Technical Aspects of the Online e-Management Control and Evaluation System for Universities

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Abstract: This paper briefly describes several technical aspects and general structure of the e-Management Control and Evaluation System (e-MCES) at the University of Technology (UTech), Jamaica. Some our original technical and security solutions we have implemented in it. We consider this web application as a base for a full management system for educational institutions that includes strategic, academic, and financial planning and management components. This approach will allow the institution to respond promptly to real-world challenges and opportunities that might affect its short- and long-term strategies.

Key-Words: e-Management Control and Evaluation System, .NET technology, Multitier Architecture, Object-Oriented Approach, Role-based security, Navigations, Connection Pooling, Just-in-Time Menu Generator

1 Introduction

One of the keys to successful management of any organization, including Educational Institution is the ability to understand and apply modern management principles and techniques effectively. As high-performance organizations, Educational Institutions may be interested in having an effective, low-costly, efficient and robust multiuser (Internet/Intranet) Educational Management Information System (EMIS) that is aimed at creating an environment which allows for the development of the full potential of its human resources in order to achieve its goals and objectives. That system on the one hand, provides an accurate diagnosis of the educational reality and an objective assessment of the impact of intervention policies to society. On the other hand, the information produced by e-MCES may then be used as social control tools to press those responsible for managing the educational system to produce necessary improvements. For development of educational institution’s strategy and policy, timely and precise analysis of current business activity on all levels of the organization, including financial effectiveness and customer satisfaction are not possible without wide implementation computerized information systems, modern methods of communications and latest achievements in the Theory of Management.

Traditional paper-based system cannot serve educational institutions any more. A new EMIS must be: (1) An Integrated System; (2) effectively able utilise the main information resources of the institution; (3) based on contemporary quantitative management approach, such as Balanced Scorecard (BSC) strategy management approach and 360-degree evaluation feedback. This research and development of the e-MCES has been done accordingly a Strategic Plan of the University of Technology, Jamaica.

2 Structure of the e-Management Control and Evaluation System

From our point of view, the e-Management Control and Evaluation System (e-MCES) internally should consist of the following components [1, 2]:

- Management & Control Solution
  a. Strategic, Operational Planning Management and Control System
  b. Performance Based Management System
- Students’ services Solution - Online Module/Instructor Evaluation System
• Financial Solutions - Online productivity and finance planning

The general structure of the e-MCES is presented in the Figure 1 below.

Main components of the e-MCES as follows:
• Information resources. Information resources of the current version of the system are based on Human Resources database (HRDB) and University portal – Integrated Students Administering System (ISAS).
• Online Module/Instructor Evaluation System (OLMIES). This system provides evaluations of modules delivered by departments/schools and evaluation of teachers by students.
• Online Strategic, Operational Planning Management and Control. There are Performance of Academic and non-Academic staff appraisal system and the Strategic, Operational planning system.
• Online productivity and finance planning. The educational institution productivity measurement system which provides aggregate objective metrics on productivity of faculty, departments and other institution’s units vis-a-vis financial inputs and budget.

3 Development platform

The e-MCES is a Web-based ASP.NET application. This development platform is designed to create interactive pages as part of a Web-based application [2].

ASP.NET like other Web development environments works on top of the HTTP protocol and takes advantages of HTTP commands and policies to set up two-way, browser-to-server communication and cooperation.

In addition, the whole ASP.NET platform comes as a native part of the Microsoft .NET Framework. ASP.NET applications compiled pieces of code, are made of reusable and extensible components, can be authored with first-class language C#, which we have extensively used in our process of development, and can access the entire hierarchy of classes in the .NET Framework.

There are seven important features about ASP.NET [3]:
• ASP.NET is a part of the .NET Framework;
• ASP.NET is compiled, not interpreted;
• ASP.NET is a multilanguage;
• ASP.NET is hosted by the Common Language Runtime;
• ASP.NET is object-oriented;
• ASP.NET is multiservice and multibrowser;
• ASP.NET is easy to deploy and configure.

In view of the above, for writing code-behind modules, classes, and business objects in e-MCES, we have selected the C# programming language [3-5].

![Figure 1 General structure of the e-Management Control & Evaluation System [1, 2]](image-url)
Multitier architecture
Unlike client-server (two-tire) system the e-MCES is a multitier or distributed application, where number of tiers is greater than two. This type of architecture provides scalability, robust, multitasking, highest level of security and performance, even with high volumes of data [6]. The tiers in this model are shown in Figure 2:

Figure 2 Multi-tier architecture of web application (number of tiers is greater than 2)

Here:
- The presentation tier consists of the ASP.NET pages that manage the appearance of the application. This layer can include bound controls and objects that bind the data controls to the data.
- The business tier contains the data access classes that manage the data access for the application. This layer can also contain business objects that represent business rules as well as the calculations.
- The data tier consists of the database that contains the data for the application. It includes SQL statements that do the database access and saved in stored procedures within the database.

Performance, scalability and connection pooling
The e-MCES is a distributed application. One common mistake of software developers is to look at distributed components as full partners in object-oriented design. Unfortunately, distributed programming, such as an ASP.NET programming, is a compromise between networking technology and object-oriented practice. For example, when we are speaking about Performance and Scalability of the web-application, we have to realize, that these issues are not the same and must be investigated at the system design level. The Performance is a measure of the application’s speed. The Scalability indicates how this speed varies as the client load increases. We can see the difference between these issues for different web solutions, which are using a session state objects. In some web applications, using state objects usually performs faster for small number of clients. However, as the number of simultaneous clients increases, they reach a bottleneck and perform sluggishly. Figure 3 depicts this relationship.

Figure 3 Performance vs. scalability [4]

One of best example of the distinction between performance for small number of users and scalability to large numbers of clients occurs with database connection pooling. Let us consider two configurations.

First one – “Configuration A” for a small size of educational institution’s staff. Another one – “Configuration B” for a large institution (UTech with number of staff greater than 1,300 employees is an example)

In Configuration A (Figure 4) all clients have local copies of the database connection service class (object). Therefore, they can use it locally (and speedily) in process. Connection cannot be pooled between clients, because the connection object is always...
instantiated in the process of the client. A fragment of ASP.NET page code, which provides this instantiation, is as follows:

```csharp
<asp: SqlDataSource ID="EmployeesList" Runat="server"
    SelectCommand="SELECT FirstName, LastName, Title FROM Employees"
    ConnectionString="Data Source=127.0.0.1; Integrated Security=SSPI; Initial Catalog=EMCES2010">
</asp: SqlDataSource>
```

Here we can see that `SqlDataSource` object creates an instance of connection object, which is associated with application that is called by user and serves it individually.

**Figure 4** Configuration A: best performance for small educational institution

**Figure 5** Configuration B: best scalability for big educational institution

In Configuration B (Figure 5), the connection service class lives on the database server and communicates with out-of-process clients through ADO.NET access classes. This intrinsically adds overhead because all calls must travel over process boundaries and the network. It allows connections to be pooled among all clients. In e-MCES, we use this technique. A fragment of code from some code-behind class of the e-MCES is given below. In this C# example, three new `SqlConnection` objects to e-MCES2010 (2010 year) and to e-MCES2011 (2011 year) databases are created, but only two connection pools are required to manage them. Note that the first and second connection strings differ by the value assigned for `Initial Catalog`:

```csharp
using (SqlConnection connection = new SqlConnection("Integrated Security=SSPI; Initial Catalog= eMCES2010 ")) {
    connection.Open(); // Pool A is created.
}
using (SqlConnection connection = new SqlConnection("Integrated Security=SSPI; Initial Catalog= eMCES2011")) {
    // Pool B is created because the connection // strings differ.
    connection.Open();
}
```}

6 Security Solutions

The e-MCES has been developed for all members of staff of the university, including academic/non-academic, administrative, technical and ancillary staff with different areas of responsibility. Some of them are managers and supervisors while others are employees – and all of them are members of the one university’s community. Because the system serves all of us in the institution, with a single Internet interface and common data storage, it must have restricted access to the resources. Our solution is based on the concept of the role of the currently logged-on user [1].

Using role-based security (or simply RBS), it is possible to programmatically determine the role/roles of the current user interacting with a given type or type member.

.NET provides four possible security policies: - (1) Forms: A RBS implementation for ASP.NET; - (2) Generic: Enables us to define our own custom RBS system; - (3) Passport: A RBS implementation for MS .NET Passport; -
Windows: A RBS implementation for Win32 user account system.

Because the Form-based principal policy is used extensively when securing ASP.NET in web applications, we have decided to use it in our solution. The .NET security model enables us to restrict access to type allocation and type member invocation using Imperative RBS, which types directly into the code, making run-time demands and decisions where needed. With this approach we gain the capability to monitor access violation gracefully in code via try/catch constructs and/or simply deny a given course of action.

7 Navigation and Just-in-Time Menu Generator

Navigation is a fundamental part of the e-MCES. In conjunction with security policy, it allows for the system to provide set of various Menus for different categories of users and their roles. The menu grants to a user his/her permissions. In the University, like UTech, with number of employees more that 1,300, this is a big problem. We need to keep and maintain a Menus for all categories of staff and this is enormous job. Traditional maintenance of these processes updating an application (redesign and recompiling) is waste of time and energy. To create one very big and universal menu predicting new positions is also not possible. We have invented an novel solution for it in our system. Actually we do not keep set of Menus in the system and in some supported configuration files at all. Instead, we keep it in the database as the fragments of any menu called as tokens. The system generates each virtual menu for each user Just in Time Compilation (JITC) of his request and keeps it during the current session of the user [7]:

- collecting essential tokens from the database, using our specific algorithm,
- at run-time generating a JavaScript menu program
- renders HTML code to the final DHTML code,
- sends it to the client browser.

The Just-In-Time compilation process generates an HTML document, to be interpreted by the browser of client machine.

In e-MCES, we consider menu of two levels – parent and its subordinate - child. We have created a JIT Menu Generator (JITMG) – a C# procedure, which uses tokens of menu as input information. Under tokens, we consider all necessary elements of future menu – texts of items, which will be seen by user and touchable (in terms of ability to be hyperlinks) by user, destination addresses (URLs) associated with these items, and link to the user’s role.

We believe that this solution including C# and ASP.NET source code is an intellectual property of the University of Technology, Jamaica hence additional details are not presented here.

8 Information Resources

Processes of accepting Information Systems by academic and non-academic units of educational institutions during different periods of time are characterized by using different technologies and platforms. Computer technology has been changing very fast and information systems created in an earlier time, sometimes are not compatible with systems developed later, but anyway, can be considered as an information resource [8].

Information resources of the e-MCES are based on the Human Resources database (HRDB) and University portal — Student Integrated Administration System (ISAS). ISAS provides information to students about their assignments and exam results on-line. HRDB is built using the FoxPro database and has successfully served the staff of the HR department and management of the University for many years. ISAS is built using MS SQL-Server 2000 database and developed using VB6/ASP programming languages/environment. The e-MCES is based on other more contemporary platforms. Integration of these three different systems is a problem for developers. Our solution is based on the idea of creating a “Pool of elementary objects”, which is populated by data derived from different currently using systems [8].

This pool of objects is platform independent and allows the integration of different Information Systems of the University. In essence, these objects are independent of each other and store necessary data for populating...
database resources of information systems we are going or planning to implement.

These technologies are well described in [9].

9 Conclusion
As a relatively young university, the University of Technology, Jamaica has made great strides improving a performance culture in the institution. In this regard, the leadership of the University played a critical role in designing and deploying the system to ensure its effectiveness.

An important objective in developing the e-MCES was to more closely “connect” each staff member to the planning and evaluation processes. Employee involvement is one of the best ways to create a positive culture that thrives on performance measurement. Through the Project Steering Committee, staff at all levels had an opportunity to provide input into all phases of creating the integrated management system and by so doing to create “buy-in.”

The intention of the e-MCES is to provide a robust yet flexible online tool for the University to measure how well it is achieving its strategic targets, providing a mechanism for communicating with each staff member their individual contribution to the success of the institution.

A practical experience of using previous online evaluation systems in the University of Technology, Jamaica proves that we have selected an effective way for improving the evaluation process of the University staff.

References