

Article

The History of Enterprise Architecture: An Evidence-Based Review

Svyatoslav Kotusev

Abstract

The conventional wisdom says that the concept of Enterprise Architecture (EA) originated from the pioneering work of John Zachman. He is frequently referred to as the “father” of EA and many consider the Zachman Framework to be the breakthrough that created the discipline of EA and provided the foundation for all subsequent EA frameworks and methodologies. Is Zachman’s “A Framework for Information Systems Architecture” really the seminal publication of the EA discipline? Is it really the first EA framework? Did it really profoundly influence modern EA methodologies? In order to answer these questions, in this article I describe an evidence-based history of EA and trace the origins of all essential ideas constituting the basis of the modern concept of EA.

Keywords

Enterprise Architecture, history, frameworks, Zachman Framework, Business Systems Planning

INTRODUCTION

Almost every publication on Enterprise Architecture (EA) cites the Zachman Framework (Zachman 1987) as a seminal EA publication that fundamentally shaped the discipline of EA. Authors routinely call John Zachman the “father” of EA and consider his framework paper to be the initial breakthrough publication that created the very concept of EA and significantly influenced its modern understanding. Moreover, many authors argue that the Zachman Framework inspired all other subsequent EA frameworks and methodologies.

Feeling skeptical about these unsubstantiated statements that are typically taken for granted, I decided to initiate an historical inquiry to understand what the real roots of EA are and where the major EA-related ideas originate from. In particular, I focused on the evolution of specific actionable ideas that shaped modern EA methodologies and contributed to the current understanding of EA as an instrument for corporate information systems planning. Therefore, my study deliberately did not cover definitions and philosophy of EA, other IT-related types of architecture (software architecture, system architecture, etc.), as well as architectures for computer integrated manufacturing (CIMOSA, PERA, GRAI, TOVE, GERAM, etc.).

In order to trace the historical provenance of EA, I searched all available physical and electronic libraries and the Internet looking for early ideas and methodologies for information systems planning and related them to the modern EA literature. This led me to conclude that EA has a long history that can be logically

divided into three distinct periods: Business Systems Planning, early EA, and modern EA.

BUSINESS SYSTEMS PLANNING

The idea of deliberate information systems planning is far from new. Early planning approaches proposed various considerations on how to design corporate information systems based on an organizational strategy (King 1978), data flows between departments (Blumenthal 1969), suppliers and orders (Carlson 1979; Kerner 1979), critical success factors (Rockart 1979), management information requirements (King & Cleland 1975), and decisions (Henderson & West 1979; Zani 1970). However, the earliest origins of the modern concept of EA can be traced back to the Business Systems Planning (BSP) methodology initiated by IBM in the 1960s and led by P. Duane (“Dewey”) Walker (BSP 1975; BSP 1984; Davenport 1994; Harrell & Sage 2010; Lederer & Putnam 1986; Lederer & Putnam 1987; Sidorova & Kappelman 2010; Spewak & Hill 1992; Zachman & Ruby 2004; Zachman & Sessions 2007). The first edition of BSP (BSP 1975) resembled EA in many important aspects. Specifically:

- BSP activities are carried out by a dedicated group of experts (BSP study team) whose responsibilities include collecting data by interviewing managers and developing information systems plans in a top-down manner.
- BSP information systems plans describe the relationship between organization, business processes, data, and information systems.

- BSP uses relationship matrices, information systems networks, flowcharts, and other techniques to model processes, systems, and data.
- BSP is implemented in a step-wise manner starting from identifying business objectives, defining business processes and data, analyzing the existing IT landscape and developing a desired

future information systems plan, and ending with preparing an action plan and communicating it.

Later editions of BSP (BSP 1984) used the notion of architecture to describe the relationship between business processes and data classes (Periasamy 1993; Periasamy & Feeny 1997). The BSP methodology is shown in Figure 1.

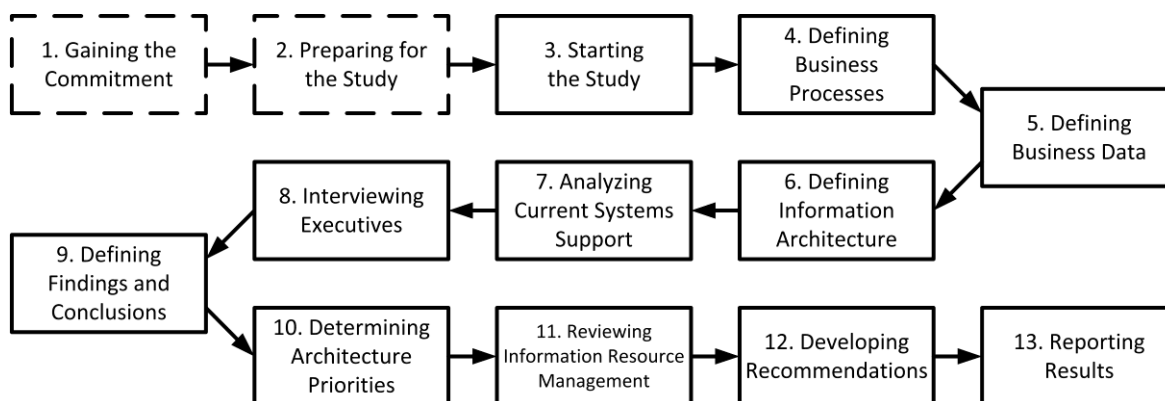


Figure 1: BSP methodology (BSP 1984, p.10)

After the introduction of the BSP methodology by IBM many other consulting companies and experts proposed similar formal architecture planning methodologies (Martin 1982; Method1 1979; Nolan & Mulryan 1987). For instance, Nolan, Norton & Company consultancy recommended the following architecture methodology (Nolan & Mulryan 1987):

1. Develop an agreed definition of architecture.
2. Identify and involve architecture stakeholders.
3. Determine the key questions to be answered with architecture.
4. Build a baseline of the existing architecture.
5. Formulate the strategic architecture vision.
6. Organize an effective IT department capable of managing and implementing the architecture.

Therefore, BSP was the earliest, definitive, and most widely known top-down planning methodology among a number of similar BSP-like approaches used by different companies (Adriaans & Hoogakker 1989; Davenport 1994; Lederer & Gardiner 1992b; Lederer & Putnam 1986; Lederer & Putnam 1987; Sullivan 1985; Zachman 1982). All these methodologies used the notion of architecture as a formal description of the relationship between business and IT. However, they were known and discussed under different titles: data architecture, information architecture, strategic data planning, and other similar names (Davenport 1994; Goodhue et al. 1992; Lederer & Gardiner 1992a; Martin 1989; Periasamy & Feeny 1997).

EARLY ENTERPRISE ARCHITECTURE

The notion of an EA framework, as a logical structure for organizing the description of an enterprise, was introduced in 1986 by the PRISM research service of Index Systems and Hammer and Company as a result of the research project sponsored by a group of companies (including IBM) and aimed at finding optimal ways to describe an architecture of distributed systems (PRISM 1986). The PRISM EA framework was the first published EA framework in the modern understanding of this concept (Greefhorst & Proper 2011; Harrell & Sage 2010; Rivera 2013); however, somewhat similar ideas were presented even earlier (Wardle 1984). The PRISM EA framework organizes an architectural description into 16 categories according to four domains (organization, data, application, and infrastructure) and four types (inventory, principles, models, and standards). The PRISM EA framework is shown in Figure 2.

One year later in 1987 a similar framework for organizing architectural documentation was published by an IBM marketing specialist, John Zachman, in the internally reviewed IBM Systems Journal (Zachman 1987). The Zachman Framework organizes an architectural description into 15 categories according to five perspectives (planner, owner, designer, builder, and subcontractor) and three interrogatives (what, how, and where). Although it is claimed that the first version of this framework was created in 1984 (Zachman 2009) or even in 1982 (Zachman & Ruby 2004; Zachman &

Sessions 2007), these claims are not substantiated by any documents. Five years later in 1992 the extended version of the Zachman Framework was published in the IBM Systems Journal (Sowa & Zachman 1992a). The extended version of the Zachman Framework organizes an architectural description into 30 categories according to five perspectives (planner, owner, designer, builder, and subcontractor) and six interrogatives (what, how, where, who, when, and why).

| | Inventory (Snapshot of the Current State) | Principles | Models (Description of the Desired State) | Standards |
|----------------|--|------------|--|-----------|
| Infrastructure | | | | |
| Data | | | | |
| Application | | | | |
| Organization | | | | |

Figure 2: PRISM EA framework (PRISM 1986, p.5)

In 1989 the National Institute of Standards and Technology (NIST) issued the first official guidance on EA (Rigdon 1989). The NIST EA model organizes an architectural description into five different architecture levels: business unit, information, information system, data, and delivery system. The NIST EA model is shown in Figure 3.

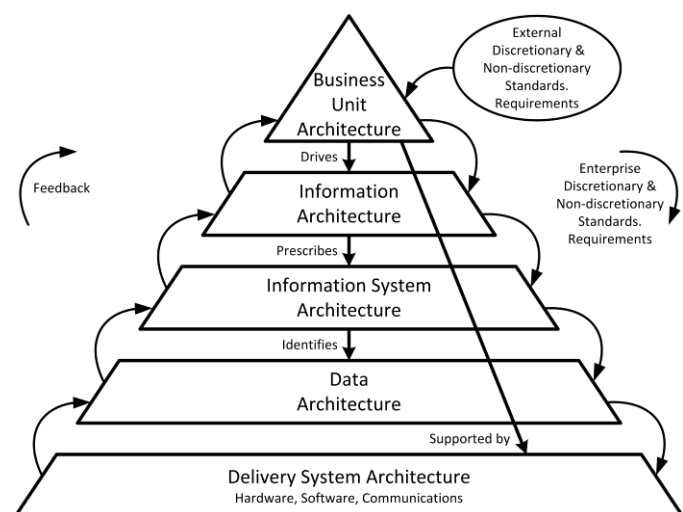


Figure 3: NIST EA Model (Rigdon 1989, p.138)

The phrase “enterprise architecture” was first used by Zachman (1982) (Harrell & Sage 2010). However, its usage was seemingly accidental since this term was mentioned only once without any clear definition. Moreover, it was not used later in subsequent

publications, which used the term “Information Systems Architecture” (Sowa & Zachman 1992a; Sowa & Zachman 1992b; Zachman 1987; Zachman 1989). The term “Enterprise Architecture” was first consistently used by Rigdon (1989) for describing the NIST EA model, although also without any specific definition of its meaning. Later the term “Enterprise Architecture” was first formally defined by Richardson et al. (1990) in their MIS Quarterly article describing the application of the PRISM framework (in particular architecture principles, its most important element) in a large oil company. They defined EA as an architecture that “defines and interrelates data, hardware, software, and communications resources, as well as the supporting organization required to maintain the overall physical structure required by the architecture” (Richardson et al. 1990, p.386).

The first EA methodology called Enterprise Architecture Planning (EAP) was proposed by Spewak and Hill (1992). “EAP has its roots in IBM’s BSP” (Spewak & Hill 1992, p.53) and prescribes essentially the following sequence of steps to practice EA:

1. Understand and document the current state of an organization.
2. Develop the desired future state of an organization.
3. Analyze the gaps between current and future states.
4. Prepare the implementation plan.
5. Implement the plan.

Although Spewak and Hill (1992, p.13) claim that EAP “creates the top two layers of John Zachman’s Framework”, the Zachman Framework is seemingly mentioned only for marketing-related purposes and is not used in any real sense because the actual deliverables of EAP can hardly be mapped to the framework as claimed. For instance, the EAP methodology and its deliverables are structured around four architecture domains (business, data, applications, and technology), which do not map to the three columns of the Zachman Framework (what – data, how – processes, and where – locations) and do not distinguish between its top two rows (ballpark and owner’s views) (Spewak & Hill 1992, pp.12-13). Subsequently, the EAP methodology served as a basis for many modern EA methodologies (Spewak & Tiemann 2006). The EAP “wedding cake” methodology is shown in Figure 4.

At the same time, the Government Accountability Office (GAO) published a somewhat similar architecture development methodology recommended for federal agencies (GAO 1992).

This methodology is made up of eight steps:

1. Mission and strategy identification
2. Function identification and analysis
3. Information needs identification and analysis
4. Data needs identification and analysis
5. Applications identification and analysis
6. Logical system definition
7. Alternative architecture identification and analysis
8. Target architecture selection

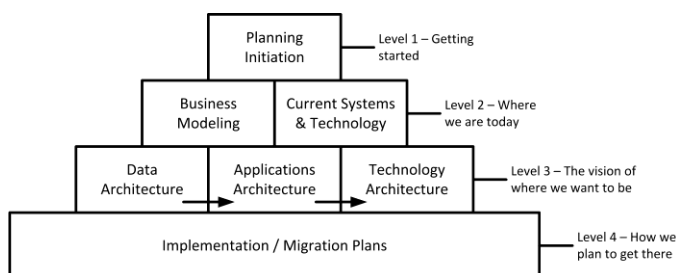


Figure 4: EAP methodology (Spewak & Hill 1992, p.16)

It was later supplemented with the best practices learned from leading private and public organizations (GAO 1994).

The Department of Defense was one of the first federal agencies to adopt EA (Buss & Shillabeer 2012). In order to speed up the delivery of information systems, lower their costs, and promote integration and flexibility, the Defense Information Systems Agency (DISA) in 1994 introduced the Technical Architecture Framework for Information Management (TAFIM) (Buss & Shillabeer 2012; Goikoetxea 2007; Sessions 2007; TAFIM 1996a), which was based on some previous models initiated in 1986 (Golden 1994). TAFIM describes EA practice as a seven-steps iterative process including documenting baseline and then target states, analyzing the gaps between them, preparing implementation plans, and following them (TAFIM 1996b). TAFIM recommends describing four domains of EA: work organization, information, applications, and technology (TAFIM 1996b). The TAFIM methodology is shown in Figure 5.

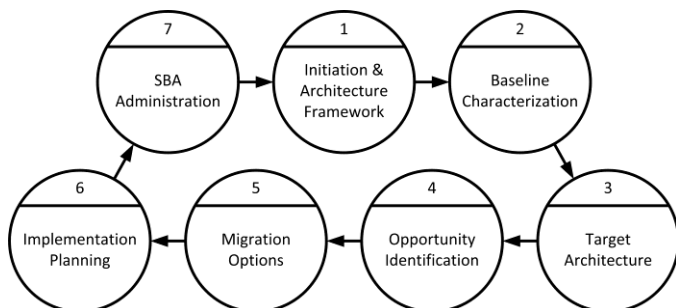


Figure 5: TAFIM Methodology (TAFIM 1996b, p.xiv)

MODERN ENTERPRISE ARCHITECTURE

In 1996 the Congress had enacted the Clinger-Cohen Act obliging the Federal Government and all its departments to develop consistent architectures compatible with the NIST EA model in order to improve the usage of information systems (OMB 1997). As a response, in 1999 the Federal CIO Council initiated the Federal Enterprise Architecture (FEA) program and published the corresponding FEA Framework (FEAF) (FEA 2001; FEAF 1999). FEAF is based on the EAP methodology and aligned with the NIST EA model (FEAF 1999; Thomas et al. 2000; Zachman & Sessions 2007). Therefore, FEAF prescribes following the same sequence of steps to practice EA, but recommends describing business, data, applications, and technology architectures in a segmented manner. Similarly to EAP, it is claimed that FEAF is based on the Zachman Framework; however, the Zachman Framework is again “used” only as a symbol without any far-reaching consequences (FEAF 1999, pp.20-23).

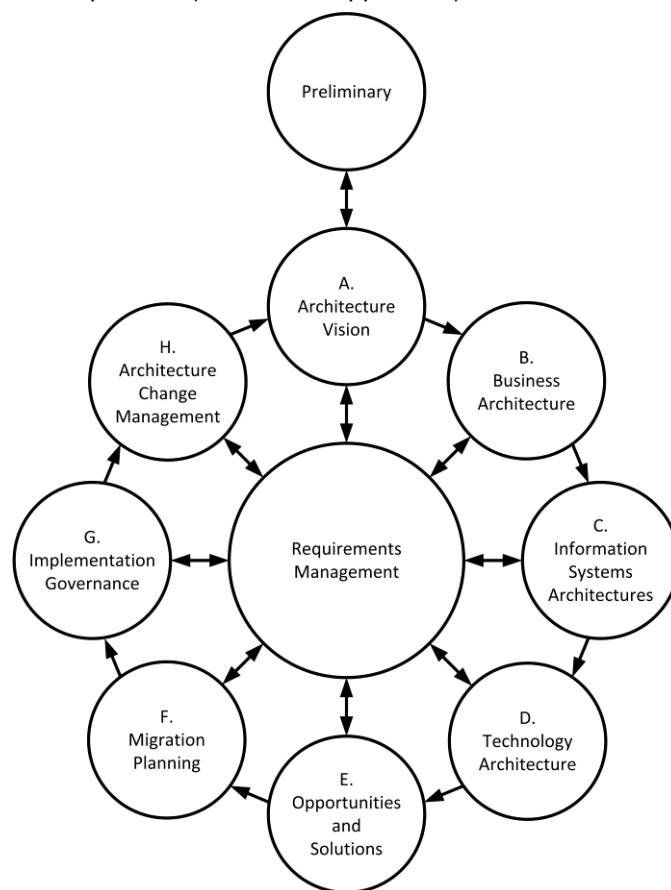


Figure 6: TOGAF Architecture Development Method (TOGAF 2011, p.48)

After the passage of the Clinger-Cohen Act in 1996 TAFIM was superseded by the Command, Control, Computers, Communications, Intelligence, Surveillance,

and Reconnaissance (C4ISR) framework (C4ISR 1997; Levis & Wagenhals 2000; Sowell 2000) and officially withdrawn in 2000 (Bhagwat 2009; DoDAF 2007a; DoDAF 2009; Goikoetxea 2007; Schekkerman 2004). C4ISR, in its turn, was later replaced with the Department of Defense Architecture Framework (DoDAF) (DoDAF 2007a; DoDAF 2007b; DoDAF 2007c) in 2003 (Bhagwat 2009; DoDAF 2009; Schekkerman 2004). After TAFIM had been replaced, its materials were explicitly given to The Open Group and provided a basis for the creation of the TOGAF® standard initiated in 1995 (Bhagwat 2009; Perks & Beveridge 2003; TOGAF 2011). Unsurprisingly, the TOGAF standard also recommends describing the typical four domains in EA (business, data, applications, and technology) and recommends the Architecture Development Method (ADM) with one Preliminary phase and eight cyclic phases including describing current and future states, analyzing gaps, preparing transition plans, and implementing them (TOGAF 2011). The TOGAF ADM is shown in Figure 6.

Presently TOGAF (2011) is the most cited and widely discussed publication in EA literature (Simon et al. 2013). It embodies the modern understanding of EA and is even considered as a *de facto* industry standard in EA practice by some authors (Brown & Obitz 2011; Dietz & Hoogervorst 2011; Gosselt 2012; Lankhorst et al. 2010; Sarno & Herdiyanti 2010; Sobczak 2013).

CONCLUSION

This analysis describes the history of EA and the origin of the most discussed EA frameworks: Zachman, FEAF, and the TOGAF standard (Simon et al. 2013). It clearly shows that the concept of EA has a long history beginning in the 1960s when the BSP methodology was initiated by IBM. The fundamental ideas of BSP permeate the entire history of early and modern EA. Specifically:

1. BSP suggested that the information systems planning for the whole organization is carried out by a dedicated group of experts (prototype of Enterprise Architects).
2. BSP introduced the notion of architecture for describing the relationship between business and IT (prototype of EA).
3. BSP recommended to describe business, data, and information systems domains (prototype of EA domains).
4. BSP proposed various techniques to model processes, systems, and data in a formal way (prototype of EA diagrams).
5. BSP advocated a formal step-wise process for architecture planning including the analysis of

the current state, description of the desired state, and development of the action plan (prototype of EA methodologies).

The comparison between BSP, early EA, and modern EA is summarized in Table 1.

Therefore, the concepts and methodologies of EA are far from new and essentially emerged from BSP in the 1960s long before the publication of the Zachman Framework (Zachman 1987). All of the foundational ideas constituting the modern concept of EA are thus almost 50 years old. In fact, all early and modern EA methodologies are based on the ideas pioneered by BSP (Armour et al. 1999; Bernard 2012; Bittler & Kreizman 2005; Boar 1999; Covington & Jahangir 2009; FEAF 1999; IBM 2006; Longépé 2003; Niemann 2006; Schekkerman 2008; Spewak & Hill 1992; TAFIM 1996b; Theuerkorn 2004; TOGAF 2011; van't Wout et al. 2010). For instance, the modern concept of EA embodied in the TOGAF standard is essentially nothing more than a modernized, revamped, and rebranded version of the BSP methodology introduced in the 1960s since the differences between them are largely stylistic and inessential with the only notable exception that the TOGAF framework is iterative in nature and more technical than BSP (see Table 1).

At the same time, PRISM (1986), the very first architecture framework, seemingly had a significant influence on the modern concept of EA. For instance, the organization of architecture according to four domains (organization, data, application, and infrastructure) initially proposed by the PRISM framework was largely adopted by the most prominent early and modern EA standards and methodologies (Bernard 2012; Covington & Jahangir 2009; FEAF 1999; Rigdon 1989; Spewak & Hill 1992; TAFIM 1996b; TOGAF 2011; van't Wout et al. 2010). Initially proposed by King (1978) in its rudimentary form, the idea of using architecture principles as the most fundamental and stable element of EA was elaborated by the PRISM framework to its modern form which is currently embraced by prominent EA methodologies (Boar 1999; Schekkerman 2008; TOGAF 2011; van't Wout et al. 2010). The PRISM framework also pioneered the idea of using architecture standards as the essential component of EA presently adopted by prominent EA methodologies (Bernard 2012; Spewak & Hill 1992; TOGAF 2011; van't Wout et al. 2010). Additionally, the PRISM framework explicitly suggested that EA should describe both current and desired states of an enterprise. This idea is now closely associated with the very notion of EA (Bernard 2012; FEA 2001).

| Aspect | BSP | Early EA | Modern EA |
|---------------------------------|---|--|--|
| Time period | 1960s – 1980s | 1980s – 1990s | 1990s – present |
| Definitive source | BSP (1975) | Spewak and Hill (1992) | TOGAF (2011) |
| Actors | BSP study team | EA planning team | Team of Enterprise Architects |
| Products | Information systems plans (later architecture) | Enterprise Architecture | Enterprise Architecture |
| Domains | Organization, processes, data, and information systems | Business, data, applications, and technology | Business, data, applications, and technology |
| Modeling | Relationship matrices, information systems networks, and flowcharts | Lists, relationship matrices, and diagrams | Catalogs, matrices, and diagrams |
| Methodology | Describe current and desired states, prepare an action plan, and implement it | Describe current and future states, prepare an implementation plan, and implement it | Describe baseline and target states, prepare a transition plan, implement the plan, and repeat the process |
| Difference from the predecessor | N/A | Pays more attention to technical aspects | Iterative in nature |

Table 1: Comparison between BSP, Early EA, and Modern EA

| Aspect | Conventional Wisdom | Evidence Shows |
|--------------------------------|---|---|
| General concept | EA is a new concept introduced by the Zachman Framework and its breakthrough ideas (Zachman 1987) that subsequently shaped the very discipline of EA. | BSP (1975) |
| Methodology | | BSP (1975) |
| Notion of architecture | | BSP (1984) |
| Notion of framework | | Arguably, PRISM (1986) or even earlier (Wardle 1984) |
| Four architecture domains | | PRISM (1986) |
| Architecture principles | | PRISM (1986), in a rudimentary form King (1978) |
| Architecture standards | | PRISM (1986) |
| Term “Enterprise Architecture” | | Arguably, Rigdon (1989) or Richardson et al. (1990) |
| Summary | | EA originated in the 1960s and is essentially an updated version of the BSP methodology significantly influenced by the novel ideas of the PRISM framework. |

Table 2: Comparison between the Conventional Wisdom on and Actual Origins of EA

The Zachman Framework (Zachman 1987), which is widely considered to be the seminal EA innovation, does not seem to have played a significant role in the formation of the concept of EA because this framework did not introduce any ideas that were subsequently adopted by the early or modern concepts of EA. For instance, the organization of architecture according to different perspectives (planner, owner, designer, builder, and subcontractor) and interrogatives (what, how, and where) recommended by the Zachman Framework was not adopted by the most prominent early and modern EA standards and methodologies (FEAF 1999; Rigdon

1989; Spewak & Hill 1992; TAFIM 1996b; TOGAF 2011) which structure an architectural documentation according to the four domains (business, data, applications, and technology). The documentary evidence cited strongly suggests that the Zachman Framework, even if referred to, as in the cases of EAP and FEAF, did not significantly influence any EA frameworks and methodologies in any real sense. The actual role of the Zachman Framework as the source of the basic concepts of EA seems to be overstated in the conventional wisdom. This is not to say that the Zachman Framework did not add any value to the

discipline, only that its concepts did not find their way into the bulk of the community's thinking on the subject.

Based on the available documentary evidence, I conclude that the widespread belief that the concept of EA originated with the Zachman Framework is unwarranted. A comparison between the conventional wisdom about EA and what the historical evidence shows about the actual origins of EA is summarized in Table 2. The evidence-based comparison shows that all the fundamental ideas of EA belong to the BSP methodology, some ideas belong to the PRISM framework, and none of them come from the Zachman Framework. The modern concept of EA is conceptually rooted in the BSP methodology initiated by IBM in the 1960s and is significantly shaped by the novel ideas introduced by the PRISM framework.

Despite my best efforts to find and analyze all early information systems planning publications that might have influenced the modern concept of EA, the analysis provided in this article may not be exhaustive since many early publications have apparently never been digitized and cannot be obtained for analysis now. Nevertheless, even this potentially incomplete analysis clearly demonstrates that the concept of EA has a long history and provides a more objective discussion of its origins than the conventional wisdom. Finally, I would be very grateful if any readers of this article could provide me with any additional relevant information that can help further clarify the real history of EA.

ABOUT THE AUTHOR

Svyatoslav Kotusev is a researcher at RMIT University, Melbourne, Australia. He has spent the last two years studying EA practices in organizations. Prior to his academic career he held various software development and architecture positions in industry. He is a TOGAF® 9 Foundation certified architect. Svyatoslav can be reached at kotusev@kotusev.com.

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