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Knowledge management: managing organizational intelligence and knowledge in autopoietic process management systems – ten years into industrial application

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Abstract

A new approach to knowledge management in engineering domains was presented in the CIRP General Assembly 2001 with the title "An Autopoietic Approach for Building Knowledge Management Systems in Manufacturing Enterprises" [1]. Based on this a new process management system was developed and deployed. Today the system supports day to day engineering work of more than 300 engineering related staff on three continents. It drives organizational behavior by mimicking intelligence and the acquisition of knowledge, using both to derive suitable processes. This paper reports on lessons learned and may shed some light on future developments of knowledge-based manufacturing systems.

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1. Background

Key to the work presented here was a new understanding to and a new concept for intelligence and knowledge on an organizational level proposed by Thannhuber, Tseng and Bullinger [1] in 2001 and Thannhuber [2] in 2005. Up until this point knowledge management in industrial applications focused on acquiring data and information as well as managing them together with contextualizing meta information in IT Systems and delivering the right information at the right time to individual employees for their decision making or to support their value adding tasks. While these activities undoubtedly deliver their benefits however a new complementary approach was proposed that should better utilize efforts spent in the real world and potentials made available by phenomena that are described by 'intelligence', 'knowledge' or 'cognition'. Instead of purely empowering the individual in an industrial organization the focus should be shifted to the organization itself and how its behavior, responsiveness and efficiency can be improved by organizational knowledge and frameworks that breed intelligent behavior.

1.1. Phenomenological discussion of knowledge and intelligence on an organizational level

Although knowledge and intelligence are widely discussed for the human domain they are phenomena that evolution brought to emergence for natural systems in general to succeed in the competition to best adapt to their ecological niche and to best exploit the resources within it. Knowledge and intelligence help natural systems to derive successful behavior. Looking closer this 'successful behavior' in particular needs to balance three mutual exclusive abilities at highest levels: precision in execution wasting a minimum amount of internal resources while at the same time being able to cope with increasing dynamics in environments that constantly change and being able to cope with an increasing

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complexity. A situation well known to the engineering domain, too! Constituted out of human beings, cooperating to exploit marked niches, industrial organizations are nothing else but natural systems themselves [2].

Knowledge and Intelligence belong to the fundamental mechanisms to derive successful behavior. In the industrial context an organization's behavior is derived from coordinated activities its human staff develops by 'enacting' organizational processes. It is the sequence of activities, their coordination and interplay that leads to a company's successful behavior.

Intelligence in this context is a framework that enables an organization to derive well-coordinated and effective processes to behave responsive and successful. A framework that is built upon a suitable structure (physical infrastructure, components, … as given by IT systems, the hierarchy of command, process planning departments, etc.) and its organization (defining the interplay of the components as given e.g. by procedures on how to coordinate activities to a process). This processing framework allows an organization to take in stimuli, derive a suitable response process, support its enactment and capture the proceedings and success of the enacted process.

Knowledge is the content gathered or established in the processing framework based on which the framework's organization derives the assembly of activities to a suitable process. It is the content that drives intelligent processing and defines how the processing framework is further developed.

Knowledge management on an organizational level now gets a rather differentiated notion. There is no knowledge without intelligence! Managing knowledge on an organizational level first of all requires the management of intelligence. Managing knowledge in addition is all about deriving the right coordination of activities of staff members rather than increasing the individual knowledge of a single staff member.

1.2. Prerequisites for managing intelligence and knowledge on an organizational level

Earlier thoughts throughout the research on this topic suggested that there are a few necessary prerequisites to a working industrial implementation [1].

First of all system intelligence is to be institutionalized by a suitable processing framework. In today's industrial engineering context, systems institutionalizing the setup and enactment of industrial or engineering processes are 'Process Management Systems' (PMS). These systems typically come along side with modern Enterprise Resource Planning (ERP) or Production Planning Systems (PPS) or are complementary standalone solutions next to ERP and PPS. It is indicated that a suitable IT-based 'PMS' is an essential part of the processing framework.

In order for a 'PMS' to play an integral role in the described framework that implements the organization's intelligence it needs to provide a conceptual solution for Taylorization. Meaning that it needs to allow processes to be regarded as compositions of work units or work steps, which are the building blocks of any process. The system needs to be able to model them as generic 'Process Building Blocks' (PBBs) [1][2] that implement capabilities of staff members and that can be assembled to form different industrial processes. They are part of the system's structure. In order to support a reasonable assembly of building blocks (leading to a reasonable coordination of work steps) the PBBs need to be equipped with contextual information (descriptive data, wrapping information) which forms a part of the system's organization. The processing framework then needs to implement what was called 'declarative processing' [1] in other words it needs to be able to link up building blocks on demand and create a workable process instance by using the contextual information of PPBs against a given situative context.

We learned that suitable processing frameworks of intelligent systems require that available constituents of the system, the system's structure (PBBs, etc.), are permanently rebuilt. This does happen by incorporation of new capabilities, the encapsulation of complex procedures consisting out of several PBBs as one new single PBB (internalization), the depreciation of existing PBBs, and other 'deriving transformations' [1][2].

So does the system's organization, defining the interplay of all structural elements, mainly given by contextual information such as sequence information, rules that branch or control the invocation of PBBs, descriptive information and the like. In intelligent systems the organization, too, is permanently altered, adapted and rebuilt. [1][2].

The PBBs as the fundamental structural elements as well as their contextual information define the contents of the processing framework. They encode the knowledge of the organization that holds the processing framework. Knowledge management on an organizational level is the effort to promote this permanent acquisition of structural elements, new PBBs und contextualizing Information, the permanent evaluation of their effectiveness in operation as well as their adaptation and refinement thereafter.

This imposes high demands on the framework that should support the organizations processing. It must implement the possibilities to select and thus assemble PBBs in a suitable way as response to a situative context. This, being a process by itself, should be implemented self-similar [1]. From a system theoretic perspective a framework that permanently reproduces its structure and its organization is not just any framework, rather is it a highly special system. A System for which the cognitive biologist Maturana in 1972 coined the term autopoietic system, as a system that has the ability to generate its specific constitution – its components (structure) and their interplay (organization) – on its own [3]. In contrast to usual system definitions in the engineering world, where the system is an arbitrary set of elements, an arbitrary domain or space separated from the rest of the world by its boundary which is setup freely by the observer who intends to describe certain principles or theories for the system, for autopoietic systems the boundary is not up to the observers definition. The system rather is defined by all those constituents that are required to implement its autopoietic operation. They are real systems, just like the processing framework that implements the organization's intelligence.