by either a soft or hard process.

Our choice is to represent this functionality with RTOS which illustrate in the following figure 7 corresponding to hardware elements(figure 8).

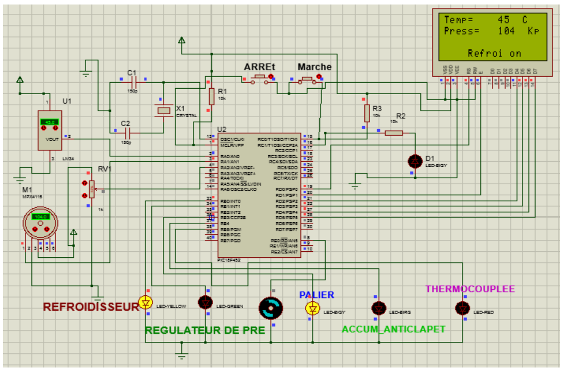

Figure 7: C-Micro-controller simulation

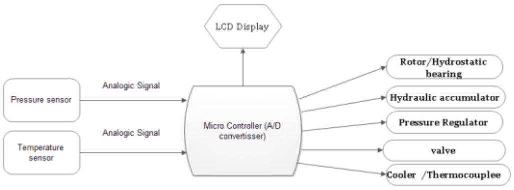

Figure 8: Diagram of hardware requirements

3.2 TRIAXIAL SYSTEM

3.2.1 Presentation of the system

The first stage of any strategy of construction is to determine if the ground of site concerned can accommodate the project. Thus, one is obliged to test and identify the properties of the ground of this site and to determine his capacity to support the structure. To arrive at an optimal solution, one analyzes in laboratory a sample of ground following of the methods by using a given apparatus. In this study, we chose the triaxial apparatus **[20].** The triaxial compression test makes it possible to better reach the mechanical properties of materials **(Figure 9)**, because it affects the state of in situ stresses. This type of test allows to control and measure the pore water pressure and to apply a range of confining pressure (isotropic or anisotropic) to initially consolidate the sample in a preset state. The various realizable types of test are:

- Test UU (Unconsolidated-undrained): test unconsolidated not drained carried out on saturated material or not
- Test CU (Consolidated-undrained): consolidated test not drained on saturated material or not
- Test CU+u (Consolidated-undrained): consolidated test not drained on material saturated with measurement of the pore water pressure.
- Test CD (Consolidated-drained): consolidated test drained on saturated material.

It is essential to specify which cohesion C and which angle of friction Φ are determined by the triaxial compression test, in particular for the fine grained soils for which C and Φ dependent degree of saturation, rate loading, field of consolidation in which the triaxial compression test is carried out. **[9]**

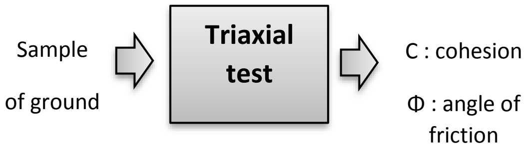

Figure 9: Objective of the triaxial test

3.2.1 System specification

We used the diagram of sequence to represent graphically the interactions between the actors and the system according to a chronological order. We used also the diagram of components to describe the organization of the system from the point of view of the material elements like the sensors (pressure, force, displacement and change of volume), and the other various components of the triaxial apparatus in order to highlight the dependences between the components.

- Sequences diagram (Figure 10)

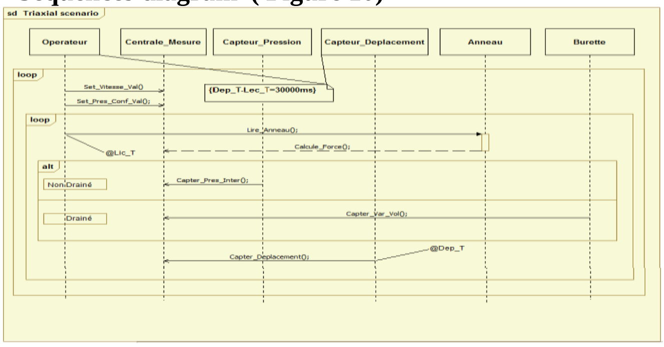

Figure 10: Sequences diagram

The operator must put two parameters (rate of displacement and confining pressure) and he must each 30 second read the various sensors. The force is calculated via value of the deformation of the ring, which we raised starting from the gauge According to the type of test, the operator take the value of pore water pressure if the test is not drained either the value of variation of volume if the test is drained. Displacement is also measured.

- Components diagram

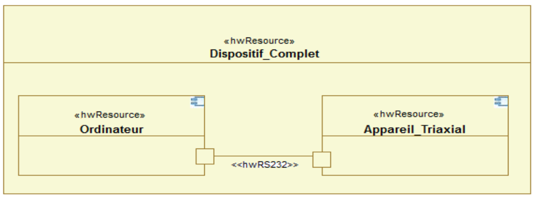

Figure 11: Model interns of the complete device

We notice at the beginning that the complete device is composed of two principal parts, which are the "Computer" and the "Triaxial Apparatus" which are connected through a "CableRS232" **(Figure 11)**.

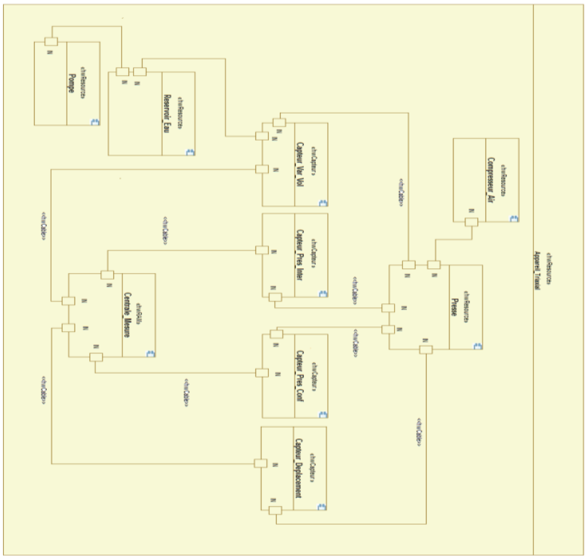

Figure 12: Model of component of the triaxial apparatus

Triaxial apparatus is also composed of "Power station of measurement" and the various "sensors" which are also connected to the power station of measurement. One also finds the "Compressor of the air", "Water tank" and the "Pump" **(Figure 5)**.

- **Simulation and Tests**

The triaxial device is equipped with a datalogger (Figures 13 and 14) connected to the computer by RS232, the datalogger has four inputs for connecting sensors of the device.

Figure 13: Front capture of datalogger

Figure 14: Behind face Capture of datalogger

Applying the notion of incrementality, we proposed to change the strategy of the manual measurement of force by another automatic technique replacing the strain gauge with a digital displacement sensor. This technique helps us to calculate the force from the deformation of the ring and the amount of movement made by the new sensor. At this point, we can say that the system becomes more automatic. For this we changed the operation of the datalogger using our map (Figure 15) keeping the sensor inputs and power and replacing the strain gauge with the new digital displacement sensor.

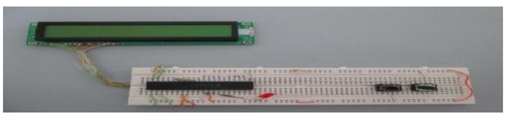

Figure 15: New realized circuit

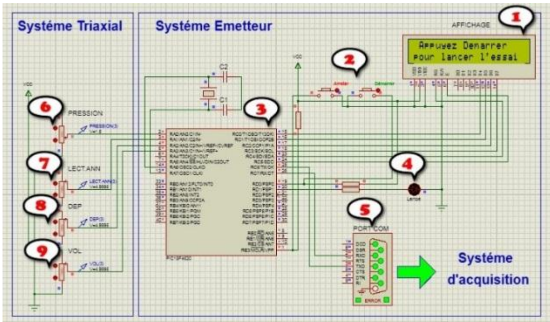

Figure 16: C-Micro-controller simulation

1: LCD display , 2 : Pushbutton Control , 3: PIC18F4520 Microcontroller , 4: Lamp , 5: Port COM , 6: Pressure sensor , 7: Force Sensor , 8: displacement sensor, 9: variation of volume sensor

When launching the simulation system (Figure 16), a message appears on the LCD "Triaxial Test CONRO LAB" for two seconds and then the LCD displays the message "Press start to start the test". After pressing the "Start" button, the LED lights and the LCD displays "Data acquisition". The system starts to read the sensor values as voltages and send them to the COM port to acquire in acquisition software. At the end of the acquisition, the LCD displays a message "Test Complete". If we press the "Stop" button, the system stops and starts.

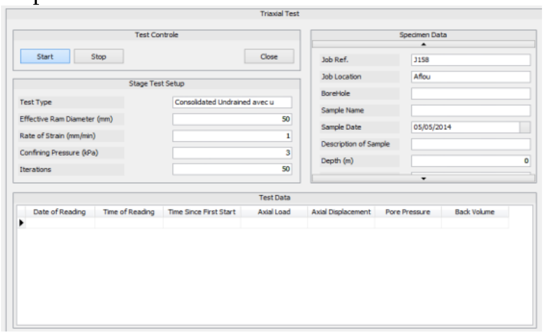

Figure 17 : Starting test window

Figures 17 and 18 present consolidated essay not drained, three essays associated to pressure curves.

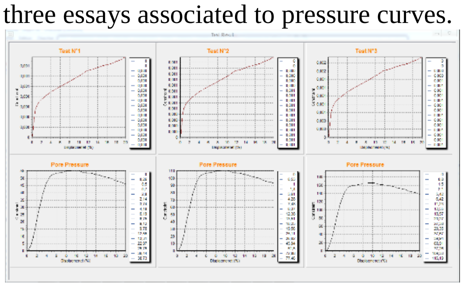

Figure 18 Consolidated and not drained essays

4. DISCUSSION & CONCLUSION

In this paper, we proposed an approach incremental in order to establish measurement parameters performance of applied methodologies for application real time systems.

	Tools	activities	Metrics
Case study one			
Specification	SART : Functionnalities	Data Flow Diagrams (DFD)	Reliability
Design	mapping functionnalities to DFD	Increments Computing	Reliability
Implementation	Mapping DFD to software Modules	Increments Computing	Survivability/maitenablity
Test	Mapping software Modules to Hardware Modules	Increments Computing	Survivability/maitenablity
Case study two			
Specification	MARTE : Functionnalities	Diagram of Components (DC)	Reliability
Design	mapping functionnalities to DC	Increments Computing	Reliability
Implementation	Mapping DC to software Modules	Increments Computing	Survivability/maitenablity
Test	Mapping software Modules to Hardware Modules	Increments Computing	Survivability/maitenablity

Table 1 : Correlation between life cycle software and software engeeniring metrics.

Table 1. Illustrates correlation between software engineering metrics and life cycle of specific domain applications (geotechnical and fluid mechanics) using based increment notion. This approach of measurement can be extended to other software engineering metrics and be applied to other methodologies like Across ARTEMIS projects etc.

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