

4 A MODEL BASED APPROACH FOR CONSTRUCTION PROCESS MODELLING

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Abstract

Process modelling methods have been developed for describing different aspects of industrial and other processes. Each method has a specific scope for which it has been designed. Used outside this scope the method may prove quite inadequate. The generic construction process modelling method GEPM has been developed as a synthesis of features of other methods. GEPM is flexible in a sense that the conceptual model can be changed in order to achieve specialised additional features when needed. The database implementation supports this approach as well as it enables the users to interact with the developed process models through views. The chosen views correspond to scheduling, IDEF0, and flow methods. GEPM can be used for describing partly company specific quality systems with reference models, which can be converted into project specific models using certain rules and finally these specific models become schedules.

Keywords: *process, modelling, model, view, usage*



INTRODUCTION

Many process modelling methods or techniques have been used to model construction processes. Process modelling is needed for various purposes, for instance for designing, planning, controlling and improving the processes. There are construction specific characteristics; projects have many participants, which change [Lahdenperä 1995] from one project to another, the building is in many cases unique. Problem objects vary from multi-storey houses to Finnish summerhouses, Figure 1. Processes, or in fact actually construction projects, are in many cases described at a general or at a specific level. Well-known methods in practice are scheduling and project planning methods such as PERT or CPM using applications such as MS Project and Primavera. IDEF0 [ICAM 1981, IDEF0 1993] has in particular in R&D been used for describing activities and information and product flows between the activities [Sanvido 1990, Laitinen 1998]. Moreover, attempts to improve the project management have been undertaken, for instance in the UK construction industry [PP 2001].

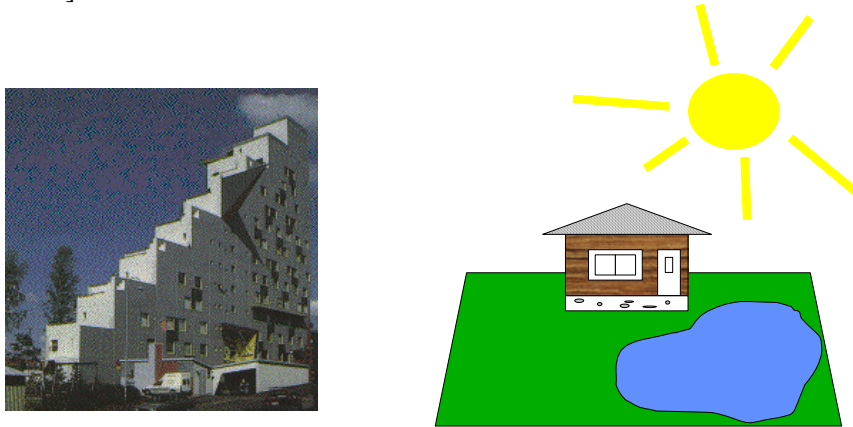


Figure 1. Problem objects vary from multi-storey houses on the left to Finnish summerhouses on the right.

Modern database tools and product modelling techniques offer new ways to develop methods which could serve the modelling requirements of several different views at the same time, by storing the models in a database format and allowing different views into the databases. In order to overcome the deficiencies of existing methods, a new process modelling method called GEPM (generic process modelling method) has been suggested by Karhu [Karhu 2000]. The basic idea behind GEPM is that a number of views can be generated from a single model to serve the different needs and requirements, Figure 2.

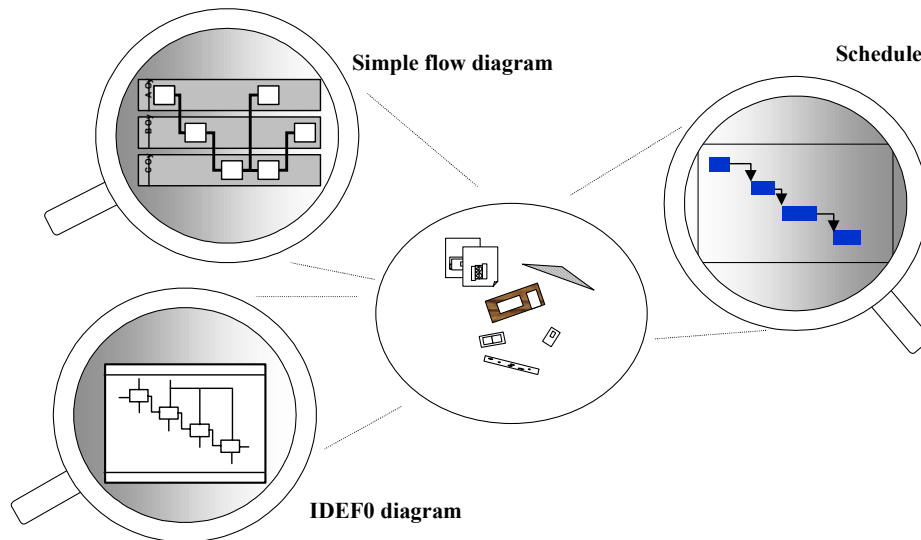


Figure 2. GEPM views.

The objectives of this paper are to describe the GEPM method at a general level, and to propose guidelines and a usage scenario for GEPM. This paper presents the intermediate results of an on-going international research project called MoPo (Models for the Construction Process). The overall aim of MoPo is to develop IT-based modelling tools and methods for construction process analysis and planning as well as adaptable models and methods which can be reused in a modular way as parts of company and project specific modelling efforts [MoPo 2000].

DEVELOPMENT OF GEPM

The generic process modelling method GEPM has been developed as a synthesis method of features of six existing process modelling methods that have been used or proposed for construction process modelling [Karhu 2000] as scheduling, simple flow method [Hoffner 1997], IDEF0 [IDEF0 1993], IDEF0v [Austin et al. 1998], IDEF3 [Mayer et al 1998] and PetriNets [Viswanadham and Narahari 1992, Wakefield and Damrianant 1999, Volkhard 1989]. The scheduling method denotes the familiar project planning or scheduling techniques, for instance critical path, resource levelling, precedence method, PERT, etc.

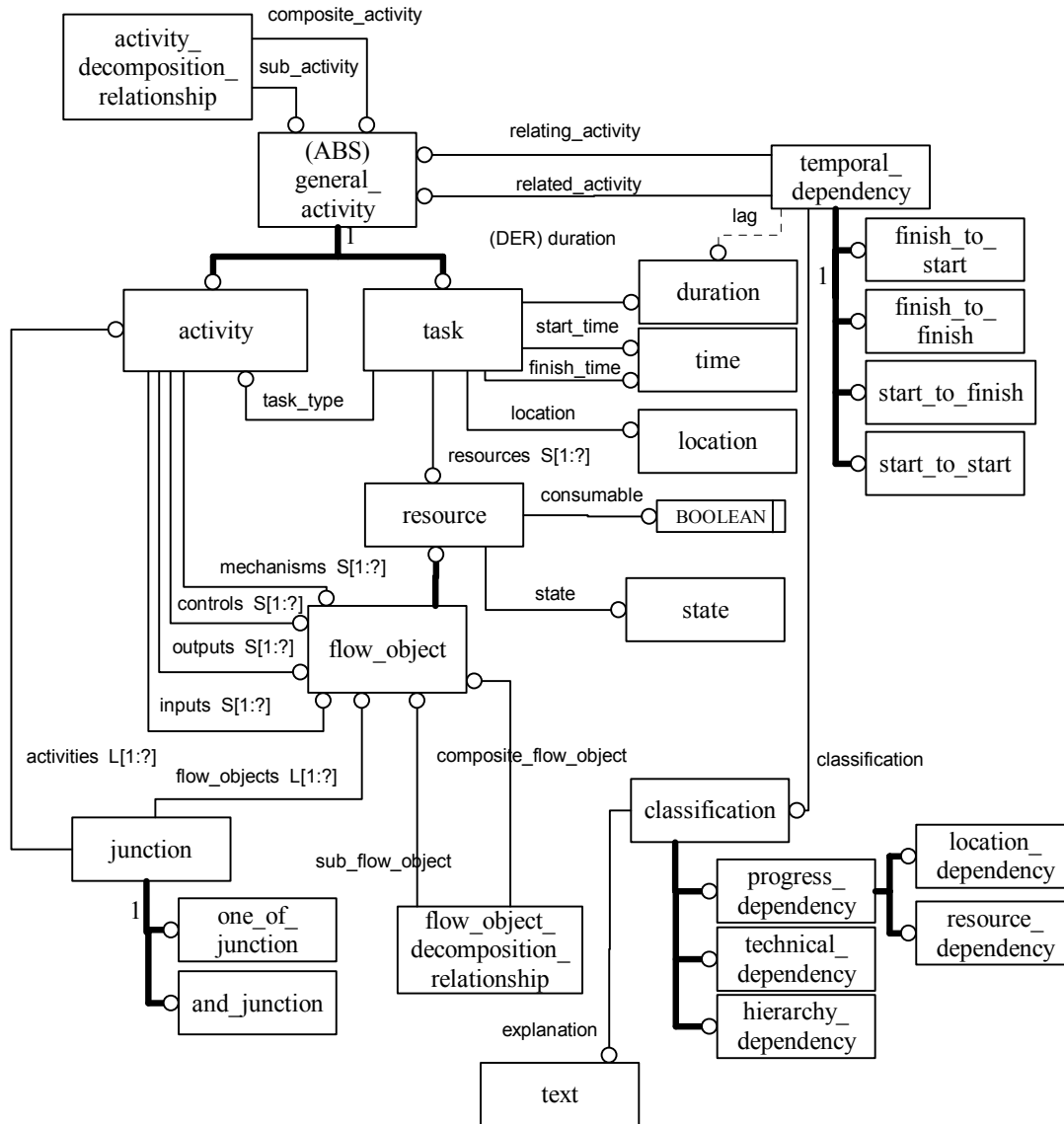


Figure 3. Conceptual model of GEPM.

One of the main concepts in the GEPM method is the distinction of an activity and a task. GEPM defines a type for the task. The type is an activity. The activity is similar to the activity in the IDEF0 method and the task is similar to a task in the scheduling method. The flow object as defined here can function as an input, output, control, or mechanism for the activity. The flow object follows the IDEF0 concept in that the role of the flow object determines whether it becomes an input, output, etc. In addition to the concepts borrowed from other methods, the analysis of one case project data [Tanhuanpää and Lahdenperä 1996] showed that the concepts of location of task and classification of temporal dependencies between are also needed. The conceptual model of GEPM is shown in Figure 3 as an EXPRESS-G diagram [ISO 1994].

PROTOTYPE APPLICATION, VIEWS AND DATA EXCHANGE

The prototype application called GEPM browser was developed using the Lotus Notes platform. The GEPM browser can be used to create a complete model, called a GEPM model here. In practice, and because of the lack of resources to develop a full software application for end-users' needs, it is appropriate to use separate and often well developed software applications to generate partial models. Figure 4 shows schematically the data exchange with a number of other tools that correspond to the GEPM views in Figure 2. The dependency table is generated with the GEPM browser and exists only in conjunction with tasks. The reason why these views, and not all constituent methods, have been chosen is that it has become clear in the interviews with the companies participating in the MoPo-project that these particular views are important and useful.

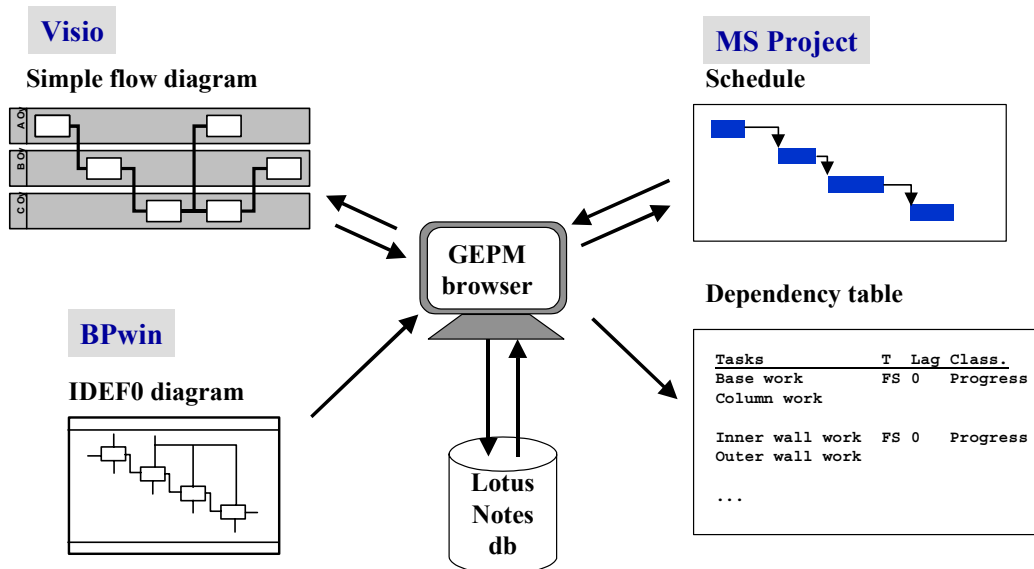


Figure 4. Views for different purposes chosen in this paper.

Table 1. GEPM concepts vs. concepts in other methods.

GEPM	Scheduling method	Simple flow method	IDEF0
activity	-	activity	activity
task	task	-	-
task type	-	-	-
activity decomposition relationship	task decomposition relationship	-	activity decomposition relationship
flow object	-	flow	icom
input	-	input of	input
output	-	output of	output
control	-	-	control
mechanism	-	person	mechanism
resource	resource	-	-
flow object decomposition relationship	-	flow decomposition relationship	icom decomposition relationship
state	-	-	-
temporal dependency	temporal dependency	-	-
dependency classification	-	-	-
location	-	-	-

The main concepts, either entities or their attributes, that can be handled in the prototype are shown in more detail in Table 1.

USING GEPM IN PRACTICE

Case scenario

The basic principles of how to use GEPM have been described in papers [Karhu 2000, Karhu 2001]. This chapter discusses a possible scenario for using GEPM in practice and how to re-use existing process solutions in a company.

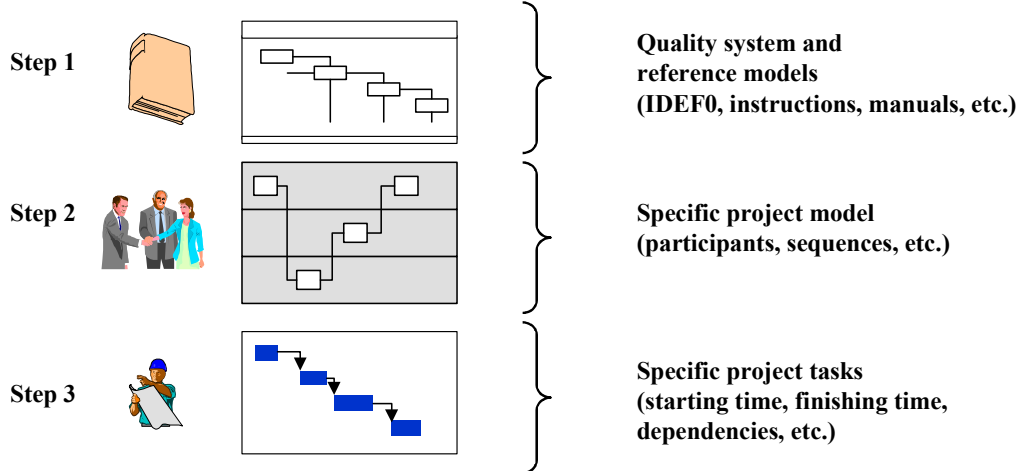


Figure 5. Usage scenario for GEPM.

Figure 5 depicts one usage scenario for GEPM consisting of three steps. Many companies have developed quality systems. Quality systems often contain manuals, checklists and instructions about how to perform certain operations, to help in deciding responsibility limits, etc. In step 1, the IDEF0 method can be used to describe parts or certain aspects of the quality system in a formal way [Hannus and Pietiläinen 1995]. There could be a number of different alternatives for various purposes documented in the quality system with a number of related documents and instructions. The GEPM browser can be used to store this information in a database format. The users interact with the quality system through views such as the IDEF0 view.

In step 2, a project specific model can be created from the reference model or the quality system using the simple flow method to emphasise participants, possible sequences of activities, etc. Here the GEPM browser works as a converter of the general process model into a project specific model. All necessary information is stored in the GEPM database as well. Further, in step 3, the specific project model is then scheduled for the actual work. Similar to the procedure in the earlier steps, the schedule is stored in the GEPM database. At this stage, the process starting from the quality system is documented in one database.

View conversions

Conversions between the different views, Figure 4, are of importance and constitute the principles of how to model using GEPM. In principle, GEPM has two basic types of entities: activities and tasks. These are orthogonal in the sense that they do not have common attributes, except for the inheritance of temporal dependencies from the abstract upper class

'general activity'. Activities may be modelled either using the simple flow view or the IDEF0 view. Considering a simplified IDEF0 example (Figure 6), converting from IDEF0 to simple flow means a reduction of the information contained in the model because the control concept is not converted and thus lost. This is because control is not part of the simple flow method. On the other hand, if the feedback 'Reinforcement' was modelled as input to the activity 'Place formwork', it would become a part of the model in the simple flow view. Thus, the conversions depend on the modelling choices, i.e. the way in which the modelling work is done. Another difference concerns the hierarchy feature, which is not part of the simple flow method.

The hierarchy functions as an abstraction mechanism in IDEF0 and may be interpreted also in such a way that certain activities are grouped together. In practice, in a conversion from IDEF0 to simple flow, the user selects the level of the activities, which shall be converted. The developed prototype application supports this kind of procedure. The resulting simple flow views may thus represent the different levels of hierarchy of the IDEF0 submodel but only one level at a time.

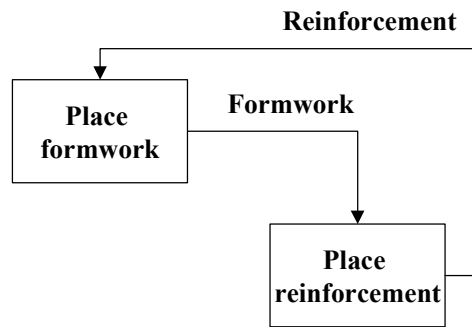


Figure 6. The modelling of feedback in IDEF0.

CONCLUSIONS

GEPM can be used to help companies to develop reference models for their quality systems. It also helps in determining how to proceed from the quality systems into actual projects. GEPM can be used to describe a process of a construction project. Questions are the conversion rules and guidelines for how to use the constituent methods in order to obtain satisfactory results. Future improvements of GEPM would require a support for more modelling methods such as Petri Nets in form of conversion rules and guidelines. Naturally, the GEPM browser needs improvements as well.

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