Adaptive Enterprise Architecture for the Future: Towards a Reconceptualization of EA

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Adaptive Enterprise Architecture for the Future

Towards a Reconceptualization of EA

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***Abstract*—In some conventional definitions, Enterprise Architecture (EA) is conceived as a descriptive overview of the enterprise, while in other views EA is seen as a prescriptive framework of principles and models that helps translate business strategy to enterprise change. The conceptualizations of EA also vary in scope. There is an increasing recognition of EA as a systemic, enterprise-wide capability encompassing all relevant facets of the organization, transcending the traditional IT-centric view. However, we argue that none of the conventional conceptualizations of EA are adaptive in the face of today's complex environment. We view that an adaptive EA must go beyond a single organization and fully appreciate enterprise-in-environment ecosystemic perspective. Drawing on the heritage of Open Socio-Technical Systems Design and adopting the "three schools of thought" as a meta-paradigmatic backdrop, the paper features four different views of long-time scholar-practitioners, who discuss what an adaptive enterprise architecture would entail. Integration of these views paints a radically reconceptualized picture of enterprise architecture for the future. With this paper, we want to lay a foundation for a debate on the need for alternative conceptualizations, manifestations and research agenda for enterprise architecture.**

Keywords—adaptive enterprise architecture; conceptualization; adaptation; maladaptation; enterprise ecological adaptation

I. INTRODUCTION

Although Enterprise Architecture (EA) aspires to improve enterprise coherence, the discipline itself seems rather incoherent [1]. Definitions of EA differ along a number of dimensions:

Nature of the term. There is pluralism concerning the nature of the term: noun, verb or both. The term enterprise architecture is sometimes used as a noun, implying that enterprise architecture is an intrinsic structure that gives rise to actual enterprise behavior, or an architectural description that captures important aspects and qualities of the behavior producing and constraining structure (e.g. [2][3][4]). As a verb, the term implies that enterprise architecture is a process concerned with translating business strategy to enterprise change. In this view (e.g. [5]), EA provides a prescriptive framework of principles and models that guides and constraints development of business and IT.

Scope of concern. There is pluralism concerning the scope of 'realities' that must be considered within the context of enterprise architecture: anything that could be considered meaningful to people, such as tangible objects (e.g. machines, buildings, physical media, etc.), intangible objects (e.g. software, non-physical media), social things (e.g. culture, values, ideals, relationships), cognitive things (e.g. ideas, goals, tasks, models, etc.), or subjective experiences (e.g. emotions, aspirations, etc.). The pluralism about scope may manifest itself in two ways: 1) what is relevant and should be considered in the context of enterprise architecture; 2) how are the realities divided to those that may be the target of intentional change (design opportunities) and those that are not (constraints).

Depth of action. There is pluralism concerning the scope of intentional actions that must be considered within the realm of EA. Typical actions include: designing strategy formulation processes, designing strategies, gathering data, presenting data, overseeing change, participation in achieving change, etc.

So within this context, it is not surprising to find all kinds of configurations of stances across these dimensions such as:

- Enterprise architecture is a model or a set of models that informs the process of decision-making (anywhere from strategic policy formulation to specific solution design) in order to achieve coherence (alignment) between desirable business objectives or outcomes and the IT resources of an enterprise.
- Enterprise architecture is a process meant to identify (and govern) the desirables changes to the IT resource landscape in order to achieve coherence (alignment)

between desirables business objectives or outcomes as well as to enable new business objectives and foster new business opportunities.

- Enterprise architecture is an on-going process that pursues all necessary changes within and outside the perceived boundaries of the enterprise and is critical of its underlying assumptions, biases and values in order to foster intentional change to the process itself.

As a term, 'enterprise architecture' began to come into the vernacular in the mid- to late-1980's, when information system implementations had increased in size and complexity to the extent that coherence needed to be imposed through an architectural approach [6]. "With increasing size and complexity of the implementations of information systems, it is necessary to use some logical construct (or architecture) for defining and controlling the interfaces and the integration of all of the components of the system." [2].

Given this information- and information technology based provenance, EA became largely synonymous to enterprise-wide IT architecture for a long time. In this sense, any business descriptions are seen peripheral and merely providing the input and the context for IT [7][8]. The legacy of this notion still persists, and the term 'enterprise' in the context of architectures and architect job titles has been inflated.

Today, enterprise architecture is increasingly understood in the scope of Extended Architecture [7][8]: encompassing all the dimensions of the enterprise, not just IT. Architecture methods and tools are used to capture strategic goals and related business requirements to design the enterprise [7].

EA is also suggested to facilitate enterprise transformation governance [9]. It would provide decision-makers with information about the internal workings of the organization; explicate the transition needed between the as-is and to-be architectures; enable impact and risk assessment of change; ensure that solution programs are coherent and complementary to each other; facilitate communications within and across organizations; and provide architectural principles and guidelines that promote reuse and overall coherence [10].

While facilitating change has been an ongoing theme in enterprise architecture, few EA frameworks provide modeling and analysis support for adaptation to fast-moving environments [11]. Today's enterprises are intrinsically enmeshed in complex enterprise ecosystems beyond their physical boundaries that include a number of globally distributed entities such as customers, partners, collaborators, government and community [12]. It is imperative to continuously adapt to the changing business, information, social and technological landscape [13]. Traditional enterprise architecture work has been focused around process standardization and integration [14]. Designing complex and dynamic enterprises, however, requires a fundamental shift in the way EA is conceived and contrived. Enterprises and enterprise architecture practices alike need adaptive thinking to survive and thrive in this period of rapid change.

While there is a plethora of definitions, conceptualizations, frameworks and implementations of EA, the researcher and practitioner communities make believe there are no differences in the paradigmatic lenses through which enterprise architecture is studied and practiced. To make sense of the vast pluralism in the EA discourse, Lapalme [15] identifies three schools of thought on EA, each with its distinct belief system, scope and assumptions (for a complete description please refer to [15]) :

- *Enterprise IT Architecting (EITA)* school views enterprise architecture as "the glue between business and IT". Focusing on enterprise IT assets, it aims at business-IT alignment, operational efficiency and IT cost reduction. It is based on the tenet that IT planning is a rational, deterministic and economic process. The role of the enterprise architect is seen as the master planner/designer of the architecture.
- *Enterprise Integrating (EI)* school views enterprise architecture as the link between strategy and execution. EA addresses all facets of the enterprise in order to coherently execute the strategy. The environment is seen both as a generator of forces that the enterprise is subject to and as something that can be managed. Enterprise architect is a facilitator, whose challenge is to enhance understanding and collaboration throughout the business.
- *Enterprise Ecological Adaptation (EEA)* school regards enterprise architecture as the means for organizational innovation and sustainability. The enterprise and its environment are seen as coevolving: the enterprise and its relationship to the environment can be systemically designed so that the organization is "conducive to ecological learning, environmental influencing and coherent strategy execution." The enterprise architect fosters sense making in the organization and facilitates transformation as needed.

The EITA school is grounded in a mechanistic and closed systems perspective, the EI school in a systemic and closed systems perspective, and the EEA in a systemic and open systems perspective. What is common to EA across the different schools of thought – coherent structure, facilitation of change – varies in scope and nature. For instance, the EITA school is concerned with cataloguing IT assets and translating business requirements into IT outputs; the EI school is about coherence of all enterprise assets in support of strategy execution; and in the EEA school coherence pertains to adaptive organizational evolution vis-à-vis the environment in order to both anticipate and instigate changes therein.

There appears to be a trend towards more encompassing and sophisticated perspectives on EA. As the environment and enterprise context have grown in complexity, the scope and dynamism of EA have increased. At the same time, its original metaphysical premises have both persisted and been appended with new paradigms. Currently, the Enterprise Integration school seems to be predominant [10].

In this paper, our focus is on adaptive enterprise architecture for the future as per the EEA school, but we also acknowledge the existence, prevalence, and maladaptive sustenance of other schools of thought. Thereby, we take the multiparadigm stance that "the provincialism that comes with paradigm confinement might instead be turned toward the production of more

complete views of organizational phenomena via multiparadigm consideration" [16]. Particularly in the area of EA, subject to pluralism along a number of dimensions, a search for comprehensiveness stemming from different worldviews may be a more useful starting point for theory building than a uni-paradigmatic search for truth.

While our perspective on EA differs from predominant views in the field, there are also considerable differences in the views of the authors of this paper. Instead of aiming at a single, coherent view on adaptive enterprise architecture, we "agree to disagree." Accordingly, the research question of this paper is as follows: "What divergences and convergences of views exist within the EEA school of thought on enterprise architecture?"

To address the research question, this paper applies the expert opinion based research approach. Expert opinion based research is not new [17] and is considered appropriate for a "cognitive input." Similar to many other studies (e.g. [18][19]), this paper uses the opinion-based research approach for eliciting, analyzing, comparing and integrating the opinions of long-time scholar-practitioners of EA, and it reports four different views based on practice and research. Instead of indirect opinion-based research reporting, a dialectical and direct approach is employed to surface implied assumptions of the experts (the authors) and to compare and integrate their various stances. As there are very few authors that take EEA as a point of departure, such an approach is justified as a means of explorative research. We view that this initial study is of significance and provides a foundation for further evidence-based work in developing a taxonomy of different EA views in the context of enterprise adaptation.

II. Enterprise Ecological Adaptation from Open Socio-Technical Systems Design Point of View

To analyze the exchange processes between the organization and elements in its environment, Emery and Trist [20] identify four 'lawful connections' pertaining to the organization and its environment: interdependencies internal to the organization (denoted L_{11}); the actions or planning of actions by the system out into its environment (L_{12}); the flow of information from the environment to the system (L_{21}); and the processes through which parts of the environment become related to each other (L_{22}) [20][21]. For the last area of interdependencies that belong within the environment itself, they re-introduce the concept of *the causal texture of the environment* [22] at a social level of analysis. The causal texture refers to the processes through which interdependencies in the environment come about. Emery and Trist [20][23] identify four "ideal types" of causal texture: 1) placid, randomized environment; 2) placid, clustered environment; 3) disturbed-reactive environment; and 4) turbulent field.

According to Emery and Trist, the present state of environmental complexity is at a minimum Type 4. In this *turbulent field* [20], the environment is no longer a stable ground for competition. The dynamic properties arise not only from the interactions of the organizations but also from the field itself – the "ground" is in motion. The complexity exceeds individual organizations' capacities for prediction and control; they cannot adapt to the turbulent environment through their direct interactions but must rely on commonly held values as the control mechanism in the field [20]. Consequently, in order to be adaptive from the perspective of the environment at large, the organizations of today must be more conscious about the impact of their actions and strive to work in ways that benefit the entire ecosystem, not just themselves (cf. [21]).

From this point of view, an adaptive enterprise is one that enables making choices that reduce environmental turbulence and the destructive nature of self-centered uncoordinated competition in the face of finite resources. According to Emery and Trist, maladaptations (improper adaptations) stem from artificial attempts to reduce the anxiety of making choice, when making choices becomes too difficult and too anxiety-laden. According to Emery and Trist such reductions can be manifested along one or more of the three dimensions of purposeful choice [24]:

1. The probability of choices: other things being equal, the probability of choosing one course of action rather than some other, because it seems more fitting to oneself or one's idea of himself;
2. The probable effectiveness of choices: other things being equal, the probability of choosing one course of action rather than some other, because it seems more effective according to the knowledge possessed or valued by oneself;
3. The probable intention leading to choice: other things being equal, the probability of choosing one course of action rather than some other, because of the underlying intentions between the actions;
4. The probable outcome of choices: this dimension is a function of the two first dimensions.

The passive maladaptive responses respective to these dimensions are [21]:

- *Segmentation* that pertains to separation of means and ends, wherein the social field is transformed into segments, each of which is integrated within itself but poorly with other segments. Anxiety in making choice is reduced by staying in the familiar. The main strategy for this is to artificially create a separation between sequences of means-ends, which begets uncoordinated action both in time and in space.
- *Dissociation* that is manifested by a lack of coordination between the parts in the whole. Anxiety in making choice is reduced by not recognizing what others do and know is relevant, hence dissociating oneself from the other in order to limit what knowledge and action is considered relevant or useful.
- *Superficiality* that refers to "indifference to what needs or demands are taken as a starting point for one's behavioral responses." Anxiety is reduced by making choices in ways that avoid questioning the intentions and values that guide action. It is specifically about avoiding to recognize that our actions go against what we 'deep-down' feel is right and fair.
- *Doomsday*: an implicit or explicit belief that change is not possible. Anxiety is reduced by making choices

based on distorted views of what outcomes are possible to be achieved.

Each of the passive responses also has a respective, active correlate aimed at reducing the uncertainty and complexity of the turbulent environment (cf. [25]):

- *Authoritarianism*: an attempt to impose a very rigid structure to prevent the means-ends or part-whole relationships from breaking down.
- *Evangelism*: an attempt to coordinate the field through notions such as 'all pulling together.'
- *Synoptic idealism*: an attempt to comprehensively cover all relevant information to control and to reduce the causal texture of the environment to a lower level.
- *Social engineering*: an attempt to deliberately obtain an outcome most desirable to the social engineer.

Albeit the core literature on the causal texture of the environment dates back all the way to the 1960s, it is the best, if not only, model that we are aware of that defines the environment component of an open system. The model of causal texture of the environment model has been discussed and elaborated in the literature to this date, and it is still valid in its basic premises. We deem it pertinent to refer to the original work of Emery and Trist.

Each of the following four sections features an essay by one of the authors and is written in first person.

III. Perspective 1: Only Enterprise Ecological Adaptation School Fosters Adaptive Enterprise

People in both researcher and practitioner communities are promoting an allegedly new perspective on enterprise architecture, touted as being either agile or adaptive. Some even go further to maintain that EA should contribute to the success of the enterprise by helping it become more agile or adaptive. The terms agile and adaptive seem to be part of a fad that many gravitate towards. In my opinion, the terms are often used very superficially, neglecting two key questions: "Enterprise must adapt to what?" and "Enterprise must adapt for what purpose?" Answers to these questions do not generally offer a specific conceptualization of what is meant by a turbulent environment and how an enterprise must adapt to such turbulence.

My perspective is firmly grounded in the open socio-technical systems ideas developed by Emery and Trist [20][23]. My starting point is that the current environment is of Type 4. Enterprises must adapt to an environment where neither tactical nor strategic planning is feasible. In order to survive, they must avoid passive and active maladaptations, as proposed by Emery [21], and must seek to coordinate their activities by pursuing the ideals of Homonomy, Nurturance, Humanity and Beauty in order to create a new Type 2 environment.

I believe that there are various ways for the maladaptation of *Segmentation* to manifest itself, when separation is created between ends and means. Some examples include: 1) separation between planning and implementation; 2) separation between coordination and doing; 3) separation between controlling and producing; 4) separation of labor, responsibilities and goals; and 5) separation between problem definition (requirements) and solution design. In an active way, the maladaptations of *Authoritarianism* manifest themselves when law and order are imposed, e.g. by 1) imposing standards; or 2) controlling conformity. Consequently, I consider that following ideas and practices should be avoided: 1) enterprise architects as Planners (separation between planning and implementation); 2) enterprise architects as Modelers (separation between labor, coordination and doing); 3) enterprise architects as Governors (separation between controlling and doing); 4) enterprise architects as Designers; and 5) enterprise architecture as a separate function, role, job, profession. In contrast, guided by open socio-technical systems design, I consider the following ideas and practices as a means to achieve adequate adaptive enterprise architecture and enterprise: 1) enterprise architecture as a competency; and 2) enterprise architecture as a concern. Enterprise architecture would be seen as a shared competency and embedded concern within the enterprise rather than as a specific job. Pursuing the concern of enterprise architecture would be about eliminating previous separations within the enterprise and society. Moreover, enterprise architecture would be concerned with the design of organizations based on the following ideas: redundancy of functions within people, multifunctional groups, participative democracy, and networks of autonomous (or semi-autonomous) groups responsible for the end-to-end delivery of value to external stakeholders. These ideas are the key underpinnings of what Emery and Trist named Design Principal 2 (DP2). Such a pursuit increases the scope of possible choice by understanding the worldviews of others. This is the pursuit of *Homonomy*.

I believe that there are various ways for the maladaptation of Dissociation to manifest itself when the actions and knowledge of others are not considered relevant or useful. Some examples include: 1) enterprise architects that believe that EA is their job and not the job of others; 2) enterprise architects that limit their decisions based on past experience or sources that they value; and 3) enterprise architects that believe that the work of others is not relevant to their work. In an active way, the maladaptation of *Evangelism* manifests itself when evangelizing is used to artificially bring people together despite low levels of respects and recognition – for instance, when EA tries to bring people together by using hollow proclamations. In contrast, I consider the following ideas and practices as a means to achieve adequate adaptive enterprise architecture and enterprise: 1) enterprise architecture that pursues the sharing of knowledge across enterprise and between the enterprise and the environment (innovation and open innovation); 2) enterprise architecture that fosters collaboration. Such ideas lead to enterprise architecture as being a capacity of organizational learning and collaboration. Enterprise architecture should strive to help people within and outside the enterprise to pursue the ideal of *Nurturance*, of self and others (promoting and engaging in innovation, ecosystem creation, industry initiatives, etc.).

I believe that there are various ways for the maladaptation of *Superficiality* to manifest itself, when EA actions do not take into consideration the well-being of workers, society and the planet. Some examples include: 1) EA with the intention of short-term gains (especially without consideration for the long term or for the impact on people, society and the planet); 2) EA

that does not consider the well-being of people, society and ecology (making choices that create poor jobs, that exploit people, and that do not respect the aspirations and identity of people). In an active way, the maladaptation of *Synoptic idealism* manifests itself, when responsibility of intention is removed from decision-makers by looking for an external "all-knower" – for instance, when it is believed that EA standards and "best practices" are the best ways of guiding decisions. In contrast, I view that active adaption is achieved by fostering well-being, human growth, social development, etc. This is the pursuit of the ideal of *Beauty*. Such a pursuit increases the alignment between actions and the deep nature of people. Moreover, the capability of enterprise architecture would strive to help others within and outside the enterprise pursue well-being, human growth, social development, etc.

I believe that the *Doomsday* maladaptation can manifest itself, when there is an implicit or explicit belief that change is not possible. Here are some examples: 1) enterprise architects that believe that they cannot change the business; 2) enterprise architects that believe that they cannot change the industry and market; 3) enterprise architects that limit their scope of design to only IT (EITA) or to the business (EI) but do not consider the environment within their scope of design (EEA). In the active way, the maladaptation of *Social engineering* manifests itself, when there is a belief that all is possible and that things can be unilaterally (or almost unilaterally) controlled or determined. For example: 1) it is believed that all change can be controlled with EA (either IT, business, etc.); 2) it is believed that the future can be planned with EA. In contrast, I consider that active adaption would include: 1) enterprise architecture that pursues outcomes within and outside the enterprise that are in accordance to the other ideals, hence pursuing the ideal of *Humanity*; 2) enterprise architecture that has a scope of design that includes the environment (market, government, society, etc.) of the enterprises. This leads to EA as a capacity to foster change within and outside the enterprise (innovation).

In conclusion, I view that many of the ideas and practices promoted by mainstream enterprise architecture practitioners and authors are examples of maladaptations. They implicitly (or explicitly) foster organizational silos that contribute to power struggles, general irresponsibility for overall awareness, and legitimization of boundaries between stakeholders. The core of the problem is that the ideas and practices promote a worldview of EA that is a noun (hence concerned with direct action), that has a scope of concern that is too narrow (either IT or the inside of the enterprise), and that has a depth of actions that is too shallow (focused on decision-making and the gathering of necessary data for the decisions). I am particularly concerned about the creation of an EA profession that legitimizes silos within enterprises and society – a paradox, given that enterprise architecture alleges to promote the idea of eliminating silos. I believe that enterprise architecture is a concern that all members of the organization should be responsible for.

IV. Perspective 2: Vertical Contingency

In my view, enterprise IT architecture has its place at the lowest levels of work complexity (cf. [26]), but true enterprise architecture addresses business and social considerations at the higher levels of the organization (cf. [10]). "Anything 'lower' is 'trade' and mere design, anything higher goes beyond a single organization's scope" [10]. The question is whether even EA is enough in today's Type 4 environment [20]. And if not, what would inter-organizational architectural approach entail at the higher levels of complexity? To shed some light on these questions, Table I suggests a juxtaposition of the three schools of thought on EA [15] with the tripartite approach to EA [26]. The solid line around a cell denotes that the school of thought would be requisite at the level of complexity, while the dotted line implies that its assumptions fall short at the given level.

TABLE I. Adaptive and Maladaptive EA

	Enterprise IT Architecting (EITA)	Enterprise Integrating (EI)	Enterprise Ecological Adaptation (EEA)
Ecosystemic Architecture	"Analysis paralysis." Lock-in in the as-is.	Inadequate renewal. Failure to sense and seize opportunities. Indifference to the wider context. Adapting to but not creating change.	EA that fosters innovation and sustainability. System-in-environment co-evolution. Environment can be changed.
Socio-Technical Architecture	Clinging to "best practices" Limited view of the scope and potential of architecture. Disconnect with the strategy.	EA is the link between strategy and execution. Holistic, systemic view of the enterprise. Choosing tactics. Changing the business.	Adaptive enterprise. Business modularity.
Technical Architecture	Architectural descriptions. EA is the glue between business and IT.	EA aimed at business outcomes. Solution architecture.	Optimized core of digitized data and processes.

As per this conjecture, the EITA perspective would be requisite in Technical Architecture (A^T) [26], when the environmental complexity is low. Rational, deterministic and economic IT planning that aims at business–IT alignment, operational efficiency and IT cost reduction [15] would seem to suffice in a placid, clustered environment [20], wherein clustering of resources and competences is required [23]. Such a placid environment, however, must be artificially created, e.g. by shielding the technical system [27] from environmental perturbations (cf. [28]). For instance, a factory may have a relatively stable operating environment, in which technical blueprints provide the necessary 'glue' between business and IT to support reliable operations and changes contained within the technical system.

EITA will, however, fall short at the level of Socio-Technical Architecture (A^S) [26]. This is the realm of 'Changing the Business' activities [1] that are less repeatable and "about setting a new direction for the organization, responding to significant problems, or instigating changes that

require significant investment and coordination." Clinging to familiar 'best practices,' failing to see all facets of the enterprise, lack of appreciation of the strategic context, and limited view of the potential of architecture can be seen as maladaptations of segmentation, dissociation, superficiality, and doomsday, respectively. In the face of Ecosystemic Architecture (A^E) level complexity [26], the shortcomings of EITA would be even more pronounced, and it would be prohibitively difficult for the organization to escape the resulting monothematic dogmatism, stalemate, and polarization (cf. [29]).

A^S would be needed in a disturbed-reactive environment [20], in which organizations need better visibility into their internal workings as well as intelligence on their competitors in order to choose between possible tactical options and to out-maneuver the competition [21][23]. Collaboration and mutual inquiry, more than specialized expertise, are needed to foster shared understanding necessary to change, not just follow, the strategic direction. To requisitely 'informate' [30] decision-makers at this level, at least the EI perspective, embracing a holistic, systemic view, will be required. The nature of A^T at the operational level would also need to change as per the EI view: it would be more focused on business outcomes and comprehensive solutions rather than IT outputs and individual information systems.

In today's turbulent field [20], EI would only be viable, when the organization is bolstered from the turbulence. Mechanisms to reduce the complexity faced by an organization include the corporate structure and the extended enterprise. Any higher level complexity is then absorbed by that supersystem. Otherwise, the organization tends to fail to renew enough (segmentation), not to sense and seize opportunities that its peers make available (dissociation), to be indifferent to ecosystem adaptiveness and the needs of the society (superficiality), and to merely adapt rather than to create change in the industry structure (doomsday).

At the level of Ecosystemic Architecture (A^E) [26], architecture must allow for co-evolution with the business ecosystem, industry, markets, and the larger society. Such architecture would deal with the structural embeddedness among exchange partners, e.g. open-ended social contracts, information architecture of ecosystem total solutions, interorganizational interdependencies, shared destiny relationships, management of obligations, expectations, etc. This calls for the EEA perspective [15] of organizational innovation, sustainability, and system-in-environment thinking. At the lower levels, this would translate to adaptive enterprise principles (cf. [31]) and business modularity on top of the optimized core of digitized data and processes [14].

Here lies the Paradox of Adaptive EA: while level L organizational structures enable locally adaptive level L-1 subsystems with a respective approach to EA, the architecture of level L structures requires a commensurate EA approach, which, by recursion, needs to be propagated to L-1 for global adaptiveness. In conclusion, the Enterprise Ecological Adaptation school of thought on EA [15] is the only adaptive approach to enterprise architecture in the face of Type 4 environmental complexity [20]. While the EITA and EI views may be requisite in complexity-reduced contained contexts, the enterprise as a whole must ultimately cope with the environment in its full complexity. Should the enterprise architecture approach be applied to this system-in-environment co-evolution, it should subscribe to EEA throughout all organizational and architectural levels.

V. Perspective 3: Enterprise As Living System

Any conversation about EA can benefit from an understanding of its point of origin. As discussed in the introduction, the phenomenon emerged in the 1980's as a response to "rapid change in technology, application requirements, and organization" as well as to "excessive choice in the marketplace" [32]. In the three decades since its inception, this originally conceptualized motivation for EA has multiplied in difficulty many times over.

In today's world, any sizable enterprise has hundreds, if not thousands, of applications, as well as commensurate levels of infrastructure elements and data structures. If the problem were limited to simply keeping track of information technology, that level of complication itself would constitute a daunting task. However, any architecture effort that concerns itself purely with technology will have very limited usefulness. Effective EA can only be performed in the presence of appropriately joined-up architectural descriptions of enterprise elements and interfaces, e.g. role players, services, information structures, agreements, resources, procedures, that provided needed context for architectural views of data processing software and hardware.

Adaptiveness in the face of the many external forces that impinge on the enterprise requires shared understanding of the effects of any changes, or adaptations. Making a change in one part of the enterprise can easily cause unintended consequences in some other part. The more elements there are, and the more they are interconnected, the greater the likelihood of such problems. The more turbulent the marketplace environment, the more adaptations are needed, and the greater the likelihood that incompatibilities and maladaptations will arise.

On top of the complications imposed from the outside, EA must come to terms with the fact that human organizations are not buildings, bridges or vehicles. As living systems [33], enterprises actually participate in the 'architecting' of themselves, often in unexpected ways. While it is true that some aspects of an enterprise can be envisioned, planned, and brought into being in a relatively linear, intentional, straightforward fashion, it is actually more likely that aspects of the living enterprise defy conscious, purposeful manipulation.

In a fundamental way, EA may have gotten off on the wrong foot from the very start by adopting the terminology of architecture. The word 'architect' originated from the Greek *arkhitekton*: master builder, or director of works. But what does it mean to be the 'master builder' of a living enterprise? To the extent this is even meaningful, that role applies primarily to the entrepreneur, or to the fiduciary responsible executives rather than to the discipline of EA as we know it in any of the three schools of EA thought [15]. For EA to aspire to the role of master builder of enterprises would require the ability to supply services that make enterprises more adaptive in turbulent environments.

Regardless of whether the 'master enterprise builder' is a realistic current or aspirational role, EA can focus on "defining and controlling the interfaces and the integration of all of the components" [2]. EA can provide the service of understanding and communicating enterprise interaction patterns. EA can attend to issues of coherence to assure that elements are appropriately joined up in ways that prevent internal and external perturbations from threatening the viability of the enterprise. Thus, I view that EA constitutes a type of System 2 homeostatic function, in terms of Stafford Beer's Viable Systems Model [34].

A reconceptualization of EA should focus on the methods and tools that are needed to provide the requisite coherence and adaptability to balance internal and external sources of turbulence. The good news is that in any viable enterprise, much of the work of documenting these elements is performed in the natural course of doing business. Such 'found' documentation includes mission and vision statements, business plans, catalogs, training materials, regulatory filings, methods and procedures, configuration management databases, charts of accounts, organization charts, etc. EA can play the special role of disambiguator and Rosetta Stone for the many working cultures and languages across the enterprise. This role involves management and manipulation of a meta-language, such as that provided by many current enterprise architecture tools, but even more importantly, the large and growing number of industry-specific ontologies and controlled vocabularies.

Unfortunately, in contrast to this vision of adaptive EA for the living enterprise, today we observe various maladaptations of the EA role, including:

- EA as a roadblock, or hindrance to the adaptations needed by the enterprise
- EA that focuses on only the internal enterprise lawful connections (L_{11})
- EA that focuses only on the information technology aspects of L_{11}
- EA in the role of arrogant dictator, operating from an ivory tower
- EA as an inflated job title, having little or nothing to do with either architecture or enterprise in any meaningful sense

Healthy, adaptive EA starts with an appetite to understand and influence how complex structures of elements work together across the extended enterprise within its marketplace environment. This living enterprise mindset can be fostered and nurtured. It can be taught. Ideally, it can be distributed across the inevitable specialties and silos.

No matter how centralized or distributed, adaptive EA constitutes a special set of capabilities applied in the never-ending battle for enterprise effectiveness and against enterprise entropy.

VI. Perspective 4: Adaptive Enterprise Design

In my view, adaptive EA is about the evolving design and practices of the human-centric adaptive enterprise. Instead of upfront, detailed, complex, documentation-centric, and prescriptive EA, adaptive EA focuses on the stakeholders or customer-centric needs or concerns or value for being adaptive (adaptive to expected and unexpected change), adaptive value chain, and adaptive principles to guide the adaptive EA both as a design and practice.

A. *Being Adaptive*

Being adaptive means making complex things simple or simpler to effectively embrace change (based on [36]). It requires the ability to actively scan and identify changes (internal and external) based on both the intuitions and analytics, and to effectively respond to such changes for continuous adaptation, for efficiency (operations and improvement), and for innovation (growth and transformation) [37][38]. The value of adaptive EA is not only to describe the complex adaptive enterprise elements, properties, and their relationships to each other and to the eco-system environment [4], but it is also about actively seeking, identifying, assessing, rationalizing and realizing the opportunities for adaptation in the overall context of adaptive enterprise value chain [38]. This is to ensure that adaptation does not occur in a part for the sake of sub-optimization, while ignoring the whole of the value chain.

B. *Adaptive Value Chain*

An adaptive enterprise design can be viewed in terms of its core value chain journey capabilities (see Fig. 1), which comprise of adaptive enterprise strategy-architecture-project-operations [38]. The value chain view demands that an adaptive EA, embedded in the value chain, should have effective integration and alignment with other adaptive enterprise value chain capabilities such as upstream adaptive strategic management capability and downstream project management and operations management capabilities (based on [39]). EA, as a discipline, has been criticized for not being able to demonstrate value generation; it is often considered as a mere cost center [9].

Fig. 1. Adaptive enterprise value chain – The Gill Framework® V3.0 (Gill 2015)

The adaptive enterprise value chain puts the adaptive EA in the overall value generation pipeline. It can be easily depicted in the value chain view that EA is an integral part of the value chain, but also that being adaptive in one part, such as project management, may not be sufficient and may result in undesirable, suboptimal performance. Hence, an enterprise may be considered to be adaptive in all or some parts of the value chain for optimal performance of the pipeline. The value-chain based adaptive EA view will help identify opportunities for improvement, integration and alignment points for the overall adaptive EA coherency. It could ensure that enterprise energy is channeled in a cohesive way to enable continuous adaptation.

C. *Adaptive Principles*

Adaptive thinking is a complex phenomenon. Instead of providing explicit or fixed descriptive instructions for the adaptive EA (and for the whole value chain), in my view, adaptive EA design and practice can be guided by six types of adaptive principles (see Fig. 2) [12][38][40]. These principles types have their own distinct features but also share some commonality; thus, unlike Boolean or discrete membership, they are fuzzy [41] in nature and appropriate to represent the complex reality of the adaptive EA. Further, this may not be an exhaustive set of adaptive principles. The principle types and underlying principles are evolving constructs, and should be adjusted and updated as the research and practice advances.

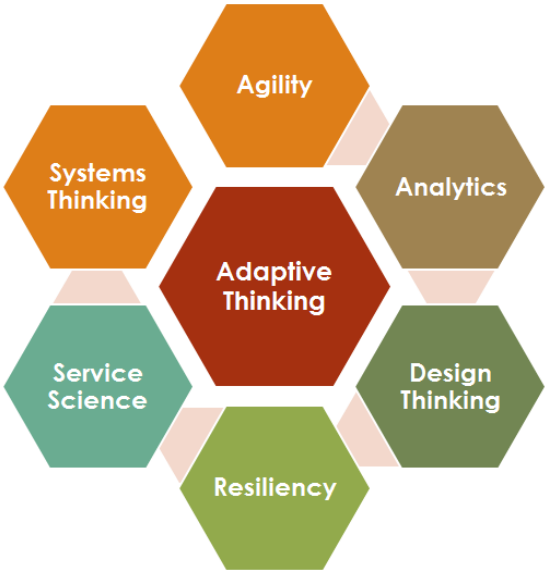

Fig. 2. Adaptive principles – The Gill Framework® V3.0 (Gill, 2015)

1) Agility. Agility refers to the principles of responsiveness, flexibility, speed, leanness and learning [42]. Thus, being agile in the context of adaptive EA means that adaptive EA, as a design and practice, enables flexible and rapid response to expected or unexpected changes by using lean and learning mechanisms for supporting adaptation.

2) Analytics. Analytics refers to the principles of quantitative thinking, types of data, types of analytics and usages [43]. Analytics-enabled adaptive EA has the ability to monitor, collect, analyse, and interpret data and information for actionable insights or changes or decision making. Analytics could be descriptive, diagnostic, predictive and prescriptive in nature and be aimed to address the strategic, tactical and operational needs of stakeholders.

3) Design thinking. Design thinking refers to the principles of human-centric and collaborative design. It offers a balanced interplay of intuition and analytical thinking for the continuous human-centric and collaborative design or re-design of an adaptive EA, as a design and practice, for adaptation [44][12]. Intuition refers to visionary ideas, and analytics refers to quantitative or fact- or data-driven rational thinking. Design thinking is not restricted to identifying changes merely based on analytics; rather, it also incorporates the generation of new visionary ideas through collaboration for efficiency and innovation.

4) Resiliency. Resiliency refers to the principles of protection, sustainment and adaptation [40]. Adaptive EA, as a design and practice, is resilient, when it has the protection mechanism for minimizing and exploiting risks that result from exposure to threats or vulnerabilities, sustains (keeps operational) under stress, and adapts by accommodating expected and unexpected changes [45][46].

5) Service science. Service science views an individual or organization as a 'service system' [47]. Service science refers to service as a fundamental unit of exchange and value co-creation. An adaptive EA practice offers services for service oriented EA design to support value co-creation through the active engagement of stakeholders [12]. In this sense, a service-centric EA is an adaptive enterprise service architecture.

6) Systems thinking. Systems thinking offers the principles of holism, autonomous, interdependence, systems, context-aware and self-organizing [33]. These principles refer to the adaptive EA, as a design and practice, that follows a holistic approach, where the whole is greater than a sum of its parts. It is a system of autonomous but interdependent elements, which are context-aware and self-organizing. Adaptive EA as a system processes the inputs within its constraints and produces outputs; and its performance is impacted by its culture, norms and control feedback loop mechanisms [12].

VII. Comparison and Synthesis of Perspectives

This paper features four distinct perspectives on adaptive enterprise architecture, based on the practical experience and theoretical insights by the authors. The four essays provide rich material for an interpretive synthesis that explores the need for and underpinnings of a reconceptualization of enterprise architecture from the enterprise ecological adaptation (i.e. adaptive enterprise) point of view.

Perspective 1 represents a radical departure from mainstream conceptualizations of EA. Based strictly on the socio-technical enterprise and ecosystem ideas of Emery and Trist, it considers all division of labor and responsibilities as well as task and job specialization as being maladaptive. The other perspectives combine ideas from other streams of literature and, consequently, arrive at somewhat different conclusions about what is considered as maladaptive. Perspective 2 adopts a contingency view that, under certain conditions, more traditional approaches to EA would be locally adaptive. While it ultimately arrives at the same conclusion that only Enterprise Ecological Adaptation is systemically viable, the idea of isolating parts of an enterprise goes against the grain of the strict interpretation of Open Socio-Technical Systems Design that underlies Perspective 1. Perspectives 3 and 4 highlight the human-centric and living system [33] nature of adaptive EA, which involves active participation and collaboration, as well as adaptive principles in the design and practice of adaptive EA.

Our four perspectives seem to represent the Enterprise Ecological Adaptation school [15]. The four perspectives

converge on a number of key assumptions. First, we share a deep concern for the environment: not only the impact that the environment has on the organization, but also how the organization can influence its context, causes autochthonous changes in the causal texture of the environment (cf. [23]), and how the organization and the environment co-evolve. Second, all of us recognize that today's enterprises are subject to a Type 4 environment [20]. Third, an adaptive response in such an environment calls for EA, whose scope of concern goes beyond the design of IT and systemically embraces all facets relevant to enterprise design. Fourth, the role of adaptive enterprise architecture is seen as high-level context-setting that facilitates decision-making, rather than as making specific operational or strategic decisions. Fifth, adaptive enterprise architecture is considered as an embedded organizational capacity entrenched in the organizational modus operandi, although, as discussed below, our views differ as to what degree EA warrants a status as a dedicated organizational capability or center of excellence.

All in all, the four views support the notion that if the organizations are to survive the turbulence of today's markets, the belief systems that have not worked even in the past will not be adaptive in the future. Consequently, the Enterprise Ecological Adaptation school of thought will be the only viable way of thinking about EA (cf. [15]). The integration of different perspectives portrayed in this paper paves way for a reconceptualization of EA that, in our view, is more in line with today's complex environment, more sustainable, and more considerate of all stakeholders.

Our four perspectives seem to give rise to a synthesis of views that would recognize the idealized, radical view Perspective 1, but also the importance of making visible and thereby tangible the architectural elements of the enterprise, their interfaces and relationships. The resulting constructional view would not be an end in and of itself, however, but rather a means to enable intentional and purposeful change. Rather than removing the responsibility from the rest of the organization and trying to act like "organizational scotch tape" to keep everything together across time (planning) and space (coordination), EA should be an embedded organizational capacity and shared concern embraced by everyone, not just some master planners and designers in an EA ivory tower.

In this view, those that have deeper expertise in certain subject matters, call them enterprise architects if you wish, would help others to improve their competencies. Adaptively, this help would take the form of Process Consultation [48]: a mutual inquiry that involves the client in the diagnosis and solution design, while transferring diagnostic and intervention skills of the architect, so that the client can deal with future problems more effectively. Given that the Expert and Doctor modes of helping [48] prevail, the difficulties of proving EA value are not surprising. When the underlying assumptions of the architect are false, the help is not judged as useful by the client. In adaptive EA, we view, the architect must have humility and a profound respect for the people being helped and believe in their capacity to grow and learn.

VIII. Discussion and Conclusions

While the research and practitioner communities have recognized the need for new perspectives on EA and have proffered 'agile' or 'adaptive' approaches and models, few have been informed by solid theoretical underpinnings of what adaptation (and its inverse, maladaptation) truly mean. In this paper, we have drawn, foremost, on the intellectual and scientific heritage of Open Socio-Technical Systems Design, spearheaded by Fred Emery and Eric Trist [20][21][23], whose work represents probably the most profound treatise of enterprise-in-environment adaptation and co-evolution. Against this backdrop, we provided four different perspectives on adaptive enterprise architecture that lent themselves to dialectical comparison.

Based on the analysis, comparison and integration of these perspectives, it can be concluded that: 1) all enterprises of today have to face and deal with Type 4 turbulent environments [20]; 2) mainstream EA practices are not adaptive in the face of this environment; 3) most theoretical conceptualizations of EA are based on outdated paradigms, whose metaphysical assumptions fall short in this environment; 4) EA calls for radical reconceptualization to inform a more adaptive EA practice.

Furthermore, some tentative tenets of the new conceptualization of 'adaptive EA' can be discerned: 1) Adaptive EA is an ongoing process that supports organizational coherence vis-à-vis continuous co-evolution with the environment; 2) Adaptive EA is a shared competency and embedded concern – everyone is an enterprise architect to a degree; 3) Adaptive EA is concerned with enacting adaptive change not only in the focal enterprise, but also in the environment it is embedded in.

This list of principles is indicative and inconclusive. What, in our view, makes Adaptive EA different from "non-adaptive" or "adaptive" (i.e. purportedly, but not actually, adaptive) EA is its capacity to effectively deal with the complexity and dynamism of the environment. In the case of today's business organizations, this environment seems to be virtually always of Type 4 (sensu [20]).

While we ostensibly agree on key principles such as the importance of environmental principles or the relevance of systems thinking, the short essays provide only limited information for a meaningful comparison of assumptions. For instance, is the environment viewed as a target of intentional design actions or merely as a constraining consideration? Different streams of systems thinking have very different underlying assumptions. Which ones do each of us draw on?

A major limitation of this type of opinion based research is the bias in the experts' input. In the future, we intend to minimize this bias: while the dialectical approach employed helped surface and objectify our own assumptions for explorative analysis, further follow-on research might include in-depth interviews of a greater number of subject matter experts for even richer data and insights.

The four perspectives are based on diverse prior knowledge and experience of the authors. This illustrates that no single view is definitive or complete and that there is richness in the multitude of perspectives that can deliberately be drawn on and applied as deemed relevant. As is the case with available EA frameworks, it is not so much about the frameworks, per se, but about how they are selected and tailored for the context in hand.

In a similar vein, organizations may select, modify and use insights from these views for their idiosyncratic adaptive EA design needs.

With this paper, we wanted to lay a foundation for a debate on the need for alternative conceptualizations of and research agenda for enterprise architecture. You are invited.

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