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Morin, Jean-Henry; Kobel, Christian; Konstantas, Dimitri

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# **Active Business Objects (ABO): When Agents meet ABC/ABM based Management**

Jean-Henry Morin

Christian Kobel

Dimitri Konstantas

## **Abstract**

This paper aims at studying a new paradigm for building and using Business Information Systems, accompanied by the required enabling technologies and business models, which will assimilate innovative marketplace concepts and thus allow for better process / activity oriented management. The proposed approach is inter-disciplinary (technology and management) and relies on combining the mobile object (agent) technology with the ABC/ABM model (Activity Based Costing / Management) towards what could be called "real time management". The core idea concerns the deployment of Active Business Objects, which may form an essential part of the emerging Global Business Infrastructure. In the ABO approach we use agents to encapsulate business objects thus becoming mobile active software entities, holding all the necessary data (i.e., the business objects) and code (i.e., the behavior) to take action according to the different situations that can occur.

## **1 Introduction**

Currently, business information and data are communicated across seamless and interweaved information supply chains among the involved parties within business-to-business or business-to-consumer operations and relations. Furthermore, the management tools used do not focus on the raw organizational material, which are the business processes composed of activities involving resources be they human, structural or material. Business processes analysis and quantification is crucially lacking in most organizations. As a result, performance is often measured by using legacy tools and techniques, which are outdated and do not reflect the core business activity. These tools often fail in providing the necessary indicators that should ultimately provide the managers with "real time" information allowing sound and accurate management.

This paper aims at studying a new paradigm for building and using Business Information Systems, accompanied by the required enabling technologies and business models, which will assimilate innovative marketplace concepts and thus allow for better process / activity oriented management. The core idea concerns the deployment of Active Business Objects, which may form an essential part of the emerging Global Business Infrastructure. The proposed approach is inter-disciplinary (technology and management) and relies on combining the mobile object (agent) technology with the ABC/ABM model (Activity Based Costing / Management) towards what could be called "real time management".

The mobile object or agent technology provides a new programming paradigm for network oriented applications allowing to move computation in a flexible and cost effective way towards

the source of data. In the scope of the ABC/ABM model agents can be used to capture essential notions such as business processes and activities. By encapsulating business objects and their corresponding behavior into Agents, the resulting Active Business Objects become part of processes that traverse organizations, travelling across the various activities required to successfully fulfill their tasks. Furthermore, they become information providers able to release relevant information about their own usage, execution and state to the information system and henceforth to management instrument panels.

The ABC/ABM methodology provides a conceptual framework to measure the resource consumption in the production of a service or product and consequently allow for efficient organization and strategic management through management instrument panels in a airplane cockpit metaphor. It is based on the analysis of the tasks, activities and processes that are involved in the production, freed from the apparent organizational structures. In this context it becomes possible to trace the real consumption of resources for the production of a product, based on the axiom that products/services make use of activities which in turn consume resources. This by opposition to classical costing approaches that have proven to be inefficient as they are based on arbitrary allocation standards which do not reflect the real resource consumption.

Section 2 provides an introduction to Activity Based Costing and Management (ABC/ABM) and how it relates to organizational controlling and management before describing how such a methodology can be used at an operational level. In section 3 we present the mobile object (agent) paradigm as an enabling technology for ABOs. Section 4 describes the Active Business Object framework resulting from the combination of the ABC/ABM model and the mobile object (agent) paradigm. Finally section 5 concludes with open issues and future work.

## 2 ABC / ABM as a Methodological Framework

The necessity of controlling organizations appeared a long time ago and lead to the development of sciences such as *management*. The instrument which most rapidly and logically emerged was cost calculation. Although the real development of costing occurred during the 19th century (Ecole supérieure de commerce de Paris, 1866) the concept originates by far before according to Johnson and Kaplan [1].

The development of industry, the scientific organization of work (20th century with Taylor) and finally new forms of organization reveal the need for a new type of management. Being able to define a cost in a precise way (arithmetic) is not enough any more. Now it is necessary to guide and orient the behavior of the persons who are in charge of financial results (i.e., managers, decision makers, etc). The General goal of management controlling is to verify the adequation between resource consumption and the corresponding output obtained in return. The concept of management instrument panel or control panel as well as a broader dimension of management control is emerging with a particular consequence: the criticism of too simplistic costing approaches and the need for strategy oriented tools. In this context, the eighties saw the development of Activity Based Costing and Activity Based Management (ABC/ABM).

Activity Based Costing and Management (ABC/ABM) is an interesting methodology in that it allows, at least in a partial way, to escape from the strict accounting and financial vision

of management. In particular, ABC addresses the issue of measuring whereas ABM is concerned by the means of action on the relation between resource consumption and result through management instrument panels or control panels.

## 2.1 Origins and Concept

The ABC/ABM method initially appeared in the United States towards the end of the eighties consequently to work done by a group of the Consortium for Advanced Manufacturing - International (CAM-I) [2]. The three following elements explain the context and the need for this method:

- increase of indirect costs in most sectors, both in relative and absolute value
- change in the nature of indirect costs. Indirect costs are being increasingly composed of costs influenced by product complexity, diversity and quality to the detriment of variables linked to the production volume.
- Evolution of direct labor. Like the evolution of indirect costs, the proportion of direct labor cost in the total cost is constantly being reduced. Such an observation highlights the inadequacy of the use of this work unit to allocate the indirect cost.

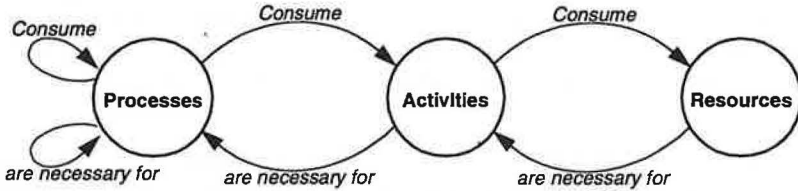
The method is not limited to providing more relevant and accurate cost information than traditional approaches. In this new approach, cost calculation is still regarded as a significant management instrument, but does not constitute an end in itself. One must first go through a phase of thorough analysis of the activities of the company [3]. The objective is not any more to influence the level of costs (as in the cost center method through successive allocations for example), but rather to allow effective action on the activities which cause costs. *"People cannot manage costs, they can only manage activities which cause costs"* [4].

A new dimension is thus given to ABC: ABM. A simple calculative aspect does not constitute the principal element of the method but it is augmented by adding to it a strategic and managerial dimension [5]. By acting on the activities, it becomes possible direct actions towards long-term objectives. All the costs having the characteristic of being variable, they become usable in the decision making process. The method thus highlights the impacts of the various strategic choice parameters on the level of the activities. This is the origin of the Activity Based Management terminology or ABM.

These statements call for a definition or model of the resource circulation process through the various activities and products of the company in the closest possible way to reality. It thus becomes possible to measure resource consumption of each activity and to value them. Likewise, it becomes possible to measure resource consumption of each process. All these information make it possible to carry out a reflection on both value added and non value added activities. Porter's *value chain* theory [6] can then be largely applied. The business policy thus becomes oriented towards an optimization of the difference between the created value and the costs rather than being limited to a simple minimization of the costs as it is largely done in traditional approaches.

The basic principle of the method can be described the following way: products / services consume activities which consume resources. To be noted that products and services can be as-

simulated to processes, compound or not. The relationship between these three conceptual building blocks can be expressed with two relations: *consumes* and *is necessary for*. Processes consume sub-processes or activities which in turn consume resources. Likewise, resources are necessary to fulfill activities which in turn are necessary to fulfill processes. These relationship are shown in Figure 1.

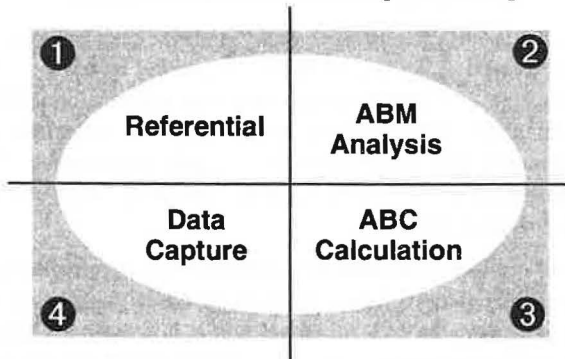


**Figure 1** Basic principle of the ABC/ABM model

If it is possible to measure each stage of this relation, then the cost price is perfectly defined. It requires to collect / capture the relevant information on consumption of resources and activities in the considered system. An ABC/ABM analysis thus requires a detailed modeling of the processes of the analyzed company, business, organization. It must describe as perfectly as possible the processes, activities and resources involved in the analyzed system. This approach is orthogonal to the organization and does not take into account aspects of the organizational structure.

## 2.2 Road Map to Putting to Work an ABC/ABM Approach

The ABC/ABM model is a methodological framework that needs to be interpreted in order to be used. The approach described below is drawn from an operational experience of using ABC/



**Figure 2** The target: four steps of an ABC/ABM approach

ABM based on real cases and situations. It can be decomposed into four major steps graphically shown in Figure 2. This approach will be called the Target in the rest of this work.

### 2.2.1 First Step: Setting Up the Referential

Practical experiences show and emphasize some difficulties in constituting such a referential. One of them being to define an appropriate modeling depth. It is often bypassed through simpli-

fication. Other approaches are even more questionable as they are based on general models of analysis where processes are defined *a priori* at a macro level.

Another difficulty relates to the validity and the perennality of the obtained model. It is important to distinguish the dynamic process which really consumes activities and evolves over time from a static procedure describing a “must be” seldom subject to fast evolution. Thus, one must be careful to distinguish the *process* aspect from the *procedure* aspect. The operational and functional reality will allow to bring out the effective management variables acknowledged by their actors. The modeling technique that we retain relies on a bottom-up approach decomposed the following way:

1. A detailed model (activities and resources)
2. A simplified model based on abstraction rules (relation between activities)
3. A global process model or business process model

The resulting referential can be considered as a dictionary holding all the relevant information about the business in terms of processes, activities and resources which must be regularly updated and maintained.

### 2.2.2 Second Step: ABM Analysis

The objective of this stage is to identify the performance indicators to be set up. These performance indicators are to be understood as the set of measures allowing to evaluate the production system at the operational level both in terms of quality and quantity. Such indicators must satisfy the following two aspects (i) determine the relationship between resource consumption and output, (ii) determine the means to act on this relationship.

These performance indicators are used to build the management instrument panels or control panels. They must be defined for any relevant responsibility level without any aggregation of information. It must always be possible to recover elementary information from any starting point. There are several types of management instrument panels or control panels:

- Operational: providing information on process operation. They are primarily measurements of activities and resource consumption
- Managerial or strategic: showing the state of the system with respect to valued objectives.

Each management instrument panel or control panel is composed of the relevant indicators with respect to the needs of its user (i.e., the person in charge) allowing to take action through it. In other words one could say: a panel for everyone. Such tools are temporary by definition and evolve according to the referential evolution.

### 2.2.3 Third Step: ABC Calculation

ABC calculation consists in determining the financial value of the real resource consumptions by the activity drivers (i.e., that induce activities) and resource drivers (i.e., that induce resource consumption).

It is important to note that the philosophy of the method is to turn all costs into direct costs with respect to an activity thus eliminating the cost allocation problem. In practice, the distance between this principle and reality mainly depends on two factors being: the quality of the referential and the available information. By definition, the calculation model evolves according to the evolution of the referential. Cost calculation is thus a consequence rather than an objective of the approach.

#### 2.2.4 Fourth Step: Data Capture

Basically, all the meaningful information of all the relations defined in the referential should be captured. This implies collecting in a database all the events relating to processes, activities and resources in their raw elementary state (i.e., non aggregated information). Such information should be preserved as much as possible:

- as raw information in order to allow “zooms” up to the finest desired level of detail from the management instrument panels or control panels
- with historical information covering a broad enough time period to be able to identify tendencies and trends.

In practice, the available information come from two sources: the accounting system and the production management system. But these information sources only seldom provide satisfactory information because they rely on organizational structures (e.g., an accounting plan does not reflect processes). Other information sources such as human resource timing systems are equally unsatisfactory as they introduce a bias due to their strong control aspects provoking behaviors masking reality.

Software tools that alleviate these difficulties exist for example *HyperABC* and its evolution *Metify* of the company *Armstrong Laing* [7] is probably the most complete. It relies on the following modules:

- A module allowing to define a process and activity based structure
- An analysis and reporting tool (Cristal Reports, hyper cubes, etc.)
- An ABC compliant calculation engine
- A powerful data acquisition module able to import data from most information systems

The third point is not commonplace since a process can in practice operate as well for a client as for itself (e.g., computer support). In the best case, it is possible to import data several times a year to calculate costs. In the worst cases, which are rather common, it is necessary to redevelop all or part of the information system taking into account this time the defined referential. The difficulty thus arises from the inadequacy between the referential and the information system. It is the main hurdle to the development of dynamic, sound and relevant management instruments.

Ideally, each and every elementary event should be accessible as soon as it occurs, in a permanent way (i.e., persistent in time) and identifiable in the referential. These three conditions are essential to achieve time continuous management (i.e., dynamic measuring and management tools).

### 3 Mobile Objects (Agents) as a Technology

While the client server model has received significant attention in recent years, a whole new domain of research has emerged from the combination of progress achieved both in object oriented research and networks. Mobile objects, mobile computations, mobile agents or simply agents [8] [9] [10] have reached the level of being a research area raising a set of issues dealing with security, distributed systems, networks, etc.

There are basically two agent communities. First, intelligent agents or multi-agents and second, mobile agents. The former, rises from artificial intelligence and is focused on knowledge representation, collaboration, behavior, avatars, etc. The later stemming from object oriented, network and distributed system research address the issue of moving behavior towards the source of data. An agent in this context can be considered as an object (compound or not) in the object oriented terminology having the following two characteristics: persistency and network awareness. Persistency in the sense the object holds state in a persistent way. Network aware in the sense the object has knowledge of network and is able to migrate between participating nodes of the network. This represents a major change for network applications thus leading to a new paradigm. Moreover, it represents a significant opportunity in the field of electronic commerce since agents can be considered as natural metaphors of commercial actors be they consumers, providers, intermediaries (i.e., brokers, facilitators) or even business objects themselves thus becoming active.

From these research issues and driven by market demand, a number of prototype systems and languages supporting this agent paradigm have been implemented (*Emerald* [11], General Magic's initial implementation: *Telescript* and current Java based technology: *Odyssey* [12], *Obliq* [13], *D'Agents* [14] formerly known as *Agent TCL*, IBM *Aglets* [15] [16], Object Space *Voyager* [17], *Mole* [18] [19], etc.) Some of which have already become commercial products which are now available on the market. However such systems represent a considerable challenge with respect to security issues. These have been identified and discussed thoroughly in [20] [21] and a prototype agent system called *JavaSeal* [22] [23] was implemented within the MEDIA project (Mobile Electronic Documents with Interacting Agents) [24].

### 4 The Active Business Object (ABO) Framework

Having discussed the groundings and an enabling technology, it is now necessary to describe the ABO framework. ABO (Active Business Objects) identifies both a conceptual and an operational framework based on the ABC/M Target, previously shown in Figure 2 and the mobile object (agent) paradigm. Our starting point unfolds from this Target, and more specifically at the Referential level. This referential level can be assimilated to the notion of a business dictionary holding everything that is necessary to describes the business at a conceptual level (i.e., in terms of processes, activities and resources).

The ABC/M model relies on a producer-consumer relationship between these three concepts that are necessary and sufficient to describe and thus model a Business: *processes*, *activities* and *resources*. We provide below a definition for each:



- **Process:** a process is a notion freed from any organizational or structural dimension. It captures a functional dimension, transverse to the organization, oriented towards a production objective. In many cases although it is not a rule, processes, compound or not, can be interpreted as products. The notion of process is not primary or final in the sense that it can be refined within the model with sub-processes. Process interpretation and perception is thus dependent of the level of abstraction of its observer. Consequently, a process describes a functional objective of the business, composed of activities and/or sub-processes together with the necessary resources involved in their fulfillment.
- **Activity:** an activity identifies an action which can be characterized by a verb and an object upon which the action applies. Activities are necessary in (i.e., consumed) fulfilling processes. Moreover, activities consume resources necessary to their fulfillment. The notion of activity can be considered primary or final in the sense it can not be refined within the model even if activities could be further decomposed into tasks. However this level of description is not needed as tasks can be considered attributes of an activity.
- **Resource:** a resource identifies in a very broad sense any production factor whose consumption occurs within activities (i.e., which are necessary for fulfilling activities). The notion of resource can be considered primary or final in the sense it can not be refined within the model.

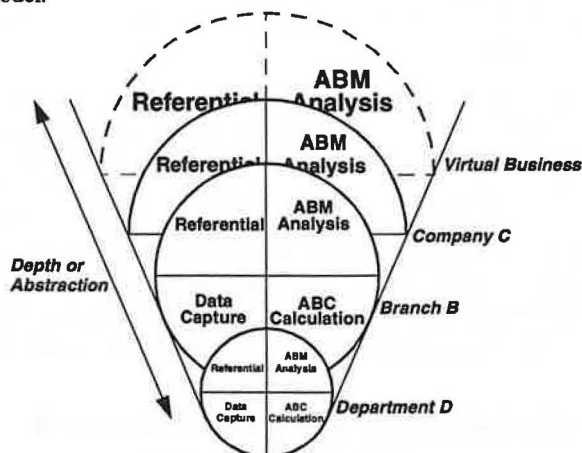


Figure 3 Different abstraction layers of an ABC/ABM approach

Such businesses can be both real and/or virtual thus spanning a network of interconnected businesses unified by a common goal (commonly called a virtual enterprise). No matter what abstraction level (depth) is considered there will always be a corresponding Target describing it in terms of referential, management instruments (ABM), costing tools (ABC) and the corresponding relevant data and their acquisition mode. This is graphically shown in Figure 3.

#### 4.1 The ABO Model

We have decomposed the ABOs in two distinct categories: Referential ABOs and Operational ABOs. The first category serving the purpose of capturing the business in terms of a model. The second category, the operational ABOs to capture the actual life (instances) of the business, through business objects. This keeping in mind that a central issue in the ABO framework is to be able at all time to measure everything and hence report activity through management instrument panels and allow action on the business to be taken both at the referential level and at the operational level. Although both categories will be modeled as agents, only the operational ABO agents will have migration capabilities. Referential ABO agents do not need mobility as they are bound to a given abstraction describing a business reason for which we consider them as static agents. The ABO model is shown graphically in Figure 4.

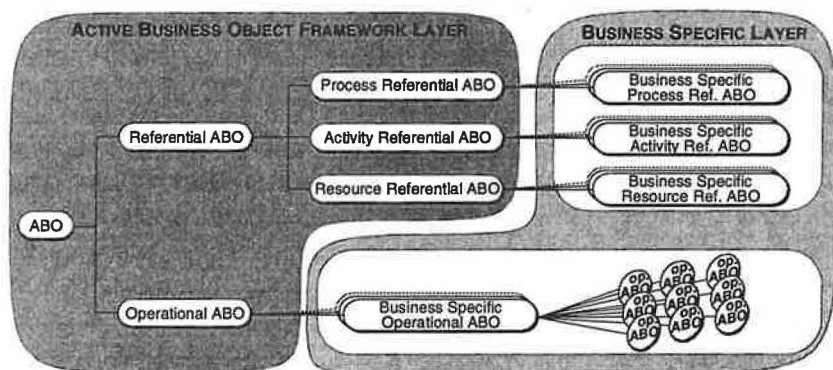


Figure 4 The ABO Model

The Referential ABO category can be further refined into three sub-categories following the ABC/ABM model. Namely: process, activity and resource Referential ABOs. This will allow to capture the model of the business in the referential upon which the Operational ABOs will be based. Furthermore having such referential objects will also allow to measure them as abstractions of the business. For example an order process referential ABO would not only allow to measure, trace and monitor the order operational ABO instances bound to it, but also the process itself and/or its activities and resources as abstractions of the business referential.

The Operational ABO type can be seen from the framework stand point as a generic Business Object wrapper which is active (i.e. holds code), mobile (i.e., able to move around the network) and persistent (i.e., able to keep state between executions). It actually represents both a container and a vehicle for any instance of a business object. Since business objects are encapsulated within agents which are active software entities that the recipient(s) must execute (in order to get access to them), the provider's infrastructure (i.e. the particular Business Information System) can include code not only defining the structure of the business information and how it should be displayed, but also how to protect itself and interact with the recipient(s) asking, for example, authorization passwords, verifying the integrity of its contents, decrypting sensitive parts of the information, allowing the recipient(s) to interrogate it and obtain basic information

about its contents, and even send messages through the network to any other involved party (e.g. bank(s), transport and insurance companies, subcontractors, e.t.c.). Furthermore ABOs are likely to interact with each other and trigger actions on their own in given situations (e.g., for a certain task two ABOs need to reach a certain state and trigger a specific action within a specified time frame; if one of the ABOs did not reach the required state within the specified time frame, a recovery action can be triggered by it or its peer ABO). Such Operational ABOs will be traveling within the business among the different activities composing the process to which it is attached as well as among various businesses and consumers thus enabling virtual business processes and interactions. This requires that the Operational ABOs be able to secure their content in clusters accessible only to their legitimate users.

From there on, it becomes possible to measure and monitor these agents in a way similar to placing probes within them. As a result, managers and decision makers can be given tools allowing them to build management instrument panels showing in real time the indicators for which they have expressed interest. These indicators can reflect information from either the referential level (i.e., Referential ABOs) or from the operational level (i.e., Operational ABOs). Furthermore, it also becomes possible to browse and navigate through the ABOs to audit the business trying to identify poor business patterns and malfunctions and thus take corresponding actions. Finally, goal oriented simulations and scenario evaluation become possible.

## 4.2 The ABO Architecture

Based on previous experiences gained in agent based systems, we have designed and implemented a prototype framework (*Hep*) for the commercial distribution and exchange of electronic documents over open networks such as the Internet [25]. This relates to what is also known as secure content encapsulation and superdistribution. Although the issues are very different, it appears that from an infrastructure stand point they share many similarities. Thus building upon this experience and the existing *Hep* framework towards our goal seems to be a promising direction where Active Business Objects could be considered as another class of electronic publishing application centered around notions of Active Business Objects and management tools. Such a layer must provide a clear interface (API) to the application layer thus allowing to build ABO based applications and interfaces to existing applications. The *Hep* framework has been successfully used in the implementation of *HyperNews* [26] [27] [28] using the *JavaSeal* agent execution platform.

The publishing paradigm fits well in this context. Literally, publishing means to make known, to announce, to release. In the same vein, one can consider that an business object instance (i.e., an Operational ABO) moving around the network is published in a restricted way (i.e., usually on a one to one basis) at each step of the business process to which it belongs. Furthermore, changes in objects that are measured by indicators in management instrument panels are also published to those having registered for notification.

### **4.3 ABO Based Tools**

Having described our approach through a model for Active Business Objects and an agent based architecture for their secure distribution and exchange, we now consider the anticipated tools for operating Active Business Objects. Among the most important we have identified the following:

The first tool that is needed to operate Active Business Objects is a business modeling tool. It will allow to define the business referential in terms of processes activities and resources based on the bottom-up modeling approach described previously. Its role is to capture and instantiate the business specific referential.

Given a referential, a tool is needed to browse and navigate through it. Such an ABO browser or navigator can be implemented easily using any standard Web browser. In a similar way, the ABO browser can also be used to browse Operational ABOs.

In order to be able to do measurements and thus build the management instrument panels, a toolbox is needed to allow managers and decision makers to extract the needed indicators and information from both the referential and the operational ABOs in a way similar to placing a probe within them. Finally cost information should be able to be witnessed in a way reflecting real resource consumption as advised by the ABC/ABM model.

## **5 Conclusion**

The history of management is probably at a turning point at least as far as information systems are concerned. When accounting was done by hand, one could reasonably defend that one or two analysis a year were enough (profit and loss, balance sheet). Nowadays, observing information a-posteriori after a long time period is not reasonable anymore. Current systems are too often traditional accounting systems that have been mechanized with more or less efficiency. Moving management analysis from a yearly basis to a monthly basis certainly is a progress, but capturing information directly at the source of consumption would be far more efficient.

In fact, the world in which we live is to be considered in its complex and continuous aspect and not in a sequence of states having transitions that remain unexplained. The systems that should be controlled are alive and evolve at fast pace. It is thus advisable to analyze them as such, and to understand the resource consumption functions that underlie them. To progress in this direction, the development of management and measuring instruments in continuous and real time is impossible to circumvent, particularly with the fantastic technological developments achieved in recent years.

In this paper we have proposed an inter-disciplinary approach (management and technology) towards real time management and global business object exchange infrastructure. It stems from the combination of a technology known as mobile objects or agents and a management framework called ABC/ABM used as a methodology. Many issues still remain open and will need further investigation as we have only sketched a vision based on solid experience in both fields of management and technology. However, we are confident that the proposed reasoning will be useful in progressing towards innovative management and information system cross-fertilizations thus setting the grounds enabling new heuristics. We anticipate in the short term to

build a proof of concept prototype in order to evaluate and assess the Active Business Object approach on a representative set of application scenarios based on real cases drawn from the industry.

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