

Fake and Real Tools for Enterprise Architecture: The Zachman Framework and Business Capability Model

Svyatoslav Kotusev (kotusev@kotusev.com)

Enterprise Architecture Professional Journal (EAPJ), August 2019

This article represents an extended and updated version of the earlier article published in April 2018 by the British Computer Society (BCS): <http://www.bcs.org/content/conWebDoc/59399>

Abstract

The discipline of enterprise architecture (EA) is teeming with numerous tools intended to help architects do their work, e.g. various frameworks, modeling languages and other techniques. Some of these tools are famous, positioned as central to the EA discipline, promoted as global standards and widely taught in various courses, but in reality they are essentially useless for all practical purposes (fake tools). At the same time, other tools actually work in practice and are broadly adopted in industry, but they are scarcely discussed in mainstream EA publications and lacking systematic descriptions (real tools). Moreover, these fake and real toolsets for enterprise architecture barely overlap with each other. In order to illustrate the current paradoxical situation in the EA discipline, this article discusses in detail one celebrated fake tool (the Zachman Framework) and one prominent real tool (the Business Capability Model), analyzes the sharp contrast between them and explains the implications of this duplicity for the EA profession.

Keywords: Enterprise Architecture, Zachman Framework, Business Capability Model, Management Fads, Best Practices.

Introduction

The discipline of enterprise architecture (EA) is closely associated with numerous tools including various frameworks, approaches, techniques and modeling notations intended to help architects plan organizations and their information systems. However, for a very long time we have been observing a rather curious situation which can be characterized as absurd, paradoxical or even schizophrenic. In particular, one set of tools is declared as fundamental to the EA discipline, consistently promoted as global EA standards and widely taught in various EA courses, but in reality these tools are largely, if not totally, useless for all practical purposes. At the same time, other set of tools constitutes the actual body of established EA best practices that work in organizations, but these tools are barely discussed and lacking sensible descriptions for newbie architects and students to learn from.

Moreover, the set of *famous* EA tools and the set of *useful* EA tools barely overlap with each other. The existence of these two disparate toolsets should be very clearly understood and acknowledged by the EA community for the normal progression and further professionalization of the EA discipline [1]. In order to illustrate the critical difference and sharp contrast between these toolsets, below I will discuss in detail two notable tools for enterprise architecture representing arguably the most extreme opposite examples of fake and real tools: the Zachman Framework as a prominent fake tool and the Business Capability Model as a prominent real tool.

The Zachman Framework: A Fake Tool

The Zachman Framework introduced in the article “A Framework for Information Systems Architecture” published in the IBM Systems Journal in 1987 [2] is arguably the most famous model related to enterprise architecture. This framework is well known to all architects and, as many people firmly believe, even created the entire EA discipline. For instance, Simon et al. [3] expressed this view rather poetically: “The discipline of enterprise architecture (EA) has evolved enormously since John Zachman ignited its flame in 1987”. The Zachman Framework allegedly provides the necessary foundation for enterprise architecture and is considered by many to be very influential. As Rao et al. [4, p. 24] put it: “The importance of Zachman’s work cannot be understated, as it is foundational in the development and evolution of EA”. Currently it has more than 4000 citations in Google Scholar and entire 750-page-long books have been written wholly dedicated to it [5].

Due to its perceived significance, in 1999 the original article describing the Zachman Framework was reprinted [6] in the special retrospective double issue of the IBM Systems Journal (Turning Points in Computing: 1962-1999) including the most important articles that appeared in the journal during 38 years since its inception in 1962 and presumably represent certain turning points in the history of computing [7, 8, 9]. Later in 2007, to celebrate the 50th anniversary of its journals IBM issued a special report (Celebrating 50 Years of the IBM Journals) highlighting the most significant papers published in these journals [10], which also included the article “A Framework for Information Systems Architecture” and characterized it as “one of the most highly cited papers ever published in the IBM Journals” [11, p. 1]. For his renowned framework John Zachman received several international awards, including a lifetime achievement award for “his long term impact and contribution to how people think and practice Enterprise Architecture today” [12, p. 1].

Superficial Novelty of the Zachman Framework

The reality around the Zachman Framework is, however, not that bright. First, contrary to the widespread opinion, from the historical perspective the Zachman Framework did not introduce any novel ideas, i.e. pioneered neither the very idea of systematic information systems planning nor the general concept of architecture, was not the first taxonomy, or “framework”, for architecture and did not even coin the term “enterprise architecture”.

Specifically, the need for deliberate information systems planning was recognized as soon as computers began their way into business in the late 1950s [13, 14] and in the early 1960s respective approaches appeared even on the pages of Harvard Business Review [15]. The term “information systems architecture” was used at least since the late 1960s [16]. The idea of purposefully designing organizations was popular at least since the early 1970s [17]. Information systems planning and architecture in some or the other form had been rather widely practiced in industry since the 1960s-1970s and respective functions had been established in many large commercial and public sector organizations around that time [18]. Multiple world-famous comprehensive architecture planning methodologies, including BSP [19], Method/1 [20], Information Engineering [21] and Strategic Data Planning [22], already existed during the 1970s-1980s long before the Zachman Framework. The architectural taxonomy of Wardle [23] and the PRISM framework [24] were also published before the Zachman Framework in 1984 and 1986 respectively. Finally, the term “enterprise architecture” originated from other sources in the end of the 1980s [25, 26], while the Zachman Framework switched to “enterprise architecture” only in the late 1990s [27, 28].

Interestingly, even John Zachman himself admitted that the concept of architecture appeared long before his framework and actually originates from IBM’s BSP [29, 30, 31, 32]:

“I acknowledge Dewey Walker, the director of architecture on the old IBM Information Systems Control and Planning staff in the late 1960s, as the “grandfather” of architecture methodologies. It was his internal IBM experience in Information Architecture that later became known as Business Systems Planning (BSP)” [32, p. xv]

Moreover, Zachman also reported that the framework was actually conceived only as an addition to BSP, which he promoted previously during his 26-years-long tenure at IBM [12, 32, 33, 34, 35]:

“At the outset, my intention in describing the Framework was merely to improve on the planning methodologies to follow BSP. [...] For me, at least initially, the Framework was simply the logical structure that connected the products of planning [resulting from BSP studies] with the products of the more technical implementation” [32, p. xvi]

Flawed Justifications of the Zachman Framework

Second, the original justification behind the Zachman Framework was entirely speculative: “Equivalency [between the architectural representations in manufacturing and construction industries] would strengthen the argument that an analogous set of architectural representations is likely to be produced during the process of building any complex engineering product, including an information system” [2, p. 281] (by the way, the analogy to classical architecture used by Zachman also emerged at least two decades earlier [36]). However, all people acquainted with the practical realities know that organizations and their information systems have a very significant social component and cannot be designed and built like other engineering products (e.g. buildings or aircrafts) as suggested by the framework. The socio-technical nature of organizational information systems is acknowledged even in the introductory textbooks on the subject [37].

The proposed taxonomy itself looks arbitrary and is based only on loose similarities. In fact, the framework was initially intended for planning separate information systems, but then was effortlessly “scaled up” to enterprise-wide planning by means of blunt renaming of its labels: “When I first drew the Framework graphic, the only words I had at my disposal for the Framework concepts were words from my information systems vocabulary” [38, p. 7], but then “I simply put the Enterprise names on the descriptive representations because I was interested in engineering and manufacturing Enterprises” [39, p. 41], explained Zachman. In light of these revelations, the arbitrary nature of the Zachman Framework is beyond question. Despite its pretended comprehensiveness, the framework does not even address all questions arising as part of information systems planning. For example, where is the question “How much?” that stands particularly often during the architectural planning activities?

It was also argued that “seven thousand years of human history would establish that the key to complexity and change is architecture” [40, p. 2], but the problem here is that all the complex objects provided as a historical justification for comprehensive architecture (e.g. Roman Coliseum) stood completely unchanged for centuries and never evolved like information systems in organizations. Essentially, the arguments put by Zachman to justify his framework have no “face validity”. These conceptual flaws have been noticed long ago by many practicing architects, including Zachman’s former colleagues from IBM:

“We may call aircraft design and enterprise modeling both modeling. We must, however, not lose sight of the fundamental differences that lie between them. An aircraft can be “frozen” in time and space, whereas an enterprise, like any social organization, cannot. It is recreated every day. The way in which processes are

carried out and procedures are followed changes continuously, sometimes without the persons involved even noticing it” [41, p. 285]

“[One of the flawed concepts promoted by Zachman] is that building enterprise information systems is just like building airplanes. In fact, an enterprise information system is much more like the nervous system of a living organism. This point has serious implications for how IS people conceptualize their work and their relationship to the societal organizations they serve” [42, p. 9]

“The analogy to classical architecture first made by John Zachman is faulty and incomplete. Over the years, it has also veered off course. We need to reexamine the analogy and correct it” [43, p. 72]

Fictional Promises of the Zachman Framework

Third, the value of the Zachman Framework was promoted with purely fictional promises: “Early numbers indicate that conservatively, taking Enterprise Architecture based approaches [...] produces implementations 10 times cheaper and 6 times faster” [40, p. 3]. Every manager acquainted with the complexities of organizational problems knows that order-of-magnitude productivity improvements cannot be achieved from any single managerial innovation, while such statements can be considered, to say mildly, only as an evident exaggeration typical for unsubstantiated marketing claims.

Interestingly, even more impressive and unbelievable productivity gains have been already promised earlier regarding once widely advertised, but now long forgotten Information Engineering, the previous “breakthrough” approach to architecture that quickly vanished without a trace: “Effective productivity gains 10-20 times greater than software engineering are today being regularly achieved [via using Information Engineering]” [44, p. vii], assured us its famous “father” Clive Finkelstein.

Practical Uselessness of the Zachman Framework

Finally and most importantly, it was never clearly explained how exactly the Zachman Framework should be used, e.g. whether its cells need to be actually filled with EA artifacts and if not, then what particular implications this taxonomy entails for practice. Despite having thousands of citations, the framework has zero documented examples of its practical application in organizations [45, 46]. With the exception of several inconsistent and empirically unverified ideas on how exactly the cells of the framework should be filled with models proposed by some industry gurus [47, 48, 49, 50] and speculating academics [51, 52, 53, 54], no sound guidance regarding its practical usage has been ever provided. Though the Zachman Framework can be populated, for example, with baseball models [55], the most common EA artifacts that proved useful in practice [56, 57, 58, 59] simply cannot be mapped to the cells of the framework in any real sense and cannot be unambiguously classified according its rows or columns.

Furthermore, even the very idea of developing comprehensive architectures, as suggested by the Zachman Framework, proved impractical long ago [60, 61, 62]. Unsurprisingly, EA practitioners who tried to employ the framework found it useless: “The Zachman Framework is too complex to support communication [...]. It is too abstract to capture our architectural problems” [63, p. 6]. Evidence from another organization suggests that the framework was found useful only for “selling” EA efforts to management, but then was “pinned on walls in many rooms without far-reaching consequences” [64, p. 15].

Again, even John Zachman himself after 15 years since the publication of the framework admitted that it was never ever implemented: “If you ask who is successfully implementing the whole framework, the answer is nobody that we know of yet” [65, p. 2].

Later after being asked to “tell us about two or three major success stories in applying the Zachman Framework”, he replied that “this is another hard question for me to answer because I am not a methodologist, [...] I am a theoretician, kind of like a scientist” [30, p. 9]. In reality, however, Zachman never was a scientist, never had a PhD degree, never published any peer-reviewed articles in academic journals and even did not work as a practicing architect, but rather “joined IBM in 1965 and has held various marketing-related positions” [2, p. 292] (though, some sources mistakenly call him Dr. Zachman [66, 67]). Recently, Zachman provided the following explanation confirming the practical uselessness of his framework:

“The Zachman Framework does not do anything. It does not imply anything about what to implement or how (methodologically) to build (manufacture) implementations. That is, the Framework does not imply anything about what composite implementations (systems) to build or methodologically, how to build them. The Framework is inert. It is simply a schema, the intersection of two classifications that have been used by humanity for thousands of years” [68, p. 1]

Naturally, after three decades since the emergence of the framework Zachman’s presentations [69, 70, 71] include only shadowy speculations and even “a story about how the Director of Intelligence for the India (national) Police Service used the Zachman Framework to solve a high visibility murder/kidnapping case” [72, 73, 74], but not a single story about how anybody actually used the framework to plan information systems. Nevertheless, Zachman Framework courses, trainings and certifications are still actively promoted in industry [75, 76, 77] and even considered by some to be among the best available certifications for enterprise architects [78].

Overall Futility of the Zachman Framework

Ironically, but the evidence-based analysis shows that all the most deeply seated beliefs about the Zachman Framework are nothing more than unsubstantiated fallacies. The framework appeared completely “out of the blue”, did not introduce any new noticeable ideas absent before, was based on inappropriate assumptions, not supported by any empirical evidence, promoted based only on empty promises and appeals to 7000-years-old timeless truths and did not provide any specific practically valuable recommendations, but yet still became widely known as the seminal EA model. In light of the analysis provided above, the fame and “success” of the Zachman Framework can be attributed exclusively to its excellent promotion to the masses and to the outstanding marketing talent of its author.

Unsurprisingly, the value of the Zachman Framework for the EA discipline is always explained by enlightened gurus using sophisticated, intentionally elusive and obscure language, e.g. the framework provides some very important “fundamental basis”, “universal classification scheme”, “non-discussable eternal structure”, “periodic table”, “enterprise physics” or even “ontology” for enterprise architecture (the word “ontology” denotes something related to philosophy, metaphysics and the nature of being). From the practical perspective, such explanations imply no consequences whatsoever, bring no real value and essentially mean only that the framework is utterly useless for down-to-earth EA practitioners working in industry.

Although the framework caused general exultation, excitement and admiration, provoked stunning applause and spectacular fireworks, acquired widespread recognition and worldwide fame, it has no tangible substance and never helped any organizations solve their problems with business and IT alignment. After more than 30 years since the “breakthrough that created enterprise architecture”, the Zachman Framework has absolutely nothing to demonstrate, the king is naked. Therefore, despite its astonishing popularity the framework

has only a purely symbolic value for the EA discipline and actually did not influence current EA best practices in any real sense, let alone defined them.

Strictly speaking, due to its evident conceptual superficiality and disconnection from the empirical realities of information systems planning, the Zachman Framework deserves neither practical nor scientific attention in the context of the EA discipline. However, it still represents an extremely curious historical phenomenon to be analyzed with an utmost care in the marketing departments of business schools. For instance, the case of the Zachman Framework can be discussed in detail as part of marketing courses as an awesome case study of an effective promotion of a useless trinket, but not as part of the EA curriculum intended to prepare future EA practitioners.

Similarly to the Zachman Framework, other well-known and aggressively promoted tools for enterprise architecture including, among others, TOGAF, FEAF and ArchiMate represent mostly fake tools (though with some caveats). They are also characterized by the very same set of attributes as the Zachman Framework: continuous marketing hype, intentional vagueness, empty promises, elusive explanations and the lack of real-life practical examples. These tools are largely useless and provide little or no practical value, but only create considerable informational noise and distort the discourse in the EA discipline.

The Business Capability Model: A Real Tool

Unlike the entirely “metaphysical” Zachman Framework with inexplicable practical value, the usage and benefits of the Business Capability Model (or map, BCM) can be explained very clearly in simple words even to “mere mortals”.

Practical Utility of the Business Capability Model

A business capability is a general capacity of an organization to perform a specific business activity. Business capabilities represent high-level abstractions encompassing all underlying business processes, roles, information systems and physical facilities fulfilling these capabilities. Due to their multifaceted nature, business capabilities are relevant to both business and IT stakeholders. The BCM shows the hierarchy of all business capabilities of an organization on a single page providing a simple but overarching view of the business and facilitating the strategic dialog between business and IT.

In particular, via using the BCM business executives can decide which capabilities should become the primary focus of future IT investments in order to execute their business strategy, whereas enterprise architects can determine which IT systems may be installed to enhance the required capabilities. Put it bluntly, business leaders can point to specific capabilities and say “we need to improve these capabilities”, while architects can reply “then we can launch the following IT initiatives to do that”. Senior business stakeholders may also indicate what types of improvement are necessary for these strategic capabilities (e.g. perform the capabilities better or at a lower cost) or specify their target maturity levels.

The achieved agreements between business and IT on the set of business capabilities to be uplifted with IT are color-coded, or “heatmapped”, in the BCM and then used as the basis for prioritizing and initiating corresponding IT projects. Thereby, the BCM helps convert an abstract business strategy and goals into a rather specific IT investment portfolio, improve strategic business and IT alignment and increase the long-term effectiveness of IT investments. Moreover, the BCM also has a number of other useful applications in the context of an EA practice including evaluating the strategic value of bottom-up IT initiatives, determining the scope, impact and stakeholders of IT projects and providing a common vocabulary to all decision-makers, not to mention various overlays that can be created on top of the BCM, e.g. applications, data and infrastructure.

Unlike the Zachman Framework, the BCM is a real EA tool with a widely acknowledged, immediate and intuitively understandable practical value. It is ubiquitously used and arguably represents one of the most essential tools in the toolkit of genuine EA best practices available to enterprise architects [56, 57, 58, 59]. Unsurprisingly, one of the recent studies [79] found that of the 25 surveyed organizations 23 (or 92%) used the BCM in their EA practices.

Unclear Origins of the Business Capability Model

The origins of the BCM in its current form are unclear. For instance, the BCM was not even mentioned in any existing “definitive” EA frameworks. Some of the earliest articles with a sensible description of the BCM and its usage that I was able to find date back to 2009 [80, 81], but these articles describe the BCM as an already existing industry phenomenon, rather than propose it as something new. While the Zachman Framework was generously bestowed to us by the wise award-winning “father” on one happy sunny day in 1987 as a profound eye-opening revelation instantly shocking all IT planners in the world like an unexpected strike of lightning, the concept of BCM was seemingly developed some time ago in the 2000s inconspicuously by unknown, “nameless” architects in organizations with no pomposity, proved useful and then rapidly spread across the industry due to its evident effectiveness without any deliberate promotion eventually becoming one of the most recognizable EA artifacts. Nobody proposed the BCM, nobody triumphantly “ignited its flame” and nobody received any lifetime achievement awards for its creation. This genuine EA best practice emerged quietly from the practical experience, not from the works of “thought leaders”, gurus or consultants.

Unnoticed Phenomenon of the Business Capability Model

Furthermore, the emergence of the BCM was not generally recognized as a significant innovation, let alone as a “turning point” in the history of computing, even though its broad industry adoption arguably can be actually considered as a major milestone in the evolution of information systems planning. Unlike the Zachman Framework, which is thoroughly described in countless articles and thick books, the BCM is barely mentioned in the mainstream EA literature, no standardized templates are available for it. For example, the latest version of TOGAF includes only some inconsistent babble about the importance of modeling business capabilities, but not a systematic and meaningful description of the BCM with realistic practical examples [82, pp. 263-268]. At the time of the publication of the original shortened version of this article in April 2018 [83] even the basic Wikipedia article on the BCM had not been created [84]. At the present moment there are arguably still no comprehensive sources available describing the BCM and its usage in detail where newbie architects can learn this best practice from.

Similarly to the BCM, many other EA artifacts and associated techniques constituting the core of established EA best practices are barely discussed in the available EA sources and never promoted. These practices include, among others, creating solution overviews and business cases for IT initiatives, managing the lifecycle of deployed technologies via color-coded technology reference models (TRMs) and estimating the technical debt for architectural deviations. The CSVLOD model I introduced earlier [56, 57, 59, 85, 86] may also become a useful evidence-based tool for thinking about enterprise architecture and understanding proven industry best practices. All these approaches, techniques and models represent real EA tools that help architects deliver tangible business value. Taken together, these tools compose what is currently understood as a successful EA practice.

What Does It Mean for the EA Discipline?

The situation illustrated above based on the two opposite distinctive examples of fake and real tools for enterprise architecture indicates the existence of a dramatic gap between what is actively promoted and what actually works in an EA practice. This situation results from the simple fact that the discourse in the EA discipline is essentially “owned” and dictated by consultants, trainers, gurus and tool vendors. These parties lead their own game and have their own shortsighted, purely commercial interests unrelated to the genuine interests of EA practitioners and organizations. They drive the artificial creation of more and more “best practices” of questionable efficacy with an intention only to sell more certifications, trainings and consulting services to fill their pockets.

Put it simply, fake EA tools are persistently promoted only because somebody profits from them, not because they benefit the EA community. Consultants and gurus do not care how much money is wasted in organizations in the attempts to fill recommended cells, follow prescribed steps or explain inscrutable technical diagrams to business executives hoping to improve business and IT alignment [87]. The criticism of fake EA tools is typically dodged with the same one-size-fits-all shallow explanation too often heard in EA-related discussions: “These tools certainly cannot be used out-of-the-box and always need to be adapted to the needs of organizations”. Of course, people giving such explanations cannot specify even approximately how it should be done. Oftentimes they are simply bluffing and have no idea what successful EA practices look like. As a result, instead of having a systematic, consistent and evidence-based body of knowledge on enterprise architecture, the EA community still has to enjoy only a “garbage can” full of random EA-related prescriptions invented by gurus and self-proclaimed thought leaders.

The excessive focus on fake tools (e.g. popular EA frameworks) currently occupying the whole EA discourse essentially blocks the healthy development of the entire EA discipline, while the slow progress in this direction is often attributed by crafty EA gurus to the fact that “unlike mathematics, enterprise architecture is only 25 years old and needs more time to mature”. This argument is deceptive, but still partly true: with the endless irresponsible promotion of fake tools it may indeed take centuries for the EA discipline to develop into something systematic. However, if the progress of the EA discipline is to be measured in years, rather than in centuries, then the flagrant corruption of the EA discourse with fake tools should be decisively stopped and their harmful impact on the EA profession should be widely recognized and acknowledged. In other words, the EA discipline should change the course and switch its focus from fake tools to real tools.

In the current uneasy situation in the EA discipline, I argue that the following actions are necessary and should be taken sooner or later to advance the EA profession and theory forward:

- Instead of trying to align their practices to unrealistic EA frameworks, architects should trust their own judgment, focus on developing practices that work well for their organizations and then share these best practices with the broader EA community
- Instead of comparing existing EA frameworks and modeling notations, EA academics should “wake up” from the slumber, acknowledge their evident faddish nature and focus on studying and codifying genuine EA best practices that proved effective in organizations
- Current EA frameworks and standards, as well as the gurus who promoted them, sooner or later should be forgotten due to their obvious disconnection from reality and replaced with more adequate, evidence-based descriptions of established EA best practices existing in industry

The analysis of fake and real tools for enterprise architecture provided above is briefly summarized in Figure 1.

Fake Tools							Real Tools						
Origin: Created artificially “top-down” by consultancies and gurus without any empirical justifications							Origin: Emerged naturally in industry “bottom-up” out of the real-life experience of multiple practicing architects						
Motivation: Purely commercial, used to sell trainings, certifications, software tools and consulting services							Motivation: Purely practical, used to solve organizational problems and not distributed on a commercial basis						
Promotion: Very actively promoted and discussed, positioned as industry standards and proven instruments							Promotion: Never promoted, disseminated quietly from architects to architects mostly through collaboration						
Description: Described in detail, many comprehensive sources, courses and trainings available							Description: Barely described and codified, no comprehensive information sources available						
Recognition: Considered as important milestones in the history and evolution of the EA discipline							Recognition: Largely unnoticed in the mainstream EA discourse, essentially “invisible” to outsiders						
Notable Example: The Zachman Framework							Notable Example: The Business Capability Model						
	What? (Data)	How? (Function)	Where? (Network)	Who? (People)	When? (Time)	Why? (Motivation)							
Scope (Contextual)							Fundamental “ontology” having no practical implications and no specific use cases in organizations						
Business Model (Conceptual)							Other Examples: TOGAF, FEAF, ArchiMate, etc.						
System Model (Logical)							Metaphor: “Pampered, lazy and unemployed noblemen of aristocratic origin”						
Technology Model (Physical)							Role: Purely symbolic, hardly influence actual EA best practices, let alone define these practices						
Detailed Representation (Out-of-Context)							Beneficiaries: Consultancies, certification centers, trainers, gurus and other “snake oil salesmen”						
							Attitude: Learn, describe and share these tools with other members of the broader EA community						
							Future: Sooner or later will be studied in detail, codified and included in “EA 101” courses and textbooks						

Figure 1. Fake and Real Tools for Enterprise Architecture

About the Author



Svyatoslav Kotusev is an independent researcher. Since 2013 he focuses on studying enterprise architecture practices in organizations. He is an author of the book *The Practice of Enterprise Architecture: A Modern Approach to Business and IT Alignment* and many articles on enterprise architecture that appeared in various academic journals and conferences, industry magazines and online outlets (visit <http://kotusev.com> for more information). Svyatoslav received his PhD in information systems from RMIT University, Melbourne, Australia. Prior to his research career he held various software development and architecture positions in industry. He can be reached at kotusev@kotusev.com

References

- [1] Kotusev, S. (2016) “Two Worlds of Enterprise Architecture”, Melbourne, Australia: Unpublished manuscript.
- [2] Zachman, J. A. (1987) “A Framework for Information Systems Architecture”, *IBM Systems Journal*, Vol. 26, No. 3, pp. 276-292.
- [3] Simon, D., Fischbach, K. and Schoder, D. (2013) “An Exploration of Enterprise Architecture Research”, *Communications of the Association for Information Systems*, Vol. 32, No. 1, pp. 1-72.
- [4] Rao, P. C., Reedy, A. and Bellman, B. L. (2011) *FEAC Certified Enterprise Architect CEA Study Guide*, New York, NY: McGraw-Hill Education.
- [5] O'Rourke, C., Fishman, N. and Selkow, W. (2003) *Enterprise Architecture Using the Zachman Framework*, Boston, MA: Course Technology.
- [6] Zachman, J. A. (1999) “A Framework for Information Systems Architecture”, *IBM Systems Journal*, Vol. 38, No. 2&3, pp. 454-470.
- [7] Hoffnagle, G. F. (1999) “Preface”, *IBM Systems Journal*, Vol. 38, No. 2&3, pp. 130-131.
- [8] Wladawsky-Berger, I. (1999) “Turning Points in Information Technology”, *IBM Systems Journal*, Vol. 38, No. 2&3, pp. 449-452.
- [9] IBM (1999) “Turning Points in Computing: 1962-1999”, IBM, URL: <https://researchweb.watson.ibm.com/journal/sj38-23.html>.
- [10] IBM (2007) “Special Report: Celebrating 50 Years of the IBM Journals”, IBM, URL: <https://web.archive.org/web/20070121183600/http://www.research.ibm.com:80/journal/50th/>.
- [11] IBM (2007) “A Framework for Information Systems Architecture (Special Report: Celebrating 50 Years of the IBM Journals)”, IBM, URL: <https://web.archive.org/web/20080511174404/http://www.research.ibm.com/journal/50th/applications/zachman.html>.
- [12] Zachman International (2018) “John A. Zachman: Biographical Sketch”, Zachman International, URL: <https://www.zachman.com/about-us/about-john-a-zachman>.
- [13] Levin, H. S. (1957) “Systems Planning for Computer Application”, *The Controller*, Vol. 25, No. 4, pp. 165-186.
- [14] Canning, R. G. (1957) “Planning for the Arrival of Electronic Data Processing”, *Journal of Machine Accounting*, Vol. 7, No. 1, pp. 22-30.
- [15] Evans, M. K. and Hague, L. R. (1962) “Master Plan for Information Systems”, *Harvard Business Review*, Vol. 40, No. 1, pp. 92-103.

- [16] Walker, P. D. and Catalano, S. D. (1969) "Where Do We Go from Here with MIS?", *Computer Decisions*, Vol. 1, No. 9, pp. 34-37.
- [17] Galbraith, J. R. (1973) *Designing Complex Organizations*, Reading, MA: Addison-Wesley.
- [18] McLean, E. R. and Soden, J. V. (1977) *Strategic Planning for MIS*, New York, NY: Wiley.
- [19] BSP (1975) "Business Systems Planning: Information Systems Planning Guide (1st Edition)" (#GE20-0527-1), White Plains, NY: IBM Corporation.
- [20] Arthur Andersen (1979) "Method/1: Systems Development Practices", Chicago, IL: Arthur Andersen.
- [21] Martin, J. and Finkelstein, C. (1981) *Information Engineering (Volumes I and II)*, Carnforth, UK: Savant Institute.
- [22] Martin, J. (1982) *Strategic Data-Planning Methodologies*, Englewood Cliffs, NJ: Prentice Hall.
- [23] Wardle, C. (1984) "The Evolution of Information Systems Architecture", In: Nunamaker, J., King, J. L. and Kraemer, K. L. (eds.) *Proceedings of the 5th International Conference on Information Systems*, Tucson, AZ: Association for Information Systems, pp. 205-217.
- [24] PRISM (1986) "PRISM: Dispersion and Interconnection: Approaches to Distributed Systems Architecture", Cambridge, MA: CSC Index.
- [25] Rigdon, W. B. (1989) "Architectures and Standards", In: Fong, E. N. and Goldfine, A. H. (eds.) *Information Management Directions: The Integration Challenge (NIST Special Publication 500-167)*, Gaithersburg, MD: National Institute of Standards and Technology (NIST), pp. 135-150.
- [26] Richardson, G. L., Jackson, B. M. and Dickson, G. W. (1990) "A Principles-Based Enterprise Architecture: Lessons from Texaco and Star Enterprise", *MIS Quarterly*, Vol. 14, No. 4, pp. 385-403.
- [27] Zachman, J. A. (1996) "Concepts of the Framework for Enterprise Architecture: Background, Description and Utility", Monument, CO: Zachman International.
- [28] Zachman, J. A. (1997) "Enterprise Architecture: The Issue of the Century", *Database Programming and Design*, Vol. 10, No. 3, pp. 44-53.
- [29] Zachman, J. A. and Ruby, D. (2004) "Erecting the Framework, Part I ", Enterprise Architect Online, URL: http://archive.visualstudiomagazine.com/ea/magazine/spring/online/druby/default_pf.aspx.
- [30] Zachman, J. A. and Sessions, R. (2007) "Exclusive Interview with John Zachman, President of Zachman International, CEO of Zachman Framework Associates", Austin, TX: Perspectives of the International Association of Software Architects.
- [31] Zachman, J. A. (2015) "A Historical Look at Enterprise Architecture with John Zachman", The Open Group, URL: <https://blog.opengroup.org/2015/01/23/a-historical-look-at-enterprise-architecture-with-john-zachman/>.
- [32] Spewak, S. H. and Hill, S. C. (1992) *Enterprise Architecture Planning: Developing a Blueprint for Data, Applications and Technology*, New York, NY: Wiley.
- [33] Zachman, J. A. (1977) "Control and Planning of Information Systems", *Journal of Systems Management*, Vol. 28, No. 7, pp. 34-41.
- [34] Zachman, J. A. (1982) "Business Systems Planning and Business Information Control Study: A Comparison", *IBM Systems Journal*, Vol. 21, No. 1, pp. 31-53.

- [35] Marengi, C. and Zachman, J. A. (1982) "Data Design Key to Systems: IBM Consultant", *Computerworld*, Vol. 16, No. 43, pp. 11-12.
- [36] Glans, T. B., Grad, B., Holstein, D., Meyers, W. E. and Schmidt, R. N. (1968) *Management Systems*, New York, NY: Holt, Rinehart and Winston.
- [37] Laudon, K. C. and Laudon, J. P. (2013) *Management Information Systems: Managing the Digital Firm (13th Edition)*, Boston, MA: Pearson Education Limited.
- [38] Zachman, J. A. (2008) "Framework Standards, What's It All About?", *Journal of Enterprise Architecture*, Vol. 4, No. 1, pp. 7-10.
- [39] Zachman, J. A. (2010) "Architecture Is Architecture Is Architecture", In: Kappelman, L. A. (ed.) *The SIM Guide to Enterprise Architecture*, Boca Raton, FL: CRC Press, pp. 37-45.
- [40] Zachman, J. A. (2003) "The Zachman Framework for Enterprise Architecture: Primer for Enterprise Engineering and Manufacturing", Monument, CO: Zachman International.
- [41] Stecher, P. (1993) "Building Business and Application Systems with the Retail Application Architecture", *IBM Systems Journal*, Vol. 32, No. 2, pp. 278-306.
- [42] Greene, B., McDavid, D. and Zachman, J. A. (1997) "Back to the Issue of the Century", *Database Programming and Design*, Vol. 10, No. 6, pp. 8-9.
- [43] Gaver, S. B. (2010) "Why Doesn't the Federal Enterprise Architecture Work?", McLean, VA: Technology Matters.
- [44] Finkelstein, C. (1989) *An Introduction to Information Engineering: From Strategic Planning to Information Systems*, Sydney, Australia: Addison-Wesley.
- [45] Kotusev, S. (2017) "Enterprise Architecture: What Did We Study?", *International Journal of Cooperative Information Systems*, Vol. 26, No. 4, pp. 1-84.
- [46] Ylimaki, T. and Halttunen, V. (2006) "Method Engineering in Practice: A Case of Applying the Zachman Framework in the Context of Small Enterprise Architecture Oriented Projects", *Information, Knowledge, Systems Management*, Vol. 5, No. 3, pp. 189-209.
- [47] Cook, M. A. (1996) *Building Enterprise Information Architectures: Reengineering Information Systems*, Upper Saddle River, NJ: Prentice Hall.
- [48] Sessions, R. (2007) "A Comparison of the Top Four Enterprise-Architecture Methodologies", Microsoft, URL: <http://web.archive.org/web/20170310132123/https://msdn.microsoft.com/en-us/library/bb466232.aspx>.
- [49] McGovern, J., Ambler, S. W., Stevens, M. E., Linn, J., Sharan, V. and Jo, E. K. (2004) *A Practical Guide to Enterprise Architecture*, Upper Saddle River, NJ: Prentice Hall.
- [50] Vail, E. F. (2002) "Causal Architecture: Bringing the Zachman Framework to Life", *Information Systems Management*, Vol. 19, No. 3, pp. 8-19.
- [51] Pereira, C. M. and Sousa, P. (2004) "A Method to Define an Enterprise Architecture Using the Zachman Framework", In: Haddad, H. M., Omicini, A., Wainwright, R. L. and Liebrock, L. M. (eds.) *Proceedings of the 19th ACM Symposium on Applied Computing*, Nicosia, Cyprus: ACM, pp. 1366-1371.
- [52] Iyamu, T. (2018) "Implementation of the Enterprise Architecture Through the Zachman Framework", *Journal of Systems and Information Technology*, Vol. 20, No. 1, pp. 2-18.
- [53] Fatolah, A. and Shams, F. (2006) "An Investigation into Applying UML to the Zachman Framework", *Information Systems Frontiers*, Vol. 8, No. 2, pp. 133-143.
- [54] Abdullah, A. and Zainab, A. (2008) "The Digital Library as an Enterprise: The Zachman Approach", *The Electronic Library*, Vol. 26, No. 4, pp. 446-467.

- [55] Bahill, T., Botta, R. and Daniels, J. (2006) “The Zachman Framework Populated with Baseball Models”, *Journal of Enterprise Architecture*, Vol. 2, No. 4, pp. 50-68.
- [56] Kotusev, S. (2017) “Eight Essential Enterprise Architecture Artifacts”, British Computer Society (BCS), URL: <http://www.bcs.org/content/conWebDoc/57318>.
- [57] Kotusev, S. (2017) “Enterprise Architecture on a Single Page”, British Computer Society (BCS), URL: <http://www.bcs.org/content/conWebDoc/58615>.
- [58] Kotusev, S. (2019) “Enterprise Architecture and Enterprise Architecture Artifacts: Questioning the Old Concept in Light of New Findings”, *Journal of Information Technology*, Vol. 34, No. 2, pp. 102-128.
- [59] Kotusev, S. (2018) *The Practice of Enterprise Architecture: A Modern Approach to Business and IT Alignment*, Melbourne, Australia: SK Publishing.
- [60] Kim, Y.-G. and Everest, G. C. (1994) “Building an IS Architecture: Collective Wisdom from the Field”, *Information and Management*, Vol. 26, No. 1, pp. 1-11.
- [61] Beeson, I., Green, S., Sa, J. and Sully, A. (2002) “Linking Business Processes and Information Systems Provision in a Dynamic Environment”, *Information Systems Frontiers*, Vol. 4, No. 3, pp. 317-329.
- [62] Schmidt, C. and Buxmann, P. (2011) “Outcomes and Success Factors of Enterprise IT Architecture Management: Empirical Insight from the International Financial Services Industry”, *European Journal of Information Systems*, Vol. 20, No. 2, pp. 168-185.
- [63] Janssen, M. and Hjort-Madsen, K. (2007) “Analyzing Enterprise Architecture in National Governments: The Cases of Denmark and the Netherlands”, In: Sprague, R. H. (ed.) *Proceedings of the 40th Hawaii International Conference on System Sciences*, Big Island, HI: IEEE, pp. 1-10.
- [64] Buckl, S., Ernst, A. M., Lankes, J., Matthes, F. and Schweda, C. M. (2009) “State of the Art in Enterprise Architecture Management”, Munich, Germany: Software Engineering for Business Information Systems (SEBIS).
- [65] Zachman, J. A. and Ruby, D. (2004) “Erecting the Framework, Part III”, *Enterprise Architect* Online, URL: http://archive.visualstudiomagazine.com/ea/magazine/spring/online/druby3/default_pf.aspx.
- [66] Saha, P. (ed.) (2007) *Handbook of Enterprise Systems Architecture in Practice*, Hershey, PA: Information Science Reference.
- [67] Alexander, J. (2018) *Capturing the Organization Organism: An Outside-In Approach to Enterprise Architecture*, Basking Ridge, NJ: Technics Publications.
- [68] Zachman, J. A. (2019) “Enterprise Architecture: Exploring a Chemistry Metaphor”, IRM UK Connects, URL: <https://www.irmconnects.com/enterprise-architecture-exploring-a-chemistry-metaphor-2/>.
- [69] Zachman, J. A. (2015) “The Practice of Enterprise Architecture”, Zachman International, URL: http://didattica.cs.unicam.it/lib/exe/fetch.php?media=didattica:magistrale:abit:ay_1718:zachman_thepracticeofentarch.pdf.
- [70] Zachman, J. A. (2017) “Enterprise Physics 101”, Zachman International, URL: <http://dama-phoenix.org/wp-content/uploads/2013/07/John-Zachman-Presentation-2017.pdf>.
- [71] Zachman, J. A. (2018) “Avoiding Unintended Consequences of Change”, Zachman International, URL: <https://feapo.org/wp-content/uploads/2018/12/John-Zachman-Avoiding-Unintended-Consequences-Version-2.pdf>.
- [72] IASA (2015) “ITARC 2015”, IASA, URL: <https://www.iasa.se/itarc-2015/>.

- [73] Association of Software Engineers (2016) “ITARC Sofia 2016”, Association of Software Engineers, URL: <https://2doit.co/itarc/>.
- [74] DAMA Puget Sound (2013) “The Zachman Framework: Solving General Management Problems with John Zachman”, DAMA Puget Sound, URL: <https://dama-ps.org/event-685448>.
- [75] Zachman International (2019) “Zachman Framework Training and Certification”, Zachman International, URL: <https://www.zachman.com/32-uncategorised/268-zachman-certification>.
- [76] FEAC Institute (2019) “Zachman Framework Training and Certification”, Federal Enterprise Architecture Certification (FEAC) Institute, URL: <https://feacinstitute.org/feac-training/zachman-framework-training-and-certification>.
- [77] Coghill, C. and Zachman, J. A. (2019) “Zachman Enterprise Architecture Certification: Modelling Workshop”, IRM UK, URL: <https://irmuk.co.uk/events/zachman-enterprise-architecture-certification/>.
- [78] Tittle, E. and Lindros, K. (2018) “Best Enterprise Architect Certifications”, Business News Daily, URL: <https://www.businessnewsdaily.com/10758-best-enterprise-architect-certifications.html>.
- [79] Khosroshahi, P. A., Hauder, M., Volkert, S., Matthes, F. and Gernegross, M. (2018) “Business Capability Maps: Current Practices and Use Cases for Enterprise Architecture Management”, In: Bui, T. X. (ed.) *Proceedings of the 51st Hawaii International Conference on System Sciences*, Big Island, HI: Association for Information Systems, pp. 4603-4612.
- [80] Scott, J. (2009) “Business Capability Maps: The Missing Link Between Business Strategy and IT Action”, *Architecture and Governance Magazine*, Vol. 5, No. 9, pp. 1-4.
- [81] Greski, L. (2009) “Business Capability Modeling: Theory & Practice”, *Architecture and Governance Magazine*, Vol. 5, No. 7, pp. 1-4.
- [82] TOGAF (2018) “TOGAF Version 9.2” (#C182), Reading, UK: The Open Group.
- [83] Kotusev, S. (2018) “Fake and Real Tools for Enterprise Architecture”, British Computer Society (BCS), URL: <http://www.bcs.org/content/conWebDoc/59399>.
- [84] Wikipedia (2019) “Business Capability Model”, Wikipedia, URL: https://en.wikipedia.org/wiki/Business_capability_model.
- [85] Kotusev, S. (2016) “Six Types of Enterprise Architecture Artifacts”, British Computer Society (BCS), URL: <http://www.bcs.org/content/conWebDoc/57097>.
- [86] Kotusev, S. (2017) “The Relationship Between Enterprise Architecture Artifacts”, British Computer Society (BCS), URL: <http://www.bcs.org/content/conWebDoc/57563>.
- [87] Kotusev, S. (2016) “Enterprise Architecture Frameworks: The Fad of the Century”, British Computer Society (BCS), URL: <http://www.bcs.org/content/conWebDoc/56347>.