Workflow management based on Information Management

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Abstract
In manufacturing processes, the role of the underlying information is of the utmost importance. Based on three different types of integration (function, information and control), as well as the theory of information management and the accompanying information structures, the entire product creation process can be formulated in terms of the information requirements of distinct processes. So-called task chains can establish the correlation between processes. Using formal representations of the information content (ontologies), a flexible resolution of process-steps is achieved. Based on this, an improved method for workflow management comes within reach.

Keywords: Information management, Integration, Workflow management

1 INTRODUCTION

During the last century, different types of manufacturing organisation structures have been implemented. From the start of intentional formalisation in industry, decentralisation and specialisation were considered to contribute to both the efficiency and the effectiveness of production activities. In many cases, this has indeed been true as, for example, the introduction of both fabrication and assembly lines offered higher profitability. The tendency to shape non-production processes (like design and engineering processes) in the same manner as the production processes and to impose the decentralisation and specialisation of labour on these processes as well led to increasing formalism in all departments of manufacturing industries. The resulting lack of interdepartmental co-operation often counteracts the increased performance in specific departments to such an extent, that the overall performance decreases. This calls for an approach in which the interaction between departments (either in terms of co-operation or integration) gains undivided attention, but without the denial of the specific quality and significance of separate departments and processes.

1.1 Definition of integration

In order to allow for an unequivocal approach towards the co-operation of processes, it is important to establish an unambiguous interpretation of the notion integration. Because most definitions given in literature originate from a specific context, and are therefore hardly suitable (nor intended) for use in different situations, it makes sense to start from a definition that is independent of the context. In general, the act of integration can be defined as the effort to: i) combine (parts) into a whole; ii) complete (an imperfect thing) by the addition of parts.

In both cases, the result is something that can be seen as a whole; however, it is not necessarily an indivisible unity. This seemingly non-essential detail has been the cause of many flaws in integration efforts; often, integration is interpreted as the once-only, irreversible amalgamation of functions. This approach leads to a number of problems, as e.g. the addressing of specific functions or functionalities in the instantiated entity becomes increasingly difficult. Moreover, the control of the integrated functions will –opposed to expectations– require a significant increase in the intensity of communication, from which the flexibility and decisiveness will suffer considerably.

In order to avoid a biassed approach and a prejudice for certain methodologies, the paradigm must be that in the integration of functions, the identity of the separate functions should not be lost. Limiting conditions in this are the controllability, flexibility and configurability of the participatory functions. Furthermore, as the extendability with respect to the addition of new or modified functions has to be guaranteed on beforehand, it is clear that a panacea for the integration of functions can impossibly be delineated in terms of a definite recipe. No recipe can deal with all the differences between specific manufacturing environments, and for the time-dependent changes in those environments.

What can be done, however, is to design a methodology that facilitates the functional linkage of functions, in which the focus is on the relation between these functions [1]. This implies that the emphasis has to be on the way in which co-operation between functions can be achieved, and not on the way in which functions have to be adapted to become part of an integrated environment. Consequently, the notion of integration is interpreted as the facilitation of mutual co-operation and interaction between distinct functions.

2 INTEGRATION AND INTERACTION

In a manufacturing environment, almost all functions are interrelated –if not entangled–, showing definite and rigid mutual coherence. It is this complexity that may cause saturation in a manufacturing system [2]. A logical conclusion therefore is, that a function can make the most positive contribution to the entire process, if it is not hindered by other functions. From this, an approach has been developed in which functions are treated as multi-employable modules, each contributing their specific output, and deploying their specific expertise. The consequence of this line of thought is that a backbone has to be available, that supports these functions.

Therefore, the basic principle for integration is based on facilitation instead of prescription. Facilitation enables the deployment of functions, founded on a common basis. The result is a focus on the feasibility of integration, instead of a focus of the integration itself.

Integration efforts that interfere with functions on the same level tend to cause rigidity and inflexibility. Consequently, the basis for integration is sought at a higher aggregation level, above the level where the functions act and interact. At this higher level, it becomes possible to achieve a survey of the 'landscape' in which the integration has to be achieved. From this abstract viewpoint three important factors are notable. Firstly, the amalgamation of functions is purposeless; attention should be focussed on the goals the different functions aim at. Secondly, the availability of information that serves as input for functions and the adequate conveyance of generated information allows for the provision of the information backbone that enables the effective and efficient execution of the functions. Thirdly, if the functions are becoming increasingly independent, the potential for improvement of process control increases. As a consequence, three possible ways of integration can be indicated, together contributing to a generic basis for integration:

- Integration of function;
- Integration of information;
- Integration of control.

2.1 Integration of function

The importance of a function stems from the added value that is defined by the difference between its generated output and its required input. In other words, the deployment of a function –and not the function itself– has a certain significance in the overall manufacturing process. From the fact that this importance is not the same under varying conditions, it is clear that the way in which the integration of functions should be performed can not be prescribed in a generic way. Neither can the area or context, with which the integration effort is concerned, be established on beforehand.

Consequently, integration has to aim at the effective and efficient co-operation of functions. The interactions that emerge, must depend on the input and output of the functions instead of on the functions themselves or on their location in whatever process description. In this way, the co-operation of functions can be related to their required contribution to the manufacturing process, taking into account the context and the significance of the individual functions.

2.2 Integration of information

Because it is recognised that the main input and output of functions in the manufacturing environment consist of information, it is clear that an information-processing facility can make a valuable contribution to the backbone required for the co-operation of functions. In this, it is important to note –possibly redundant– the difference between data and information. Here, data is considered to be the non-interpreted and non-contextual deposit of the information content that is required both in the employment of any individual function and in their co-operation. In other words, information is that which is extracted from data in attempting to answer specific questions. As the context is important, varying conditions will also influence the significance of information; it is therefore important to distinguish different types of information. This distinction not only encloses the difference between control information, manufacturing instructions and context information, but particularly the distinction between information related to orders, products and resources [3]).

Standards (like STEP etc.) seem suitable to fulfill the tasks described in the above. However, as every standard has to be defined on beforehand to ensure its communication goal, only an all-embracing standard would satisfy the needs. The varying context –to mention one influence– makes such a solution impracticable. The increasing interaction between functions and the accompanying information content requires more interpretation capabilities than any standard can offer. It is this lack of contextual knowledge and the dependent interpretation of data into information that prevents the unrestrained use of standards.

2.3 Integration of control

Where the functions in the manufacturing environment cooperate, based on their (information) input and output, a different approach for the control of these processes is required. Not the functions themselves, but their contributions to the manufacturing process –in effect the evolution they cause in the information content– are important. Control has to shift from something that is process based to something that is based on the information content. In other words, the information content, and especially its evolution, becomes the driver. Although it might seem different, the major part of all control concepts and methods remains applicable; under the condition that control can be exerted based on the same structure that is used as a backbone for the functions. It therefore inherits the underlying flexibility of this backbone, from which control methods can be developed in a more generic way.

3 INFORMATION MANAGEMENT

The backbone mentioned in the previous section is based on information management. In short, information management is a provision, based on which the various functions can be executed. The three information structures (for order, product and resource information), that are the main constituents, provide a robust and transparent way of dealing with information in the manufacturing environment [3]. Besides the information content, the formalisation of this content is particularly important. For this purpose, two types of ontologies are used (see figure 1).

3.1 Information content; ontology of state

If a product consists of two parts, it will immediately be recognised for being an assembly. In broadening the concept, every element in an information structure can be considered to be of a certain type; this type can be employed to specify its nature and genius. The same holds for the relations between any elements: the 'assembly' is said to *consist of* 'parts' and perhaps *have* a certain 'weight'. A typification of an element can endorse its meaning as well as the connections it has with other elements and the influence it exerts on these elements. In assuming that the principle of equality applies to all elements and relations that are addressed by a certain typification, a definition of elements and relations is engendered by all its differentiated instantiations. Formally, this growing and adapted definition contributes to the comprehension of the 'nature of being' of any concept.

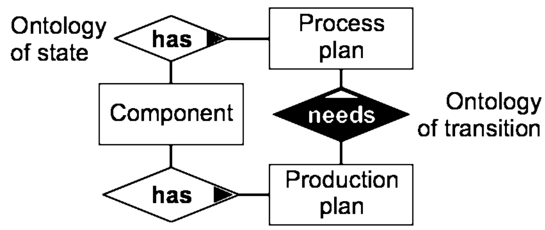

Figure 1: Ontology of state and ontology of transition.