

# BUSINESS PROCESS EMBEDDED INFORMATION SYSTEMS

## *For Flexibility and Adaptability*

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**Abstract:** In this ever faster changing world, organisations are faced with the need to have flexible processes. This is only possible if these processes have full control over their supporting information systems, which we propose to embed into the business processes, in stead of a global, common enterprise information system. Therefore we are introducing a fifth stage in the architecture maturity model of Ross to implement these Embedded Information Systems.

## 1 INTRODUCTION

Organisations need to continuously adapt to changing business environments. However, the justified desire for a flexible business processes support is impossible without adaptive software.

In this paper we describe a proposal for a business process embedded information system. First, we will look at information and describe how it relates to the business. Information is not only needed at operational level but it also provides raw material for intelligence in the decision process. Next we will discuss the enterprise architecture where all components (information, business processes and Information and Communication Technology) are brought together in one framework and we state our proposal. Finally, before some conclusions we give indications for further research.

## 2 INFORMATION

The U.S. Office of Management and Budget (OMB) defines information as any communication or

representation of knowledge such as facts, data, or opinions in any medium or form, including textual, numerical, graphic, cartographic, narrative, or audiovisual forms (OMB A-130). Knowledge itself is the awareness and understanding of information gained through experience or observation or through reasoning (deduction and induction).

Burkan (1991) states that information has four functions:

- Mandated;
- Control;
- Management;
- Leadership.

Compulsion causes the first, tactical survival of the enterprise is the concern of the second. Much of the attention regarding information is given to these functions in Information and Communication Technology (ICT) less to the latter two. The strategic management use of information reflects to minimise surprises. Its effectiveness is measured in the ability to detect and anticipate, both short term and long term. Contrary to control, which is inwardly focused, strategic management is more outwardly focused. If strategic management is the ability to see the future, then leadership is the ability

to shape the future. It is measured by how well the leaders can move the enterprise's resources to new directions (Burkan, 1991).

Related to this and before discussing these business processes, Art of War (Bernard, 1976) is briefly introduced, because its principles prescribe the way of doing business.

### 3 BUSINESS

#### 3.1 Art of War

To Bernard (1976), there are three principles of the Art of War:

- Balance between Goals and Means;
- Liberty of Action;
- Economy of Forces.

The first principle has one rule: the permanent seeking of intelligence, inside and outside the organisation (see below). The balance between goals and means is about determination of the right objectives, given the environment and the available and/or possible needed resources related to these objectives. The result is the Grand Strategy of the entire organisation. As a consequence of this balance, two other strategies can be derived: Business and Resources Strategies. The first is focused on the creation and the deployment of the core competences to attain the imposed objectives, while the latter is focused on the means and the processes to support the first (Rabaey, 2004, 2004b).

The liberty of action is about security: avoiding, preventing as much as possible hostile actions of other organisations and the assuring of the communication lines (logistics, information (for intelligence)). The economy of forces treats the economical and right use of the resources (efficiency and effectiveness).

The deeper in the hierarchy of the organisation the less impact have the leaders on the resources aspects and the scope of their business levels. Therefore in the ever faster changing world, the structure becomes less hierarchical, so flexibility is gained. This implies that these leaders (and/or managers) need to have access to more information and have a more extended information system.

#### 3.2 Business Processes

An information system supports the organisation and consequently its business processes. Rabaey (2004a) defines a business process as a logical set of

activities that consumes resources to attain its objectives.

Now, information in the processes is used on different levels: steering information, operative information and historical information. These types of information will be found in BPM-tools. The last years we can see an effort to merge BPM-aspects and ICT-aspects into one tool.

However a mental gap exists between both worlds. BPM-people think process-wise, while ICT-people think application-wise, meaning only some parts of the processes are automated and relevant information are stored in databases. Reporting on transactions is based on the information kept in this databases. As a matter of fact, only historical information is kept in these databases. Information about steering and executing the processes are not stored in databases, but in the models of automated workflows, only a data-query cannot be performed on these models.

Automating partly or totally a business process was first done by a workflow system. Kobiellus (1997) defines a workflow as the flow of information and control in a business process (p. 32).

For the leaders and managers of organisations, it is useful to be able to query these business processes and workflows for a better control.

#### 3.3 Business Integration

In the era of merges and virtual organisations (McHugh, 1995), business integration becomes important. Business processes and workflows now span multiple organisations. They start with the expression of the needs of a customer and end with the satisfaction of his/her need (and the administration). Different levels of integration are possible: Strategy, strategic, operational and operative (Rabaey, 2005c).

Strategy Integration is when two or more organisations decide to develop and to adopt one global strategy for all the concerned organisations. So everything is integrated and the multiple organisations are seen as one.

If the common interest of two or more parties is of such a strategic importance that one or more business processes are integrated and possibly business units are integrated, the term Strategic Integration is used. Its main characteristics are the set up of common business and resources strategies and by consequence a common information management, next to the individual ones of the involved parties.

Within Operational Integration, no common business or resources strategies are set up. From the

respective individual strategies, a common Operational Strategy is deduced. Neither a common information management is established, only conventions are defined.

Operative Integration is, looked upon from a strategic point of view, the weakest of the possible forms of integration. In this case, no common strategy and even no common Operational Strategy are formed. The impact on ICT is that for the realisation of the integration merely interaction standards between business processes have to be defined. For these purposes, no information management has to be defined, a merely commercial contract between two or more parties is sufficient.

### 3.4 Strategy and Capabilities

Kaplan (2005) states that strategy at many companies is almost completely disconnected from execution. Therefore Kaplan (2005) proposes a new, dedicated unit to orchestrate both to help the bridge the divide. However the military deployment (communication) of strategy through operation orders exists since ancient times (Bernard, 1976, Lidell Hart, 1991, Rabaey, 2004a, 2004b). Nevertheless, the implementation of the balanced scorecard (Kaplan, 1996) in the enterprise has enabled the deployment and feedback of the strategy. Kaplan (2005) gives an example of the US Army, which applied the balanced scorecard for the deployment and communication of the strategy (and for the feedback). This alignment on the civil balanced scorecard system enabled the “demilitarisation” of the strategy deployment, so that civil partners of the US Army can now better understand the military context.

Rabaey (2005b) proposes a new type of balanced scorecard to better suite the principles of the Art of War (Rabaey, 2004a). The Board of an enterprise would like the enterprise to have some effects on the society (outcomes) by using its capabilities, which will then perform actions (output) to obtain these effects. The sum of these effects is the vision of the enterprise. The wanted effects will be described in a number of scenarios. Therefore the CEO will configure capabilities to perform actions for all relevant scenarios. In the ever faster changing world, these capabilities have to be flexible and easy to reconfigure.

Modules deliver the necessary capabilities, where one module can serve multiple capabilities. These modules are composed of resources. In the process area of capabilities generation, modules and/or resources are acquired following investment and recruiting plans (acquisition function). So we

have a schema of outcomes – outputs – capabilities – modules – resources.

### 3.5 Enterprise Application Integration

With the hype around Business Process Reengineering (Hammer, 1993) and the raise of the Internet, more specifically e-Business, priority was given to improve the efficiency and effectiveness of the business processes. The processes have to act and react more agile in the faster world economy.

In a later stage, when simple information exchange by itself was no longer sufficient, and the need for more intelligent integration, for instance on procedures and the semantics of the data, became clear, a solution was found in Enterprise Application Integration (EAI). In related research however (Vandenborre, 2003), it is shown that EAI by itself is only an end to the means. A more complete solution is found in the “logical bus architecture” and its implementation on a technical, organisational and informational level.

So, EAI was the response to the interconnection of information system islands between different functional domains in a company or network of companies throughout the Internet. In this context web services became the way to go for most of those companies (Zimmerman, 2003, Rabaey, 2003). Now, Enterprise Application Integration (EAI) and e-Business are evolving towards Service-Oriented Architecture (SOA) by using Web Technology as Web Services. The logical bus architecture became SOA. The main reason is that flexibility can be obtained. (Rabaey, 2005a).

However information management is very difficult in these situations, because of the fact that organisations want to continue to integrate the new area into their information model, but still want to be master of the information model even integrated. The larger the information model, the tougher become the semantics.

### 3.6 Information Model

Rebuilding the information model can be started from the databases systems. However research has shown that applications contain a lot of meta-data and data structures. Research by Rever SA (a spin-off of the Belgian university Notre Dame de la Paix) shows that 40 to 60% of the data structure and flow in ICT are in the applications and are thus not in databases. The University Notre Dame de la Paix is developing the software DB-Main to do a reversed engineering by analysing the databases and the

programs. The result is a conceptual model from which a logical model for any type of database system can be derived down to the operative schemes (Hainaut, 2003, Hick, 2003, Henrard, 2003).

Since the environment of the organisation is permanently changing and thus the organisation also, the information system of the organisation has to be adapted to the new situation. As a consequence part of the databases will change, so that after a while a new re-engineering has to be performed.

So, if a business process could be fully automated into workflows and it holds itself the information, then a consistent part of the producible and needed information will be embedded in the business process. Referring to the capability approach, the housekeeping of the information of a capability is done by the management module.

## 4 DECISION MAKING

### 4.1 Intelligence

Information is not only needed for the business processes or functions in an organisation (direction and control of the uses of resources; the effectiveness of the business). It is certainly the fuel of the strategy development process (planning future activities; linking the business with its environment (Anderson, 1986). If a business process has to choose itself the needed resources, then it may have to seek for information to prepare its decision making. The needed information to reduce the uncertainty of the decision maker at a level that is acceptable to him, is called intelligence (Rabaey, 2005a).

Intelligence is the product of the intelligence process, which collects, analyses, integrates, and interprets information. It disseminates the intelligence to the customer, with the purpose to reduce the uncertainty on a problem (decision) and/or to improve the inference rules. And last but not least, it makes the organisation “aware” of information and therefore aware of knowledge.

### 4.2 Decision and Intelligence Process

As mentioned above, collecting intelligence is the only rule of the first principle of the Art of War (Balance between resources and objectives). If we combine the decision process (on any level of the organisation) with the intelligence process, then a two way communication is needed. One way to express the information need from the decision

making process to the intelligence process. Another is in the opposite direction with the asked information (pull) or with spontaneously generated intelligence (push).

The intelligence process will check if the need can be covered with information in its intelligence base (see Rabaey 2005a for more details), if not then it will give its network (sensors) the order to seek for the relevant information. If it's found then the assessment process leading eventually to intelligence will be started.

Rabaey (2005a) proposes a SOA-based solution –called Intelligence Bus- because of the fact that the intelligence capability can be formed of modules, which correspond with business steps in the intelligence process. This intelligence bus can be plugged in the management information system of a business unit (process). As a matter of fact, it can serve multiple business units, as long as strategic or operational needs for it exist. Specific security rules can restrict access to the intelligence bus.

So, small units (related to the strategic mother-organisation) can have access to a large knowledge and intelligence bases of the mother-organisation and nevertheless have their own independent information system. This results in an enormous flexibility for these units (resources and intelligence). Of course, these units provide the mother-organisation and other units also with facts and intelligence.

## 5 ENTERPRISE ARCHITECTURE

### 5.1 Framework

Lots of different interpretations of the term Enterprise Architecture do exist. These interpretations range from, at one end of the spectrum, the list of technological choices made in an organisation concerning infrastructure and application design to the other end of the spectrum wherein Enterprise Architecture encompasses these technological decisions but also sets guidelines to information architecture and business architecture.

Therefore it is a necessity to consider Enterprise Architecture broader than merely infrastructure architecture and application architecture. This necessity stems from the fact that applications are built to support business processes and operate on information gathered through these business processes (see above). Hence, architecture only concerned with infrastructure and application design is insufficient to support a business because such an Enterprise Architecture has no view on the business and its dynamics and hence it cannot take

precautions for changing business requirements or the reuse of certain artefacts in other business domains.

For these reasons, an Enterprise Architecture consists of distinguished levels. The naming of the distinguished levels may be different but at least the general ideas as described hereunder should be part of the Enterprise Architecture:

- Business Architecture is about the description of the business processes as viewed from a business perspective.
- Information Architecture describes the information need of the business and its processes.
- Application Architecture is about how to implement the applications or ICT systems, the programming paradigms and languages, the development environment, software documentation guidelines, release to production procedures, etc.
- Infrastructure Architecture deals with guidelines concerning hardware platforms, network infrastructure, operating systems, etc.

Ross (2003, 2004) defines Enterprise Architecture as “the organizing logic for applications, data and infrastructure technologies, as captured in a set of policies and technical choices, intended to enable the firm’s business strategy”.

## 5.2 The Level of Architecture Maturity

Ross (2003) defines four stages:

1. Application Silo Stage in which the Enterprise Architecture is just the collection of the architectures of isolated applications, often implemented in different technologies.
2. Technology Standardization Stage as the first step towards an enterprise wide Enterprise Architecture in which technology gets standardized and often centralization is put in place. The deployment of resources shifts from application development into the development of a shared infrastructure. This phase is further often characterized by the introduction of data warehouses and sporadic and not institutionalized business management participation.
3. Data Rationalization Stage characterized by an expansion of the enterprise architecture

to include process and data standardization. The deployment of resources shifts from application development into data management and infrastructure development. The involvement of senior business managers becomes institutionalized and a dialogue between business managers and IT becomes common practice. Very important in this phase is the shift of data ownership from IT towards the business. This phase is further often supported by tools like ERP, CRM.

4. A Modular Architecture characterized by enterprise wide global standards with loosely coupled applications, information and technology components to preserve the global standards while enabling local differences through modules extending the core processes.

## 6 EMBEDDED INFORMATION SYSTEM

### 6.1 The Fifth Stage of Enterprise Architecture

This paper proposes to add a fifth stage, business process embedded information systems. Due to the ever faster changing environment of an organisation and increasing interactions with it, a global and central “steering” becomes quite impossible, if the organisation aims flexibility and rapid response. So the organisation delegates to the business units and their processes. However, if the ICT is not federated then the autonomy is jeopardised by the ICT-applications. Therefore we propose to embed information systems into business processes.

As seen with the Intelligence Bus, mostly all aspects of the information system can be federated without losing the consistency of the information system of the mother-organisation. However before going to the fifth stage, an organisation and its underlying (business) units have to perform a information model as described above, simultaneously the organisational structure has to be defined, and the business processes have to be modelled in the Business Process Management (BPM-) tool following the capability approach.

Once BPM and the conceptual information model defined, then they have to be merged into a global model (information and business processes), where the capabilities should manage their own (embedded) information system. But as already

mentioned, it has to start with conceptual information model to solve the problems of information management.

Since the environment of the organisation is permanently changing and thus the organisation also, the information system of the organisation has to be adapted to the new situation. As a consequence part of the databases will change, so that after a while a new re-engineering has to be performed at organisational level.

So, if a business process could be fully automated and it holds itself the information, then a consistent part of the producible and needed information will be embedded in the business process. Referring to the capability approach, the housekeeping of the information of a capability is done by a (management) module (See also Vandenborre, 2003).

## 6.2 The Possibilities with Integration

In the case of strategy integrations, Business Process Embedded Information Systems (BPEIS) are recommended for the new processes in the new organisation. The 'old' processes can only receive their BPEIS, if they have been re-engineered. In function of the existing architecture and infrastructure of the different former organisations, the new organisation may opt to go through an EAI-project before installing BPEIS. The same reasoning is applicable for a single organisation.

Strategic integrations of business processes have the advantage that they can start immediately with BPEIS, since they have no legacy systems. Certainly the different "mother-organisations" may have legacy systems, but they can be interfaced or integrated through the capabilities of SOA.

As already mentioned, within operational integration no common business or resources strategies are set up, only an operational strategy. If one (or more) of the mother-organisations has the adequate SOA capabilities then BPEIS can be realised. Otherwise the duration of the business integration will be the main decision element to evaluate the implementation of BPEIS.

In almost all cases of operative integration, BPEIS will not be implemented, since no common business processes are existing.

## 6.3 Virtual Data Federation

The consequence of Business Process Embedded Information System is that if somebody needs to collect information then that person will have to query each process management module. This

resembles to Virtual Data Federation or Enterprise Information Integration (EII) issues.

Friedman (2004a) writes: "Gartner positions EII as a goal, not a technology. The goal is to achieve a state where the various data assets of the enterprise are integrated to best meet the needs of the business:

- Delivering a timely and complete view of critical entities and events
- Providing connectivity and accessibility to data across multiple platforms and databases
- Ensuring the consistency of data underpinning related applications

As such, the goal of EII differs little from the general goals of data integration, which has been a focus of enterprises for the last three decades." At its core, EII technology performs virtual data federation based on distributed database queries (Friedman, 2004b, 2005).

However the biggest problem is to know if the semantic of one item is the same in all the databases. This is the added value of software like DB-Main (Hicks 2003) which produces a conceptual or semantic model of the organisational information. From thereon through logical and physical models the operative models are defined. Again, this will only be a snapshot if the maintenance of all models is not done. But since information system is embedded in business processes or units, the burden is less. However consistency with the organisational level must be maintained.

## 7 FURTHER RESEARCH

This approach of business process embedded information systems needs another way of making decision in ICT-investments. Earlier works (Rabaey, 2004a, 2004b, 2005d) propose a holistic framework for global ICT-investments. In the situation of business process embedded information systems, ICT is more federated. Business units have more autonomy but are not independent from the mother-organisation.

Research has already been done in the domain of investments in Service-Oriented Architecture (called Service-Oriented Investments). Since SOA is the most suited environment to develop business process embedded information systems, research on Service-Oriented Investment will be continued.

## 8 CONCLUSIONS

With the discussion on information and business in the context of the need for flexibility, we came to the conclusion that not only the processes themselves have to be flexible but also the supporting software.

This is only possible if the business units or processes can dispose on a autonomous way over their information systems, more specifically their "own" ICT-applications. Therefore we call it business process embedded information systems. It is however not independent because of the fact that the ICT-applications and the underlying ICT-infrastructure need to fit in the global ICT-framework of the mother-organisation.

Further research is the adapted way of making investments in the Service-Oriented Architecture.

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