Conceptualizing Enterprise Systems from an Integrationist Perspective

Lars Taxén

Original Publication:

Lars Taxén , Conceptualizing Enterprise Systems from an Integrationist Perspective, 2012, Fjärde nationella workshopen om svensk affärssystemforskning, Linköping, 30-31 augusti 2012.

Postprint available at: Linköping University Electronic Press
http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-111339

Conceptualizing Enterprise Systems from an Integrationist Perspective

Lars Taxén, Associate Professor
Linköping University
lars.taxen@telia.com

Abstract
A purported feature of Enterprise Systems (ES) is that they are "integrated"; meaning that they in some sense bring parts into a unified whole. However, it is far from clear what is integrated into what, or how integration is achieved in practice. Moreover, the very concepts of integration and other related, fundamental concepts such as 'organization', 'coordination' and 'knowledge' are abstruse. To this end, the purpose of this contribution is to make an inquiry into integration by departing from the perspective of *integrationism*; a new development in the theory of communication. This view is further elaborated using Vygotsky's distinction between lower and higher mental functions, and the notion of activity modalities suggested by Taxén. Integration thus conceived provides a foundation from which inquiries into ESs, both from a theoretical and practical point of view can be carried out. The ideas in the foundation are illustrated by some examples from the Ericsson telecommunication company. A sketch of an ES implementation method is outlined. The main conclusion is that a thorough ground for advancing the knowledge about Enterprise Systems can be established only if our unique human predispositions for coordinating and integrating actions are considered; something which may have far-reaching consequences for advancing our knowledge about Enterprise Systems.

INTRODUCTION

Enterprise Systems (ES) have made a major break-through in organizations in the last decades, mainly in the form of Enterprise Resource Planning (ERP) systems such as SAP, Baan, Oracle, and People-Soft. A definition of such systems, which appear to have been adopted by the community, is given by Davenport:

> "…the seamless integration of all the information flowing through a company financial and accounting information, human resource information, supply chain information, and customer information." (Davenport, 1998, p 121)

In addition to ERP systems, Product Lifecycle Management (PLM) systems are becoming increasingly important in organizations. PLM systems are designed to managing revisions and configurations; mainly during the development of products and services, while ERP systems are transactional oriented without revision control. As such, both systems are enterprise-wide, integrative systems, however different in nature[1]. For the purpose of this paper I will include also PLM systems in ESs.

As is well-known, the implementation[2] of ESs in organizations is hazardous, often resulting in spectacular failures. An extensive amount of research has been devoted to analyze the success or failure of ERP projects (for an overview, see Cumbie et al., 2005). Usually, such research efforts try to identify various "factors" that can explain the outcomes (e.g. Gargeya & Brady, 2005). However, the results are fragmented in the sense that it is hard to find some underlying framework or theory that is capable of explaining how all these factors are interrelated.

One reason for this is that there is no consensus about fundamental concepts such as 'organi-

[1] An interesting observation is that PLM-systems, in contrast to ERP systems, have by and large been ignored by the research community. This is indeed surprising since the information in PLM systems is a prerequisite for that which is subsequently managed in ERP systems.

[2] By implementation I mean all activities necessary to make an ES a resource in an organization, such as adaptation of a vendor platform to specific organizational needs, user training and acceptance, operation, maintenance, and the like.

zation', 'integration', 'coordination' and 'knowledge'. For example, a number of different Unit of Analysis (UoA) have been suggested for capturing the essence of the organization, such as: "individual act" (Morgeson & Hofmann, 1999), "dyad" (Sosa, 2011), "organizational field" (Schoonhoven, Meyer, & Walsh, 2005), "practice" (Brown & Duguid, 1991), "organizational routines" (Volkoff, Strong, & Elmes, 2007), "transaction" (Argyres, 1999), "activity" (Nickerson & Zenger, 2002), "social actor" (King, Felin, & Whetten, 2010), "work teams" (Nonaka & von Krogh, 2009), and "work system" (Alter, 2006).

Concerning integration, this "is the key to ERP" (Cumbie et al., 2005, p. 27). Integration is defined as "the act or process or an instance of integrating", as in "coordination of mental processes into a normal effective personality or with the individual's environment" (Merriam-Webster, 2012). 'Integrating' in turn is "to form, coordinate, or blend into a functioning or unified whole" (ibid.). However, it is far from clear how to operationalize integration in ES implementation projects.

The same goes for coordination. In spite of an extensive amount of research, it is remarkably hard to pin down coordination. For example, Larsson (1990) lists nineteen definitions, and Malone & Crowston (1994) identify eleven interpretations. Malone & Crowston also emphasize the multidisciplinary nature of coordination; the study of coordination must draw on organization theory, management science, computer science, economics, linguistics, and psychology (ibid, p. 88). To further aggravate this situation, Nicolini concludes that there is a lack of knowledge about how coordination is actually carried out in practice:

> In spite of the recent resurgence of interest in the study of coordination (Bechky 2003, 2006), we still know markedly little about the practice of coordination and, above all, the coordination of practices and knowings. (Nicolini, 2011, p. 617)

An additional issue is knowledge. With the Knowledge-Based View (KBV), knowledge has surged to the front as an important turn in organizational inquiry; the basic tenet of which is to regard the firm as an institution for integrating knowledge (e.g. Grant, 1996). However, arguments about the essence of knowledge are paradigmatic in nature. On the one side of the abyss proponents claim that knowledge is a decontextualized resource that can be acquired, embedded, packaged, and transferred between brains. On the other side, protagonists rather talk about knowing than knowledge - an ongoing enactment process between individuals in social contexts[3]. As a result, knowledge integration remains obscure:

> [Despite] the wide consensus in the literature on the prominence and centrality of knowledge in production activities and the role of the organization as a knowledge integrator, there is still very little theory on what constitutes knowledge integration …, and even less on how this integration is accomplished in practice in terms of the actual organizational channels and mechanisms for integrating knowledge (Haddad & Bozdogan, 2009, p. 8).

All in all, it is obvious that the implementation of integrative ESs is based on muddled grounds. There is something deeply disturbing about this situation. On the one hand, we are somehow perfectly capable to devise and run organizations that serve our daily needs; on the other hand we seem to have insurmountable problems in understanding how this is possible (or at least to agree on this). It is though we have created a Frankenstein's monster that we are unable to fathom.

Continued efforts to resolve this enigma by tinkering with surface phenomena such as "factors" seems bleak. As an alternative we might reconsider the very fundamentals of how humans organize and carry out goal-oriented work. To this end, the purpose of this contribution is to suggest an "integrated" conceptualization of human activity by departing from *integrationism* as proposed by the English linguist Roy Harris (Harris, 1995; 1996; 1998; 2009; 2012). The gist of integrationism is expressed as:

> Knowledge is not a matter of gaining access to something outside yourself; all knowledge is

[3] For insightful discussions of these matters, see e.g. Fahey & Prusak (1998) and Orlikowski (2002)

> internally generated by the human capacity for sign-making; the external world supplies input to this creative process but does not predetermine the outcome; signs and, hence knowledge, arise from creative attempts to integrate the various activities of which human beings are capable. (Harris, 2009, p. 162)

Thus, integrationism acknowledges that we are the same biological creatures regardless of whether we were engaged in mammoth hunting some 30 000 years ago, or in developing highly sophisticated telecom systems today. As a consequence, whatever propensities for knowledge integration we have acquired during the phylogenetic evolution of mankind, these will inevitably be at play in organizations today. This observation is a key motivation for the work presented here; suggesting that the fragmented knowledge we have about ES is a result of neglecting or ignoring human constraints and enablers for acting.

With integrationism as a general framework, biological and neurological predispositions for coordination can be inquired into. To this end, I have suggested the construct of *activity modalities* (Taxén, 2009. These modalities – *motivation, objectivation, contextualization, spatialization, temporalization, stabilization*, and *transition* – are found in every organism equipped with a neural system[4]. The function of the modalities is to provide the organism with an actionable, unified and integrated percept of the situation at hand by integrating sensations from various sensory modalities.

Obviously, we are not the only creatures that coordinate their actions. However, humans have the unique quality of being able to imagine past and future. We can conceive of a house to be built by looking at a drawing of it; we can envision the battle of Trafalgar by reading a book or going to a movie; we can make up worlds that never existed in science fiction or fantasy plays. Thus, we need to understand the roles of integrative signs. One possible way of achieving this is offered by the influential psychologist Lev Vygotsky, who lived and worked in the early decades of the Soviet Union (Miller, 2011). One of his major claims is that the difference between humans and other organisms is the capability to use signs in actions.

The final step is to put all the pieces together in the construct of the *activity domain* (Taxén, 2009). In the activity domain, integrationism according to Harris, the activity modalities, and the ideas of Vygotsky are incorporated into a unified blueprint for human activity from a coordination vantage point. The ultimate claim of this conceptualization is that any intentional and goal-oriented human activity can be seen as activity domains. For organizations, this means that individual actions, groups, teams, projects, organizational units, organizations, over to network of organizations, can all be structured as activity domains. This in turn implies that ESs initiatives can be based on a common theoretical foundation.

With this as a background, the paper is organized as follows. First, the main ideas of integrationism are outlined. This is followed by a conceptualization of human activity in the form of a "coordination anatomy", in which coordinative and integrative capabilities are gradually built up starting from innate predispositions. After that, I provide some concrete examples of manifestations of the activity modalities from the Ericsson organization. Next, suggest an ES implementation strategy based on the integrationist perspective. Finally, I discuss some implications for ESs. In conclusion, I claim that thorough ground for this ES endeavors can be established only if our unique human predispositions for coordinating and integrating actions are brought to the fore.

INTEGRATIONISM

Integrationism is a new development in the theory of communication, which emerged from the work of a group of linguists at the University of Oxford during the 1980s (IAISLC, 2011).

[4] The construct of activity modalities was gradually conceptualized by the author over many years in the Ericsson development practice as a way to comprehend the development of extraordinary complex telecom systems (Taxén, 2009). Ericsson is a well-known, worldwide telecommunication equipment's supplier: http://www.ericsson.com/

Communication is not seen as "transmission" of given signs or messages from one person's mind to another's, but of setting up conditions for those involved to construct possible interpretations, depending on the context.

Integrationism is based on two axioms: "(1) What constitutes a sign is not given independently of the situation in which it occurs or of its material manifestations in that situation. (2) The value of a sign (i.e. its signification) is a function of the integrational proficiency which its identification and interpretation presuppose" (Harris, 2009a, p. 73). In this sense, "[e]very act of communication, no matter how banal, is seen as an act of semiological creation" (Harris, 2009a, p. 80).

These axioms mean that knowledge is intrinsically individual in nature; however dependent on interaction with the environment. Consequently, contextualization is fundamental for sign making and use:

> Integrational semiology makes no ambitious assumptions about knowing exactly how we communicate with one another. It starts from the more modest thesis that no act of communication is contextless and every act of communication is uniquely contextualized. (Harris, 1998, p. 119)

Integrationism views all communication as time-bound. Its basic temporal function is to integrate present experience both with our past experience and with anticipated future experience. The first precondition for any sign-based society is that participants must be capable of grasping that integrational process and its temporal implementation (Harris, 2012).

The gist of the integrationist approach towards communication is that "one's mental activities are indeed jointly integrated with one's bodily activities and one's environment" (Harris, 2004, p. 738). More specific, the rationale of the term *integrated* is "that we conceive of our mental activities as part and parcel of being a creature with a body as well as a mind, functioning biomechanically, macrosocially and circumstantially in the context of a range of local environments" (Harris, 2004, p. 738). The first relates to the physical and mental capacities of the individual participants; the second to practices established in the community or some group within the community; and the third to the specific conditions obtaining in a particular communication situation. Thus, integrationism provides a general and coherent foundation for framing the entire complex of issues around ES undertakings.

AN ANATOMY OF COORDINATION

Drawing on the integrationist perspective, it is clear that both individual and social aspect of coordination need to be incorporated into a common framework. To do so, I will employ two threads of thinking from Vygotsky: the distinction between "lower" and "higher" mental functions, and the social genesis of the individual[5].

According to Vygotsky, humans have evolved specific functions for the formation of abstract and general concepts, which provide a comprehension of the world that stretches beyond the immediate situation. Examples of such higher mental functions, which distinguish humans from primates and other organisms, are focused attention, deliberate memory, verbal thinking, planning for the future, and remembering the past. The difference between higher and lower mental function is meticulously captured in a passage from Marx:

> A spider conducts operations that resemble those of a weaver, and a bee puts to shame many an architect in the construction of her cells. But what distinguishes the worst architect from the best of bees is this, that the architect raises his structure in imagination before he erects it in reality. At the end of every labour-process, we get a result that already existed in the imagination of the labourer at its commencement. He not only effects a change of form in the material on which he works, but he also realises a purpose of his own that gives the law to his modus operandi, and to which he must subordinate his will. (Marx, 1867, p. 193).

[5] Of course, the presentation of these truly ground-breaking insights into the human psyche can at most be sketchy here; the interested reader should consult, for example, the book by Ron Miller (2011).

Higher mental functions are influenced and structured by *signs*, of which language is the most prominent one. The characteristic of signs, which Vygotsky called "psychological" tools, is that they do not change anything in the material world; rather their effects are directed inwards; towards the brain. Examples of such tools are models, documents, drawings, plans, and the like. This is in contrast to "technical" tools, such as hammers and axes, which make a difference in matter outside the individual[6].

Since signs are truly social in character, this implies that higher mental functions are formed in the interaction between the individual and her cultural-historical environment. A nice example discussed by Vygotsky is pointing. When a baby first stretches out her arm and finger, it is an attempt to grasp an object of her attention; i.e. the baby uses the phylogenetically evolved capability of grasping that the hand and fingers provide. However, a mother may interpret the outstretched arm and finger as pointing to something that the baby wants, and proceed to give the object to the child. The moment the child realizes that she can get the same result by invoking another person through the same gesture, the mental organization of the child changes drastically; a higher mental function has been created in the mind of the child. The essence of this way of understanding the human psyche is that the ontogenetic development of the individual proceeds by incorporating the social as a constitutive element in her personality. The individual cannot be separated from the social; quite the opposite: the social is the genesis of the individual.

Higher mental functions are dependent on what Vygotsky called "lower mental functions", which provide the innate mental capabilities that an individual is born with. Examples of such functions are neural circuits for perception, attention, memory, evaluation, and motoric actions; functions which are similar in nature for both humans and non-humans. For humans, lower and higher functions are jointly exercised in action. For example, perceiving a red light on a pole beside a road informs a driver about the obligation to stop, which result in a state change of the driver's higher mental functions. However, the subsequent motoric action of breaking the car is by no means guaranteed. The driver may choose to ignore the obligation to stop, which may have dire consequences. Usually, though, the driver will comply with the social codes and halt the car at the perception of the red light.

Regarding coordination, it is clear that both humans as well as other organisms equipped with a neural system can coordinate their actions. This means that there are certain lower mental functions enabling coordination of actions. I have suggested conceptualizing such functions as *activity modalities*: *motivation, objectivation, contextualization, spatialization, temporalization, stabilization*, and *transition* (Taxén, 2009). These modalities are all interdependent and engaged by the organism as follows. Driven by some motive (*motivation*), something is perceived and a target is attended (*objectivation*); relevant objects and their orientation in space are cognized (*spatialization*); the situation is evaluated, and possible alternative actions are contemplated and executed (*temporalization*). If the acts are to be successful, purposeful acts must be distinguished from misconceived ones. This ability comes through engaging repeatedly in similar situations; thus lending a stabilizing character to action (*stabilization*). The end result of this is the formation of an actionable context around the target (*contextualization*). Next, attention is re-focused to another target (*transition*), and the cycle starts all over again; a cycle that may be precluded by deficiency of enacting a certain modality. For example, a brain lesion in the hippocampal area severely impairs spatial navigation, which in turn impedes moving towards a desired target.

The function of the activity modalities is to provide the organism with an actionable and unified comprehension of situations at hand by integrating sensations from various sensory modalities. Consequently, there must be some circuits in the brain, the function of which is to integrate sensations over perceptional, attentional, memorial, evaluative, and motoric neural circuits and into the activity modalities. One possible candidate for such an integrating function is the

[6] The categorization of tools as "psychological" and "technical" has been questioned in the literature (see e.g. Leiman, 1999), but for the purpose of this paper I will stay with this categorization.

neuronal global workspace suggested by Dehaene, Kerszberg, & Changeux (1998)[7]. Thus, it is possible to conceive of an "anatomy" for integration of lower mental functions as in Figure 1, where the lower layers are prerequisites for the upper ones:

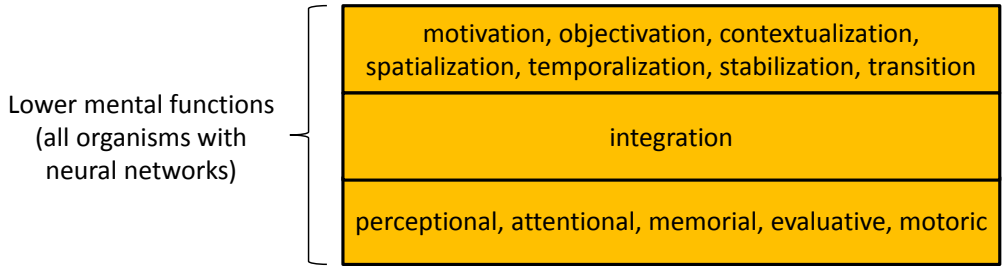

Figure 1: Integration of lower mental functions

Since higher mental functions are dependent on lower ones, the activity modalities are at play also when humans coordinate their actions. This means that certain "coordinative" psychological tools / signs reflecting the modalities will be drawn upon in human activity. Such tools are easily discerned in everyday life. For example, the now abundant GPS navigator displays a map, which is a manifestation of spatialization since it shows how things are related to each other in a certain context. The map may be used to calculate a route from one place to another, which is a manifestation of temporalization since it signifies a time dimension. It is also clear that the map and the route are interdependent; the route could not be estimated without the map. In addition, stabilization is manifested in the codes used: distance in kilometers, time in seconds, etc.

All in all, an anatomy of coordination for humans can be illustrated as in Figure 2:

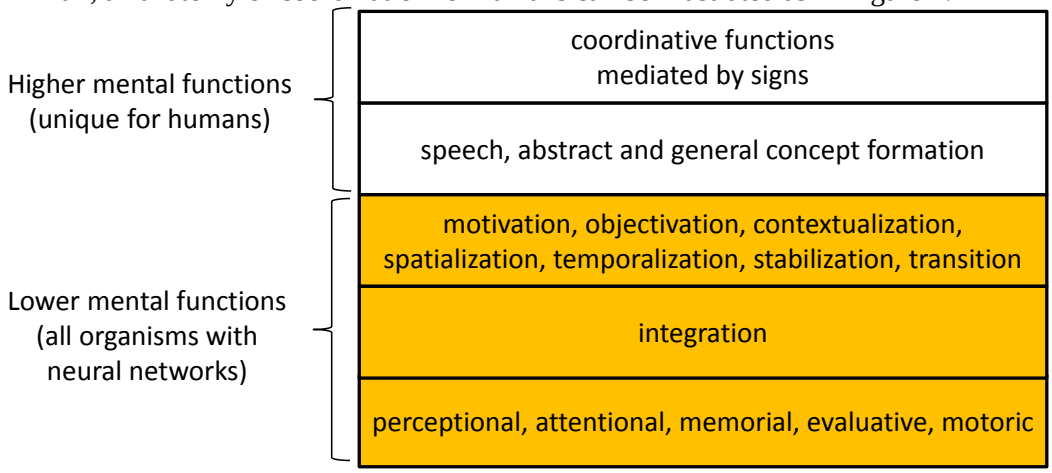

Figure 2: The anatomy of coordination

The anatomy of coordination provides a conceptualization of the biological and neurological prerequisites for coordinating actions. Although these prerequisites are firmly rooted in the individual, the actions are truly social in character. Thus, there is no contradiction between the individual and the social; on the contrary, they presuppose each other.

Having outlined the anatomy of coordination, it is a small step to envisage the construct of the *activity domain* (Taxén, 2009), in which integrationism according to Harris, the ideas of Vygotsky and the activity modalities make up a structured context. The activity domain is meant as a blueprint for human activity from an integrative point of view. In essence, this rather bold statement implies that the activity domain can be seen as the core organizational construct, ranging from individual actions, groups, teams, projects, organizational units, organizations,

[7] The neurological grounding of the integration into activity modalities is discussed in Taxén (2011).

over to network of organizations. These groupings can all be structured as activity domains. In the next section, I will illustrate this idea using examples from the Ericsson practice.

ORGANIZATIONAL ILLUSTRATION

The straight-forward way of illustrating the integrationist approach in organizational settings is through *models* of various kinds, since these are regarded as psychological tools, aiming at influencing higher mental functions.

Objectivation

A model of prime concern is the one signifying the target of the activity. Unless there is such a model, those participating in the activity have to rely on their inner images of the target to be sufficiently aligned; something which becomes more unlikely with increasing complexity and volatility. An example[8] of such a target model is the so called *system anatomy* shown in Figure 3:

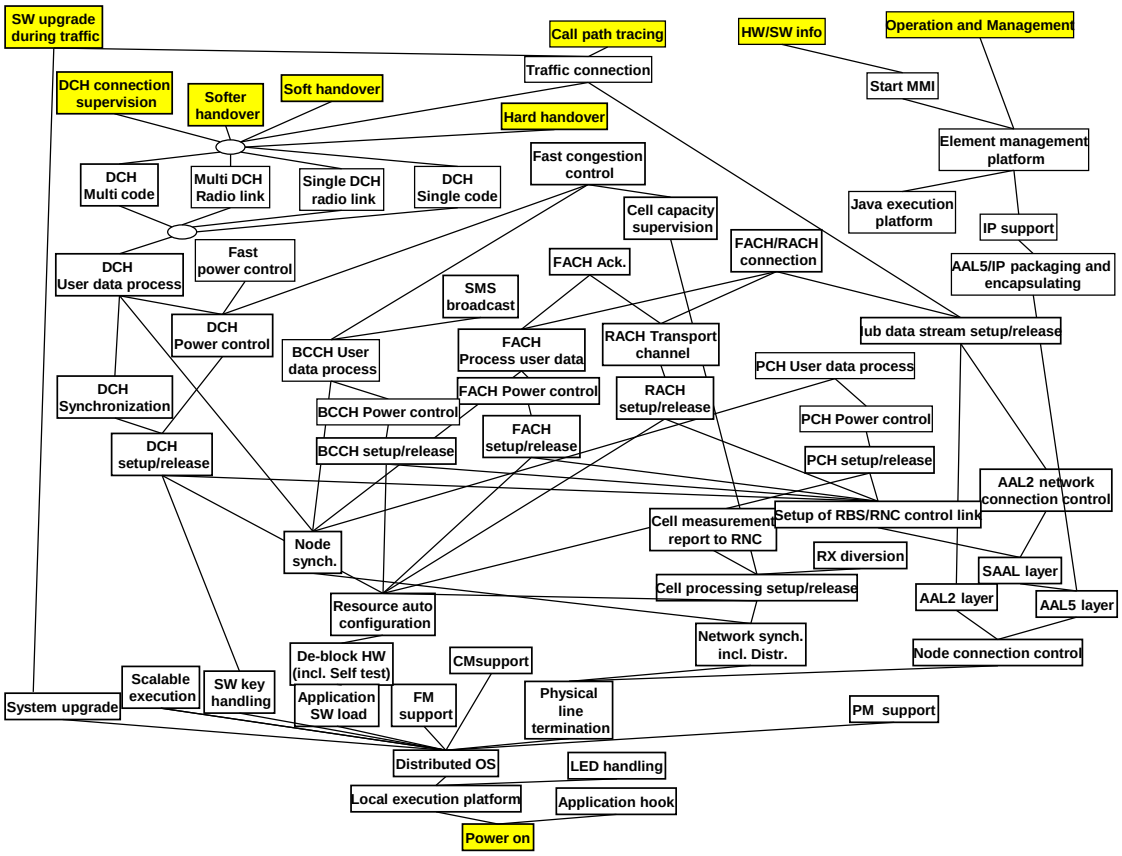

Figure 3: A model of the target – a manifestation of objectivation

The system anatomy shows *the dependencies between capabilities* in the system from start-up to an operational system (Taxén, 2011b).The boxes in the figure should be read as *capabilities* needed in the system. However, the components providing these capabilities are subdued in the anatomy. The dependencies (lines) proceed from the bottom to the top of the anatomy, where the desired capabilities of the system are displayed ("SW upgrade during traffic", "DCH connection supervision", and so on). If a certain capability fails in the dependency chain, for

[8] The examples are all from the Ericsson development practice, but not necessarily from the same development project.

example, “Power on” at the bottom of the anatomy, the whole system will fail.

The particular point about this model notation is that it is simultaneously easy enough to align individual interpretations in an efficient way; yet powerful enough to signify what has turned out in practice to be the main concern in complex situations: to manage dependencies (ibid.).

Spatialization

Examples of spatial manifestations in organizations are information models like the one in Figure 4:

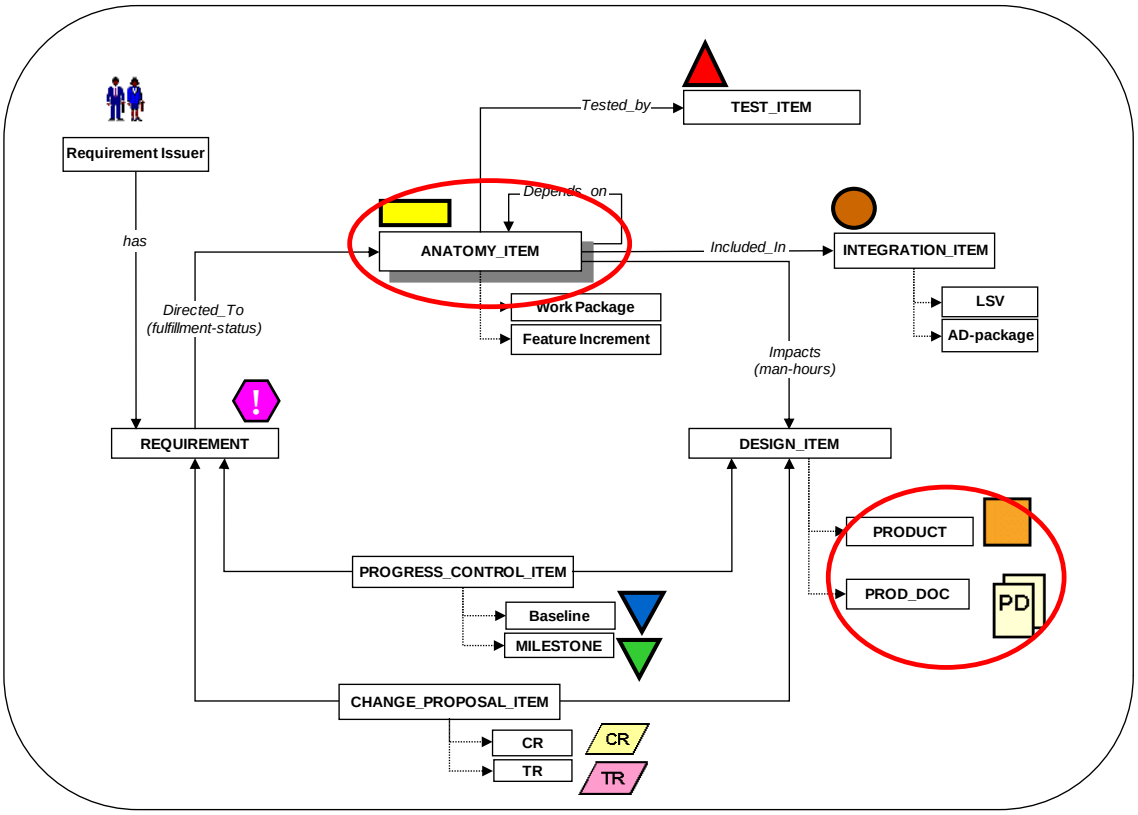

Figure 4: An information model – a manifestation of spatialization

The image shows an information model for coordinating the development of the 3rd generation of mobile systems at Ericsson around year 2000. The model represents a consensual understanding of what actors in one particular domain considered relevant information elements. The target is visible in the encircled parts of the model. The enactment of this model, and its detailed implementation in an information system, was a long and tedious process spanning several years (Taxén, 2009).

Temporalization

Business process models such as the one in Figure 5 are examples of manifestation of the temporalization modality:

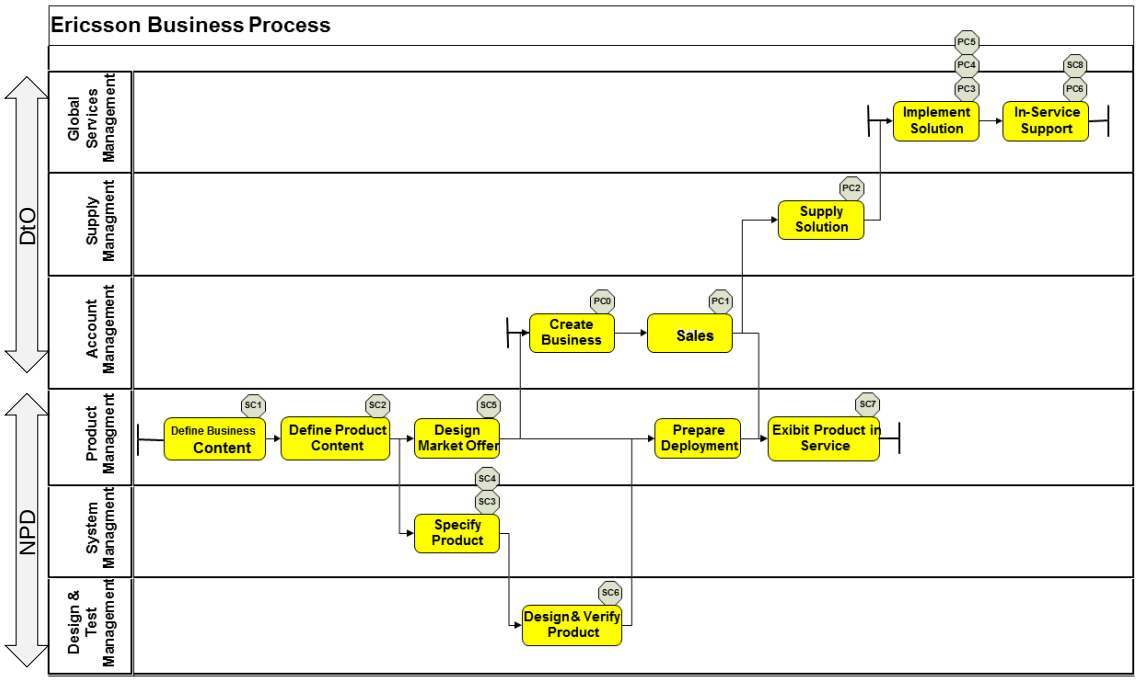

Figure 5: A business process model – a manifestation of temporalization

Each swimlane (the horizontal lanes) represents a management area containing one or several activities. The swimlanes are grouped into 'Delivery to Order' (DtO), which sells systems that can be configured from existing modules, and 'New Product Development' (NPD), which develops new modules. The progress within each group is indicated by the 'PC' and the SC' state sets respectively. The temporalization modality is manifested in the main flow of activities from left to right. Spatialization is only indirectly visible in the text in the activities ("Define *Product* Content", "Design *Market Offer*", etc.)

Stabilization

In a large and distributed organization like Ericsson, design centers around the world have certain autonomy to locally evolve in the manner they themselves find the best. At the same time, there must be some enterprise-wide common rules about how to approach customers, take heed for compulsory legislative norms, purchase materials, and so on. In Figure 6, an example of such a stabilizing element at Ericsson is shown; rules for how to identify products:

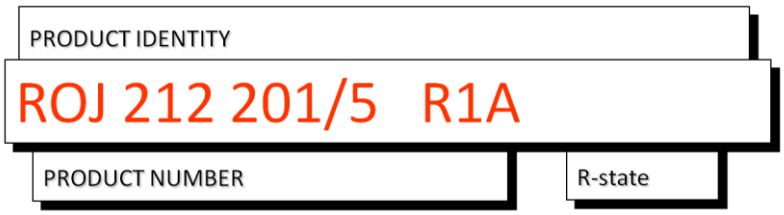

Figure 6: Rules for product identification – a manifestation of stabilization

As can be seen, the particular way such rules are manifested is idiosyncratic to the organization. For most people, they are completely unintelligible. In order to make sense of such rules, they need to be integrated in the Ericsson activity domain.

Contextualization

Contextualization can be illustrated by the product development cycle in Figure 7:

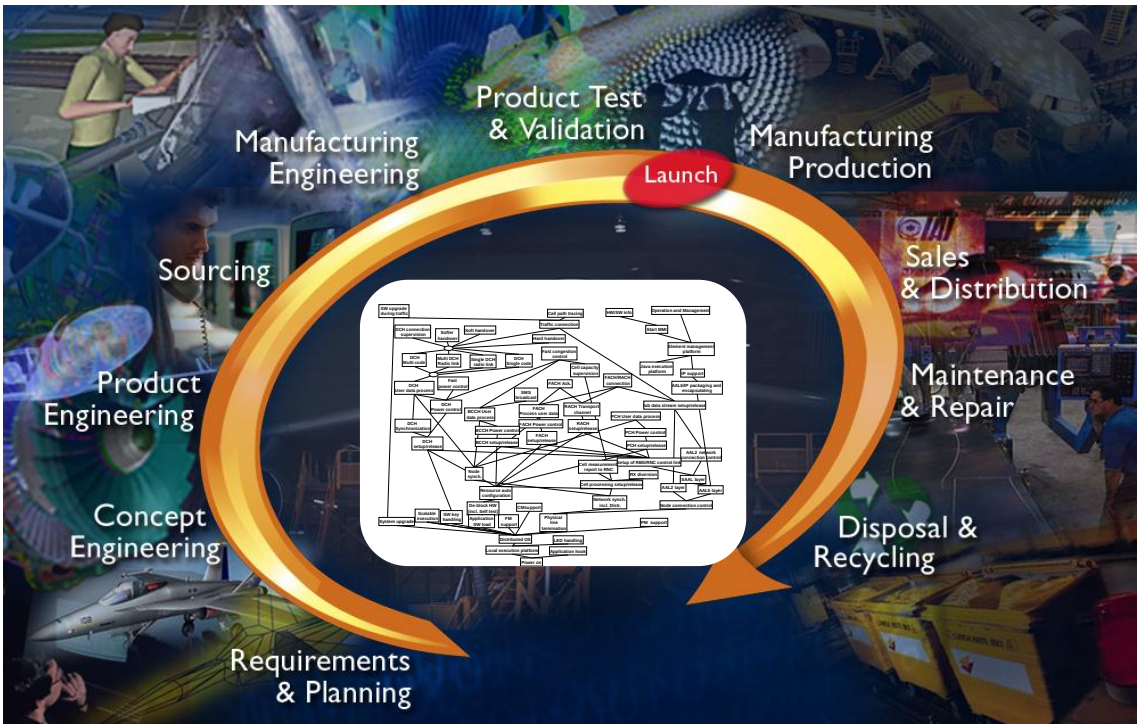

Figure 7: The lifecycle of a product (courtesy: Siemens PLM Software)

From its inception to its disposal, the product passes through a number of different activity domains such as marketing, design, manufacturing, distribution, maintenance, and finally, scrapping. Although the product is recognized as a particular individual throughout its lifecycle, it will be characterized differently in each domain. When marketed, properties like appearance, price, availability, etc., are relevant; when manufactured, the manufacturability of the product is in focus; when disposed, recycling and environmental concerns are emphasized, and so on. In general, a product consists of many different parts that may be realized in various technologies like hardware, software, mechanics, optics, radio, etc. These parts are all worked on in different activity domains with specific targets and motives.

Transition

Transition is, in short, the complement to contextualization. Since every domain evolves its own worldview there is a need to elaborate how the transition between the "inner" and "outer" of each activity domain shall be take place. For example, different terms and concepts used internally and externally must be reconciled in some way. The effort of developing these transitional capabilities is a substantial part of enacting coordination. An example of this from Ericsson is shown in Figure 8, which illustrates of how two activity domains – Research & Development and Hardware Design – are coordinated in terms of rules mapping between information states ([PR-, PR1, PR2, PRA, PRB] ⇔ [SC3, SC4, SC8, SC7]) . Such rules are examples of transitional capabilities.

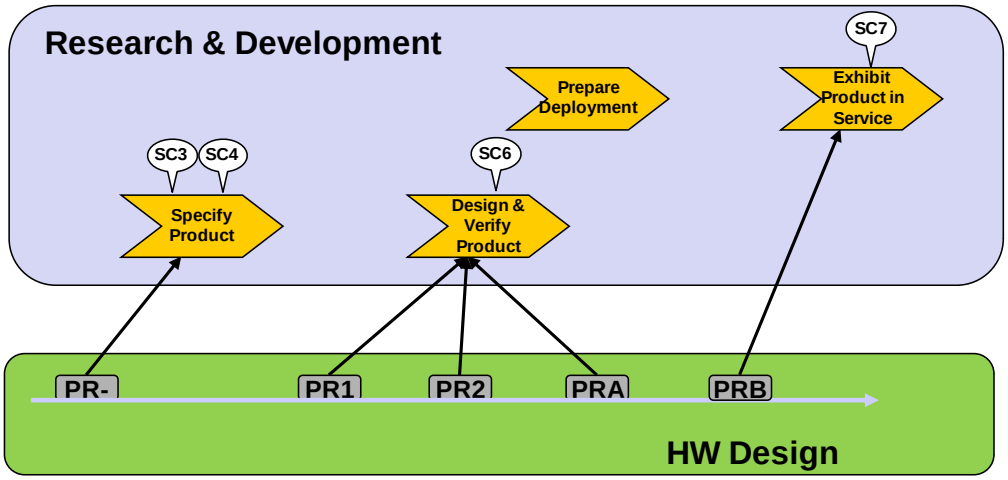

Figure 8: Mapping between states – a manifestation of transition.

Enterprise systems

In Figure 9a screen dump from implementation the information model in Figure 4 in a PLM system is shown:

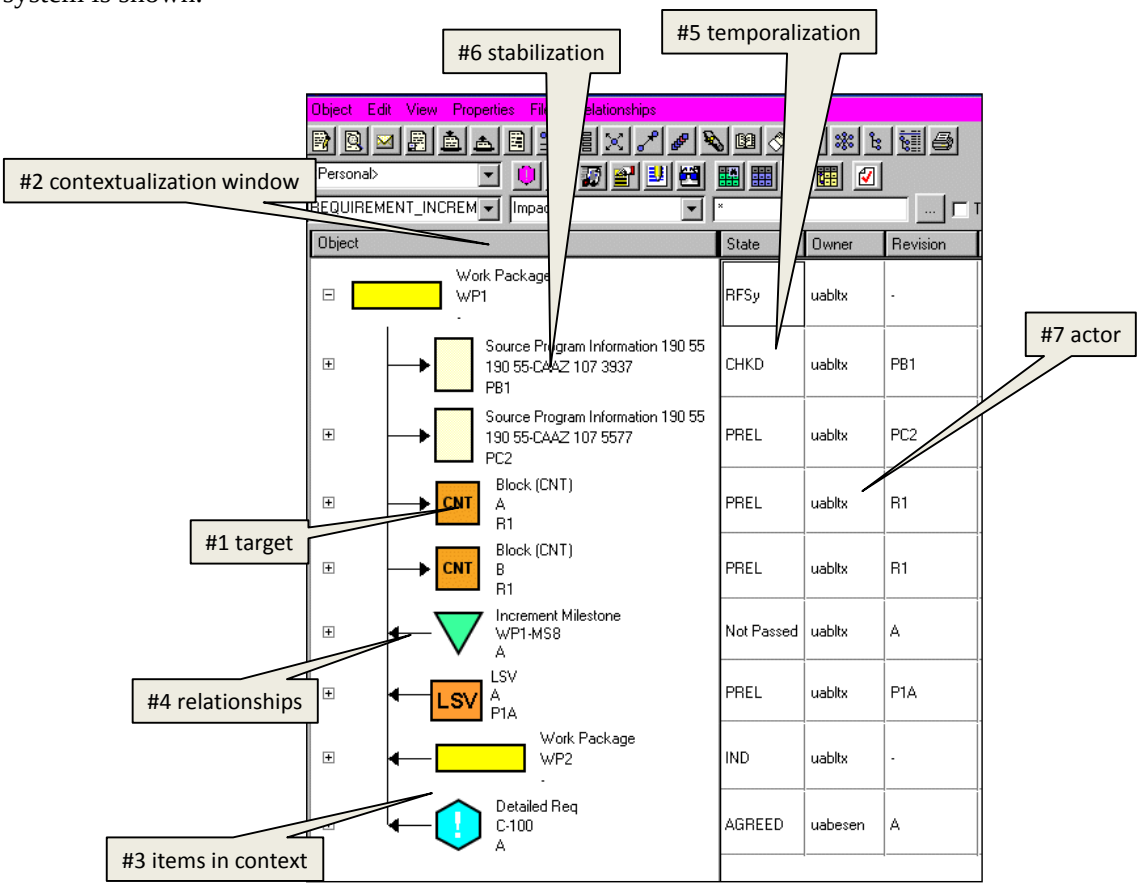

Figure 9: A screen dump from a PLM system at Ericsson

From the integrationist perspective an ES is mainly a coordinative psychological tool since its purpose is to manipulate higher mental functions[9]. Its main function is to support the

[9] However, in some instances an ES may function as a technical tool as well; for example, in connection with automation and supervision of systems.

management of all modalities as well as their interactions. As indicated in Figure 9, manifestations of several activity modalities can be recognized. First, the target is visible as products and documents (#1). Contextualization is indicated in the left window (#2), which shows relevant items in the context (#3) and their relationships (#4). Temporalization is displayed by the different status values an item can take (#5). Thus, the temporal dimension is indirectly visible only through the effects of activities; the activities themselves are not seen in this view. Stabilization is evident in the Ericsson idiosyncratic way of identifying products and documents (#6; see Figure 6). Finally, the identity of the actor who created the information items ("uabltx" = this author) is visible (#7). The transition modality is not visible here, since only one particular activity domain is illustrated.

AN ES IMPLEMENTATION STRATEGY

In this section, a skeleton ES implementation strategy, based on the integrationist approach, is outlined. Although parts of this strategy has been applied in the author's work with industrial PLM implementation projects, much remains before it becomes a repeatable and reliable ES implementation methodology.

A first observation is that the organization can be conceptualized as an anatomy in line with the system anatomy described in Figure 3 – an *organizational anatomy*. Figure 10 shows such an anatomy on a high-level:

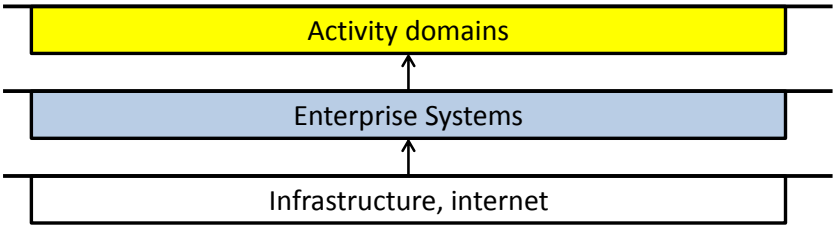

Figure 10: An organizational anatomy

In the bottom layer, computers, networks, operational systems like Linux, routers, etc., and the internet with its "Cloud" services, provide IT infrastructure capabilities that are necessary for bringing the ESs capabilities "alive". A power failure, for example, will bring the entire organization to standstill unless alternative power supplies can be summoned. In the next layer, the ESs provide information management capabilities to the activity domains. These capabilities will be more or less relevant in different domains[10]. Finally, in the top layer, the activity domains provide the organizational capabilities that organization employs in fulfilling its intended outcome.

The organizational anatomy thus conceived is a sign – a psychological tool in Vygotsky's terms. In a situation where an ES is to be implemented in the organization, the anatomy shows the perceived future realization of the implementation. In achieve this, at least the following steps are needed (not necessarily in the order below):

Identification of activity domains

The first step is to identify activity domains from their targets and motives. An initial domain is the organization itself. Other domains can be identified from main business process models, which usually are documented in large organizations (see the example from Ericsson in Figure 5). Next, each of these domains may be "zoomed into" in order to identify other domains. This may be repeated until it does not make sense to continue detailing the identification of activity domains.

[10] For example, in a domain working with sales from stock, an ERP system is certainly quite relevant, but not in a software development domain, where a PLM system is more useful.

Devising an organizational anatomy

In this step, the dependencies between activity domains are explicated in an organizational anatomy. An example of such an anatomy, derived from the business process in Figure 5, is shown in Figure 11. Two ESs are also shown; the ERP system supporting "Delivery from stock" domains, and the PLM system supporting "New Product Development" domains[11]. In addition areas in the anatomy affected by the interactions between these two systems are indicated by ovals.

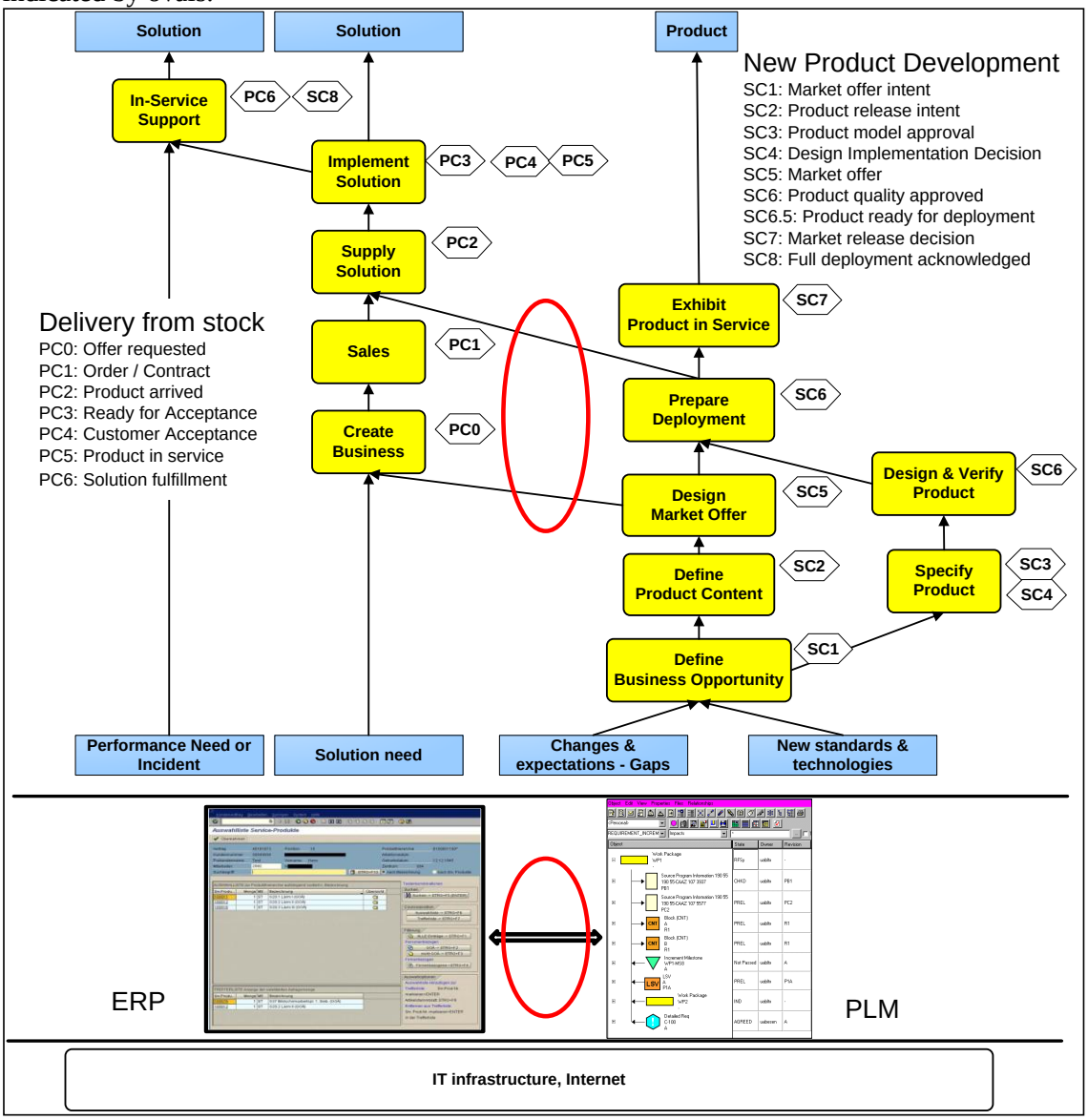

Figure 11: A more detailed organizational anatom

It might be argued that the anatomy is but a rearrangement of the business process in Figure 5. However, from an ontological perspective, there is a profound difference. In contemporary organizational discourse, the nexus of the organization is apprehended as the *process*, meaning that all other organizational constructs are subordinate to this construct: information, resources, IT systems, organizational functions, etc. The most expressive trend in this vein is the Business Process Reengineering (BPR) drive during the 1990s (Hammer, 1990; Hammer & Champy, 1993). In the integrationist perspective however, the activity domain is the nexus, and the

[11] This is a common information system architecture in product development organizations.

process is a manifestation of temporalization, which means that it is but one of the modalities.

Defining transitions between domains

Next, the transitions between activity domains must be clarified. In doing so, all modalities need be considered such as data to be transferred (spatialization), protocols deciding the order of transferred items (temporalization), and rules for translation and mapping between domains (stabilization). A major drive in this endeavor is to find a proper balance between what is local to each domain (meaning that which does not need to be exposed outside the domain), and global (which is necessary for coordinating several domains).

Defining the inner structure of each identified domain

Here, the inner of each domain is illuminated using various models signifying the activity modalities, such as information models (spatialization), process models (temporalization) business rules, standards, etc. (stabilization). A basic modeling principle is that different modeling notations need to be devised for different modalities in order to be most proficient. So, for example, modeling temporalization needs to be distinguished from modeling spatialization, while still maintaining the interdependencies between them.

Developing the ESs

After the articulation of the activity domains, the ES part of the anatomy is zoomed into, subduing the dependencies between the domains. Here, these dependencies are not important; what matters is the information management needs in the domains, which the ES capabilities shall meet up to. Thus, the focus is on dependencies between ES capabilities. Again, these can be signified by an ES anatomy. In Figure 12, such an anatomy developed in an industrial setting for a PLM system is shown:

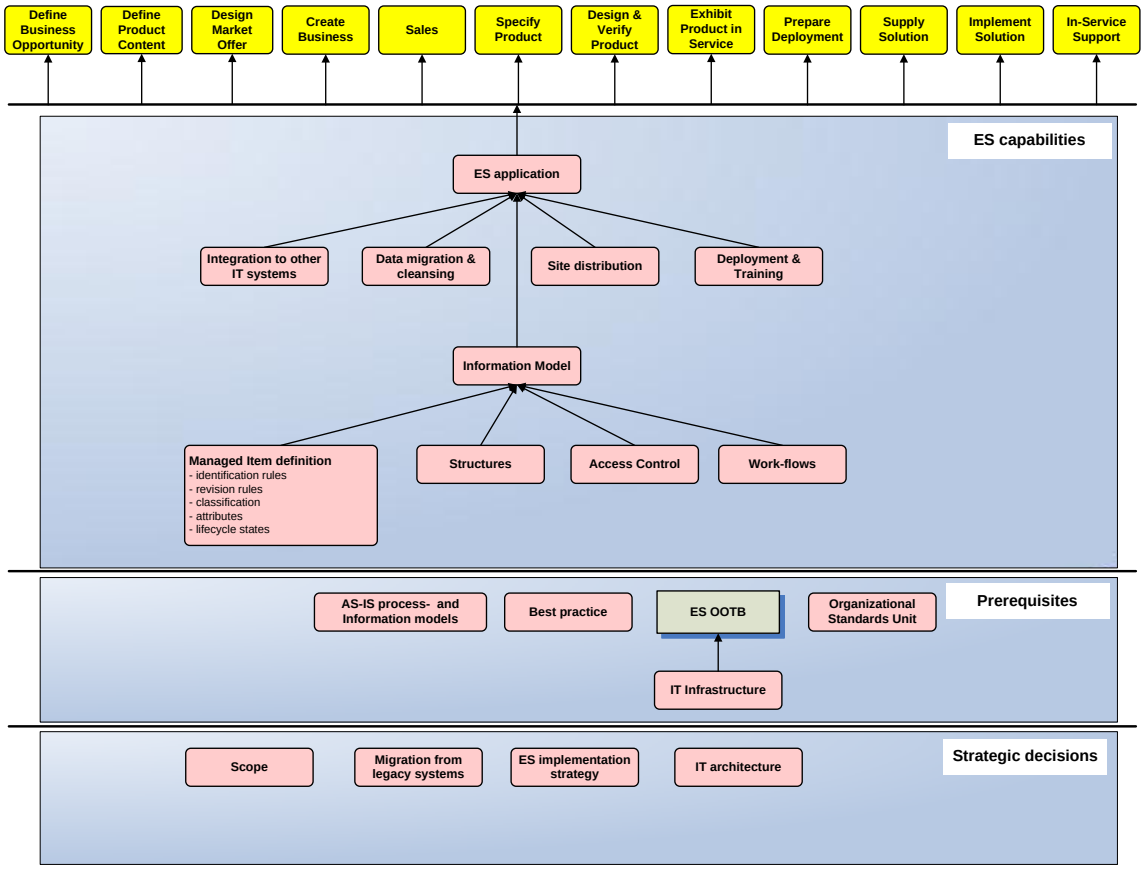

Figure 12: An anatomy for an Enterprise System

Basically, three groups of capabilities can be identified: strategic decisions, prerequisites and PLM system capabilities. In the following, these capabilities are briefly outlined.

Strategic capabilities may be the following:

- Scope: The scope of the system needs to be defined in terms of what activity domains should be supported.
- Migration: This concerns directives and principles for the migration from legacy systems to the PLM system.
- Implementation strategy: A decision about the implementation method needs to be taken; for example if agile methods shall be employed.
- IT architecture: There is a need to position the system in the existing IT landscape. For example, it must be decided which legacy systems shall be replaced by the PLM system.

Some *prerequisite capabilities* are as follows:

- AS-IS process- and information models: The existing models may be used as a starting point for the implementation.
- Best practice: Experiences from other implementations should be considered.
- PLM OOTB (Out Of The Box): The PLM platform supplied by a PLM system vendor such as Siemens / Teamcenter, Dassault / Enovia, or PTC / Windchill.
- IT Infrastructure: The computers, network, maintenance, support, etc., needed to run the OOTB system efficiently in all activity domains, regardless of where these are physically located.
- Organizational Standards Unit: There is a need for some activity domain, which is responsible for the definition and maintenance of mandatory, enterprise-wide rules, standards, norms, etc.

At least the following *PLM capabilities* are needed:

- Managed items' definition: The items to be managed in the system must be defined. Such definitions include, but are not limited to, item identification rules, item revision rules, classification of items, item attributes, and item lifecycle state sets.
- Structures: The main types of structures that managed items can be included in, need to be defined. Examples of such structures are *marked_as, designed_as, built_as*, and the like.
- Access Control: This capability is necessary for specifying what various actors can do in terms of creating, reading, modifying, and deleting items in the system.
- Work-flows: Work-flows for routinized tasks like creating a new item, releasing a product, doing controlled changes, approval of documents, and the like, need to be defined.
- Information Model: This spatialization model shows which items are relevant in the activity domains using the PLM system, and how these are characterized and related to each other. The model is implemented in the OOTB system.
- Integration to other IT systems: This capability concerns the interaction between the PLM system and other systems.
- Data migration & cleansing: Before the system can be used, data must be loaded into it. In addition, eroded data quality must be restored.
- Site distribution: The physical and logical distribution of data to different geographical locations must be defined.

- Deployment & Training: This amounts to getting the systems used and accepted by users.
- ES application: The overall, final capabilities of the PLM system.

As with other system anatomies, the PLM anatomy it is an excellent means for planning and monitoring the implementation project (Taxén, 2011b).

It goes without saying that the indicated procedure should be kept as simple as possible. Most likely, only certain areas in the overall anatomy will be focused. For example, the HR-department may look for and employ persons with specific knowledge needed in the domains, possibly by engaging in discourses going on in relevant Communities of Practices (Lave & Wenger, 1991). Executives can discuss consequences from acquisitions and outsourcings of various domains, such as outsourcing the IT-department. In the same vain, many other scenarios can be conceived, which all will use the common psychological tool of the organizational anatomy.

DISCUSSION

In this section I will discuss some implications of the integrationist approach for ES endeavors.

Business-IT alignment

Since the organizational anatomy includes both activity domains and ESs, the anatomy provides a coherent conceptualization of the organization as dependencies between capabilities. Thus the anatomy can be used for aligning IT with the strategic intents of the organization, which is a major issue in organizations (see e.g. Luftman, Kempaiah, & Rigoni, 2009). An outline of how this can be achieved is found in Taxén (2009b).

The organizational unit of analysis

In the integrationist view suggested here, the core organizational unit is the activity domain. A common conceptualization of units can be used, regardless of organizational "levels" (see below). This greatly alleviates the cognitive load of making of making sense of the organization, and conceiving empirical investigations for researching it. For example, issues about local / global will be regarded with respect to the activity domain. "Local" concerns the inner of a domain, and "global" its environment, which might be another domain making use of the capabilities the domain provides. This also means that what is considered local and global will recur at every transition between domains, no matter where in the organization this take place.

Levels

Another consequence is that the problematic notion of "levels" in organizational inquiry can be phased out of the discourse, since every conceivable constellation of humans acting towards a common goal can be seen as activity domains[12]. This goes all the way from individual acting alone to networks of collaborating organizations. The focus is thus re-directed to the transition between activity domains, and the tension between the inner workings of the domain and what needs to be exported outside the domain.

Knowledge Integration

Whatever knowledge is involved in integration, this knowledge is always related to the motive and target of the domain. As pointed out by Virkkunen and Kuutti (2000), "Organizations are not basically knowledge systems, but systems that produce something of value to the society"

[12] See e.g. Wiley (1988) for a discussion of "levels".

(ibid., p. 297). Thus, KI needs to consider what the knowledge is *of*, i.e., the target by for example, a model such as the system anatomy in Figure 3. But this is not enough; also knowledge *about* the target needs to be elaborated, which is equal to establishing the activity domain around the target.

Knowledge integration has been devised as the integration between individual knowledge "bases":

> [Knowledge integration] depends upon the extent of commonality in […] specialized knowledge. There is something of a paradox in this. The benefit of knowledge integration is in meshing the different specialized knowledge of individuals - if two people have identical knowledge there is no gain from integration - yet, if the individuals have entirely separate knowledge bases, then integration cannot occur beyond the most primitive level. (Grant, 1996., p. 116)

This is certainly the case. However, this integration cannot proceed directly between the individual and organizational "levels" since individual knowledge integration always takes place in the domain in which individuals are active. This means that knowledge integration must include also the integration of knowledge between activity domains. Thus, a better acronym than "Knowledge Integration" might be "Knowledge *In* Integration".

Reification of knowledge

The integrationist approach implies that anthropocentric reifications are rejected. Knowledge, acting, learning, etc. are always located in the individual. Expressions like "organizational learning", "organizational memory", "putting more knowledge into databases", and the like[13], can at most be see figurative speech, in which case they probably contribute more to confusion that enlightenment. Likewise, packaged conceptualizations of knowledge as "embedded", "transferrable", etc., are precluded.

Sense-making

How to achieve a common understanding or making sense of a certain situation is a foremost practical issue. Discussions of how to characterize key concepts, such as customer, product, service, requirement, etc., at the level of detail where they can be implemented in an ES, tend to be extremely tedious and prolonged:

> [At] an abstract level, some consensus may be achieved over a generic set of business processes. However, it is also becoming evident that as the level of detail increases, disagreements begin to surface. (Bititci & Muir, 1997, p. 366)

The research community has certainly recognized this issue at a general level (e.g. Weick, 1988, 1995, 2001; Kim, 1993; Robertson, 2000; Bechky, 2003). By and large, however, a systematic treatment of sense-making from a practical point of view is absent in the literature.

In the integrationist approach, sense-making is intrinsically related to the context in which integration occurs, i.e. the activity domain. Everything involved in the integration will take on a semiotic or sense value: terms, tools, resources of various kinds, and even people in their specific roles in the domain. In particular, a domain-specific language will be developed over time, which will include idiosyncratic terms. For example, "flying jib", "gaffsail", and "horizontal boom" are terms that make sense in sailing a full-rigged sailing ship but hardly elsewhere. Thus, the sense-making process can be framed in local and global terms with respect to the activity domains, which lend an alleviating structure to this process.

Models

Often, models are referred to as being models of the "real world". One example is the influential Bunge-Wand-Weber (BWW; Wand & Weber, 1993; Weber, 1997) ontology:

---

[13] See e.g. Cross & Baird (2000) for a case in point.

> "Bunge-Wand-Weber (BWW) [is a] representation model, which specifies a set of rigorously defined ontological constructs to describe all types of real-world phenomena" (Recker et al., 2010, p. 503)

Taken literally, this means that models are part of another world; the question is then: which world is that?

In the integrative perspective, models are relevant means in the integration of activity. The model of the telecom system in Figure 3 – the anatomy – is in fact the only "real" expression of the work object that exist when the development starts; the final system in terms of hardware and software just does not exist yet. The model is a (psychological) tool that enables coordinative actions towards the final outcome – a "real" telecom system.

The difference between a representational and an integrational view of models is in fact important to realize. Instead of never-ending discussions about which model is the "best" representation of a system, the focus is turned to finding models that are efficient in the integrational process.

CONCLUSION

Integration is the key to the understanding and implementation of Enterprise Systems in organizations. However, there is a lack of consensus about how to conceive of integration and other related, fundamental concepts such as 'organization', 'coordination' and 'knowledge'. This state of play quite naturally aggravates implementation projects. In this contribution, a foundation based on Harris' integrationism, Vygotsky's distinction between lower and higher mental functions, and the notion of activity modalities is suggested, which acknowledges and brings to the fore human constraints and enablers for acting. The main conclusion is that a thorough ground for advancing the knowledge about Enterprise Systems can be established only if our unique human predispositions for coordinating and integrating actions are considered; something which may have far-reaching consequences for advancing our knowledge about Enterprise Systems.

References

Alter, S. (2006). The Work System Method: Connecting People, Processes, and IT for Business Results. Larkspur, CA: Work System Press.

Argyres, N. S. (1999). The Impact of Information Technology on Coordination: Evidence from the B-2 "Stealth" Bomber. *Organization Science, 10*(2), 162-180.

Bechky, B. A. (2003). Sharing meaning across occupational communities: The transformation of understanding on a production floor. *Organization Science 14*(3), 312–330.

Bechky, B. A. (2006). Gaffers, gofers, and grips: Role-based coordination in temporary organizations. *Organization Science 17*(1), 3–21.

Bititci, U., & Muir, D. (1997). Business process definition: a bottom-up approach. *International Journal of Operations & Production Management, 17*(4), 365-374.

Brown, J.S., & Duguid, P. (1991). Organizational Learning and Communities of Practice: Towards a Unified View of Working, Learning, and Innovation, *Organization Science*, 2(1), 40-57.

Cross, R. and Baird, L. (2000). Technology Is Not Enough: Improving Performance by Building Organizational Memory. *Sloan Management Review, 41*(3), 69-78

Cumbie, B., Jourdan, Z., Peachey, T., Dugo, TM., & Craighead, C.W. (2005). Enterprise Resource Planning Research: Where Are We Now and Where Should We Go from Here?, *Journal of Information Technology Theory and Application (JITTA), 7*(2), 21-36.

Davenport, T. (1998). Putting the Enterprise into the Enterprise System. *Harvard Business Review, 76*(4), 121-129.

Dehaene, S., Kerszberg, M., & Changeux, J. P. (1998). A neuronal model of a global workspace in effortful cognitive tasks. *Proceedings of the National Academy of Sciences, USA (PNAS), 95*(24), 14529-14534

Fahey, L., & Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California Management Review, 40* (3), 265-276.

Gargeya, B., & Brady, C. (2005). Success and failure factors of adopting SAP in ERP system implementation. *Business Process Management Journal, 11*(5), 501-516.

Grant, R. (1996). Toward a Knowledge-Based Theory of the Firm. *Strategic Management Journal*, 17 (Winter Special Issue), 109-122.

Haddad, M., & Bozdogan, K. (2009). Knowledge Integration in Large-Scale Organizations and Networks – Conceptual Overview and Operational Definition. Available at SSRN: http://ssrn.com/abstract=1437029 or http://dx.doi.org/10.2139/ssrn.1437029

Hammer, M. (1990). Reengineering Work: Don't Automate, Obliterate. *Harvard Business Review*, 104-112.

Hammer, M., Champy, J. (1993). *Reengineering the Corporation: A Manifesto for Business Revolution.* New York: Harper Business.

Harris, R. (1995). *Signs of Writing*. London: Routledge.

Harris, R. (1996). Signs, language, and communication: integrational and segregational approaches. London: Routledge.

Harris, R. (1998). Three models of signification. In Harris, R., Wolf, G. (Eds.), Integrational Linguistics: A First Reader. Pergamon, Oxford, pp. 113–125, [Originally published, 1993. Gill, H.S. (Ed.), Structures of Signification, Wiley, New Delhi, vol. 3, pp. 665–677)].

Harris, R. (2004) Integrationism, language, mind and world. *Language Sciences, 26*(6), 727–739.

Harris, R. (2009). *After Epistemology*. Gamlingay: Bright Pen.

Harris, R. (2012). *Integrationism*. Retrieved July 31st, from http://www.royharrisonline.com/integrationism.html

IAISLC. (2011). The International Association for the Integrational Study of Language and Communication (IAISLC). Retrieved March 20th, 2012, from http://www.integrationists.com/IAISLC.html

Kim, D. (1993). The Link between Individual and Organisational Learning. *Sloan Management Review, fall 1993*, 37-50.

King, B. K., Felin, T., & Whetten, D. A. (2010). Finding the Organization in Organizational Theory: A Meta-Theory of the Organization as a Social Actor. *Organization Science, 21*(1), 290–305.

Larsson, R. (1990). *Coordination of Action in Mergers and Acquisitions - Interpretative and Systems Approaches towards Synergy*. Dissertation No. 10, Lund Studies in Economics and Management, The Institute of Economic Research, Lund: Lund University Press.

Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*, Cambridge: Cambridge University Press.

Leiman M (1999): The concept of sign in the work of Vygotsky, Winnicott, and Bakhtin: Further integration of object relations theory and activity theory. In Y. Engeström, R. Miettinen, R.L. Punamäki (Eds.) *Perspectives on Activity Theory* (pp. 419 - 434). Cambridge UK: Cambridge University Press.

Luftman, J., Kempaiah, R., & Rigoni, E. H. (2009). Key Issues for IT Executives 2008, *MIS Quarterly Executive, 8*(3), 151-159.

Malone, T., Crowston, K. (1994). The Interdisciplinary Study of Coordination. *ACM Computing Services, 26*(1), 87–119.

Marx, K. (1867). *Capital*. Vol. I, chapter 7, section 1: The labour process or the production of use values. Retrieved August 2nd 2012, from www.marxists.org/archive/marx/works/1867-c1/ch07.htm

Merriam-Webster (2012). Retrieved March 20th, 2012, from http://www.merriam-webster.com/

Miller, R. (2011). *Vygotsky in Perspective*. Cambridge: Cambridge University Press.

Morgeson, F. P., & Hofmann, D. A. (1999). The Structure and Function of Collective Constructs: Implications for Multilevel Research and Theory Development. *Academy of Management Review, 24(*2), 249-265.

Nicolini, D. (2009). Zooming In and Out: Studying Practices by Switching Theoretical Lenses and Trailing Connections. *Organization Studies, 30*(12), 1391–1418.

Nickerson, J. A., & Zenger, T. R. (2002). Being Efficiently Fickle: A Dynamic Theory of Organizational Choice. *Organization Science, 13*(5), 547–566.

Nonaka, I., & von Krogh, G. (2009). Tacit Knowledge and Knowledge Conversion: Controversy and Advancement in Organizational Knowledge Creation Theory. *Organization Science, 20*(3), 635–652.

Orlikowski, W. (2002). Knowing in Practice: Enacting a Collective Capability in Distributed Organizing. *Organization Science, 13*(3), 249–273.

Recker, J., Indulska, M., Rosemann, M., & Green, P. (2010). The ontological deficiencies of process modeling in practice. *European Journal of Information Systems, 19*, 501–525.

Robertson, T. (2000). Building bridges: negotiating the gap between work practice and technology design. *International Journal of Human-Computer Studies, 53*(1), 121-146.

Schoonhoven, C. B., Meyer, A. D., & Walsh J. P.(2005). Pushing Back the Frontiers of Organization Science. *Organization Science, 16*(4), 327–331.

Sosa, M. E. (2011).Where Do Creative Interactions Come From? The Role of Tie Content and Social Networks. *Organization Science, 22*(1), 1–21.

Taxén, L. (2009). *Using Activity Domain Theory for Managing Complex Systems*. Information Science Reference. Hershey PA: Information Science Reference (IGI Global). ISBN: 978-1-60566-192-6.

Taxén, L. (2009b). A Practical Approach for Aligning Business and Knowledge Strategies. In M. Russ (Ed.), *Knowledge Management Strategies for Business Development* (pp. 277-308), Hershey PA: Business Science Reference (IGI Global). ISBN: 978-1-60566-348-7.

Taxén, L. (2011). Modeling the Intellect from a Coordination Perspective. In B. Igelnik (Ed.), *Computational Modeling and Simulation of Intellect: Current State and Future Perspectives*(pp. 413-454). Hershey PA: IGI Global. ISBN: 978-1-60960-551-3.

Taxén, L. (Ed.) (2011b). *The System Anatomy – Enabling Agile Project Management*. Lund: Studentlitteratur. ISBN 9789144070742.

Virkkunen, J., & Kuutti, K .(2000). Understanding organizational learning by focusing on "activity systems". *Accounting, Management and Information Technologies, 10* (4), 291–319.

Wand, Y., & Weber, R. (1993). On the ontological expressiveness of information systems analysis and design grammars. *Journal of Information Systems 3*(4), 217–237.

Weber, R. (1997). *Ontological Foundations of Information Systems*. Melbourne, Australia: Coopers& Lybrand and the Accounting Association of Australia and New Zealand.

Weick, K. (1995). *Sensemaking in Organizations*. Thousand Oaks, CA: Sage Publications.

Weick, K. E. (1988). Enacted sensemaking in crisis situations. *Journal of Management Studies, 25*(4), 305-317.

Weick, K. (2001). *Making Sense of the Organization*. Oxford: Blackwell Business.

Volkoff, O., Strong, D. M., & Elmes, M. B. (2007). Technological Embeddedness and Organizational Change. *Organization Science, 18*(5), 832–848.

Wiley, N. (1988). The Micro-Macro Problem in Social Theory. *Sociological Theory, 6*(2), 254–261.