

# A Systematic Approach to Organizational Workflow Application Development

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## Abstract

Workflow applications automate business processes. A common approach to the development of workflow applications usually consists of the description of the desired functionality directly followed by workflow implementation. This approach has the disadvantage that it considers mainly implementation issues and the developed application is no way related to the business process it automates. In this paper we claim that a systematic approach to workflow application development should start from the definition and understanding of the corresponding business process before proceeding to the specification and implementation of workflow applications. Along these lines, we present our experience and efforts to describe and analyze a real world business process and to design and implement corresponding workflows in a systematic way by using the formal Modified Petri Net (MPN) model for business process modeling and the commercial product FlowMark for workflow development. The advantages of this approach is also discussed.

**Keywords:** business processes, workflow application development

## Introduction

Business processes (b.p.'s) are collections of activities with a common goal or objective such as fulfilling a business contract, and/or satisfying a customer need. Workflow applications implement b.p.'s by automating the coordination, control and communication of basic activities performed in an organization by information systems or humans. Therefore, for the efficient workflow application development, one should start with definition and understanding of the b.p. before specifying and implementing workflow applications which support the automation of the b.p.

A b.p. definition, i.e. a description of a b.p. at a high conceptual level necessary for process understanding, evaluation and redesign, in order to be constructed, requires a *model* that provides a set of concepts appropriate to describe b.p.'s, their activities, the coordination of the activities, and the required roles that can perform the specified activities. Such a model should also be rich enough and enable process validation (e.g. by simulation or static analysis) in order to decide that the process definition actually represents the intended process. In this paper, the model we use for constructing b.p. definitions is the Modified Petri Nets (MPNs) (Tsalgatidou et al, 1996), a formal model based on Petri Nets (Murata, 1988) which satisfies the above requirements.

A b.p. definition can then be used for developing a workflow definition, i.e. a description of the same process at a lower-level of detail required for b.p.

implementation. The definition of a workflow involves the specification of consisting activities, workflow data and resources necessary for the execution of an activity, organizational structure and roles, participants or performers of an activity as well as the control flow and dataflow dependencies between activities. Workflow implementation is realised by Workflow Management Systems (WFMS). WFMSs manage the enactment of processes through the use of software that directly interprets the process definition and coordinates human and system participants by passing information or tasks from one participant to another for action, according to a set of predefined rules. WFMS provide a workflow model which has the necessary concepts for creating workflow definitions. Therefore, workflow definitions are usually constructed using the model provided by the WFMS at hand. The WFMS we have selected for workflow implementation is the commercial product FlowMark by IBM (IBM 96).

It has become clear now that a systematic approach to b.p. automation through workflow application development should consist of discrete stages related to

- the definition and study of a business process (b.p.) and
- the definition and implementation of the workflow

In this following sections we describe our efforts and experience in defining b.p.'s (using MPN) and subsequently developing workflows (using FlowMark) for the internal communication and coordination of the Departmental Libraries in the University of Athens in Greece. More specifically, we first present the "Material Ordering" b.p. of the University Library as a typical example of a process which is automated by a parametric workflow application. Then, we describe briefly MPN and demonstrate how it can be used for b.p. modeling. In the sequel we discuss the mapping of the constructed MPN b.p. model to a workflow model supported by FlowMark. This mapping is necessary in order to ensure that the functionality of the specified b.p. is fully presented and realized within FlowMark's environment. Finally, the advantages and disadvantages of using and combining both tools is discussed.

### **Business Process Description**

Athens University is the oldest and largest university in Greece offering courses covering a wide range of scientific areas. Within the framework of a reorganization project until year 2000 all the university libraries will participate in University's *Library Organization* founded a year ago. A proposed structure for this organization involves a three-level hierarchy consisting of:

- a) A Central Management Unit (C.M.U.), responsible for coordinating library operation and financial management.
- b) 12 Central Libraries (C.L.) supporting different scientific areas and consisting of different offices responsible for discrete operation procedures.

- c) Departmental Libraries (D.L.) which belong to a specific C.L. and follow its operation procedures.

The “Material Ordering” b.p. was chosen as a typical executive b.p. example. It involves all the entities composing the *Library Organization* structure, requires the participation of employees working in different locations and can be applied in exactly the same way for all the supported libraries. These characteristics allowed us to evaluate all the parametric features of the tools used. The “Material Ordering” b.p. consists of discrete activities recorded in Table 1.

1	Collect and Register ‘Item Ordering Forms’
2	Group ‘Item Ordering Forms’ according to the library which has submitted them
3	Check for Duplicate ‘Orders’ in orders from libraries belonging to the same Central Library and Confirm Orders
4	Collect all Confirmed Orders and Create the C.L. Order
5	Check for Duplicate Orders in orders submitted by different C.L. and Confirm
6	Check the availability of the Ordered Items in cooperation with suppliers.
7	Form the Final Order and forward it to the supplier.

Table 1: Activities in the “Material Ordering” business process

Some of the people involved in the “Material Ordering” b.p. are the employees of the *Resource Management Office* (R.M.O.) in D.L. and C.L., the Manager of R.M.O., the Director of C.L.s and the employees of R.M.O. in the C.M.U.

### Modelling Approach

The Multi-Level Modified Petri Net model is formally defined as a tuple:  $MPN = \langle P, T, F, N, \Sigma, script, struct, SubMPNs, M_0 \rangle$ . A detailed description of MPNs can be found in (Tsalgatidou, 1996). MPNs provide constructs for accommodating all kind of information necessary for b.p. description. More specifically *activities* are modeled as transitions, *control* information, *resources* and *actors* required for the execution of activities are modeled as objects inscribing the MPN places. Control objects are either signals (representing messages among activities) or events (representing occurrences of incidents) and allow for the representation of control flow in the process. Resource objects are data objects used by the process, such as invoices, etc. and allow for the representation of data flow in the process. An actor represents a set of duties and responsibilities in the organization or an external participant. Actors are required in the input places of a given transition where the presence of specific human

participants is essential for its enactment. The organizational hierarchy is depicted in the underlying structure  $\Sigma$  of the MPN, while actors are mapped to specific employees using appropriate MPN functions. The various steps carried out during the execution of an activity are described by *scripts*.

The MPN model for the “Material Ordering” b.p. is depicted in figure 1. As indicated in the figure, the b.p. consists of several activities corresponding to the steps presented in Table 1.

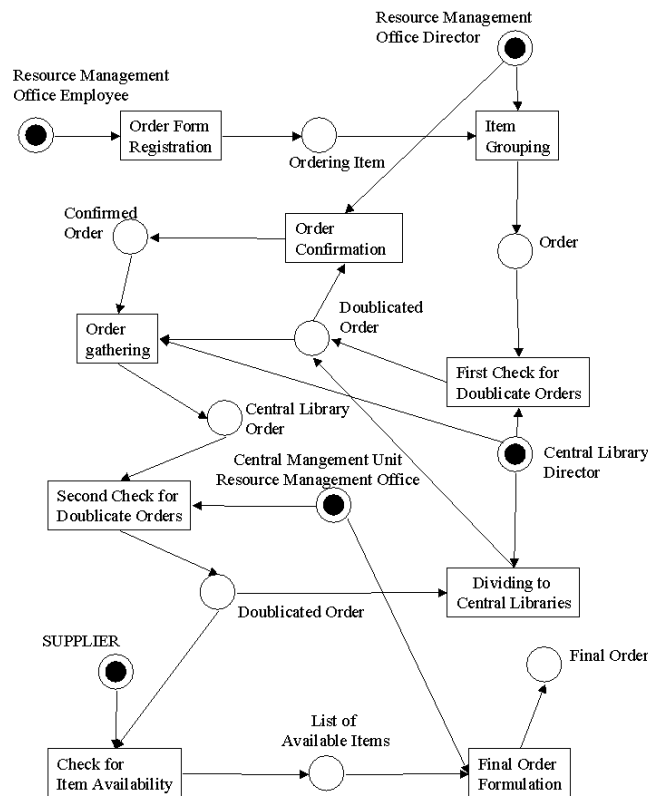


Figure 1: MPN model corresponding to the “Material Ordering” b.p.

The “Item Grouping” activity corresponds to the grouping of all item ordering requests in a specific library. It is represented as a transition from “Resource Office Management Manager” and “Ordering Item” places to “Order” place. This indicates the fact the Resource Office Management Officer of each library is responsible for performing the Item Grouping activity. The result of this activity is the formation of an Order for each library based on the Ordering Items.

In order to write scripts we have introduced a Pascal-like language, which was easy to use and understand and allowed the description of activities in a parametric way. The same activity description can be applied for different libraries, with the modification of proper parameters. The MPN model provides to framework to

activate the same activity many times, each time with different parameters. The script corresponding to the “First Check for Double Orders” is presented in fig. 2.

```

Activity: First check for double orders (Actor: Director)
Description: The Director of every Central Library gathers all the orders from the
Departmental Libraries, checks if there are items ordered twice and creates a list of the
double orders.
Script :
READ order;
IF order.Central_Library = CL1 THEN N1= N1+1 AND i =1;
IF order.Central_Library = CL2 THEN N2= N2+1 AND i =2;
...
IF Ni = (Number_of_PL)i+1 AND Director.Library = CLi THEN
  READ ALL order WHERE Central_Library = CLi;
  SEARCH FOR double_records;
  IF double_records THEN Existence_of_double_records = YES
  ELSE
    Existence_of_double_records = NO;
    Ni = 0;
    Confirmed= NO;
    CREATE Duplicate Order;
  ELSE WAIT;

```

Figure 2. Script for “First Check for Double Orders”

### Implementation

FlowMark is a client-server program developed by IBM to operate in an heterogeneous environment (IBM 1996). The main entities supported by FlowMark for workflow applications construction are: *Processes* which consist of activities or other processes and allow the description of workflows in various abstraction levels, activity, *Activities* which are process steps and are represented in the FlowMark as program or process activities, *Connectors* which connect the activities of the process, *Data Container* which is used as data input or output for an activity, *Data Structure* which is a list constituted from a name and a data type, *Staff* which contains the organisational structure and corresponding employees performing the activities and *Bundle* which is a structure allowing the parametric invocation of an activity.

Stages 2 and 3 of the “Material Ordering” b.p. as modelled in FlowMark are presented in figure 3. Bundle\_1 indicates the parametric invocation of Order\_Gathering for all the C.L.s. The Input Data Container contains a list of the twelve Central Libraries. The definition of Bundle\_1 is presented in figure 4.

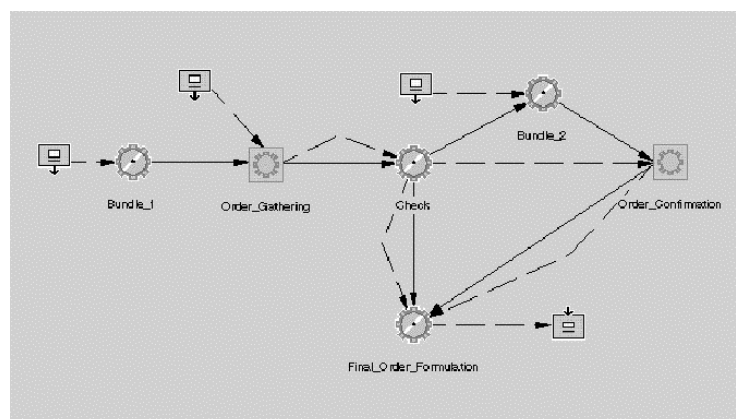


Figure 3: FlowMark model corresponding to Items Purchasing Procedure

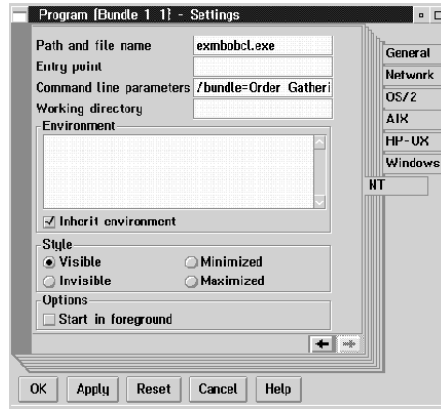


Figure 4: Bundle Definion in FlowMark

The mapping between MPN's and FlowMark's model entities is depicted in the following table:

Modified Petri Nets	IBM FlowMark
Actor	Role
Employee	Person
Organization	Organization
Activity	Activity
Resources	Data container
Control information	Transition condition

Table 2: Mapping between MPN's and FlowMark's Model

As indicated in the table all the main entities of MPN can be directly mapped onto FlowMark's environment. The successful mapping between the two models contributed in two directions: (a) The full representation of the business process as an automated workflow application is guaranteed, since all the activities described using MPN are directly implemented in FlowMark and (b) It allowed the evaluation of FlowMark's ability to support the business process functionality depicted in MPN model.

## Conclusion

The definition and study of a business process before workflow implementation can save both time and money, since it facilitates the representation and study of real world business processes before considering implementation issues. In this paper we presented a systematic approach for developing workflow applications. The formal MPN model and the IBM's FlowMark were used for modeling, analyzing and automating a real world business process by implementing workflow applications.

Both MPNs and FlowMark provided appropriate constructs for the parametric description of business processes and the corresponding workflows. Also both tools provided different levels of abstraction facilitating the user to describe workflow in different levels of detail, although this was not shown here due to space limitations. The modeling of the b.p. using MPN enabled the analysis and evaluation of the process at hand prior to its implementation. This aspect, in combination with the straightforward mapping of the MPN model to the FlowMark's workflow model, resulted to the efficient and successful development of a workflow application that automates important features of the selected business process.

## References

D. Georgakopoulos and A. Tsalgatiou, (1998). «Technology and Tools for Comprehensive Business Process Lifecycle Management», in *Workflow Management and Interoperability*, A. Dogac et al (eds.), NATO ASI Series F, pp. 324-263, Springer Verlag.

IBM FlowMark – Installation and Maintenance, 1996.

Murata, T. (1989). Petri Nets: Properties, Analysis and Applications. Proceedings of the IEEE, 77 (4), pp. 541-580.

A. Tsalgatiou, P. Louridas, G. Fesakis and Th. Schizas, "Multilevel Petri Nets for Modeling and Simulating Organizational Dynamic Behaviour", *Simulation & Gaming*, Special Issue on Simulation of Information Systems, Sage Publications, vol. 27, no. 4, pp. 484-506, 1996.