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Supporting Pentatomic Organizations Using DNA Architectural Constructs

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Abstract

The volatility and fierce competition of the business environment in the 21st century has forced enterprises to constantly review and change their structure, hierarchy, command, control and management styles. The pentatomic organization enterprise architecture offers a non-conventional approach to address these challenges. The pentatomic framework integrates five different enterprise models and adds a feedback loop to enable dynamical adaptation of enterprise architecture to changing business requirements. The dynamism and expandability of pentatomic organizations require architectural constructs that are flexible and align with the fundamental principles. DNA constructs have evolved from the study of merger and acquisitions of enterprises. The new modelling approach is particularly adaptable to changes and enterprise re-engineering due to merger and acquisition. This paper explores the use of DNA modelling methodology to support the implementation of pentatomic organizations which might have gone through a series of changes. The outcome is a more efficient enterprise changing process that ensures a smooth transition of state of enterprise.

Keywords

Enterprise Modelling, Enterprise Architectures, Pentatomic Organisations, DNA enterprise constructs, enterprise transformation, dynamic enterprises, change management, organisational integration

1. Introduction

The volatility and fierce competition of the business environment in the 21st century has forced enterprises to constantly review and change their structure, hierarchy, command, control and management styles. Research showed that many enterprises continue to adjust its strategic and tactical plans (Coghlan and Nicholas, 2006). For example, inter-enterprise activities of merger and acquisition can have the objective of creating value for the investors (Swamimanthan et al, 2008) or adapting changes in technological deployment (Tsai and Hsieh, 2006).

Frequent organization change leads to instability. Enterprise structures and processes need to be more versatile and adaptable to changing environment (Tilebein, 2006). Maintaining coherency during change (Doucet et al, 2008) is a challenge for enterprise architects and managers. A good methodology to manage transformation is the key to enable change while minimizing disruption to the normal business of the enterprise. In a roundtable workshop, Murray and Greenes (2006) found that in order to help organizations transform themselves, four areas of change were required including co-creation of new business enterprise systems and integrating them into a unified structure.

The changing landscape of the global business environment has induced significant impact on the management structure of manufacturing and service organizations (Zhang and Huang, 2012). Traditional



enterprise modelling uses monolithic organizational management in terms of structure, hierarchy and command-control styles are being constantly challenged and questioned. According to Thinyane and Terzoli (2011), cultural diversity affects the architecture and subsequent deployment of different segregation of work force within an organization. This type of organization architecture requires separation of presentation, interaction, access, social networking and knowledge base components.

Using enterprise modelling concepts, Chattopadhyay and Mo (2011) provided a standard and universal process that recognizes these portraits as different views and operational needs of the same vibrant architecture and system behavior of the organizations nowadays. They described the necessary ingredients of organizations and should be embraced as a unified concept, the Pentatomic Organization (PO). The term "Pentatomic" is derived from penta (means five) and atomic (means indivisible composition). The POs appear as diverse, non-traditional and unique but they are all fundamentally identical and integrated at the fundamental principle. The advantage of this approach is that the formation of enterprises becomes a way of selecting elements from the PO architecture.

However, the PO concept is good for understanding of phenomena in modern enterprises but not sufficient to design and implement an enterprise in practice. The dynamics of pentatomic organizations requires appropriate constructs to assist in the implementation of organizational structure and processes. On the other hand, Mo and Nemes (2010) described the characteristics of agile enterprises by analogy to the concept of DNA. The characteristics of the enterprise are then governed by the way the DNA bases are grouped together in the genes of the enterprise. Understanding of the basic enterprise architectural constructs is a matter of identifying the permutation of the bases in each of the genes. This paper explores the use of DNA enterprise construct concept to create a PO. Section 2 and 3 of this paper will give an outline of the PO and DNA concepts. Section 4 discusses the integration of two concepts to a unified outcome. The paper will use a global manufacturing company as a case study to illustrate how the PO is supported by DNA architectural constructs.

2. The Nature and key concepts of pentatomic organization

Modern enterprises are highly agile and adaptable. To understand and maximise efficiency of the enterprise system, people need a way to reduce the complexity of the enterprise system into a manageable number of entities and to understand how these entities relate to each other (Bernus and Nemes, 1996). When given an integrating framework using common sense language, people are able to simplify and understand the complexity around them. It enables them to think clearly about difficult issues, to build shared views and develop an implement roadmap with others and work collaboratively. It enables them to communicate effectively while they are building their new enterprises or improving their existing enterprises. It promotes a sense of predictability in a unpredictable environment.

Organisational change is often resisted by people who lose out in the chain of actions (Li et al, 2007). Conflicts are often the result of differences in opinion, culture and many other factors (Barmeyer and Mayrhofer, 2008). Oberg et al (2007) presented the concept of "network pictures" as the modelling framework to illustrate and analyse changes in managerial sense-making and networking activities. Gregor et al (2007) argued that by drawing on established alignment to architectural theory, an organisation's enterprise architecture can enable the alignment of business strategy and information systems and technology. The use of enterprise architecture can provide a good foundation for managing risks in information system development projects (Janssen and Klievink, 2012).

When these enterprises are examined closely, micro architectural views are critical to exhibit different facial expressions of the enterprise outfits. The following five models portray the micro architectural views:



- People-centric Model
- Molecular Model
- Kaizen Lean Six Sigma Model
- Globally Dispersed Model
- Disaggregated Value Chained Model

People Centric Model (PCM)

This new enterprise model (Chattopadhyay and Mo, 2010) has been developed from a comprehensive study of a global Engineering, Procurement and Construction Management (EPCM) company. People play the pivotal role in any organization and their presence pervades through all layers of the organization from shop floor to the board room as shown in the people-centric model. The organizational structure is driven by the strategy of the organization. Any enterprise has to have its own organization structure, strategy and customer. In fact a customer focused strategy drives a continual changing structure and restructuring of any organization today. The PCM is therefore supported by three pillars: people, strategy and customer, connected by a feedback loop. The essence of this model is that people will generate outputs utilizing their skills and resources over time.

Molecular Model (MM)

The MM perceives humans as an independent, standalone, intelligent and effective information and communication system by themselves – resembling an enterprise. In the work environment people use both tangible and intangible resources (R) and information (I) to produce tangible/intangible 'output' utilizing their skills (S). This model argues that people are the metaphor of atoms with skills and resources represented by the orbits of the electrons in the atom (Chattopadhyay et al, 2011a). The key operational functions such as planning, scheduling, shop floor management and control etc are performed by the human atoms in the energy bands of the molecules. As the value adding operational activities mature towards completion, incremental human energy is continuously spent by the human atoms to collectively transform raw materials to finished products.

Kaizen – Lean Six Sigma Model (KLSSM)

Based on a study of 168 manufacturing managers in North America, Boyle and Scherrer-Rathje (2009) identified a number of best practices, techniques, and major groups involved in improving manufacturing flexibility, while keeping broader organizational strategies such as lean. Azis and Osada (2010) studied a number of world-class companies and concluded that six sigma, total quality management and similar innovation tools are key success factors for leveraging organizational performance. The core essence of KLSSM is about change through innovation or transformation to their best practices (Vella et al, 2009).. The model has a layered flexible enterprise architecture with built-in lifecycle phases. To signify the flexibility for adding new tools and further enhancement, the KLSSM has incorporated a flexible extension as a pair of vertical dotted lines at the side of the central block. The long short vertical dotted lines imply that S, R and I have a pervasive role in the people-centric KLSSM which is supported by the same three pillars. These supporting pillars along with the feedback represent the model as a simple control system. This model is customer facing and driven by the strategy which is formulated by ongoing brainstorming and collaborative overtures within an organizational culture of trust and mutual respect.

Globally Dispersed Model (GDM)



This GDM represents a holistic and simplistic approach for a business model for virtual manufacturing that embraces a human-centric and eco-friendly approach in line with the emerging global trend in manufacturing. This model, which was previously described as multi-manufacturing company virtual enterprise (Chattopadhyay et al, 2010), presents a theoretical view of today's complex business environment, that large manufacturing firms are moving towards a globally dispersed but integrated business model. The emerging trend suggests more IT spending on collaborative decision environments and to incubate on multi-enterprise business networks delivery. This model proposes a typical regional production system connected through GDM. It also enumerates a manufacturing system in the shop floor that operates through an integrated and optimized combination of cellular, manufacturing execution system (MES) and hybrid of cellular and MES mode.

Disaggregated Value Chain Model (DVCM)

The disaggregated value chain is perceived as a value adding collaborative partnership amongst people who work closely together on trust to manage the flow of goods and services along the entire value adding chain (Chattopadhyay et al, 2012). In a disaggregated value chain structure the key value generating activities take place across various units or locations within or between a number of other independent organizations acting as suppliers, distributors, producers within a network architecture or structure as the progress of value creation of the product or service moves towards its final exchange outcomes. These fast transitions of people add new dimension to their roles and relations within the organization and outside. The dynamics of such complex relationships between people, resources and information against time need to be modeled in an organization. The DVCM represents a synchronized material and material flow cycle in servicing customer needs in supply chains in a closed loop 'demand-design-develop-deliver' cycle (4D). A supply chain transaction is triggered by the customer demand driven product life cycle activities. All subsequent manufacturing activities including planning, scheduling and shop floor management etc are then embedded in the "develop" and "deliver" phases of the DVCM. The supply chain feeds raw materials, parts and sub-assemblies etc to the required value adding shells/orbits in synchronization (e.g. Just-in-time etc). During the transformation processes of raw materials to finished product, human atoms as individuals or members of cross-functional teams push the product into its outermost orbits.

Integrated Architecture – the Pentatomic Organization

While the five portraits of an organization focus on people's roles, responsibilities and reactions, the link to consultation processes, which is a key characteristics of modern organizations, is missing. From EA's point of view, the five portraits are different views of an enterprise. The Pentatomic Organization Model (POM) can therefore be developed as a federation model that adapts to different enterprise modelling requirements by enabling or disabling its constituent sub-models (Figure 1).



Figure 1. The "federated" Pentatomic Organization Model

Each of the five foregoing models apparently looks different but has the same vibrant characteristics due to people in their hearts. An individual always radiates its sphere of influence onto the business environment that is extremely difficult to model. Human interaction is the chemistry of actions and reactions that take place when an individual sphere of influence comes in direct contact with others in a personal, societal and professional context (Chattopadhyay, 2010). Emotion plays a very significant role in any decision and is usually catalyzed by personal and external stimuli. Despite uniqueness of each human sphere of influence, emotion can largely influence the dynamics of an interaction and hence the outcome of a transaction.

An individual may behave or react in a totally different and unexpected way at different times. This unpredictability makes it very hard to model or simulate human interactions. The critical success factors for POM's are careful selection of the sub-models along with their combination and need-based deployment. One should remember that modelling is a continuous effort and not a one off exercise. Success is governed largely by the accurate assessment of the external business environment, business needs and customer requirements, strategy and cost and so on.

3. DNA Constructs and EA Building

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DNA is the foundation building block for all living cells (Watson and Crick, 1953). Baskin (1995) was among the first few researchers using DNA as an analogy for exploring enterprise characteristics. The enterprise DNA was represented by two interwoven "strands": identity and procedure. Since then researchers including Sireesh (2006), Spear and Bowen (1999), Towill (2007) explored the use of DNA as a modelling construct to explain the inheritance of characteristics of organizations. The exploration by Mo and Nemes (2010) defined the enterprise DNA as 3 foundation elements: *data, people* and *assets*



(*machines*). In such DNA thinking, these building blocks are itemized to enable free combination in any order for creating new enterprise architectures. With these building blocks, the anatomy of the enterprise can be constructed using three inter-connected strands: *control, knowledge and processes*. Subsystems of the enterprise are therefore characterized by the genes in the form of departments, products, services and other tangible entities (Figure 2).



Figure 2. DNA constructs for enterprise architecture modelling

Traditionally the objectives of enterprise modelling is to align "AS-IS" (existing) enterprise architecutre with the business objectives that drives the "TO-BE" (future enterprise architecture) within the constraint of a given time horizon against cost. A set of projects is then constructed to achieve this goal. According to Schwaninger (2006), organizational changes should be made on the basis of viability, which covers a broad range of preconditions. It would not make sense to build complex business processes on top of obsolete enterprise architecture.

However, the problem is that the external business environment, under which an enterprise operates, is constantly changing and not necessarily in line with the expectations or forecast of the enterprise. Therefore development of enterprise transformation plans that are designed for achieving the future enterprise architecture becomes a moving and unreachable target. In the fast changing business and information technology world, companies today need to have a well-thought out, well-documented, and well-communicated enterprise transformation plan to ensure that the enterprise captures a competitive

advantage. If the transformation costs become larger in the budget, the cost of "mistake" in the change process needs to be more closely scrutinized.

The DNA model can provide a traceable method to represent the state of the enterprises before and after the enterprise transformation. Before the enterprise transformation, the enterprise is represented by different enterprise architecture genes. Each of them will have special characteristics due to different permutation of the bases. At the time of enterprise transformation, the genes are broken into different parts and re-assembled. A new enterprise is then formed with the new genes.

This modeling method does not replace the existing lifecycle architectures and modeling tools. It serves different purpose. Here we assume that the two or more enterprises are already in their operating phase of their respective lifecycles and the unified one (after enterprise transformation) will be a combination of them. The mission, values, etc. will be adopted from the dominant one. So the DNA blueprint can be viewed as the description, documentation of certain phases of the lifecycles. This is therefore an extension of the "normal" mission oriented enterprise engineering method rather than its replacement. The mission elements can be changed by replacing very specific genes in each enterprise.

Hence, cloning of the newly acquired enterprises can be done from the most effective one, most likely to be the enterprise that dominates the enterprise transformation process. It is also possible to create plug and play (i.e. by replacing genes) enterprise sub-systems that fit the new enterprise. Optimisation of production (whatever the delivery output is going to be: manufacturing, banking, health care, government services. etc) can be done by mix and match value adding activities irrespectively from localities. People skills and their opportunities for creativity can be maximized rather then consider their present positions for the newly transformed enterprise. It is also worth to note that inheritance of genes may not be entirely controllable by the enterprise designer, for example, one may not have the freedom to select products or services due to historical reasons.

4. Genes for pentatomic organization

The genes for Pentatomic Organizations can be defined for each of the individual models. Depending on the need and importance of the enterprise, the appropriate genes are switched on. Taking this approach, there are numerous genes need to be defined. This paper does not attempt to define all genes because many of these fundamental constructs are evolving. Some examples are given here to provide an initial starting point of constructing a PO (Table 1).

Model	Importance	Process	Knowledge	Control
People- Centric	Pivotal role of people who are propelling force for any enterprise	 IT network Corporate services Business rules 	 Skills, Engineering R&D Customer services Manufacturing Staff development 	 Resource allocation Company governance Finance Distributed Business Units



Molecular	Business transaction is driven by human relationships	 Transaction processing Technology Tools IT infrastructure 	 Human behaviour Motives Client relationships Sphere of influence 	 Human resource system Code of conduct Performance indicators
Kaizen- Lean Six Sigma	Operational model for continuous improvement	 Continuous improvement process Corporate services Support engineering Statistics and process monitoring 	 Engineering R&D Customer services Training Champion Quality management 	 Company governance Costing Productivity Process monitoring and control
Globally Dispersed	Human Network of Networks through cyberspace	 IT services Standards of data bus Dealership Logistics management 	 Engineering R&D Supply chain management Manufacturing networks 	 Transparency of supply chain Company governance Financial accounting Internet security
Disaggre- gated Value Chain	Resembles atomic fission phenomena in value creation	 Computer support Design team Entrepeneurship Team work 	 Products and processes Technolog Customer relationship management Shared resources 	 Finance Accountability Governance and vigilance Coordination and monitoring

 Table 1: Basic DNA constructs for models of PO

It is important that a very first step of the POM creation process is to define a long term strategy that remains unaffected due to any other unforeseen shortcomings in the short term. Using the DNA model, the five portraits of PO can be constructed.

5. A Case Study

The PO created by DNA constructs, which evolved over time, is illustrated by the study with GEW, a large global manufacturing organization based in Hong Kong. It has a manufacturing facility with some 2,400 employees in Dongguan, China - mainly for export. GEW exports mainly to Europe and North America and is an OEM (Original Equipment Manufacturer) & ODM (Original Design Manufacturer)



electrical heating appliances manufacturing company for brands like Philips, AEG, Toshiba, Kenwood and Sanyo (Yip, 2008).

Study of the case revealed that GEW had a simple, flexible and non-hierarchical structure involving entrepreneurs, small business owners, consultants, contractors and so on, that was characterised by DVCM. Under PO architecture (Figure 1), the overall GEW enterprise architecture will have DVCM switched on within the POM overall enterprise architecture. However, the individual organisations have their own architecture DNAs due to local characteristics can be modelled using other PO architectures. Hence, individual organisations within GEW will inherit different DNA constructs.

Thus the GEW DVCM entities are submerged in the heterogeneous mix of primary, secondary and tertiary manufacturer/dealer/supplier and customer relationship network working in a 4D cycle (Figure 3). The model forms the foundation for understanding the interactions within and among people oriented enterprises.



Figure 3. DVCM view of GEW POM

Being a global organization, GEW is drawing upon facilities globally that are distributed, not only in China, but also in Europe and other parts of the world. This view of GEW is therefore represented also by GDM that presents a collaborative and synchronized model for globally distributed organizations that adapt to different segments of the global market. The GDM is transactional in nature and portrays the interdependencies of the main business entities: Parent Company in Europe, Hong Kong Strategic Business Unit and Dongguan Factory China. The enterprise architecture of these business entities are constructed from the DNA inherited from the global GEW DVCM based POM (Figure 4). All these are shadowed under the PCM that drives the strategy for working with staff, contractors, customers and defining feedback channels, roles, functions and responsibilities.



Figure 4. DVCM and GDM DNA constructs for global GEW enterprise architecture

At the regional markets: Europe, Australia/New Zealand, South America, South East Asia, etc, GEW regional offices operate largely independently to maximise penetration to the local markets. The MM enterprise portrait has the tightly coupled molecular bonding that is necessary to ensure strong links to customers. The enterprise architecture at the regional markets are constructed from DNAs that are most suitable for MM interactions (refer to Table 1).

The Dongguan Factory China has a different enterprise architecture requirement. An essential element of this organizational behaviour is the facilitation of continuous improvement in manufacturing activities that drive the cost of production done and allow the greatest flexibility in meeting changing market demands. The process of continuous improvement that is driven by the changing needs of the customers is modelled by the KLSSM of POM. KLSSM can also be well integrated into this model since it addresses the wastage minimization and recycling aspect of the outfit for the distributed manufacturing scenario. On the other hand, the Dongguan manufacturing facility relies on a large number of supply chain partners within the locality of the southern part of China. A DVCM enterprise architecture that reflects in some way the global GEW enterprise but with a different emphasis on team work, coordination and monitoring is required. Operating the DVCM enterprise structure in the regional supply chain in such as way that its capabilities and outcomes meet the expectation of the GEW–GDM is of utmost importance for the success of the global GEW–POM.



Figure 5. Enterprise architectural constructs representing different parts of GEW

The enterprise architecture for GEW–POM consists of an interactive network of different POM models built by the individual model's DNA constructs (Figure 5). The GEW Global is created from a mix of DVCM and GDM that extend their rungs to Europe, Hong Kong and Dongguan. Inter-connected to the nodes are the local DNA rungs of Europe and Hong Kong regional marketing enterprise architecture. The Dongguan Factory has two complementary DNA constructs from KLSSM and DVCM handling different aspects of manufacturing requirements.

6. Conclusion

This paper reviews the five models of organizations and their integration into a federated pentatomic organization model. The dynamics of PO has necessitated the use of a highly flexible enterprise architectural construct based on the concept of DNA enterprise architecture elements. The DNA architectural elements are mapped to the POM where different elements are abstracted as functional descriptions. Based on the characteristics of each of the POM, the DNA architectural constructs are aligned with the enterprise architecture to enable fast-track enterprise transformation. The new modelling process has been demonstrated by a case study on a global manufacturing enterprise with distributed offices and functions in Europe, Hong Kong and Dongguan. The enterprise model has a mix of switched on POM portraits at different levels illustrating the capability of the new modelling concept for modern manufacturing system analysis.



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