A Leadership Approach to Successful Digital Transformation Using Enterprise Architecture

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Abstract

Digital transformation has been a focus of public and private sectors to both improve and sustain business value by leveraging rapidly evolving technology. Digital technology is ubiquitous and inter-connected, changing the face of business, government and society through the creation of new industries, with automation replacing two thirds of existing jobs. The challenge is that most digital transformation efforts fail, mainly due to inadequate leadership and management as well as failure to accept that it is a multi-disciplinary problem. Another challenge is to distinguish between digital transformation (DT) and digitization where the former is based on a customer-centric value proposition and the latter focuses on cost-cutting and operational excellence. This difference also highlights the business/technology divide where the former is mainly DT and the latter is mainly digitization.

The challenge addressed in this thesis is how to obtain management acceptance that digital transformation is multi-disciplinary and to make recommendations with respect to how best to achieve DT goals. The research methods followed is a blend of participatory action research (PAR), case study analysis and literature analysis.

The principal research findings are that there is no single, management methodology that can increase the chances of DT success but that a modified form of enterprise architecture (EA) that collaboratively interacts with the other management frameworks can likely provide a solid foundation to effectively achieve DT.

The thesis consists of an assessment of the current methodologies, four articles that each discuss an area to support effective DT, followed by a request for change (RFC) to update the TOGAF 9 EA framework standard. TOGAF was selected due to its pervasive usage globally (80% of Fortune 50 and 60% of Fortune 500). The RFC accommodated both the concepts raised in the articles and other innovations highlighted in the literature review and assessment.

The thesis concludes that enterprise architecture is a key business technique that allows the sharing of core decision support information across the enterprise, enabling all management frameworks, especially those on the technology-management divide, to collaboratively realize digital transformation.

Acknowledgments

This PhD is a milestone on a long road started in 1985 when I was brought into the Defence R&D Canada facility in Valcartier. I was a subject matter expert in plans and operations and my role was to apply my military experience, civil engineering and staff college knowledge to the new digital challenge in command and control. I have not stopped since.

This PhD was important as I needed to feel confident that my views and advice on digital transformation (DT) and enterprise architecture (EA) to colleagues, students and clients were still relevant and up to date.

I would like to thank my thesis supervisor Timothy Lethbridge PhD for his time, patience and valuable insights into DT and all his assistance getting the Thesis Advisory Committee (TAC) together and making this thesis happen. Also, I would like to thank Liam Peyton, PhD for the confidence and support he has shown me while I created the graduate EA course and outline EA graduate certificate program. In the same vein, thank-you to Eric Champagne, PhD who provided a different social perspective on the content of the thesis and Daniel Amyotte, PhD who counseled me with respect to integrating EA and SE as well as requirements engineering.

Most importantly, the backing and encouragement of my wife Brenda, has been paramount in my life-long learning adventure. I thank her from the bottom of my heart for her understanding and support.

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Chapter 1. Introduction

The ability to lead the transformation of existing and new enterprises to leverage new innovations has lagged the rapid evolution of new technologies. Neither government nor industry business models and management frameworks have kept pace. Worse, current frameworks and models are increasingly developed in isolation ("professional silos") and transfer their incompatibilities and incoherence into companies or governments implementing a set of these practices. This has resulted in major, unnecessary losses in terms of productivity and business value.

Consequently, this thesis has focused on e-Management (and governance) to deliver business value and enhance the quality of life in the e-Society.

This thesis starts with a literature search to find the key issues associated with digital transformation, as assessment of how the key management paradigms address them and then highlights the key issues. These issues are then discretely discussed. The thesis culminates with proposed modifications to an existing, pervasive framework to help leaders and managers successfully execute digital transformation.

The intent was to only change if necessary but not necessarily change existing frameworks and models, thereby leveraging the existing bodies of knowledge to meet the challenges of tomorrow. This modification proposal will in effect federate the existing models (and bodies of knowledge) so they can collaboratively and effectively lead to increased business value and wealth that can enhance quality of life, address social inequities and enhance global stability.

The thesis uses a blend of research paradigms from engineering as well as the social sciences that include case-based, action, participatory action research and modal reasoning to tackle the wicked problem of digital transformation.

1.1. Problem

Enterprise digital transformation (Forrester 2019) and software development (Guillaume-Joseph et al 2015a, 2015b) have a 50% failure rate costing the global economy trillions

of dollars. Professional associations have appeared to address specific parts of the digital transformation challenge using appropriate detailed methodologies. Over the past ten years (2009-2019), these associations have realized that they cannot address the issues surrounding digital transformation in isolation and have expanded their methodologies, overlapping with other domains of expertise. Most associations are addressing the intersection set between the methodologies in isolation creating friction and contributing to the failure of digital transformation efforts.

A key consideration is to differentiate between what Ross (2017) calls digital and digitization. "Digitization" is the mechanics of narrow, process-centric applications of technology to streamline operations and cut costs, whereas in "digital" (in this thesis we will call it digital transformation) the focus is on the creation of a vision based on, "customer-centric value proposition such as Philips, "improving lives through health care innovation" (from Ross 2017).

This thesis addresses the wicked problem of digital transformation, which is extensive and multi-dimensional, covering many aspects of e-Society, e-Management and e-Technology.

1.2. Overview of the Solution

The thesis provides a set of action research-based recommendations to improve the success of enterprise digital transformation efforts through the modified use of enterprise architecture (EA).

1.3. Contributions

The key contributions of this thesis are as follows:

a. Identification of the digital transformation challenges in the management sphere;
b. Identification of key issues associated with Digital Transformation specifically identifying the need for;
    1) harmonizing management frameworks, based on professional (not academic) association bodies of knowledge;
    2) blending business design and engineering concepts including the use of both scientific and artistic methods and inquiry;

3) integrating systems and enterprise engineering to address INCOSE's key vision document;
4) using the concept of EA stewardship to coordinate all of the elements associated with digital transformation; and

c. The modification of the TOGAF standard, as well as its use within the enterprise, to provide an integrated approach to digital transformation across all management frameworks.

1.4. Limitations of the Work

The recommendations of the thesis are widely applicable but need detailed follow-up to change the culture of the professional associations to effectively harmonize the intersection set between the various frameworks.

1.5. Thesis Outline

The organizational logic of the thesis can best be described in three parts:

Part 1 includes Chapter 1 containing the scope and context of the thesis, Chapter 2 discussing the hybrid research method and Chapter 3 containing the actual results of the search.

Part 2 includes in Chapter 4 an evaluation of the various management and technology management methodologies (existing and emerging) with respect to how they address both enterprise digital transformation and the govern-plan-build-run cycle.

Part 3 includes a series of four discrete discussions on issues identified as key in the previous chapters' literature search in Chapters 5, 6, 7 and 8.

Part 4 concludes the thesis with Chapter 9 dedicated to a proposed modification of an existing and widely used EA methodology and then Chapter 10 concludes with a re-iteration of the key contributions as well as future work.

1.6. Chapters

The thesis chapters are as outlined below:

- Chapter 2 – A Research Method to Resolve the Wicked Problem of Digital Transformation;
- Chapter 3 – "Assessment of Digital Transformation Factors" – to be submitted as an article to an MIS journal;
- Chapter 4 - Analysis of Different Methodologies With Respect to Digital Transformation
- Chapter 5 - Integrating Business Design into Enterprise and Systems Architecture – (an article submitted to an engineering management journal;
- Chapter 6 - Enterprise Architecture: Bridging the Business-Technology Divide (an article submitted to a business journal;
- Chapter 7 – Integrating Systems Engineering and Enterprise Architecture for Better Results (submitted to a journal covering systems engineering and enterprise architecture);
- Chapter 8 – Managing the Management Framework: Enterprise Digital Transformation Using EA Stewardship (submitted to a journal on digital transformation);
- Chapter 9 – A New Enterprise Architecture Development Method (to be submitted as an RFC to The Open Group for the TOGAF 9.2 Standard); and
- Chapter 10 - Conclusion and Future Work.

Chapter 2. Research Method

In this Chapter we outline the research method we have followed in this thesis.

Since there is a lack of clarity surrounding certain terms, for the purposes of this thesis the following definitions are used:

- **Wicked problems**: These are "a class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision-makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing" (Rittel and West 1967).
- **Abductive Reasoning:** This can be summed up as follows: "Abduction is the logical process whereby we make sense out of a phenomenon that doesn't follow an existing deductive rule and hasn't happened enough to make an inductive finding. In such situations, in the words of the originator of the term, philosopher Charles Saunders Peirce, the individual needs to make an ''inference to the best explanation'' or a ''logical leap of the mind.'' That is, in his view, the source of all new ideas. The problem, for an analytically driven world, is that no new idea can be proven in advance with inductive or deductive logic. For this reason, too many new ideas are sacrificed on the cross of analysis." (Martin 2011).
- **Case Study Based Research**: This is research based on cases found in the literature or in discussion with other subject matter experts in national and international associations and working groups.
- **Action Research**: The action research referred to in this thesis is based on actual cases which author closely observed,
- **Participatory Action Research**: This is research based on actual cases in which the author *actively participated*, often in a leadership role.

2.1. Research Techniques

The thesis is based on case-based participatory action research on cases that have resulted in both successful and failed enterprise digital transformation. It has focused on leadership and management frameworks and qualitatively highlighted several areas where improvements could ameliorate the success rate of digital transformation. It has leveraged numerous case studies and created a multi-disciplinary set of recommendations.

The research conclusions and recommendations (the thesis contributions) address the concerns of various groups of stakeholders, and the decision was made to address these concerns in a series of articles to be sent to a disparate set journals reflecting the multi-disciplinary nature of digital transformation.

The research method morphed during the thesis as the structured literature review revealed that the need to develop a new digital transformation theory and methodology was unnecessary. This is because an existing methodology, namely Enterprise Architecture (EA), was discovered to be adequate, although not in its present form and practice. Using EA was also considered expeditious as practitioners are already in place. Discovery during the thesis research indicates that the corporate implementation and practice of EA as an IT centric and IT-led methodology is inadequate for the demands of digital transformation.

As work progressed, the thesis focus changed to the elaboration of a multi-disciplinary and collaborative approach to EA that would make EA fit for purpose, particularly for effective digital transformation.

Of the EA methodologies examined, emphasis was placed on TOGAF (The Open Group 2018) as it has become a de facto global standard with 80% of Fortune 500 and 60% of Fortune 500 companies (Perez-Castillo et al 2019 p.12) using it. TOGAF originated in government, specifically the US Department of Defense as the Technical Architecture for Information Management (TAFIM), and it is still widely used in governments albeit in many customized and enhanced forms. There is much cross-pollination, in that the latest, and most successful, versions of TOGAF Version 9 (The Open Group 2009, 2011, 2018) have incorporated new techniques from government such as capability-based planning, risk management, interoperability concepts, business transformation readiness assessments, transition architectures, and migration planning techniques.

2.2. Digital Transformation as a Wicked Problem

It was discovered early in the research that digital transformation is really a wicked problem. Wicked problems are called “mysteries” and are addressed using heuristics (expert “rules of thumb” normally typified with expert-specified degrees of certainty”) and algorithms. The latter are readily automated whereas heuristics are often found in the field of decision support where the information system and human can collaborate (e.g. medical diagnostic systems). These systems were often called expert systems and are an active branch of artificial intelligence research and development.

To solve challenging “wicked problems”, an atypical way of reasoning is required. Modal reasoning uses standard deductive and inductive reasoning but also includes abductive reasoning (as we have defined above) which is somewhat akin to the military concept called “sense-making”.

To find meaningful answers to the research questions, we applied modal reasoning combining inductive, deductive and abductive reasoning to discover heuristics and new models. Deductive and inductive reasoning alone was insufficient to answer why certain enterprises failed at digital transformation.

Participatory action research, in conjunction with the standard and ongoing literature survey, was found to be useful to assess the principal mysteries associated with digital transformation success and failure. In the action research, the author participated in key roles in several cases which are discussed in some detail owing to access to unpublished interviews, reports, meeting minutes and point-in-time presentations. In the literature, publication bias, in the form of only reporting successes at a point in time is problematic, in that published tactical successes tend to be negated by unpublished strategic failures (e.g. Nortel).

2.3. Research Steps

The research process evolved during the course of the thesis, with the initial discovery that the more traditional systematic academic literature search process just did not provide the requisite information needed. This methodology was enhanced and culminated in the following process steps, each of which will be discussed in further detail in subsequent sub-sections::

a. Formulation of research questions;

b. Structured literature search including the analysis of both academic and non-academic professional literature, government policies, etc.
c. Literature Assessment to determine the state of digital transformation (DT) and how the existing methodologies address the DT themes;
d. Action and Participatory Action Research (1985-present) including government service with multiple departments, consulting, participation in international professional and research working groups, workshops and interviews;
e. Extracting illustrative case studies from action and participatory action research and using them to discuss key DT issues;
f. Synthesizing from the above;
g. Developing a new methodology to address the DT issues;
h. Continuously iterating ; and
i. Establishing parameters for future work.

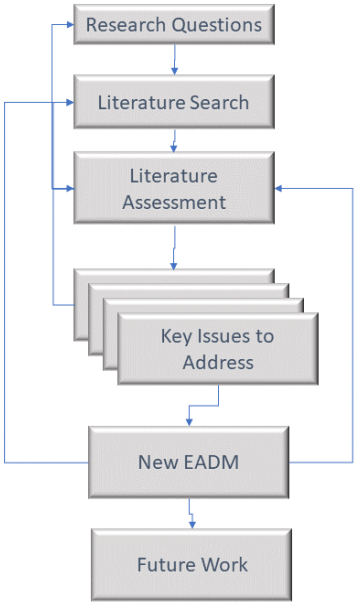


Figure 1 – Research Steps Used in the Thesis

2.3.1 Formulation of Research Questions (Digitization versus Digital Transformation)

The two primary research questions were constantly reviewed and modified. Additionally, three supplementary research questions (as described in Section 3.2.1) were added.

2.3.2 Structured Literature Search

The original structured literature search (found in the Appendix: Literature Review Process) was inadequate and the results focused on "micro" problems rather than the "macro" issues associated with digital transformation. The search was expanded to include a wide array of not only peer-reviewed academic literature, but also practitioner literature. Care was taken to only accept literature from well-established organizations with a large following and formal processes existed where documents were collaboratively created and approved by member votes. The sources were divided into primary, secondary and tertiary sources as explained below.

Primary sources included (in order of priority) were used to direct the research:

a. academic literature (e.g. IEEE family of documents, Harvard Business Review, Rotman Management Review);
b. professional journals and books (e.g. Information Systems Audit and Control As-sociation (ISACA) Journal);
c. international standards (e.g. Project Management Institute standards, The Open Group Architecture Framework (TOGAF) V9.2, IT Governance Institute, Axelos UK Government, Data Management Association, CMMI, NIST and so on);
d. conference proceedings (e.g. Open Group local and global conferences and member working group meetings, IEEE Conferences);
e. organization specific documents (e.g. Australian Government Architecture); and
f. interviews with subject matter experts in the various domains.

Secondary sources included:

a. reviews by academic or professional institutions (e.g. Sloan School of Management Center for Information Systems Research (CISR), Harvard Business Review, Financial Times /Economists Business Review);
b. published best practices such as studies that are open and in not-for-profit organizations and peer-reviewed White Papers (e.g. The Open Group White Papers issued by the Forums);
c. aggregation surveys of communities of practice (e.g. National Association of State CIOs [NASCIO] assessments); and
d. findings of research and management consulting firms such as Forrester, Gartner and PwC.

Tertiary sources included:

a. Archival material (e.g. Meeting minutes, presentations, business cases, workshop reports) from previous implementations, mainly in the government sector;
b. Government legislation, policies, directives, visions, architectures and implementation plans; and
c. Publicly available audit reports, mainly in the government sector.

Citation chaining was used extensively to discover new sources.

2.3.3 Observation /Participation Action Research (1985-2019)

Much of the work started in Defence R&D Canada (DRDC) at the research establishment in Valcartier Quebec in 1985, where the author was posted as a subject-matter expert in plans and operations, to participate in a testbed for the use of new technologies in military command and control (C2). This rapidly evolved into both a digitization and digital transformation effort: It was realized that the introduction of the newer technologies (digitization) would not only make existing processes faster, but would also change the fundamental nature of the supporting heuristics (a.k.a. doctrine in a military sense) upon which the processes were based (digital transformation). The DT transformation possibilities were trialed in the testbed and assessed ("ground-truthed") in the real world, with the results indicating revolutionary

gains in combat effectiveness. The challenges were both with digitization as the technology was not fit for purpose and digital transformation as these revolutionary capabilities necessitated a cultural transformation. Notes and papers from this experience informed this thesis.

This work carried on at the Royal Military College of Canada (RMC), assessing how artificial intelligence (AI) techniques could be used in the realm of decision support with research grants enabling the problem space and opportunity space to be further elaborated. Structured interviews were rigorously conducted indicating the complexity associated with C2 and a major issue was the lack of digital structured data. The paradigm used was collaborative man-machine decision-making with each using their abilities to handle different dimensions, often with the machine processing algorithms and humans assessing the machine generated data using heuristics to make sense (sense-making) of the situations. This included ethics and empathy in generating a usable solution. The work was ported out of the military sphere into whole of government crisis management and the military C2 paradigm proved to be resilient. At the RMC, the author was an assistant professor of computer science where he created and taught many new undergraduate courses for a variety of disciplines.

This was continued when the author was posted to National Defence Headquarters (NDHQ) as part of the strategic direction staff for the newly formed Defence Information Services Organization (DISO) to plan and implement what was researched previously. The DT was complicated by a concurrent business transformation to federate the Army, Navy, Air Force and those already integrated elements (e.g. supply) into a joint force. With the author responsible for the DT of the C2 and Intelligence portfolio (the key business functions), there were many cases where the author was directly implicated in a senior capacity. External challenges including harmonization with the efforts of various international organizations such as NATO. After five years, there were numerous participatory action research cases where the implementations were novel and there was little in the way of existing research to help. All the efforts were conducted hand-in-glove with the defence science community in Canada and in allied nations and much literature was reviewed and indeed generated. At this time, architecture-based planning, using the pre-cursor of the TOGAF standard (The Open Group 2009, 2011 and 2018), facilitated the orderly and incremental creation and execution of new capabilities.

Subsequently, the author became an executive management consultant with a large global consulting firm and specialized in government. Creating a team and then starting the global enterprise architecture (EA) practice, he participated in numerous activities in Canada, Europe, US and Australia at the State / Provincial and Federal level. These cases all involved DT and digitization, and many were visionary (i.e. unprecedented) requiring extensive and ongoing research and the careful insertion of new capabilities. Much work was spent on interviews (structured and unstructured), surveys (questionnaires), workshops, education and communication to bring about the DT in the most effective way possible. During this time, the author also became active with The Open Group and contributed to the TOGAF standard in conjunction with his global colleagues in industry, consultancies, government and academia.

To focus on research (mainly with The Open Group and the University of Ottawa), mentoring and consulting in the field of DT the author created his company and then was on contract (at the executive level) for several years with the Canadian government working on the establishment of a corporate information/knowledge architecture, which impacted many of the established information systems. Concurrently the author taught EA and then started studies (mainly to ascertain that his knowledge was still fit for purpose) and work as a part-time professor where he created the new multi-disciplinary EA graduate course. All the while the work was constant with The Open Group and now academia.

In summary the participatory action research was constant from 1985 – 2019 and virtually all of the cases included significant research, cooperation with R&D organizations and involved end-to-end implementations providing a rich source of case studies, some of which were used in this thesis.

2.3.4 Extracting Illustrative Case Studies

There were numerous cases where participatory action research, action research and case studies (from the literature) were conducted. The relevant case studies used in the thesis were distributed between the literature review in Chapter 3 to illustrate the DT themes, the methodology assessment in Chapter 4, the illustration of the DT related issues in Chapters 5-8 and then the substantiation of the modified architecture development model in Chapter 9. Essentially only the cases pertaining to DT (rather than digitization) were extracted and used and, in Chapters 5-8 (which were based on submitted articles to journals catering to different

disciplines) the cases that would best communicate the issues to the specific stakeholders (and their concerns) were used.

2.3.5 Synthesizing from the Above

There was a constant process of synthesis and culling of irrelevant material. As mentioned before, only the DT literature was maintained and then a select few were mentioned in the bibliography. The techniques mentioned in 2.4 were used to organize and present the results of the research.

Iteration between the research steps was constant and each chapter in the thesis called for a review of the literature coming from all sources.

2.4. Assessing and Organizing the Results

There were three dimensions that were used to organize the findings of the literature review (that was continuous throughout the thesis timeframe from 2014 – 2019), namely:

Digital Transformation Factors: These were recurrent themes in the digital transformation literature and were used to group the partial literature review findings as described in Chapter 3.

Management Focus Areas: These were common themes for management and addressed the governance, management, planning, building, operations and audit/monitoring functions prevalent in virtually all enterprises in private and public sectors. Both the DT factors and focus areas were used to evaluate the methodology areas in Chapter 4.

Methodology Areas: These were generic methodology areas that provide guidance and direction for professionals engaged in digital transformation. Most are in the practitioner literature coming from the professional associations (e.g. Project Management Institute) or standards associations (e.g. The Open Group). Their analysis with respect to their ability to address DT issues is covered in Chapter 4.

This same assessment is used to assess the value proposition of the recommended EA Development Method in Chapter 9.

Chapter 3. Background and Literature Review

In this chapter, we present a systematic analysis of the background for this thesis, based primarily on the literature retrieved in the last chapter. The initial synthesis of the sources has been conducted to confirm whether the research questions have been answered or not.

The initial literature search was submitted in December 2014, as part of a scientific research course at the University of Ottawa and to guide the thesis proposal in March 2016. It has been subject to major revisions to be updated for this thesis.

The literature review includes a derived protocol that assessed the suitability for digital transformation various families of practice against digital transformation factors and key business functions.

3.1. Assumptions

Several assumptions have been made and are key to the conduct of the literature review. They are as follows:

a. e-Business relies on digital knowledge, information and data as well as other more conventional sources (i.e. non-digital such as tape recording or a paper Record of Decision).
b. Knowledge, Information and Data Management (KM/IM/DM) manages the information holdings available to the enterprise to get quality information to key stakeholders so they can make quality decisions.
c. Information technology (IT) stores, secures and provisions the e-Business with the digital knowledge, information and data that are needed.
d. e-Business is core to the Knowledge-Based Economy which therefore has a heavy reliance on KM/IM/DM and IT.

3.2. General Findings

The research is iterative and focuses on "macro" issues rather than the more traditional dissertations that focus on a narrow and well-defined problem space. By definition, "macro" infers a broad literature search covering many areas of practice and potentially a never-ending literature search.

3.2.1 Research Questions

Several primary research questions were raised and gradually refined. In this literature review the following two primary and three supplementary research questions were raised, based on analysis of the action research and literature review:

The initial Research Questions were:

- Question 1: Is there a holistic management structure that allows enterprises to innovate and evolve over time? and
- Question 2: Is there a recognition that there is a need for a holistic management structure?

As the review and thesis progressed, supplementary research questions were added and addressed as indicated below:

- Question 3: Why are IT related endeavours subject to such a high rate of failure?
- Question 4: Are the different professional communities using distinct methodologies to achieve the same goals, but in conflict rather than in harmony with one another?
- Question 5: Why is IT (the domain of CIOs) misaligned with business?

The final Main Research Question was:

- Question 6: How can EA be improved to address digital transformation?

3.2.2 Preliminary Responses to Primary Research Questions

In findings to date, the answer is "no" to Question 1 and "yes" to Question 2. With respect to Question 1 - references are scoped to address specific dimensions of the management challenge, but none that looks at the enterprise in a holistic manner. With respect to Question

2 - references (i.e. industry best practices in business, planning, marketing, building, operations, IT and so on) indicate the need for a holistic approach but they all want to do it their way to respond to their specific needs. The net result is a collision of best practices that are often incompatible and complicate rather than facilitate the creation or transition of organizations to e-Business enterprises.

The supplementary research questions (Q3-6) were derived and somewhat addressed in the course of the following literature search and methodology analysis. More complete answers to all of the research questions were compiled in Section 4.11.1 - Research Questions.

The following section will discuss the factors that were used to focus the literature search to answer the two questions and ensure the key issues were considered. Based on an analysis of the literature review and verification through the action research, the supplementary research questions were raised.

3.3. Assessment Methodology

The literature review was considerable, mainly due to the expansive nature of DT. The initial guidance was based on literature that addressed the preliminary research questions. Then certain recurrent themes were discovered that were useful for organizing the findings. These themes were called factors and formed the basis for looking at what was necessary in any DT effort. The themes are as follows and will be discussed in the following paragraphs in some detail. They are:

Factor 1 - A Transition to a Knowledge-Based Economy (Section 3.3.1);

Factor 2 - The Relevance of Knowledge (Section 3.3.2);

Factor 3 - The Relevance of IT (Section 3.3.3);

Factor 4 - Continuous Innovation and Business Transformation (Section3.3.4);

Factor 5 - Leadership Versus Management (Section 3.3.5); and

Factor 6 - Scientific Versus Creativity Approaches (Section 3.3.6).

3.3.1 - Factor 1 - A Transition to a Knowledge-Based Economy

There is much talk of a knowledge-based economy (OECD 1996, 2004), however there is not necessarily agreement as to what that constitutes. OECD defines “knowledge-based

economies" as "economies which are directly based on the production, distribution and use of knowledge and information" (OECD 1996, p. 7) or more completely, "a knowledge based economy is an expression coined to describe trends in advanced economies towards greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all of these by the business and public sectors" (OECD 2005, paragraph 71). This recognizes the primacy of knowledge and information in all of its forms and the social implications associated with changing from a "blue" to "white" collar, highly educated workforce.

Many societies, North American and European in particular, are transitioning from industrial-based economies to ones that are based on services not associated with manufacturing. However even traditional "blue collar" jobs are transforming with knowledge-based manufacturing economies using sophisticated automated production lines leveraging robotics and incorporating the System Control and Data Acquisition (SCADA), Social Media and more traditional information systems (operations and analytics). Governments have to consider the immense social innovation dimensions of technology innovation "Forty-seven percent of American jobs are at high risk for robot takeover and another 19 percent face a medium level of risk" (Ross 2016, p. 38).

In a knowledge-based enterprise the employees are generally well-educated (as described in OECD 2001) and the services are expected to be delivered in a customized fashion as illustrated in Figure 2 (Prahaland and Krishnan 2008, p. 6). This figure shows client expectations to be personalized service delivery from the best resources available globally. This capability is a function of the culture of the organization as reflected in the social architecture and the technical architecture that underpins it.

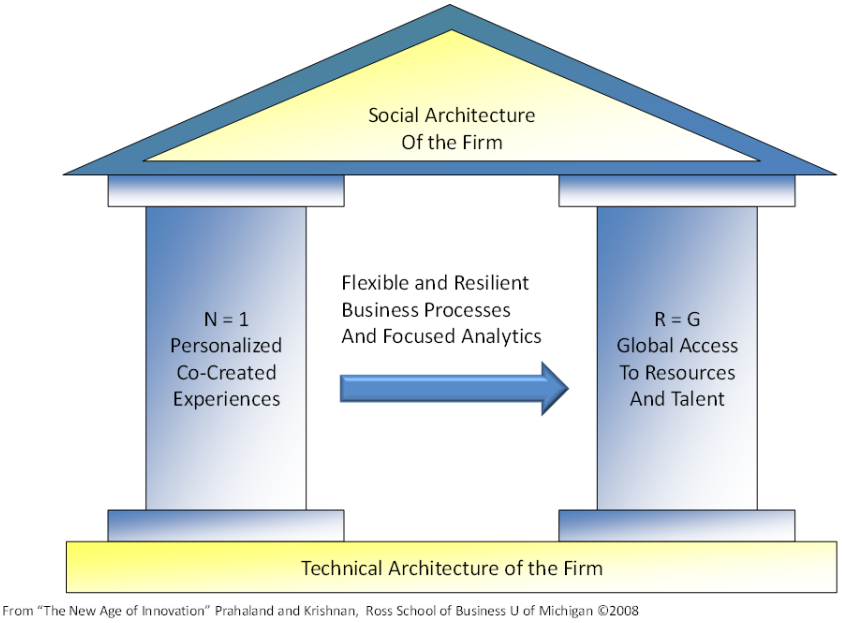


Figure 2 – The New House of Innovation (Prahaland and Krishnan 2008 p. 6)

The knowledge-based enterprise expects and allows employees to have a great deal of discretion in order to provide personalized co-created experiences in a world-class manner. This is a very different business operating model that most executives have seen in the past. For example, a service desk is manned by some of the most senior individuals rather than junior interns as the "personalized, co-created experience" (see Figure 2 Prahaland and Krishnan 2008, p. 6) will require a sound knowledge of the client (and their purchasing patterns) as well as an in-depth knowledge of the products and services the enterprise can provide. These service desk personnel would have access to all the relevant corporate information/knowledge to enable them to deliver the best service possible (Prahaland and Krishnan 2008, p. 6).

Another aspect of the knowledge-based enterprise will be decentralized decision-making where enterprise personnel will be empowered through the provision of relevant information to make local decisions be it service delivery to a client or the stocking of a store to accommodate local client needs, (e.g. 7/11 stores "Store Clerk Hypothesis" from Ross, Weill and Robertson 2006). The effectiveness of the decisions made in the aforementioned scenarios will be highly dependent on the enterprise provision of quality information. The concepts of

both information and decision quality are defined as what information is needed by the decision-maker to make a quality decision (i.e. one with the most effective outcomes). (based upon Davenport et al 2007, 2010, 2012, 2014).

Implicit in the above paragraphs is the need for increased level of education and for educational institutions to increase their curriculum focus on knowledge-based economy related professional development, supporting skills and relevant research. This has been a long-term trend recognized as early as 1993 (OECD 1996, p. 10) *"It is skilled labour that is in highest demand in the OECD countries. ... Although the manufacturing sector is losing jobs across the OECD, employment is growing in high-technology, science-based sectors ranging from computers to pharmaceuticals."* The same report goes on to define, *"knowledge workers – those who do not engage in the output of physical products – are the employees in most demand in a wide range of activities, from computer technicians, through physical therapists to marketing specialists."* (OECD 1996, p. 11). A relevant question is whether educational institutions are meeting the needs of developing a knowledge economy in the context of their national circumstances?

Successful transition to a knowledge-based enterprise will be a function of an enterprise's capability to *"hire the right people"* (Collins 2001 - Page 63) and then manage and make accessible its knowledge holdings through the targeted use of information and related technology. Unfortunately, the science of corporate management has not really advanced apace with new concepts and the last major innovations of management are dated some 100 years ago. Indeed, management innovation is lagging with minimal changes in the past 20-30 years (Hamel 2007, p. 7). The management of information is similarly inadequate.

3.3.2 Factor 2 - The Relevance of Knowledge

Knowledge is a key enterprise asset for a Knowledge-Based e-Business. Although research is replete with the need for capturing corporate knowledge, there is no agreement as to what really constitutes knowledge, information and data. This has led to confusion between the decision support, analytics, operations, records and archives management, document management and content management communities who all claim to manage enterprise knowledge holdings.

In the Open Group, The Information Architecture Working Group took two years to get a consensus on some common definitions (Open Group, March 2012, "An Information Architecture Vision"). This is illustrated in Figure 3 (which was contributed by the author to The Open Group).As this literature search / dissertation will make numerous references to knowledge it is best to get a common understanding of the associated terms.

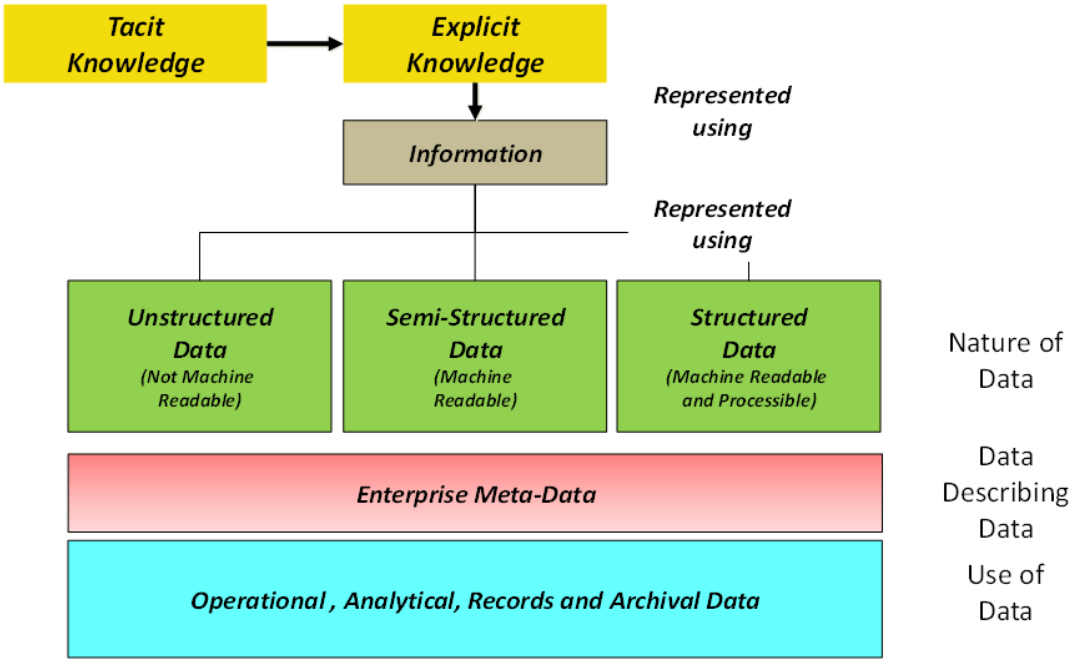


Figure 3 – Knowledge and Digital Information Concepts (From The Open Group 2012 "Information Architecture Vision")

3.3.2.1 Definitions of Knowledge

First there is a considerable variance between the definitions of knowledge in many different domains, but knowledge acquisition, knowledge representation, and knowledge-based systems have been in use for many decades. (McCorduck et al 1983, Winston 1984). The definitions below make use of ISO standards, Dalkir 2011 and the Data Management Body of Knowledge, but the differentiation between the classes of data are from the Open Group. Knowledge (Dalkir 2011 Page 8) can be either:

a. Tacit – *in the head of the knower and represents a combination of formal, informal, and experiential learning. It is often acquired over time and most often not documented. With the current demographics, the need to capture as much of this*

knowledge as possible is paramount to continue existing levels of service in industry and government with fewer human resources. (The Open Group 2013)

b. Explicit – *tacit knowledge that has been acquired and documented in the form of information that may be human and/or machine-understandable*. (The Open Group 2013)

Explicit knowledge is represented using information which is represented using data. The following definitions are international standards: (The Open Group 2013)

a. Information – "*knowledge concerning objects, such as facts, events, things, processes, or ideas, including concepts, that within a certain context has a particular meaning"* (ISO/IEC 2382-1: 1993)
b. Data – *"…a reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing…"* (ISO/IEC 2382-1: 1993)

3.3.2.2 Nature of Data

The definition of data is unclear in many of the references and is hence open to interpretation. In the Open Group, after 18 months a set of definitions were agreed to as a means of clarifying the way that data was classified and exploited. (The Open Group 2012, p. 39). These definitions are used in the paragraphs below:

Data can be stored in many ways varying from media to paper, to microfiche to electronic data in many differing formats. The promise of effectively leveraging advances of IT makes it useful to describe data in terms of its technology accessibility:

a. Unstructured Data – refers to data that is only human-intelligible and cannot be either searched or processed by IT. Often this information in stored in non-electronic media such as a book, microfiche, or electronically in an imaged file that is not able to be searched or processed (even though the latter is becoming rare as image processing is becoming exceedingly sophisticated).
b. Semi-Structured Data – human-readable and machine-readable (e.g., able to be accessed by a search engine). Most electronic documents (e.g., automated office files, web pages) are in this category.

c. *Structured Data – describes data that can be both searched and processed by machine. This data typically resides in databases, including spreadsheets, and is used for both transaction and analytical processing. The latter normally conforms to an enterprise-wide semantics and syntax that transcends specific business processes and functions and includes the representation of knowledge (e.g., decision trees and rule bases).* (The Open Group 2013)

3.3.2.3 Information Usage Definitions

Information can often be categorized as operational or analytical or both.

a. Operational Data is the detailed data used to support the daily activities of an enterprise. (DAMA 2009)
b. Analytical Data is "*the data used by the enterprise for the purposes of analytical processing, such as decision support, business intelligence, and select corporate functions, many of which use aggregate data which is information that combines and summarizes atomic (or other) data."* (DAMA 2011)
c. Records and Archives Data where "records are information created, received, and maintained by an organization or person for business purposes, legal obligations, or both, regardless of medium or form." (Government of Canada 2009 - Definitions) and Recordkeeping is *"A framework of accountability and stewardship in which information resources are created or acquired, captured, and managed as a vital business asset and knowledge resource to support effective decision-making and achieve results..."* (Government of Canada 2009 - Definitions)

Archiving deals with information that is held for extended periods of time and is a key enabler for decision support and business intelligence. Whereas information can be modified in the records and the original deleted, the archives keep all the information so that trends can be assessed, traced, aggregated, and so on. Information quality constraints often differ from records allowing more flexible information structures and requisite storage. Again, the information is stored in a consistent enterprise format. The issue is that archiving is a concept that is not consistently understood in the Information Management community.

3.3.2.4 Analytics and Common Usages

Analytics are often referred to in many ways. For the purposes of this thesis, we can use a vulgarized set of definitions that are commonly used in industry as per (Davenport 2014, p. 202) and are as follows:

- Descriptive analytics reports on the past;
- Predictive analytics uses models based on past data to predict the future; and
- Prescriptive analytics uses models to specify optimal behaviours and actions.

Both Predictive and Prescriptive use models, benefit from machine learning / data mining to generate business rules (Siegel 2013, p. 4) using past data, but the latter also uses algorithms and heuristics to augment the automatically generated business rules.

Analytics has also been popularized as Analytics 1.0, 2.0 and 3.0 which are as described in Table 1.

Table 1 – Three Areas of Analytics (From Davenport 2014 Page 194)

	Analytics 1.0	***Analytics 2.0***	***Analytics 3.0***
Types of Companies	Large Enterprises	Online and Start-Ups	All - "Data Economy"
Analytics Objective	Internal Decisions	New Products	Decisions and Products
Data Type	Small, Structured	Large, Unstructured	All types combined
Creation Approach	Long-cycle, batch	Short-cycle Agile	Short-cycle Agile
Primary Technology	Software Packages	Open Source	Broad Portfolio
Primary Analytics Type	Descriptive	Descriptive, Predictive	Prescriptive
Business Relationship	Back Office	"On the bridge"	Collaborative

Unfortunately, the use of these eras is common, but the descriptions are not consistent. For this paper we will use these definitions in Figure 3.

3.3.2.5 Enterprise Meta-Data

Meta-data is defined in many ways, but the following are the most useful:

a. *"Information pertaining to the information for purposes of description, administration, legal requirements, technical functionality, use and usage, and preservation*" (DAMA DMBOK 2011)

b. *"The definition and description of the structure and meaning of information resources, and the context and systems in which they exist."* (Government of Canada 2010)

There are several types of meta-data that must be considered to address issues such as Accessibility, Quality, Discoverability, Interoperability and Governance.

3.3.2.6 Datafication and Big Data

Datafication essentially refers to the process of transforming unstructured and semi-structured data into structured data that is machine processible. This follows the work that the Oxford Internet Institute, amongst many others, has been conducting on Big Data (Mayer-Schönburger et al 2013, p. 15 and Chapter 5).

This is not a new process indeed many companies have been converting their paper holdings into digital data, which is rapidly converted to semi-structured (i.e. machine-readable) for decades. This includes but is not limited to:

a. Scanned paper documents to semi-structured data using optical character recognition;
b. For images analog-to-digital conversion (e.g. video to digital camera footage) followed by digital signal processing (e.g. facial recognition); and
c. Natural language processing with structured data as witnessed by the IBM Watson on the game show Jeopardy.

Now this is gaining a new impetus as records and archives organizations are refusing to handle non-electronic media in the future.

The key advantage of datafication is that enterprises can now leverage, using information technology, data holdings that were physically impossible to access (e.g. due to their media – paper – and location in an archive in an anonymous box or on a library shelf somewhere in the organization). The extent to which these information holdings can be leveraged is a function of how they are managed.

Big Data is a new term that is having a major impact. Definitions abound but "Big data refers to things one can do at a large scale that cannot be done at a smaller one, to extract new insights or create new forms of value, in ways that change markets, organizations, the relationship between citizen and governments, and more" (Mayer-Schönburger et al 2013, p. 6). One

is dealing with large data or meta-data sets residing within or without the enterprise. Generally, the differentiating characteristics from "normal" data are:

a. Volume – e.g. Walmart collects 2.4 Petabytes per hour (McAfee and Byrnjolfsson 2012, p. 62);
b. Velocity – Speed of data creation – e.g. Mobile Phones
c. Variety – All manner of data (e.g. tweets) leading to changes in data-intensive approaches

There is also a change from correlation versus causation, with analysts needing to change from discovering a cause and effect relationship, to just intelligently looking for correlations. Medicine is a prime example as sample size rapidly becomes N = ALL rather than a limited sample size.

IEEE has discussed Big Data as the convergence of traditional information systems, social media and system control and data acquisition (SCADA) or control systems. Often this mass of data/information can be overwhelming if not properly managed.

Big Data poses major management challenges, not the least of which are privacy and relevance. For example, the Canadian Government issued a policy stating that all social media had to be managed. With digital phones (VOIP), every telephone conversation, every tweet, every email became a managed asset. With the IT staff madly creating massive storage area networks, a simple IM policy stated that unless requested, every telephone conversation would be life-cycled and deleted after 20 minutes. This avoided major privacy issues and IT infrastructure costs. Unfortunately, most organizations have weak KM/IM/DM policies and create challenges for any knowledge-based company wanting to leverage its key asset.

3.3.2.7 Knowledge, Information and Data Management (KM/IM/DM)

The disciplines of Knowledge, Information and Data Management (KM/IM/DM) are some of the oldest disciplines in the world dating back to the great library of Alexandria (MacLeod 2005). Their proper execution allows for the right information being available to the right person at the right time to make quality decisions. However, their use for digital media is embryonic.

The first challenge is that the meaning of the terms varies widely amongst the technical, content management, library science and business communities. Many of the issues stem from

the way that digital data was introduced. A defence case study is useful: In the pre-digital era, all institutions had clerks and library scientists who would take care of filing systems and libraries respectively. Furthermore, all members of the business were responsible for information management and knew the filing systems and library organization and *used* them daily. The file numbers were the key for the information lifecycle where files were stripped of dated or irrelevant data (in accordance with well-documented business rules). Also, the files were the repository for authoritative data (e.g. a policy directive) so it was relatively simple to take decisions based on this authoritative data. Sharing was problematic but the clerical and library staff always knew who had what; they just took time to get it. From a security perspective, documents were paragraph labelled (i.e. each paragraph and image had its own security classification) which was entered by the author. Then came the "digital" revolution.

The introduction of Information Technology allowed for massive sharing of information and the introduction of technology was often paid for by eliminating both the clerical and library staff – part of business process re-engineering (as formalized by Champy 2002). Shared drives replaced library shelves and e-mail replaced formal letters and controlled messaging centres. The Information Technology staff, experts in the technology, inherited the KM/IM/DM responsibilities for which they had little or no training.

In the Canadian Department of National Defence (DND) this step was completed in the period of two years as part of the establishment of the Defence Information Services Organization (DISO) in the 1993-1996 timeframe. Commercial Off The Shelf (COTS) products were technology focused, not information management focused; for example, the retention of formal correspondence became a function of limited mailbox size, not stringent business rules. Business became less cognisant of their IM responsibilities and copies of documents were widely circulated as email attachments, downloaded in countless shared drives and promptly lost; nobody knew what was authoritative or a final version. Documents were labeled with a security classification, rather than each paragraph, and with Access To Information legislation (Government of Canada 2016), countless person-years were wasted going through each document (by a person who had not authored the document) trying to figure out what could be released or not. The security and adherence to the letter and spirit of the access to information legislation implications were significant. Furthermore, a major goal of enhancing the quality

and speed of key decisions based on the availability of organized, understandable quality information was not proportionate to the large IT investments.

This experience was replicated throughout government and indeed throughout the private sector as well. The Chief Information Officer (CIO) was often in reality the Chief Technology Officer (CTO). Ergo in many enterprises the independent positions of Chief Knowledge Officer (CKO) were created separate from the CTO. In other organizations and international standards organizations (Open Group TOGAF 9 2009) the term IT was redefined as the *"The lifecycle management of information and related technology used by an organization."* (Open Group 2009 TOGAF 9.1 Chapter 3 Para 41) so that practitioners of disciplines such as Enterprise Architecture and Solutions Architecture would focus on the business and information holdings and not just the technology.

Slowly, best practices for KM/IM/DM are being formulated and the names of the sponsoring organizations are hampering their take-up. For example, the Data Management Body of Knowledge (DAMA DMBOK 2009) was published by the Data Management Association and addresses aspects of knowledge and information. The Canadian Government Data Stewardship Methodology was being rewritten to be called the Information Stewardship Methodology (2011) but reverted to the Data Stewardship Methodology so that it would be followed by the Structured Data community (i.e. database). It was never formally published.

3.3.2.8 Concluding Remarks

Essentially digital KM/IM/DM is still in its infancy and there is no consistent set of best practices. If Knowledge / Information / Data is to be considered as one key assets of a knowledge base enterprise, then its management is immature, and this immaturity is preventing companies from realizing the full business value of their information holdings. With information as a service, enterprises will have to put in place to management structures to not only manage their internal holdings but leverage the holdings that are available to them through the network for what is now commonly being called the cloud.

3.3.3 Factor 3 - The Relevance of Information Technology (IT)

With the immature state of information management, it is hardly surprising that the supporting technology is anything approaching coherent. Indeed "the result in many corporations is that IT is an expensive mess."(Feld and Stoddard 2004 P.1) This is indeed this is indeed more important "as corporate information assets can account for more than 50% of capital spending" (Nolan and McFarlane 2005, Carr 2003).

One of the other challenges is defining what is IT? Indeed, IT is a vague term that on the one hand addresses the infrastructure, which is mainly technology, and on the other also manages the actual information assets. In the absence of business direction (through proper KM/IM/DM) the latter is not well done. To unify the concepts of information and technology, organizations (e.g. US DoD) often refer to the "Infostructure" to remind enterprise members that access to quality information is the ultimate purpose of investing in the technology. Regardless, the ability to gather, process and present quality information in a timely manner is impossible without the use of information technology.

MIT CISR research has indicated that "companies that manage your IT investments most successfully generate returns are as much as 40% higher than those of other competitors" (Ross and Weill 2002). A recurring theme is that business doesn't get sufficiently involved in key IT decisions, often because they have no idea what the options are and what is the business value delivered. Experience has shown that there is a language barrier between business and information technology specialists that has resulted in a great deal of frustration on both on the part of the business and technology executives. Often, IT presentations are couched in "techno-babble" that obscures a lack of understanding of the business by the IT specialist making a presentation.

The business value of strategically re-structuring enterprise IT has been well-documented in numerous case studies by organizations such as the MIT Sloan School of Management Centre for Information Systems Research (see Weill and Ross 2007, Ross, Weill and Robertson 2006) using examples such as Campbells, 7/11, Toyota and Delta Airlines. The challenge is that most organizations are not strategically focused, and the long-term work associated with revamping the IT infrastructure is subsumed by the tyranny of the immediate where short-term goals and fixes patch rather than re-vitalize the IT infrastructures. Often the sunk cost effect results in good money being thrown after bad.

Without the focused application of information technology to business problems and to help manage enterprise information (both internally and externally held) a knowledge-based enterprise will neither thrive nor survive.

Furthermore, the entire concept of IT is transforming to a set of commoditized services available by external vendors to organizations that are sufficiently well organized internally (see Ross, Weill and Robertson 2006) to take advantage of the services. Indeed, the use of these commoditized services presented "a vanishing advantage" as predicted by Carr (2003) and currently realized with the advent of cloud-based computing. This business transformation of IT will allow CIOs to focus on both managing and leveraging knowledge, information, and data (especially analytics) to achieve competitive advantage (Davenport 2006, 2013). Practically, CIOs will no longer have to focus on costly platform and infrastructure services but will be able to concentrate their resources on business applications using and presenting quality information for operations and analysis.

3.3.4 Factor 4 - Continuous Innovation and Business Transformation

Any business requires continuous innovation to survive. This is well-illustrated by the "S-Curve" (Nunes and Breene 2011) where essentially a business latches onto an innovation and revenues increase to a point when the innovation no longer provides competitive advantage. Afterwards they shrink and either drop off or plateau. The successful business has the strategic agility (a key corporate attribute according to Ross, Weill and Robertson 2006) to continuously innovate to maintain revenue streams and corporate health. This is illustrated in Figure 4.

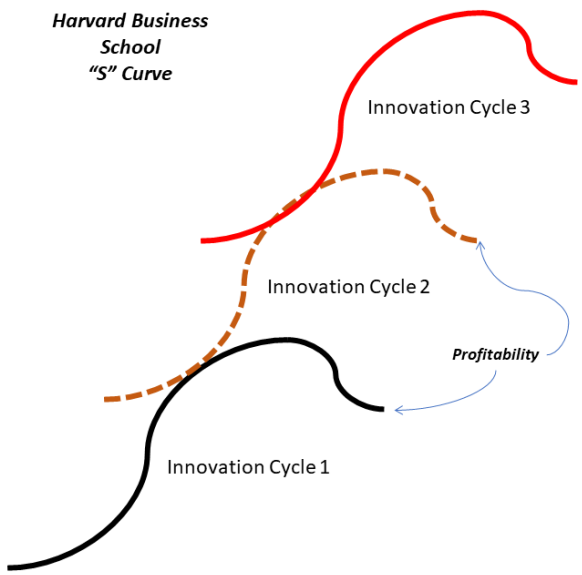


Figure 4 – S-Curve (based on Nunes and Breene 2011)

Dependent upon the industry, the time between innovation cycles may be very short. In the Knowledge Economy where e-Businesses will be dominant, analytics will provide decision-makers with the key information they need to understand the competitive landscape and either prompt and/or focus the next innovation cycle.

Innovation can be thought of strategically as well as tactically. Strategic innovation has been assessed to be in waves of 50-60 years in major waves as depicted in Knodratieff (1984). Shorter term innovation often concerns the development of and improvements to the *"dominant design"* with respect to processes and services (Utterback 1994). Utterback focuses on products, but the same can be said for technology and the business adaptations to accommodate and derive business value from new technological innovations lag the availability of the technology. Key decisions in any business methodology include considering when new innovations are ready for insertion into the company, including social innovations (a.k.a. business transformation) that must be realized to derive optimal business value. Rogers (2011) has come up with the model of innovation diffusion (using Innovators, early adopters, early majority, late majority and laggards) and any methodologies should consider two dimensions:

a. Dimension 1 - Adoption to use new innovations within the enterprise; and
b. Dimension 2 - For products and services, diffusion of enterprise delivered innovations into the marketplace.

A major impediment to continuous innovation is the concept of the Dominant Dogma (i.e. complacency) This is not new and is illustrated in Figure 5 (from Prahalad and Krishnan, 2008). Essentially a successful "innovation" is embedded in a supporting business model and that creates a business culture (and supporting IM/IT infrastructure) that can become complacent. Allowing too much complacency in an organization is the number one error in changing and transforming an organization (Kotter 1996).

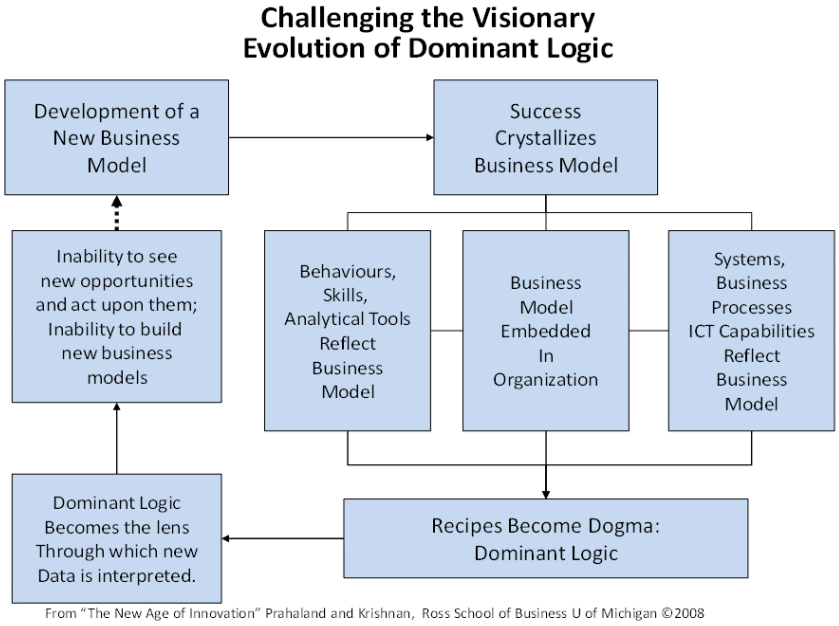


Figure 5 – Evolution of The Dominant Dogma (Prahalad and Krishnan 2008)

Major case studies about dominant dogma include companies such as Kodak (Hamel 2007) which had the patent on digital photography but were adamant that regular film (dominant dogma) was there to stay and ignored the business potential of digital cameras and film.

Business transformation is also a major challenge in the world of IT. CIOs have seen many of their traditional services (specifically platform and infrastructure services in accordance with the Technical Reference Model in The Open Group TOGAF and IEEE/POSIX) commoditized (Carr 2003) and massively available through the Internet (currently vulgarized as cloud services). CIO staff will have to transform their skill based into information systems development, specifically business application and information services which is very different from the commoditized platform and infrastructure services currently provided by most CIO groups. CIO groups can act as an impediment to transformation (Weill and Ross 2009 Chapter 1 - Transforming IT From a Strategic Liability to a Strategic Asset).

The upshot is that an e-Business must constantly innovate to stay competitive and is heavily reliant on the focused use of IM/IT.

3.3.5 Factor 5 - Leadership Versus Management, Reliability Versus Validity Mindsets

Constant innovation creates turbulence within an organization and disturbs the "status quo". So, in order to incorporate this essential business capability within the corporate DNA requires more than just a standard change in one or more business processes, it requires a new mindset and a corporate champion to see it through. Normally the champion must have more than just management ability, the individual must be able to inspire. In the military leadership is often defined as. "the ability to get people to do things that they would never do themselves."

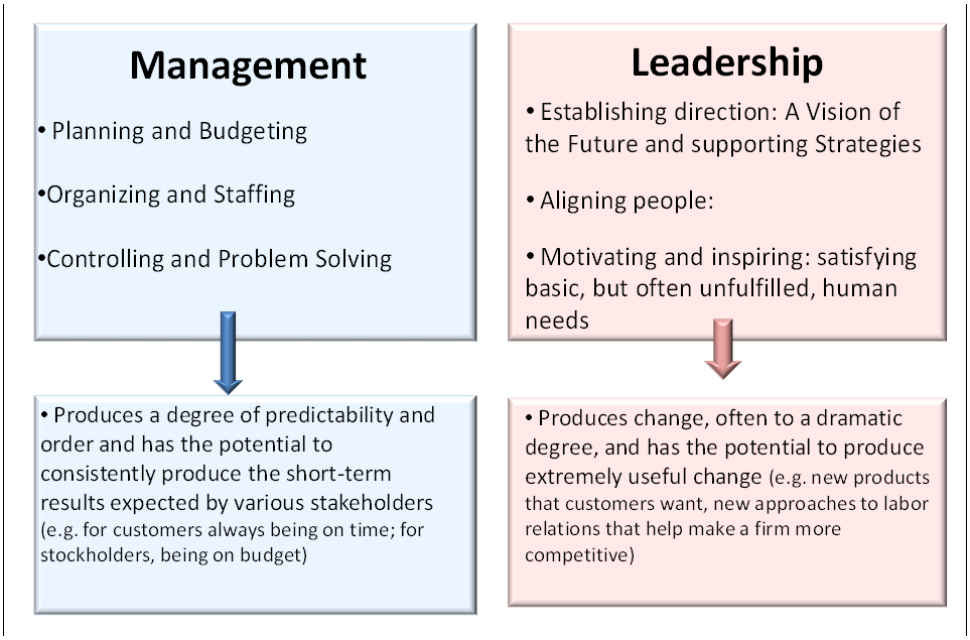


Figure 6 - Management Versus Leadership (Kotter 1996 P. 26)

As illustrated in Figure 6, (Kotter 1996) has differentiated management from leadership in a pragmatic way. Often, good leaders need solid managers and vice versa; the best is when the individual possesses both. A pure manager tends to favour the "status quo" and will potentially stagnate the company whereas a pure leader will inspire people to do things but may be an agent of chaos rather than of productive change. This is alluded to in "Enterprise Architecture as Strategy" (Ross, Weill and Robertson 2006) where EA is an effective check and balance against potentially unattainable business goals and objectives.

Roger Martin (Martin 2009a, 2009b) takes a similar but distinct approach where he differentiates between Validity and Reliability mindsets. Essentially Validity embraces the question what could we do to get ahead? It is visionary, innovative and relates to Kotter's concept of leadership. Reliability is improving existing ways of doing business and focuses on service improvement. Reliability "keeps the lights on" and is a management discipline. Business Design (Martin 2009b p. 54) embraces both mindsets saying that both need to exist for a firm to continuously innovate, and not go bankrupt in the process. The Reliability mindset embraces analytical thinking (inductive and deductive reasoning) whereas the Validity mindset focuses on intuitive thinking (abductive reasoning), not unlike Malcolm Gladwell's "Blink" (Gladwell 2005) which provides a psychological basis on the validity of intuition that is often based upon deep tacit knowledge and imagination.

As noted in Martin 2009b, p. 40, the "reliability" mindset is epitomized in the ITIL/Six Sigma approaches found in operations, whereas the "validity" mindset is often found in the enterprise strategic planners and marketing communities. They often clash and when creating the executive team, it is important to have a good mix of mindsets around the table.

The scope of Business Design is described in Figure 7 where the concepts are illustrated.

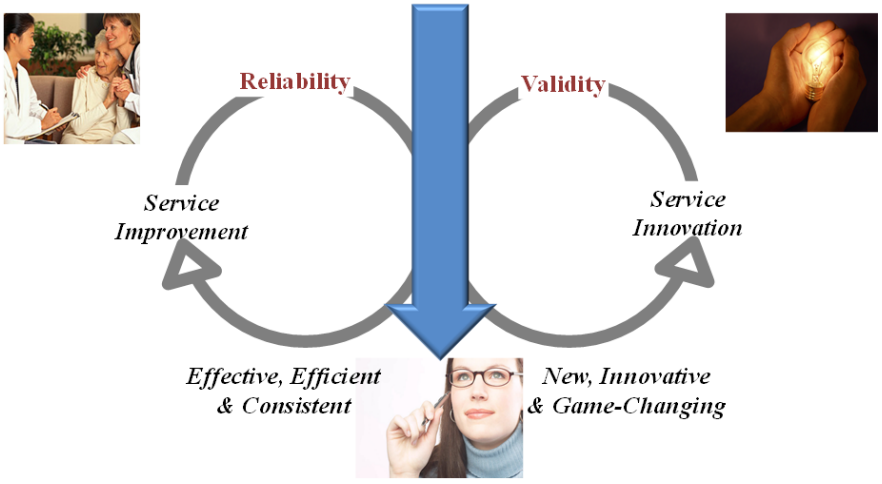


Figure 7 - Business Design (based on Roger Martin 2009b p. 54)

In summary, blending Reliability and Validity mindsets by having both managers and leaders support a more orderly continuous innovation enterprise environment.

3.3.6 Factor 6 - Scientific Versus Creative Analysis

A major impediment to creating innovation and balancing the reliability and validity mindsets in a knowledge-based enterprise is the friction between scientific / engineering (analytical) and creative (intuitive) analysis (based on Martin 2009b). The crux of this problem is the concept of "wicked problem". Jennifer Riel (in Martin 2009b p.94) identified these as a class of problem that would defy the use of classical analytical techniques.

Again, it is not a question of right versus wrong, but a need to balance the two approaches. Often an analytical, quantitative approach will not work, and a more creative, qualitative approach is required. A good example is Apple when they innovated to create a series of "feel good" products (e.g. iPod) that turned the corporation's fortunes around. These products were leveraged to open new revenue streams such as selling music.

To a certain extent the creative analysis looks for "Blue Oceans" (Kim 2005): new markets where competitive advantage can be gained with minimal or no competition versus trying for part of an existing market (Red Oceans). Of course, Blue Oceans turn Red quickly with competition, so the next innovative cycle must be started. The fiscal return of launching in Blue versus Red Oceans is illustrated in Figure 8 showing that 61% of profits go to the 14% of companies launched in Blue Oceans.

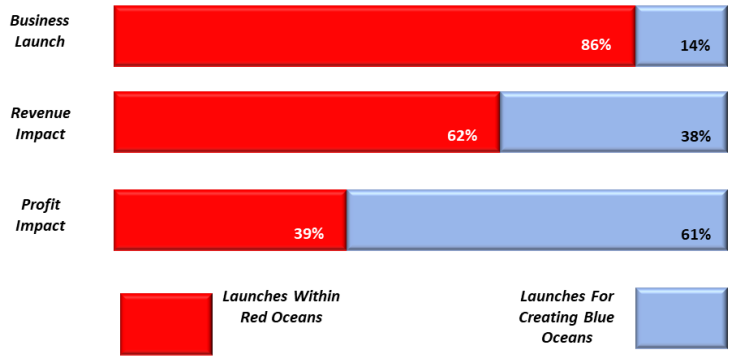


Figure 8 - Profit Impact of Blue Ocean Launch (Kim and Mauborgne 2015 P.7)

Subjectively, the differences between scientific and artistic inquiry are described in the Table 2.

Table 2 - Differentiating Between Artistic and Scientific Inquiry (Austen 2014)

Artistic Inquiry		Scientific Inquiry
1. Results are expressed		1. Results are stated
2. Validity Depends on the Power of qualitative forms to shape our conception of the world		2. Validity depends on bias-free methods and conclusions
3. Captures undergone, felt experience and its meaning		3. Reports on low inference, measurable observations
4. Generalizations are formed by qualitatively vivid single samples		4. Generalizations are based on sound statistical samples
5. Results are presented in a variety of expressive formats and forms		5. Results are presented in standardized reports, objective language and statistical findings
6. Says what needs saying by combining facts and fiction		6. Reports only the facts
7. Generates heuristics that provide ineffable forms of understanding		7. Generates algorithms used to predict and control future events
8. How data are collected and presented depends upon the investigator's unique approach		8. Data are collected and reported with investigator-neutral methods and instruments
9. Knowing is rooted in emotion		9. Knowing is emotionally neutral
10. Aims at creating meaningful understanding.		10. Aims at making true statements about the world

The business design community has documented some tacit knowledge and differentiated between artistic and scientific methods of inquiry and empirical research in Table 3. Indeed, in history (Kennedy 2013) there have many times when engineers had to turn to a more artistic approach as in World War II when many activities had just not been conducted before (e.g. Mulberry Harbours on D-Day in France). Kennedy defers to Webster's Dictionary where an engineer is defined in a broader sense as, *"a person who carries through an enterprise through skillful or artful contrivance."*

Table 3 - Comparing Artistic and Scientific Methods of Empirical Research (Austen 2014)

Basic Artistic Method		Basic Scientific Method
Experience Qualities		Ask a Question
Generate Possible Relationships Between Qualities		Do Background Research
Undergo Experience to Create Further Understanding		Construct a Hypothesis
Create and Connect Qualities as Experience Tests Understanding		Conduct Experiments and Collect Qualitative Data
Begin Shaping Understanding into an Expressive Form		Analyze Results and Draw Conclusions
Present Understanding in a Qualitative, Expressive Form		State Results in Standardized Formats

Chapter 4. Analysis of Different Methodologies With Respect to Digital Transformation

Having assessed the factors (or themes) of digital transformation, it is now incumbent to address RQ1 and RQ2 by the assessment of various areas (or groupings) of methodologies with respect to their ability to address the DT Factors and the key business functions using the COBIT 2019 standard (ISACA 2018) as an outline. The following paragraphs will describe the assessment analysis and its visualization.

4.1. Conducting the Assessment

As previously mentioned, the assessment is a function of how well a certain family of methodologies (or methodology areas) address the DT factors and the business focus areas. The DT factors, business focus areas and methodology areas are shown in Figure 9.

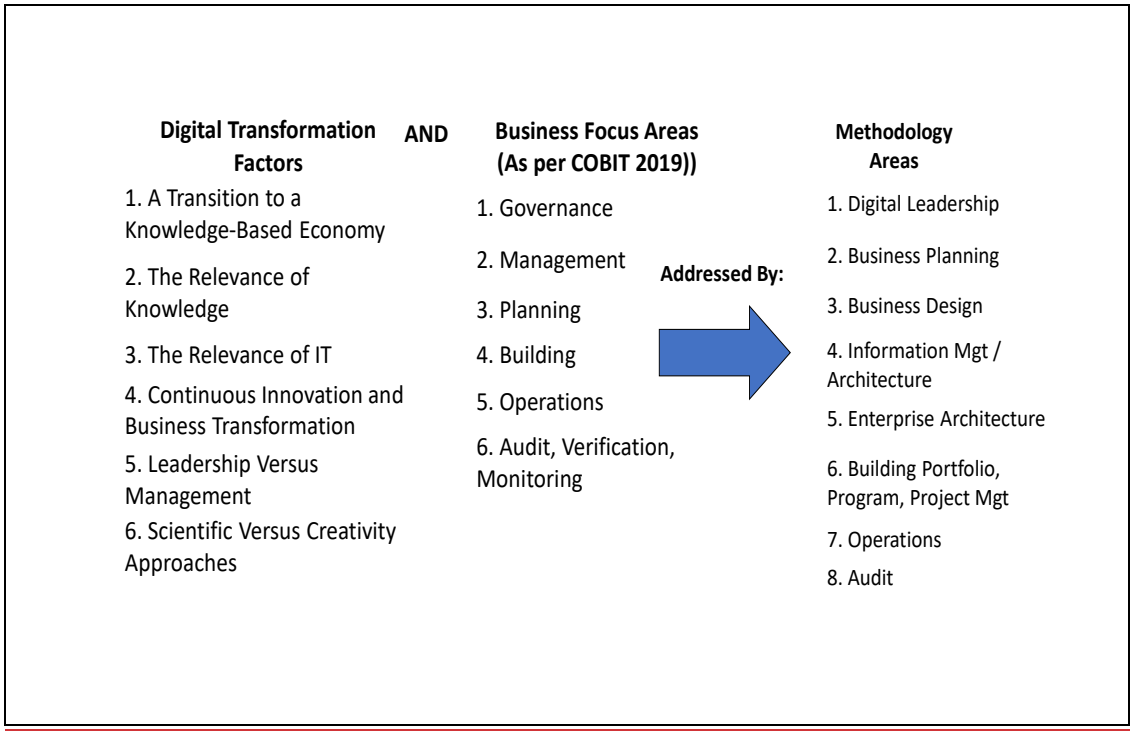


Figure 9 - Assessment of Methodology Areas

4.1.1 Business Focus Areas

The key business functions were based on the COBIT standard (ISACA 2012, 2018) and are those involved in the creation of a knowledge-based enterprise (as detailed in Figure 44). They are:

a. Governance – Governance ensures that stakeholder needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved; setting direction through prioritisation and decision making; and monitoring performance and compliance against agreed-on direction and objectives (ISACA 2012, p.14).
b. Management - Management plans, builds, runs and monitors activities in alignment with the direction set by the governance body to achieve the enterprise objectives (ISACA 2012, p.14).
c. Planning (a.k.a. Align, Plan and Organize);
d. Building (a.k.a. Build, Acquire and Implement);
e. Operations (a.k.a. Deliver, Service and Support)); and
f. Audit, Verification, Monitoring.

4.1.2 Methodologies Reviewed and Methodology Areas

The review researched the literature across academia and the practitioner space (e.g. ISO, Project Management Institute, IT Governance Institute, CMMI, etc). Numerous methodologies were reviewed and were heuristically grouped into eight areas and assessed. The methodology areas are as follows:

a. Digital Leadership based upon the Westerman methodology (Westerman et al 2014, 2014b and 2012) and public strategies from government such as DOD Digital Modernization Strategy (US DOD 2019);
b. Business Planning (Balanced Scorecard Family) based upon Kaplan extended methodology which is in use in some 95% of companies in one form or another (Kaplan 1996, 2001, 2004, 2006, 2008);
c. Business Design based upon the Martin methodology (Martin 2009a, 2009b) and the Business Strategy Canvas (Kim and Mauborgne 2015, 2017);

d. Information Mgt / Architecture based on the DAMA Body of Knowledge Versions 1 and 2 (DAMA 2009 and 2017), Knowledge Management in Theory and Practice (Dalkir 2011, 2017), US government initiatives (US Govt 1996b, 2007b; US DOD 2014; US ODNI Vision), and the CMMI Data Management Maturity Model (2014);
e. Enterprise Architecture based upon TOGAF 9.2 (2018), US Government Common Approach to Architecture (US Govt 2012), NATO and OMG Unified Architecture Framework (NATO 2018, OMG 2017);
f. Building Portfolio/ Project Management based upon the Project Management Institute (PMI) Portfolio and Project Management Bodies of Knowledge;
g. Running Operations Management based upon the ISO 55000, ITIL (Alexos) and IT4IT (The Open Group 2016); and
h. Audit based upon the Information Systems Audit and Control Association (ISACA) / IT Governance Institute (ITGI) Standards mainly COBIT 2019 (ISACA 2018).

4.1.3 Rating

Each family of methodologies was assessed with respect to their ability to address the key business functions and factors using a simple rating scale and colour codes (e.g. in Table 5 Table 6, Table 7, Table 8, and so on) as follows:

0 - indicated that the methodology in no way addressed the business function or factor;

1 - indicated that the methodology referred to but did not address the business function or factor;

2 - indicated that the methodology partially addressed the business function or factor, but did not use standards from that business function or factor domain;

3 - indicated that the methodology addressed the business function or factor but did not use standards from that business function or factor domain;

4 - indicated that the methodology addressed the business function or factor referring to standards from that business function or factor domain; and

5 - indicated that the methodology fully addressed the business function or factor using the standards from that business function or factor domain.

4.1.4 Colour Coding

The results were further colour coded (to address some of the subjectivity) as illustrated in Table 7 - Assessment of Methodology Area 4 - Enterprise Architecture. The significance of the colours is as defined below:

a. Green - Good Coverage - 4 or 5;
b. Yellow - Partial Coverage - 3; and
c. Red - Inadequate or No Coverage - 1 or 2.

4.2. Methodology Area 1 - Leadership (Digital Masters)

There is an obsession in organizations with the concept of alignment whether it be the lines of business with the corporate strategy (e.g. Kaplan and Norton 2006), operations with strategy (e.g. Kaplan and Norton 2012), and IT Infrastructure with the business (e.g. Ross et al 2006). CIOs have a particularly difficult time as the previous generation were business personnel who learned IT, whereas now the IT personnel are pure IT and have no corporate network or knowledge. Furthermore, they have inherited an IT infrastructure that has evolved over time and is extremely maintenance intensive leaving little budgetary space for innovative capital spending[1]. Additionally, business leaders turn to CIOs for quality information/data to make decisions, but their technology-centric IT infrastructures have ignored data/information management. This has led to the rise of the Chief Data Officer (CDO) phenomenon, currently, in North American corporations to work alongside the CIO (de facto the Chief Technology Officer) to provide stakeholders with quality information/data[2] .

There are many references in this domain but one of most relevant is a well-researched approach published as "The Digital Advantage" and "Leading Digital" (Westerman 2012, 2014) which has roots in Capgemini Consulting and the MIT Initiative on the Digital Economy. Their work is based on a survey of 391 companies in 30 countries (Westerman et al 2012) where they have deduced that those who innovatively leverage technology (called "Digital

[1] For example, in one large Canadian government department $343 M was allocated for IT operations and maintenance leaving only $15M for capital innovation. The latter ended up paying off licences for software purchased by the lines of business with no thought to Total Cost of Ownership/Lifecycle Management.
[2] This is trend indicating the de facto failure of CIOs to deliver quality information and has led to the creation of institutions such as the "MIT Chief Data Officer and Information Quality (CDOIQ) Program". Estimates indicate an order of magnitude increase (in North America) in the number of CDOs in 2015.

Masters") "outperform their peers ... masters are 26% more profitable than their average industry competitors. They generate 9 percent more revenue with their existing physical capacity and drive more efficiency in their existing products and processes." (Westerman et al 2014 Page 4).

Another emerging form of alignment is that of aligning the business to the technology where business has an obligation to intelligently leverage the new technology in a timely manner. This is somewhat at odds with "The Future of Management" (Hamel 2007), which sees IT as more of an enabler to realize the business vision. This form of alignment is essentially at the heart of Westerman's work and was enunciated recently in Europe (Tolido 2015). The overview of the concepts is summarized in Figure 10 and evaluated in Table 4.

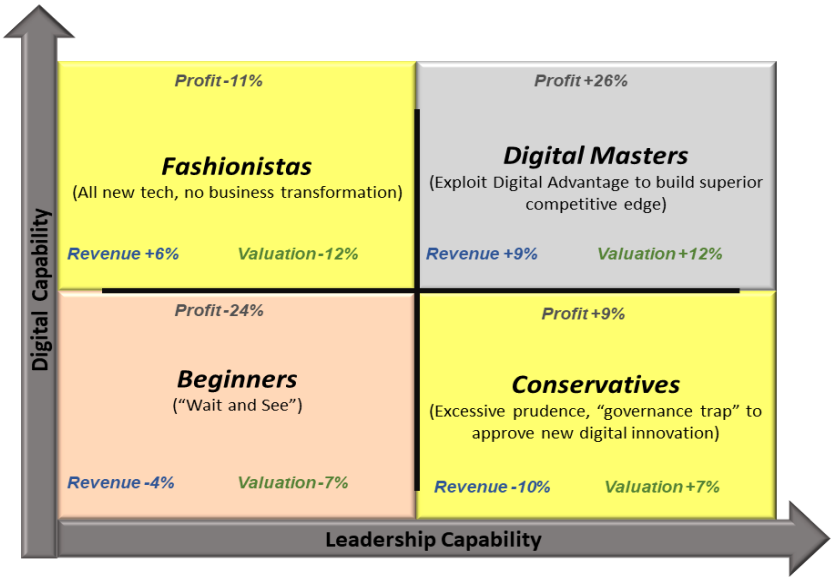


Figure 10 - Digital Mastery and Implications (Combining Concepts from Westerman et al 2012 (P.7), 2014 (P.15,16))

Table 4 – Assessment of Methodology Area 1 - Digital Mastery

#	*Coverage / Feature*	*Score (/5)*	*Comments*
1	Governance	4	Gives good general guidance on the creation of governance for the organization and the transformation. Includes a Digital Transformation Compass that highlights key activities and introduces "digital governance".
2	Management	3	Good management suggestions, but little in the way of concrete Performance Management criteria.
3	Planning	3	Designed for planning at the conceptual level; many useful case studies
4	Building	2	Focus is on the Conceptual level and little interaction with the portfolio of projects and integrating into the operational landscape.
5	Operations	1	Little mention of the impact on operations or service management
6	Audit, Verification, Monitoring	1	Little mention of audit or verification
	FACTORS		
1	Transition to a Knowledge-Based Economy	5	Good mention of the planned use of advanced techniques and technology and its impact on the corporate bottom line.
2	The Relevance of Knowledge	2	Even though "Big Data" is used, there is little mention of how the data / information and knowledge are to be handled. There is little mention of the integration of information systems, SCADA / control systems and social media.
3	The Relevance of IT	3	The word digitization infers IT in the methodology, and it is focused on digital skills and transformation.
4	Continuous Innovation and Business Transformation	5	The work focuses on continuous innovation and transformation.
5	Leadership Versus Management	4	Although not explicit, the work is one focused on leadership with requisite management. The impact on the existing management structure is not fully considered, even though it does draw upon Kotter's business transformation work (Kotter 1990, 1996, 2014)
6	Scientific Versus Creativity Approaches	4	This is not raised explicitly, but the work focuses on Creativity with the right mix of scientific reasoning to ensure that the technology is applied in a way that provides business value

4.3. Methodology Area 2 - Executing Strategy: The Balanced Scorecard, Strategy Maps

The Balanced Scorecard was designed to “translate strategy into action” (Kaplan and Norton 1996) and gave rise to a body of knowledge that included more detailed direction on applying the Balanced Scorecard (Kaplan and Norton 2001) as well as tools such as Strategy Maps (Kaplan and Norton 2004). The linkage to execution was well-described in Alignment (Kaplan and Norton 2006) and “The Execution Premium” (Kaplan and Norton 2008). This is a (the) major business driven methodology as the Balanced Scorecard (or enterprise specific variants thereof) is used in roughly 95% of enterprises (Kaplan 2013).

The concept of a Balanced Scorecard was predicated on creating sustained growth based on examining the crucial dimensions of an organization, not just the bottom line. These dimensions were the basis for the creation of Strategy Maps relating the various activities in each one of the dimensions to concrete strategic outcomes. Figure 11 illustrates the dimensions and their recommended priority for both private and public sector enterprises.

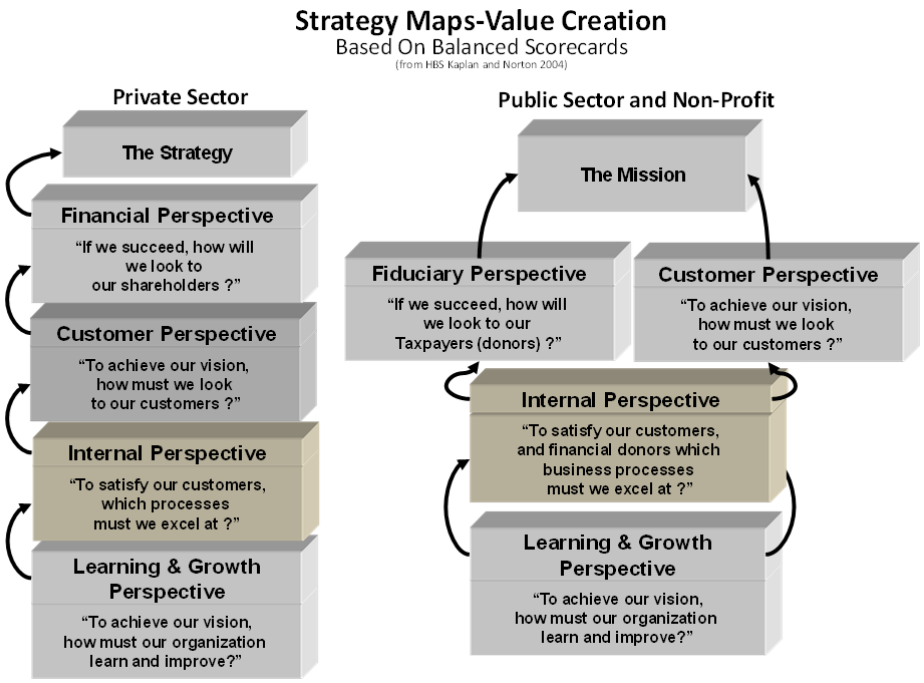


Figure 11 - Balanced Scorecard and Strategy Maps (Kaplan 2004)

Essentially the methodology is top-down strategically driven and does not dwell specifically on technology or digitization. One uses whatever is needed to get the job done.

To develop and execute on strategy there are five core principles that guide the strategy-focused organization as described in the figure below. Most management methodologies echo these principles in one way or another and they are implemented in most organizations. The principles of a Strategy Focused Organization form the unifying theme between the various works of Kaplan and Norton (2008, p. vii) and are as illustrated in Figure 12.

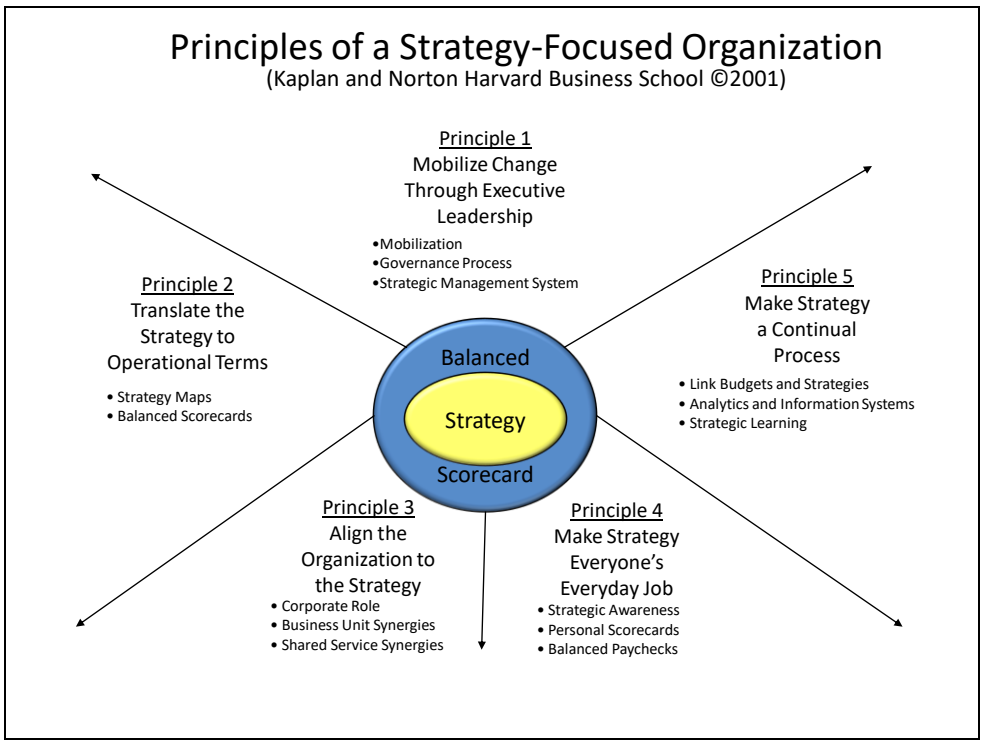


Figure 12 - Principles of a Strategy-Focused Organization (Adapted from Kaplan and Norton 2001)

Case studies using these traditional approaches are mainly private sector, but Balanced Scorecard is also used in the Public Sector (e.g. Canadian Department of National Defence, City of Ottawa). The approach is thorough and the linkages to operations are well-thought out (Kaplan and Norton 2008).

The challenge is in execution and its heavy reliance on top-down corporate strategic direction. In practice it is ponderous and is often circumvented as there is little actionable strategic direction in enterprises due to corporate fixation on the sort-term financial dimension. This has been echoed in Hamel in his call for a renewed Management Theory with features such as agile Innovation Democracy based on a lattice versus hierarchical organization structure (Hamel 2007 Page 87). This is directly supported by work by Kotter in business transformation (Kotter 2014) in his Dual Operating System. Government implementation has been hampered by its cultural reliance on collaboration and its complexity as reflected in its Diversified Business Operating Model (Ross et al 2006). Even in organizations such as Defence/Defense, the various lines of business (i.e. Navy, Army, Air Force, ...) are in a competition/cooperation ("coopetition") and coherent top-down direction is challenging to formulate, especially

given the high level of uncertainty and complexity associated with potential operations. The challenges of defence program management are well described in Dempster (2001).

Many of the business methodologies are strategically focused and deal with contextual and conceptual aspects of the digital transformation but provide minimal direction for the detailed implementation. They are also mainly product focused, and none address the social or climate issues associated with digital transformation. For example, the coal industry in West Virginia has automated, so they still produce as much coal as before, but only require 40% of the work force (Ross 2016 p. 42). No methodology addresses what happened to the 60% who lost their employment or the impact on the environment (e.g. causing black lung), as they focus on competitive advantage and efficiencies.

Other sample strategic methodologies include:

a. Porter's 5 Forces (Porter 1980) is good for addressing the context of an enterprise industry / innovation / product by assessing the impact of market forces, specifically new entrants, institutes, buyers, suppliers and existing competitors;
b. Porter's Value Chain (Porter 1985) is good for describing linkages between core and supporting processes to achieve a key outcome(s) as illustrated in Figure 42 - IT4IT Value Chain - IT4IT Reference Arch V2.1 (The Open Group 2017 p.7) where it is used for an operations management standard called IT4IT.
c. Kotter's eight phases of change (Kotter 1996) describe the need for urgency, coalition creation, visioning, sharing, empowerment, short-term wins, consolidation and anchoring to achieve success.
d. Senge (Senge 1990) relies on the definition of essences, principles and practices to achieve personal mastery, mental models, shared vision, team learning and systems thinking as the basis for the creation of a learning organization

Detailed business analysis techniques are laid out in numerous books, but, from a practitioner perspective, there are two main sources that are in use:

a. The Business Analysis Body of Knowledge (BABOK) (IIBA 2015) describes business analysis techniques. It was initially targeted at project level business analysts with weak coverage of information/data side, but is evolving to address concerns at the strategic and tactical level; and

b. The Business Architecture Body of Knowledge (BizBoK)- by the Business Architecture Guild (2019) which is semi-proprietary and covers analysis at the project, portfolio level. More holistic and is closely associated with other Object Management Group Standards (e.g. Business Motivation Model) and provides a business front end for the OMG more physical level standards. Since 2017, it has been working with The Open Group to enhance the business architecture aspects and open up their BizBOK concepts to a larger audience.

The assessment of business planning methodologies is found in Table 5.

Table 5 - Assessment of Methodology Area 2 – Executing Strategy

#	*Coverage / Feature*	*Score (/5)*	*Comments*
1	Governance	4	The description of governance and performance management is well defined. Structures for different operating models are less so.
2	Management	3	Management is well defined for the traditional model, but it does not lend itself well to strategic agility.
3	Planning	3	The concept of planning is highly dependent on top-down direction.
4	Building	2	Alignment of projects/portfolio is discussed but not expanded upon. Unclear project direction (i.e. charters) is not well described.
5	Operations	3	Good linkage to processes but not to ability to nimbly change to accommodate environmental changes.
6	Audit, Verification, Monitoring	4	Good linkage with "dashboards" to monitor compliance with strategic direction.
	FACTORS		
1	Transition to a Knowledge-Based Economy	3	Good focus on strategic direction to get the enterprise moving in a unified direction, but little to support "bottom-up" or inclusive initiatives.
2	The Relevance of Knowledge	3	There is a focus on knowledge, but only to support corporate management and ensure alignment (i.e. Performance Management Frameworks). It is not an inclusive treatment of knowledge to support better outcomes for all stakeholders.
3	The Relevance of IT	4	There is a recognition of IT as an enabler for the enterprise.
4	Continuous Innovation and Business Transformation	1	It is strategic and its continuous renewal is implicit but not explicit. In practice the "tidy" alignment stultifies innovation. Business transformation is not really addressed.
5	Leadership Versus Management	3	It is a management-oriented methodology, but the work infers top-down traditional leadership. It is heavily management oriented.
6	Scientific Versus Creativity Approaches	1	The body of work is overwhelmingly scientific and analytical. It is a good management methodology to keep the enterprise running efficiently.

4.4. Methodology Area 3 - Business Design

The need for continuous innovation (as typified by the S-Curve (Nunes and Breene 2011, p. 4)) and the awareness of almost continuous business transformation (Kotter 1990, 1996, 2008, 2010, 2014) has led to alternative leadership and management models. Kotter's work recognizes that is not just enough to give strategic direction but also to inculcate it within the enterprise despite petty politics (Kotter 2010).

Collins (2001, 2002, 2011), conducted several exhaustive research studies on why companies succeed and has come up with concepts such as the "hedgehog" where companies focus on doing what they are best and passionate about as well as the concept of Level 5 Leadership that focuses on getting the right people on board and then worrying about transformation (Collins 2001). The concept of a 20 Mile March (Collins and Hansen 2011, p. 85) talks about a flexible, strategically guided, but managed creative journey to the meet strategic objectives. In military parlance operational guidance rather than detailed direction, relying on other layers in the leadership hierarchy to contribute. Again, there is a notion of a hierarchy rather than a lattice.

A descriptive methodology that embodies many of the above concerns is that of "Business Design" (Martin 2009a, 2009b), which flexibly embodies many of the new as well as the old design theories with successful implementation in companies such as Proctor and Gamble (Lafley and Martin 2013). These concepts are illustrated in Figure 13.

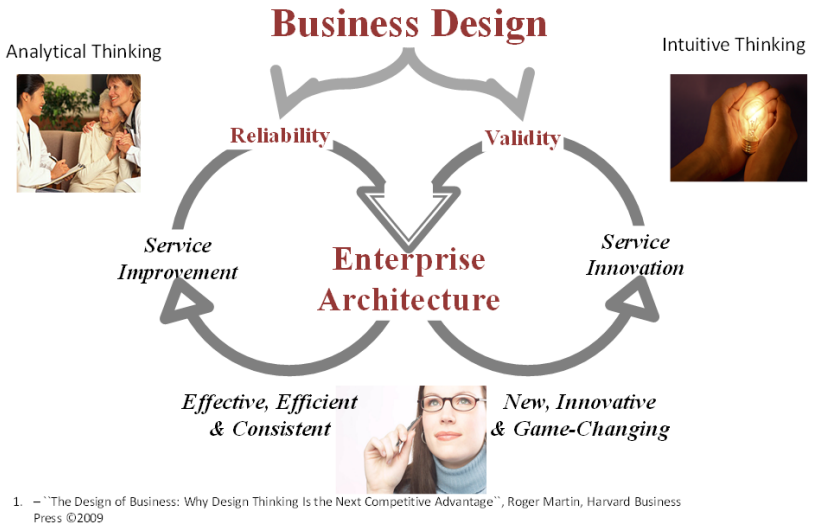


Figure 13 - - Business Design Thinking and New Enterprise Architecture (Based on Concepts from Martin (2009a, 2009b))

The Business Design concept is closely related to Enterprise Architecture but is more innovation oriented, combining the tensions inherent in most enterprises between analytical (e.g. Big Data) and intuitive thinking and the two associated camps mainly those who manage and keep the lights on (Reliability Thinkers) and those who are creative and always looking for the next big innovation (Validity Thinkers). The main difference between Business Design and Enterprise Architecture (discussed in the next section) is that EA is based on systems engineering theory and is focused on analytical thinking, making it a good management tool. Business Design embodies both creative leadership as well as management.

Business Design is integrative (as is EA) in nature, as illustrated in Figure 18, but relies on a de-centralized planning and execution model guided by well-defined contexts ("Whole Visualized While Working on the Different Parts"). The latter is very similar to the Zachman Information Systems / EA Framework (Zachman 1987) with his viewpoint of "Out of Context" where initiatives/projects are executed given the correct constraints and guidance. The difference is that in Out of Context the planner does not have to be familiar with the whole, just his/her aspect.

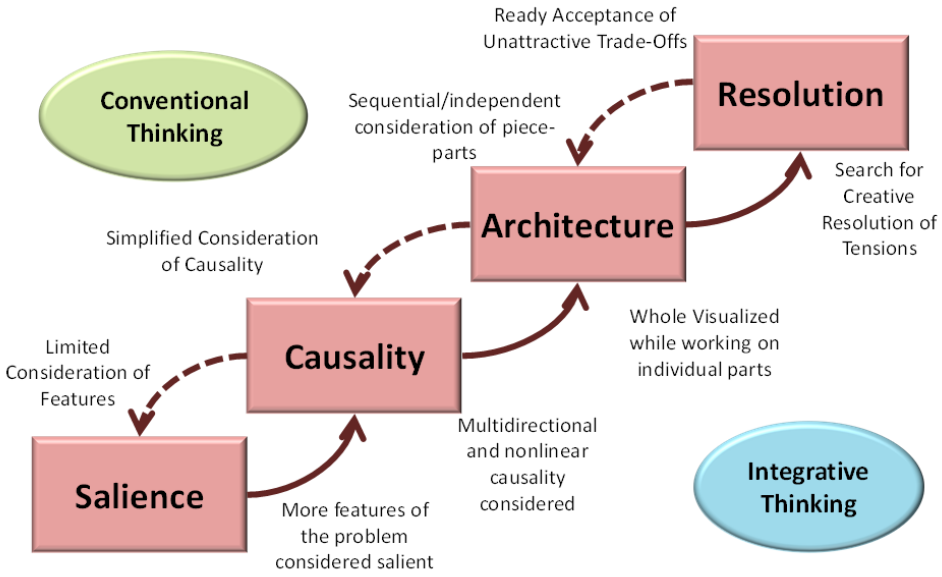


Figure 14 - Integrative Versus Conventional Thinking (Martin 2009)

The de-centralized nature of the Business Design is well-illustrated by the concepts of a "Community of Explorers" (Di Fiore 2013) where the competencies of the entire organization are mobilized to realize the strategic objectives of the organization. These concepts are illustrated in Figure 15.

Figure 15 - The Insight Driven Organization (Di Fiore 2013)

Another variant of the Business Design school of thought is that of the Strategy Canvas (Kim et al 2015) that look for innovative ways of competing in the marketplace, often based on a combination of analytical and intuitive reasoning. Figure 16 illustrates the use of the Strategy Canvas to chart the intuitive and innovative way ahead of the Cirque de Soleil, based on validity thinking and sparse data.

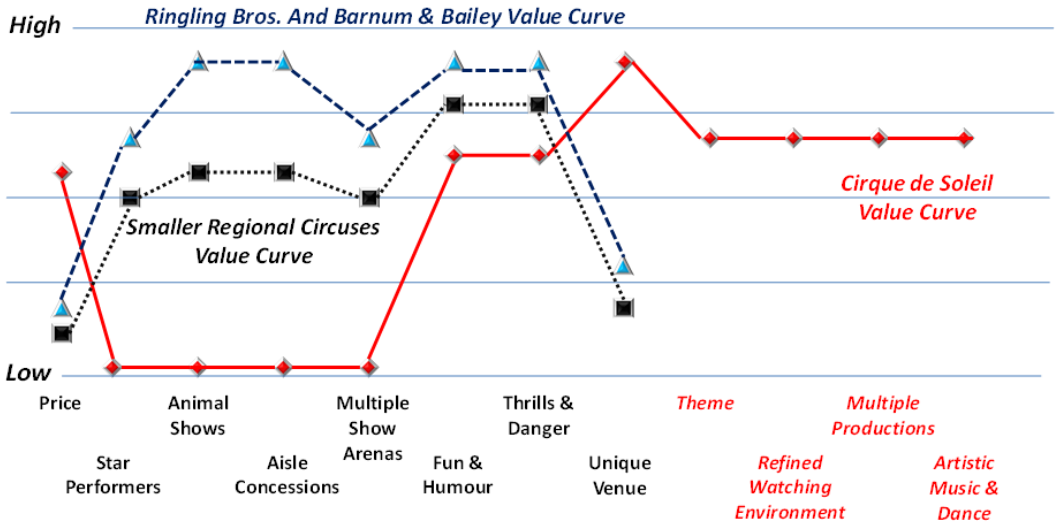


Figure 16 - Strategy Canvas – Cirque du Soleil (Kim 2015, p. 43)

The assessment of the Business Design related methodologies is contained in Table 5.

Table 6 - Assessment of Methodology Area 3 - Business Design

#	*Coverage / Feature*	*Score (/5)*	*Comments*
1	Governance	3	The nature of governance is not explicitly addressed, but the emphasis is on leadership and management.
2	Management	3	Management is discussed (not in structured detail) but sufficiently to draw conclusions).
3	Planning	3	Planning is discussed descriptively.
4	Building	2	The concepts of projects and portfolios is not explicitly assessed.
5	Operations	2	The concepts of operations is not explicitly assessed.
6	Audit, Verification, Monitoring	2	The concepts of audit, verification and monitoring are not explicitly assessed.
	FACTORS		
1	Transition to a Knowledge-Based Economy	5	Excellent description of what is required.
2	The Relevance of Knowledge	3	Alluded to but not explicit.
3	The Relevance of IT	3	Acknowledged as a key enabler, but not dwelt upon
4	Continuous Innovation and Business Transformation	4	Entirely based on continuous innovation. Business Transformation is described but not in any great detail.
5	Leadership Versus Management	5	Clearly describes the differences
6	Scientific Versus Creativity Approaches	5	Based upon the integration of both approaches within an enterprise.

4.5. Methodology Area 4 - Enterprise Architecture / Business Re-Engineering / Urbanisme

Enterprise Architecture initially started in the late 1980s as the Zachman Information Systems Framework (Zachman 1987) which was a simplified but scalable framework for an architecture description. The framework was re-named the Enterprise Architecture Framework and Steven Spewak took the EA Framework and included the concepts of baseline, target and implementation plan and called the framework EA Planning (Spewak 1992). John Zachman and Steven Spewak consulted for the US Government and helped develop the initial versions of the US Federal Enterprise Architecture Framework. Concurrently DoD further developed their Enterprise Architecture but called it the Technical Architecture for Information Management (TAFIM). In the 1990s the EAs at this time were firmly embedded within the IT organization which was normally subordinated to the CFO (until the 1996 Clinger-Cohen legislation).

A preliminary analysis, based on the preliminary research, reveals the linkages between the EA frameworks and explains the similarities.

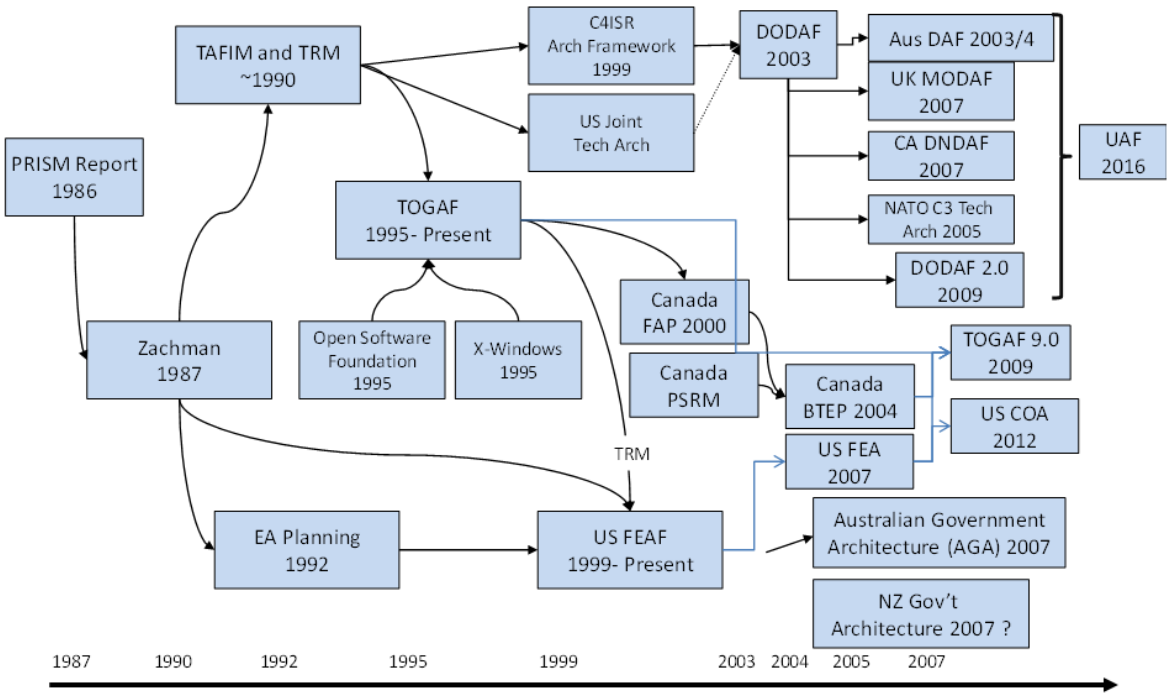


Figure 17 - Analysis of EA Linkages (Up to 1 Jan 2016)

As of the time of writing, EA is overwhelmingly still considered a CIO function and those conducting EA are often technically oriented with limited background in non-technical domains (e.g. business architecture). This is not surprising given the roots of EA in IT and the US Government IT Reform Act (1996) creating CIOs and making EA compulsory.

Coverage of the EA Frameworks has evolved. Initially the PRISM report (PRISM 1986) tried to solve the growing number of IT project failures by providing a consistent basis for architecture decision making. PRISM was a consortium of some 50 companies in the United States that together wrote a report entitled "Dispersion and Interconnection: Approaches to Distributed Systems Architecture" (PRISM 1986). They described four architecture domains (Infrastructure, Data, Application and Organization) and four types of architecture namely:

a. Principles upon which the architecture is based;

b. Inventory, a simple structured listing of architectural elements;

c. Models of the desired architecture state; and

d. Standards for selecting and using architectural elements.

PRISM 1986 indicated that the domains and the architecture types were related in a matrix as shown in Figure 18.

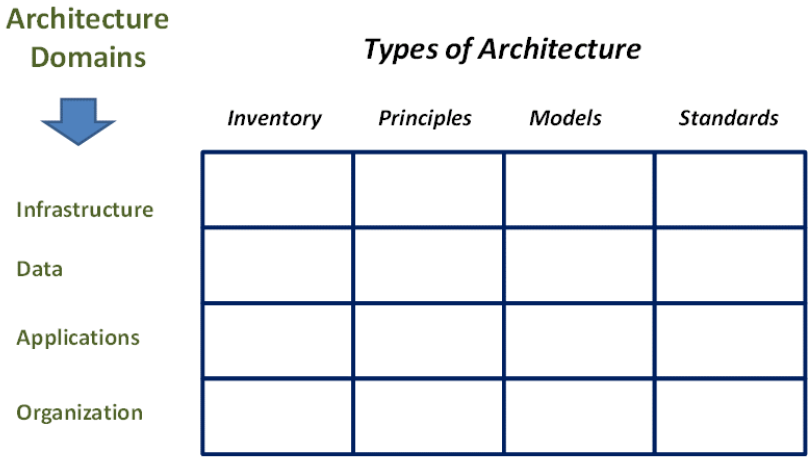


Figure 18 - PRISM Architecture Matrix (PRISM 1986, p. 5)

John Zachman (1987), who was ex-US Navy and working for IBM, expanded on the PRISM framework by including the levels of abstraction and expanding on the architecture types by using the journalistic interrogatives (Zachman 2011) What (Data), How, Where, Who,

When and Why). The 1987 framework was called an "Information Systems Framework" and contained only What, How, and Where. This was the basis for Spewak 1992 in his book "Enterprise Architecture Planning" using the domains Business, Data, Applications and Technology. The generation of the original architecture domains is illustrated in Figure 19. Zachman also addressed (in Zachman 2011) by what were termed Audience Perspectives (Planner, Owner, Designer, Builder, Sub-contractor and Functioning Enterprise). These were modified in Zachman 2011 to Executive, Business Management, Architect, Engineer, Technician, and Users). These perspectives were paired with what could be called levels of abstraction, namely Conceptual (high level overview), Logical (Implementation Independent), Physical (Implementation Dependent) and Physical Out of Context (Project/Builder View). These views were tied to the approval and acquisition process and form a valuable contribution to the field of EA.

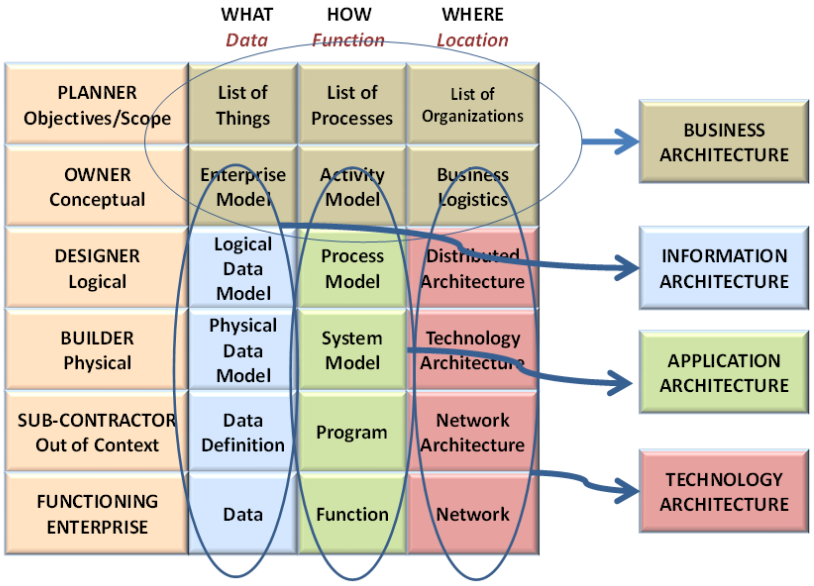


Figure 19 - Based on Zachman (1987) Framework Showing Derivation of Original Architecture Domains

The contribution of Steven Spewak (1992, 2003) was that he made architecture dynamic adding the idea of managing the architecture as a project, a baseline and target architecture and a plan to go from one state to the other. This changed the EA framework from a static description to an implementation framework. Spewak's basic model is illustrated in Figure 20.

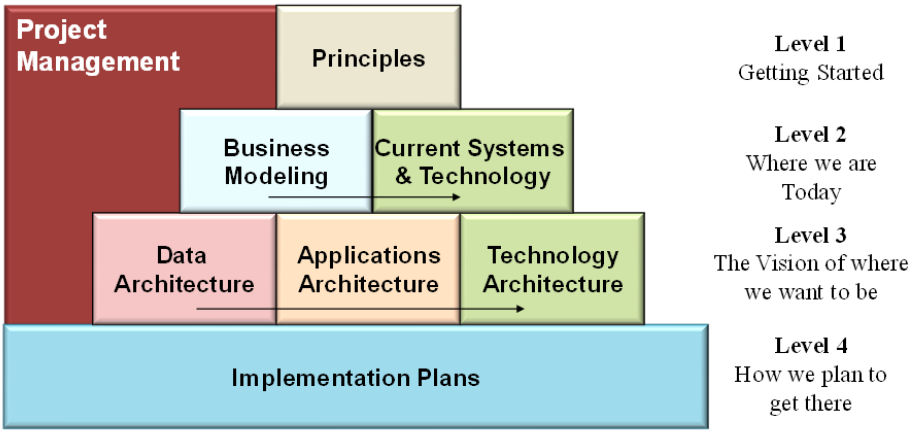


Figure 20 - Planning EA Implementation - Spewak 1992

The Zachman Information Systems Architecture continued to evolve and, as described in Sowa and Zachman (Sowa et al 1992) the framework was extended to include Who (People), When (Time) and Why (Motivation). The framework was also renamed The Enterprise Ontology (Zachman 2011) as explained in Figure 21.

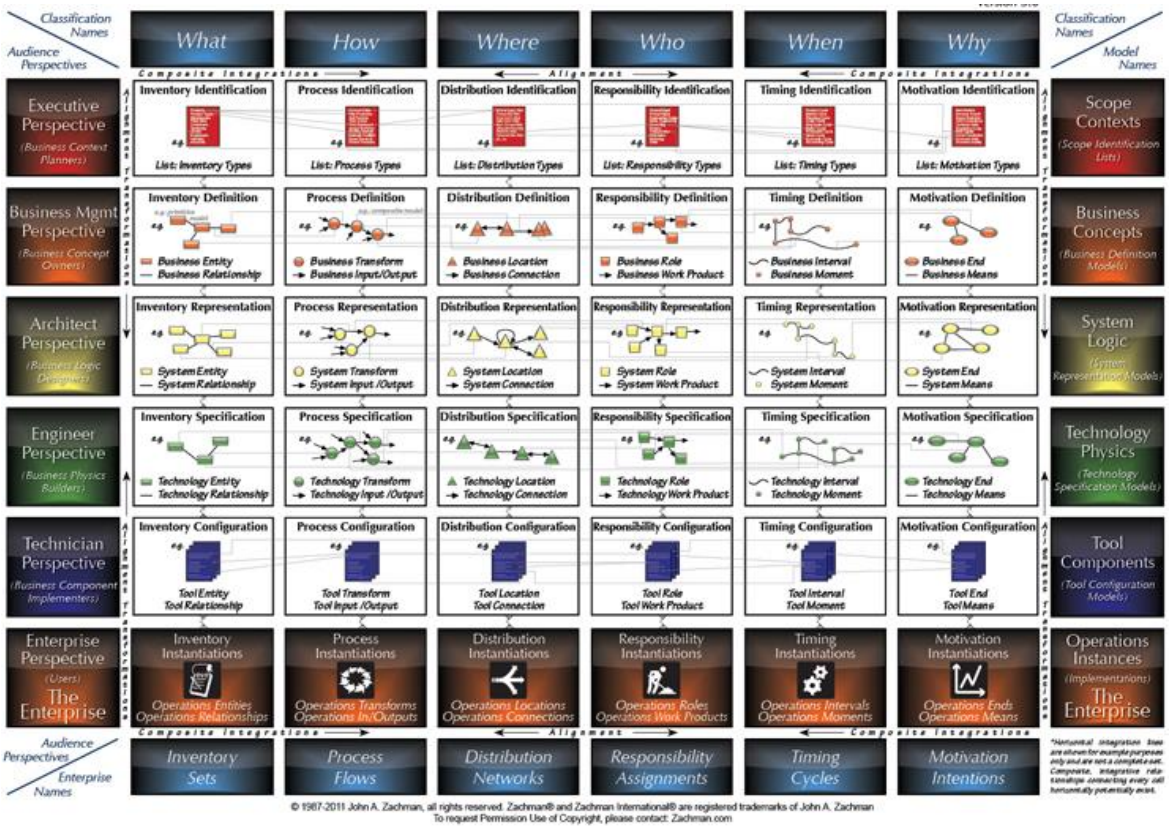


Figure 21 - The Enterprise Ontology (Zachman 2011)

Overall the Zachman Framework for EA has changed into an ontology and there have been changes to the nomenclature for both the audience perspective and levels of abstraction that has led to challenges and will be further addressed in Chapter 9.

As will be discussed in 4.5.4-TOGAF, some of the key EA methodologies are still based on the 1987 (Zachman 1987) architecture domains when the framework was intended to be a framework for information systems architecture, not EA.

4.5.1 Defence/Defense Architecture Frameworks

The defence architecture frameworks are closely related (as described in Figure 21) and can readily share models and information.

The major defence architecture frameworks are the US DOD Architecture Framework (US DoD 2009) and the UK Ministry of Defence MODAF (UK MOD dated 2010) upon which are based other frameworks used in NATO, Canada and Australia. The DODAF, MODAF, Canadian (GC DND 2011) and Australian have been able to share information through the Integrated Defence Enterprise Architecture Specification (IDEAS) upon which is based the UML Profile for DOAF and MODAF (UPDM) (OMG 2007) which allows EA information to be shared. As the Defence EAs have been enhanced with more domains (or architecture viewpoints) upon which the US Government has incorporated into the Common Approach to Federal Enterprise Architecture (US 2012) the current direction at time of writing is to enhance the UPDM to form the basis for the Unified Architecture Framework, which is a prescriptive, implementation oriented framework currently being published by the Object Management Group (OMG).

The challenges to date with the implementation of the defence frameworks is best summed up by the following assessment, “While we have made progress in system and data interoperability, we still lack a common joint ISR [intelligence, surveillance and reconnaissance] architecture that allows data to be moved from all domains and across multiple platforms and sensors rapidly, efficiently, and effectively. Proprietary systems, networks, formats, and protocols impede integration and interoperability when fielding sensors, processing capabilities, analytic tools, and storage systems. The development of ISR Joint Force 2020, in con-

junction with our emerging Mission Partner Engagement framework, will enable unprecedented access to common mission networks for operational planning and execution with U.S., Coalition, allied, and other mission partners." (US DoD 2014, p. 4)

4.5.2 GERAM (Generalised Enterprise Reference Architecture and Methodology)

"GERAM, ..., defines a tool-kit of concepts for designing and maintaining enterprises for their entire life-history and ... is meant to organise existing enterprise integration knowledge ... with potential for application to all types of enterprise. Previously published reference architectures can keep their own identity, while identifying through GERAM their overlaps and complementing benefits compared to others." (IFIP 1999, p. 4). "GERAM is intended to facilitate the unification of methods of several disciplines used in the change process, such as methods of industrial engineering, management science, control engineering, communication and information technology, i.e. to allow their combined use, as opposed to segregated application." (IFIP 1999, p. 4)

This framework (IFIP 1999) comes from the industrial / systems engineering world and offers first a vocabulary for enterprise reference architectures and then provides a holistic view of the enterprise through the classification of assets as "entities" that must be managed through their lifecycle. Figure 22 illustrates the very useful common vocabulary that assists in classifying the various frameworks.

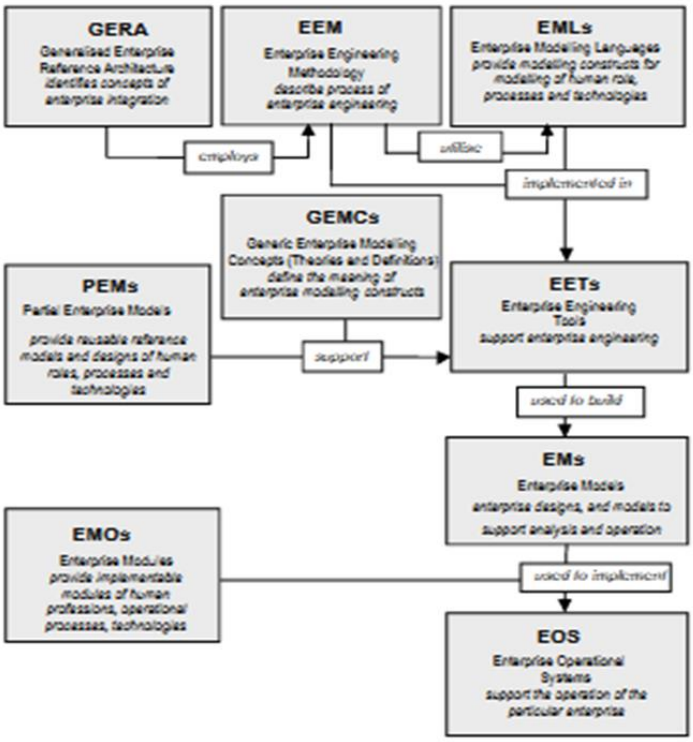


Figure 22 - GERAM Framework Components (IFIP 1999 Page 5)

The classification by entity introduces non-physical assets such as Strategic Management, Engineering Information, Methodology and enterprise entities, addressing items such as business direction, information/data and business processes that are key for the knowledge-based enterprise. Figure 23 illustrates the classification of the various entity types, their relationships and their lifecycle.

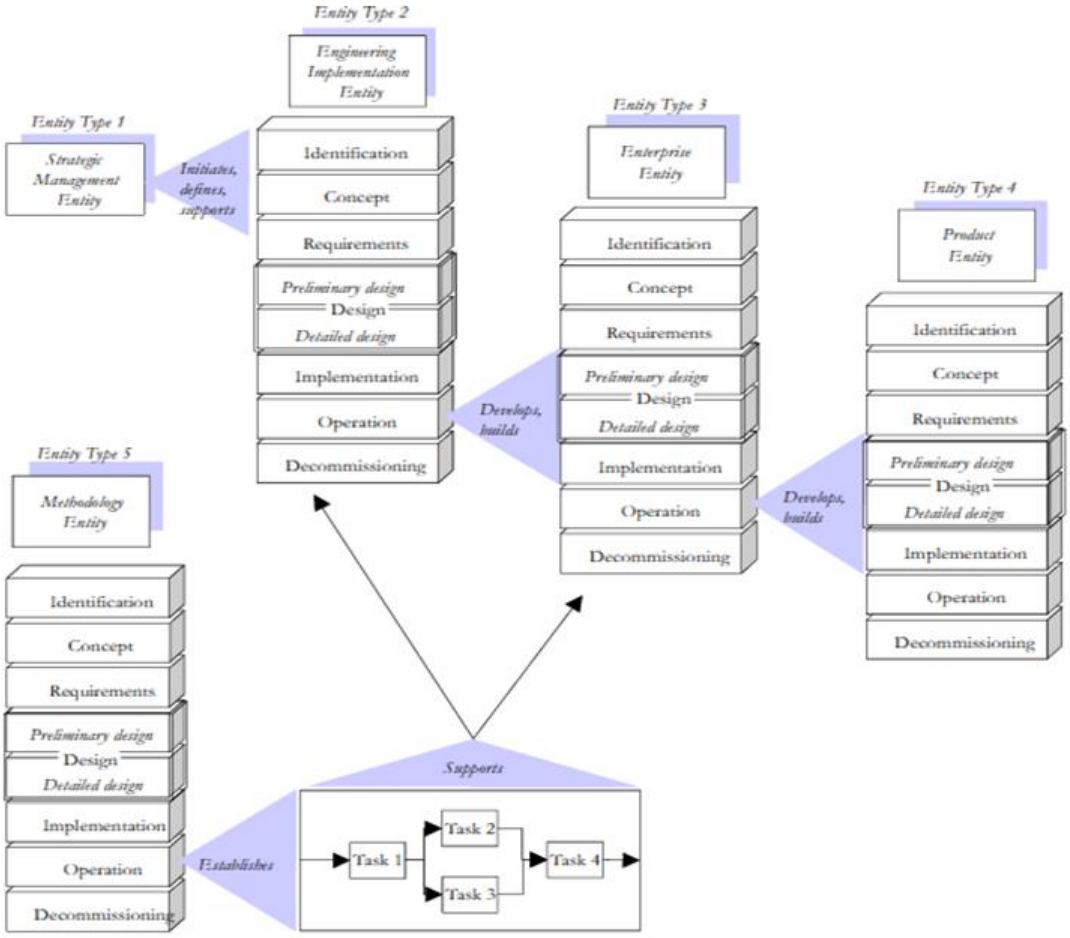


Figure 23 - Relationships between lifecycles of GERA entity Types (IFIP 1999 Page 15)

Each entity is further considered with respect to its genericity specifically classifying views of the entity as Generic, Partial and Particular. This classification lays the basis for re-use and potentially shared services. It also highlights entities that are unique to the enterprise and are core to competitive advantage.

From a business perspective, the model emphasizes the need to manage each entity (whether abstract or physical) throughout its lifecycle (as illustrated in Figure 24) ensuring that the Total Cost of Ownership (TCO) is budgeted for. Challenges arise in current industry practices when the abstract entities are not clearly identified and managed, leading to enterprise direction not being followed up (i.e. measured and validated), methodologies remaining tacit (not documented), and information not managed leading to poor information quality for decision making.

The framework is a generic, integrative outline that can form the basis for any well-managed enterprise architecture, but it has no associated methodology nor a set of associated best practices.

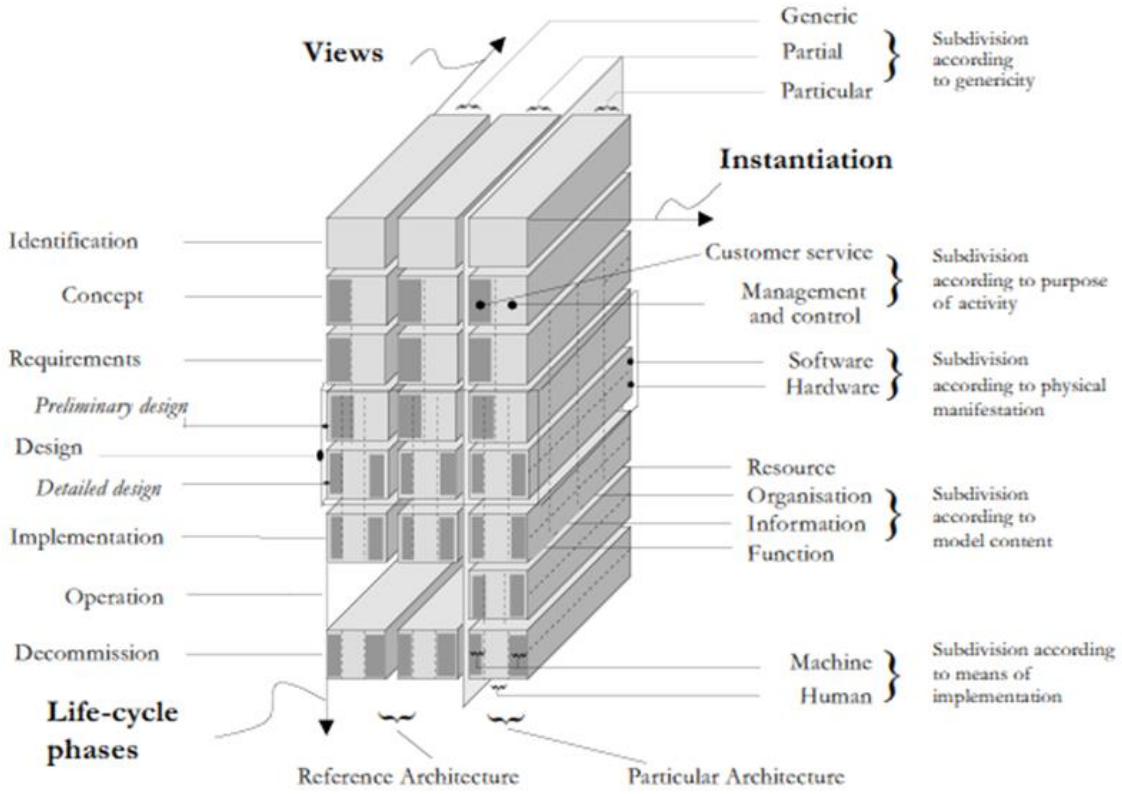


Figure 24 - GERA Modelling Framework with Modelling Views (IFIP 1999)

4.5.3 US Government

The US Government has been a pioneer in the use of Enterprise Architectures, but started in the field of information technology. The landmark legislation, Information Technology Reform Act of 1996 (US Government 1996) (a.k.a. Clinger-Cohen Act) , established the position of Chief Information Officer (CIO) and defined architecture as, "information technology architecture ... means an integrated framework for evolving or maintaining existing information technology and acquiring information technology to achieve the agency's strategic goals and information resource management goals." (US Government 1996 Section 5125 (d)).

4.5.4 TOGAF

The Open Group Architecture Framework (TOGAF) has evolved over time since its beginning when it was donated by US DoD to the newly formed Open Group (Merger of the X-windows Foundation and the Open Software Foundation) in 1992. It was initially focused on creating better IT architectures but with release TOGAF 8.1 it expanded more into the Enterprise sphere. In 2009 with the release of TOGAF 9, it became a full-fledged EA Methodology and with a technical upgrade in 2011 TOGAF 9.1 became by far the most extensive EA Methodology used globally. It has been improved with the issue of TOGAF 9.2 in 2018 (The Open Group 2018). Its modular structure allowed users to use as much or as little of it as they needed to fulfill their needs. TOGAF 9.2 is also designed to complement other existing methodologies and is often used in conjunction with other formalisms (e.g. DODAF).

The standard has been modularized to facilitate its use and navigation as illustrated in Figure 25, but much of the actual standard has been de-centralized into a set of TOGAF Guides addressing some of the modules originally in TOGAF 9 (The Open Group 2009).

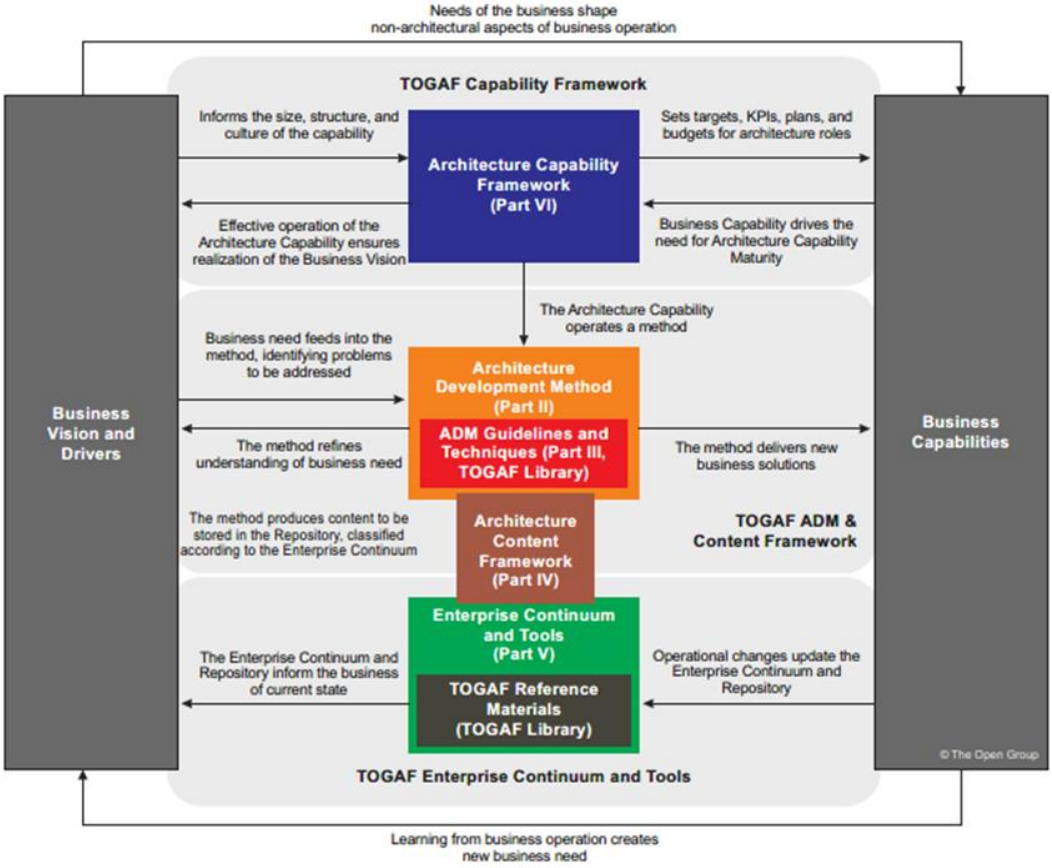


Figure 25 - TOGAF 9.2 Modular Structure (Open Group 2018 p. 4)

For its part many parts of the TOGAF specification require serious revision and are still solidly focused on CIO/IT stakeholders. The contents lack coherence (often the case with a standard which is a collaborative effort) and its' requirement to be generic and cross-industry domain makes the offering too general. What is often overlooked is that the TOGAF specification is amid a rich Open Group eco-system of Books, Guides, and White Papers that address many if not most of the specific issues not covered in the generic main specification.

At the heart of the framework is the Architecture Development Method (ADM) as illustrated in Figure 26, which has not changed since TOGAF 8.1.1 (The Open Group 2006). It is noted for the business-driven approach and getting a vision together and approved before going into detail. It has three main domains (business, information systems and technology), which shows its IT roots. The US Common Approach to Architecture (US Government 2012) has more than ten domains as it is coping end to end with all enterprise variables. TOGAF 9 also incorporates capability-based planning (as in the defence architectures such as US DOD 2009) that guides users to consider all problem space dimensions in the architecture, rather than just the technological innovations. The centrality of Requirements Management is key as architecture can be considered a well-formed set of requirements. The standard is still IT focused but is still evolving and is used globally.

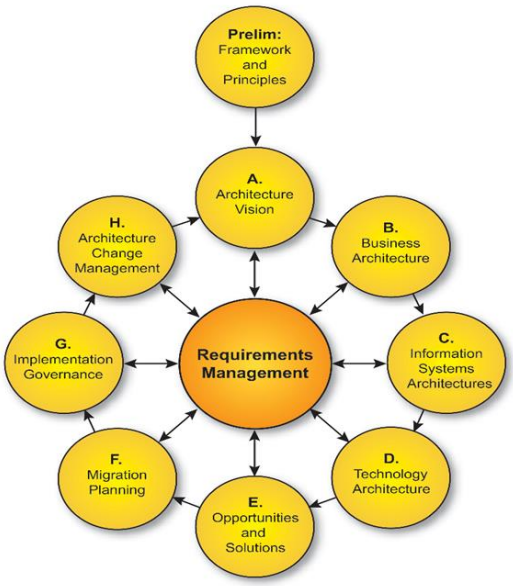


Figure 26 - TOGAF 9.2 - Architecture Development Method (The Open Group 2018 p. 40)

4.5.5 Unified Architecture Framework (UAF) and NATO Architecture Frameworks (NAF)

The UAF (OMG 2017) originated as a joint NATO-UK Government effort to create a NATO Architecture Framework (NAF) based on the existing NAF and the UK Ministry of Defence Architecture Framework (MODAF). The UAF is a generic version of the NAF sponsored by the Object Management Group (OMG). As shown in Figure 27, the UAF is comprehensive and has been conceived to accommodate, "views that can capture human machine interface and human factors concerns, security analysis and systems-of-systems lifecycle concepts." (OMG 2017)

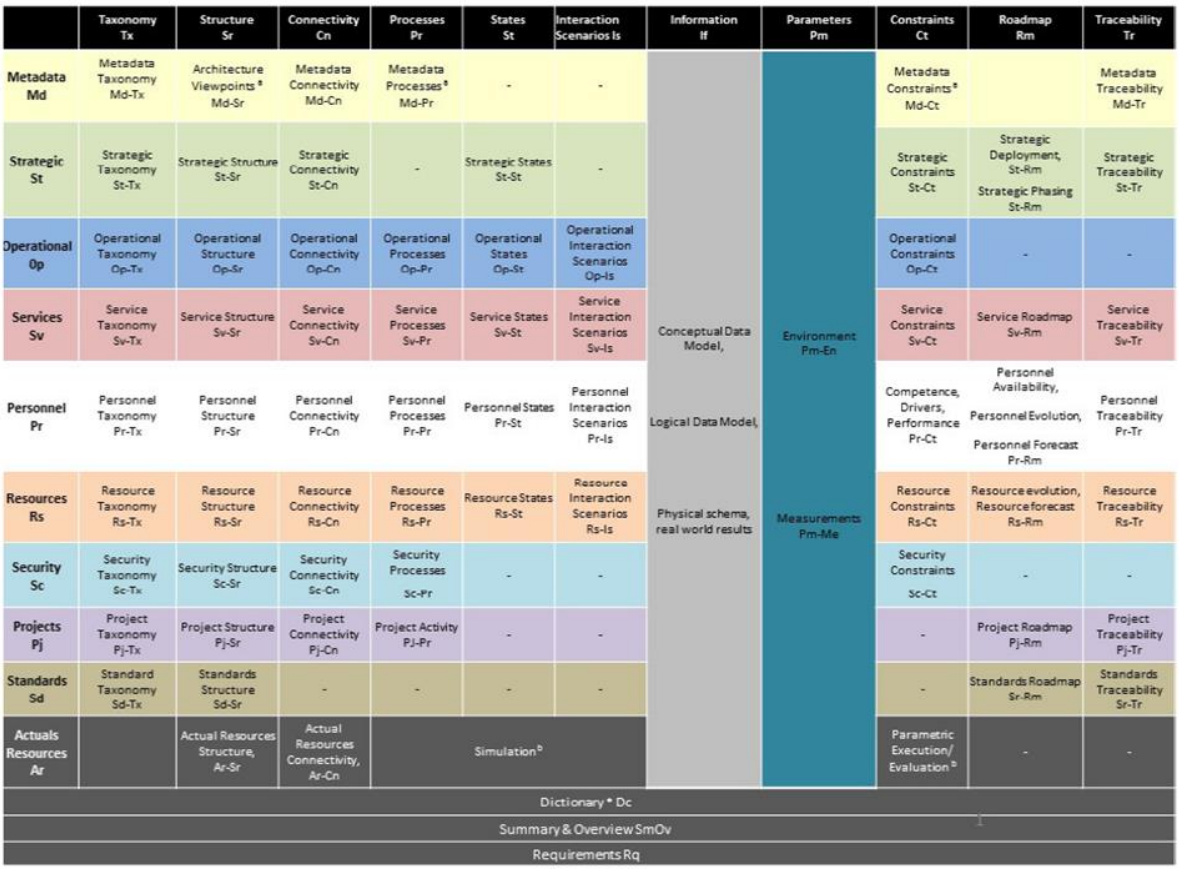


Figure 27 - Unified Architecture Framework (OMG 2017)

The NATO Architecture Framework Version 4 (NATO 2018) addresses multiple business models (Ross 2006), namely a diversified multi-national one (at several levels of diversity) and an internal one that is unified. It is a complex environment relying on IT for interop-

erability. In addition to using elements of the UAF (Figure 27) it effectively integrates enterprise and system architecture methodologies using a foundation for architecting as illustrated in Figure 28.

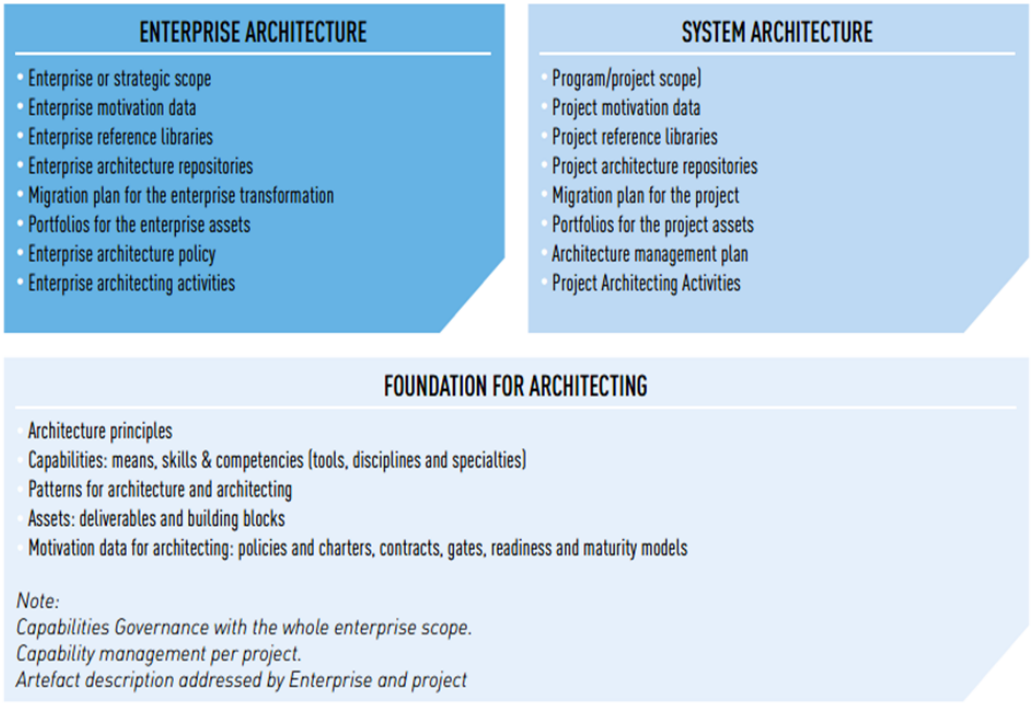


Figure 28 - NATO Arch Framework V4 Three Main Methodological Area - (NATO 2018 p. 23)

The NAF also tiers its architectures to address different time spans, capabilities and levels of detail. It also closely aligns projects with the lower level of the architectures as shown in Figure 29. The author adapted an earlier version of the NAF to include into the TOGAF 9.0 standard (The Open Group 2009 p.59) called progressive architecture development.

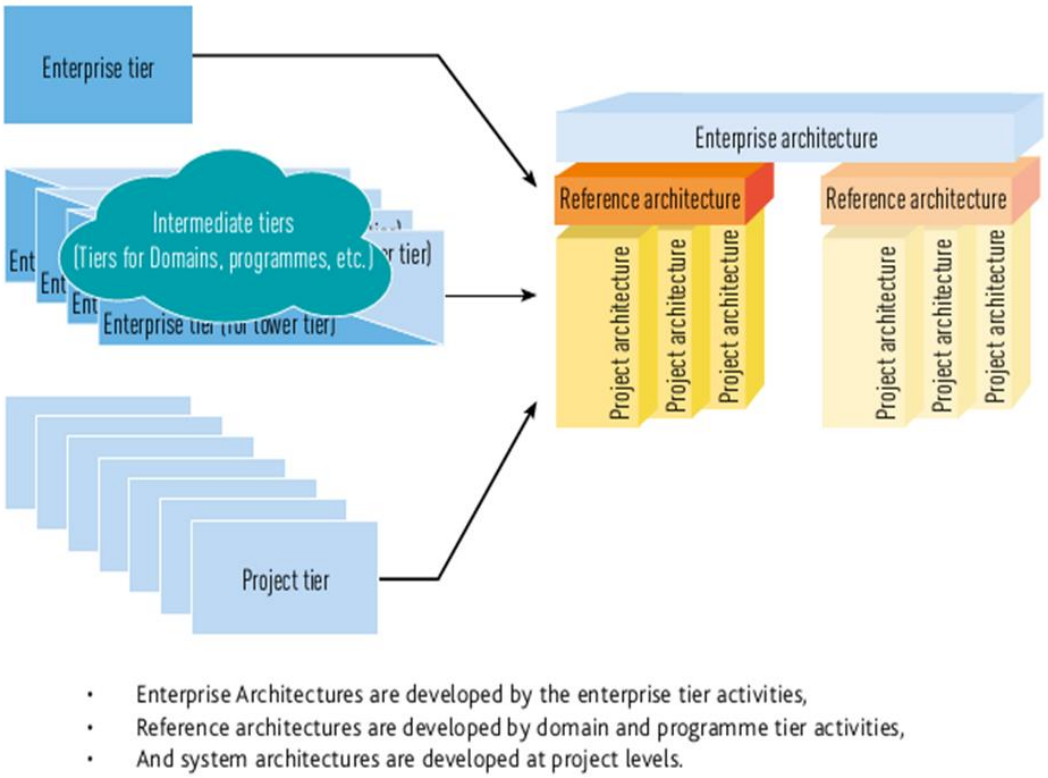


Figure 29 - NATO Multi-Tier Architecture (NATO 2018 p. 30)

4.5.6 Agile Methodologies – Scaled Agile Framework®

SAFe has grown with the marketplace to describe new and better ways of developing software and systems. SAFe has evolved since 2011 to address lean product development to agile to DEVOPS (i.e. lifecycle maintain what you develop) to system thinking. Looking at the overall framework, as described in Figure 30, EA is seen to be at the enterprise level working at the portfolio level. The framework is owned by Scaled Architecture and its main business focus was software development and delivering value. (https://www.scaledagile.com/about/about-us/). It is a rapidly evolving framework with much of its own jargon and worldview (software) and embraces iterative, incremental development and the use of scenarios and epics to get the business requirements right. SAFe does not yet address the other features of EA, there is little documented on information or data, and the challenge is that much software is bought rather than developed, forcing the choice of adopting the embedded processes and data structures or modifying them. Given the failure rate of digital

transformation (Forrestor 2018), the softness of enterprise requirements and the high dependence on software, it is predicted that the SAFe will venture into the EA space (just like TOGAF did going from version 7 to 8.1), but it is not there right now.

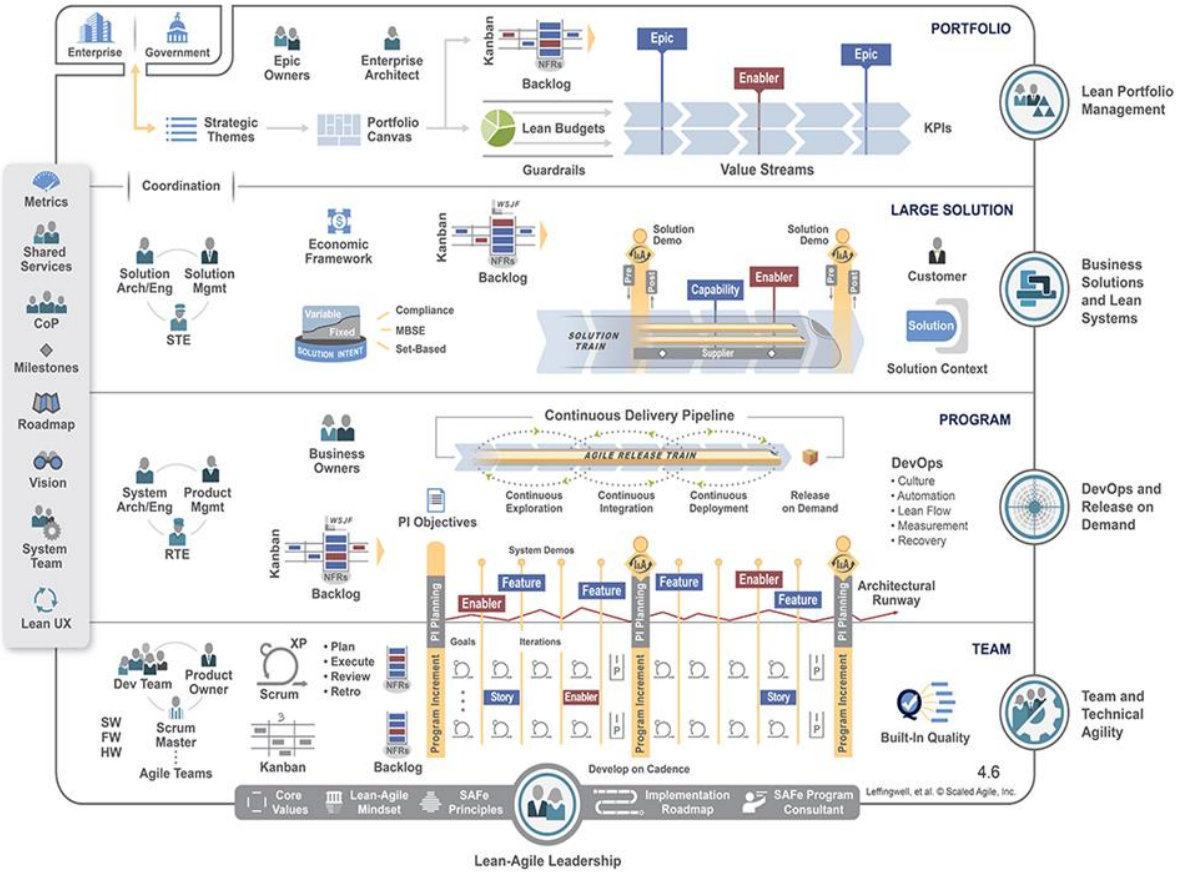


Figure 30 - Scaled Architecture Framework (Leffingwell 2019)

4.5.7 Architecture Modeling - ArchiMate

ArchiMate is another Open Group offering that allows users to create enterprise architectures. ArchiMate 1.0 supported architecture modeling at the logical level for the Business, Data, Applications and Technology domains (Phases B, C and D in TOGAF). Version 2.1 has incorporated Motivation and Implementation & Migration extensions that allow it to be used to model the entire TOGAF.

ArchiMate has a three-layer model with Business, Applications and Technology layers. It also has notions of the following concepts (From the ArchiMate 3.0 specification The Open Group 2016):

a. Motivation Aspect represents the elements that drive the architecture, including concepts such as stakeholders, and so on. These motivation elements *"provides the context of or reason behind the architecture of an enterprise."* (The Open Group 2016 p.18).
b. Active Structure Aspect represents the structural concepts (the business actors, application components, and devices that display actual behavior; i.e., the "subjects" of activity).
c. Behavior Aspect represents the behavior (processes, functions, events, and services) performed by the actors. Behavioral concepts are assigned to structural concepts, to show who or what displays the behavior.
d. Passive Structure Aspect represents the objects on which behavior is performed. These are usually information objects in the business layer and data objects in the application layer, but they may also be used to represent physical objects.

ArchiMate is a powerful modeling language with a solid meta-model but there are concepts that must be managed as follows:

a. For one "business objects" and "data entities" are passive structures that do not display behaviour, which is contrary to object-orientation. The data is not encapsulated, and all manner of active objects can access the data to effect various operations. This will invariably lead to data corruption and poor-quality information.
b. ArchiMate is also based on the UML 2.0 notation which hinders its presentation value and the most objects are difficult to discern. It is a complex language with suggested meta-model relationships, but users can use as much or as little as they want.
c. The rich but numerous concepts in the language has added an additional layer of complexity.
d. There are notions, such as architecture plateaus, that are not used outside of ArchiMate and could cause semantic confusion.
e. There is no consistent use of colour for the ArchiMate objects leading to confusion when reading other architects' work.

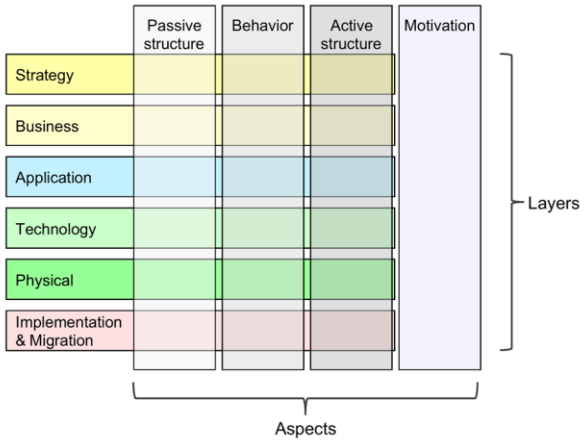


Figure 31 - Archimate 3.0 - Full Framework

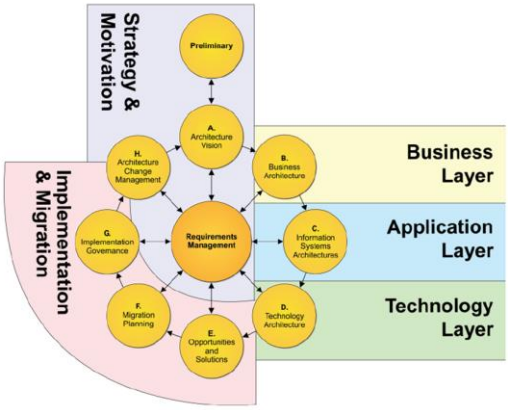


Figure 32 - Correlation Between TOGAF and the ArchiMate Spec 3.0 Dated 2016

Regardless, ArchiMate is being used globally and has been implemented in several major EA Tools (e.g. IBM System Architect, Avolution, Bizz-Design) and The Open Group has certified individuals globally. It is really the only architecture language available, and its use requires skill to handle and read the architecture work products. Most users will only use a subset of the functionality available. Table 7 illustrates the assessment of EA related methodologies.

Table 7 - Assessment of Methodology Area 4 - Enterprise Architecture

#	*Coverage / Feature*	*Score 0-5*	*Comments*
1	Governance	**3**	Governance is addressed from an architecture perspective in the methodologies, but they are predominantly IT in nature and often focus on the CIO area of responsibility, rather than the entire enterprise. EA is generally used at a program level and is considered an IT rather than enterprise resource (despite guidelines in the US COA (2012). More recent frameworks (e.g. NAF (NATO 2018) , UAF (OMG 2017), Archimate (The Open Group 2016) and TOGAF 9.2 (The Open Group 2018)) have much better coverage of governance related elements and COBIT 2019 (ISACA 2018b p. 21) includes EA as a key Management Objective (APO 3)
2	Management	**4**	For project completion, EA models are useful for management, especially the use of architecture contracts to ensure that project deliverables fit into a higher context.
3	Planning	**4**	Architecture-based planning integrates business and IT planning functions to a large degree. EA in many cases (e.g. DODAF Joint Capability) is used as a rigorous planning tool to ensure complex defence endeavours are integrated and succeed.
4	Building	**3**	The current use of EA does not provide a great deal of support to individual projects and often the EA artefacts must be created by the project, rather than being given to solution architects to bound the problem space and thereby expedite building and delivery. There is little support in EA methodologies for work at the program and portfolio level.
5	Operations	**1**	EA methodologies do not provide direct support to operations, except for the provision of well-documented and modelled deliverables that facilitate service transition and maintenance.
6	Audit, Verification, Monitoring	**3**	EA provides models and guidance for audit, but the audit viewpoint has not been considered. Action research with audit (Canadian Government) has revealed that EA provides little in the way of support as currently set up. Having said that, much of EA data is relevant and, if marshalled into viewpoints, would provide support to conventional and especially "continuous audit". The US COA (2012) have a Performance domain that could be used for audit.
	FACTORS		
1	Transition to a Knowledge-Based Economy	2	EA is really a system engineering approach that is focused on making a vision work rather than generating a vision. Its creativity lies in its ability to integrate the components of a complex environment, rather than focusing on innovation and business value.
2	The Relevance of Knowledge	2	The EA frameworks are focused on information exchange between various segments rather than treating semantics as enterprise standards. None of the surveyed EA frameworks deal with knowledge representation or analytics in any meaningful way.
3	The Relevance of IT	4	EA frameworks are IT centric, but there is still a horrific software project failure rate (Guillaume-Joseph 2015) of 61% or higher for IT projects overall [81%] (Personal 2016) despite EA being mandatory. It is a contradictory finding, leading to the conclusions that the EAs are not used or followed.
4	Continuous Innovation and Business Transformation	3	EA development methodologies are cyclic meaning that they are reviewed, verified and validated on a continuous cycle that is often aligned with investment planning (e.g. fiscal year). They provide a future view of the enterprise that is more granular than the strategic plans to enable personnel to get ready for transformation. EA is more of an engineering tool, but the integration of capability-based planning
5	Leadership Versus Management	2	EA is more of a management technique than a leadership one as currently used. Most EA cells are in the CIO departments and their role is to document in an IT centric manner rather than simulate potential future realties. This is evolving.
6	Scientific Versus Creativity Approaches	1	EA is overwhelmingly scientific and is based upon quantitative measures, often to the detriment of qualitative requirements. This contributes to project failure.

4.6. Methodology Area 5 - Planning - Information / Data / Knowledge Management

Having the right information in the right place at the right time has driven the creation of many systems (manual and now automated) since Egyptian times when the first military organizations were created.

The military has always been flooded with data and information and "sense-making" is a major concern (author is a trained military staff officer specializing in plans and operations). This challenge is well-described by Field Marshall Montgomery as follows: "A commander has got to be a very clear thinker: able to sort out the essentials from the mass of lesser factors which bear on every problem. Once he has grasped the essentials of a problem which faces him, he must never lose sight of them - he must never allow a mass of detail to submerge what is essential to success" (Montgomery 1968).

The overall conclusion from research is that the field is siloed with library scientists, web aficionados, Big Data scientists/mathematicians and computer scientists working in isolation. The process of "datafication" (previously explained) has led to a need for these communities to come together to look at data holistically to drive systems development in a coherent manner. The key documents examined were:

a. The Data Management Body of Knowledge (DAMA 2009);
b. The Data Management Maturity Model (CMMI 2014);
c. Knowledge Management in Theory and Practice (Dalkir 2011, 2017);
d. Information Engineering approaches (Finkelstein 1989, 1992, 2006); and
e. Fundamental military command and control literature such as Alberts et al 1999, Van Creveld 1985 and Treverton 2009.

4.6.1 Data Management Body of Knowledge (DMBOK)

The DMBOK (2009) and its accompanying glossary (DAMA 2011) essentially defines and covers the various aspects of data management in chapters that are written by different authors. The flow between the chapters is weak and it deals with different data types (e-docs and database essentially) differently and does not have a holistic view of data use. It pre-dates

Big Data, but the analytics portion is still good, but needs to be refreshed. Figure 33 describes the various areas covered by the DMBOK. The book is the first comprehensive practitioners guide to the various types of data encountered. Academically integrative literature such as Dalkir 2011, 2017 complements the DMBOK well. Major problem is academic learning with practitioners coming from all walks of life (mainly IT).

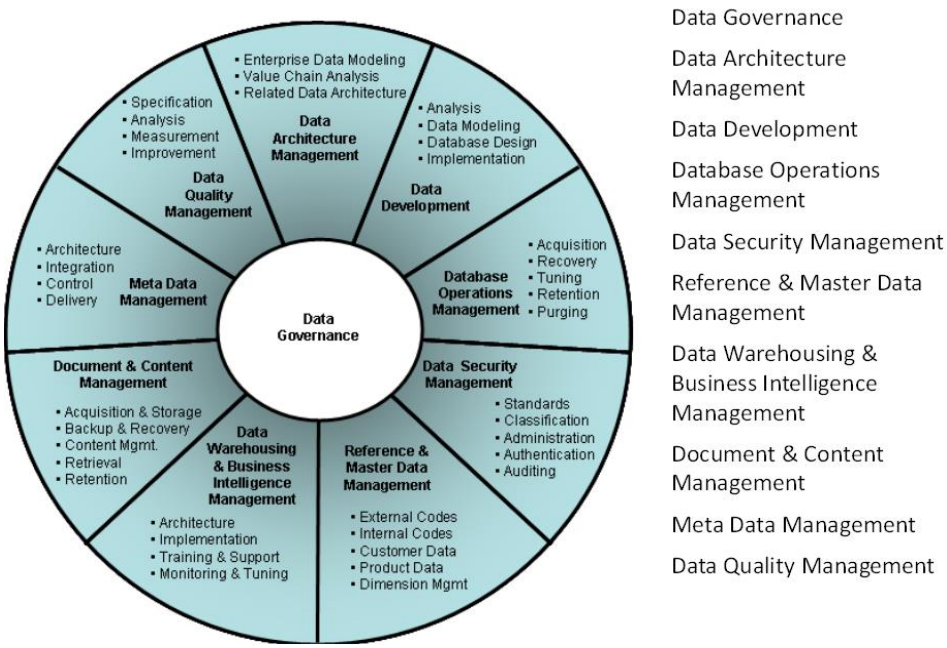


Figure 33 – Data Management Body of Knowledge (DMBOK V1) - Process Areas (DAMA 2011)

4.6.2 CMMI Data Management Maturity (DMM) Model

This model is from Carnegie Melon University/Software Engineering Institute/CMMI Institute (CMMI 2014) and covers the areas described in the Figure 32. Personal communication with Melanie Mecca, Program Director CMMI Institute (Mecca 2014, 2015) has indicated that the DMM was created with the help of DAMA President (Peter Aitken). To a certain extent the DMM can be regarded as a more rigorous and integrated update of the DMBOK (DAMA 2009). The areas covered are as described in Figure 34.

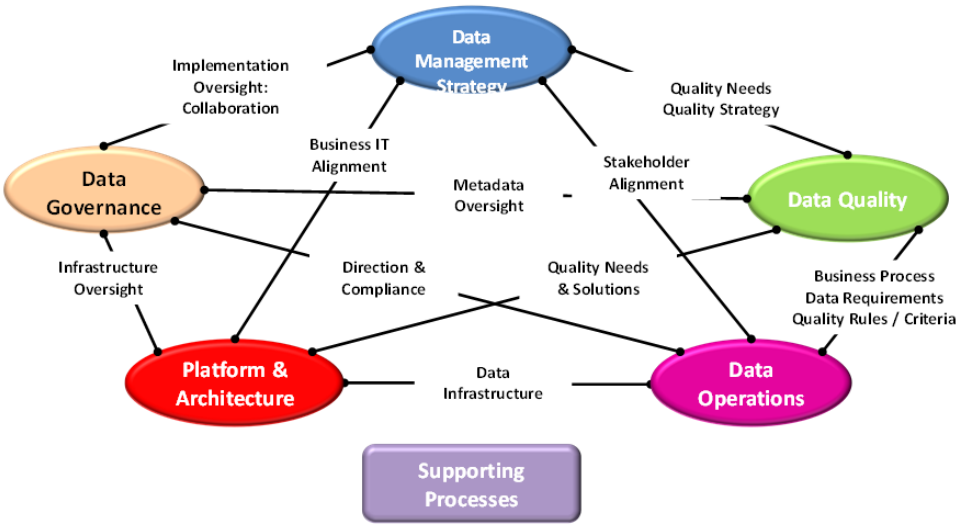


Figure 34 - CMMI Data Management Maturity Model V1.0 (CMMI 2014)

To illustrate the disconnect between core standards is displayed in Table 8 showing the areas covered by TOGAF (the leading EA Standard). The main weakness of the DMM is that it only addresses structured data and not the larger issues of "datafication" (Mayer-Schonburger et al 2013) discussed earlier and dealing with unstructured and semi-structured data.

Table 8 - CMMI DMM Model Process Areas and TOGAF 9.1 Comparison

Process Category	Process Area	TOGAF 9.1	Comments
Data Management Strategy	Data Management Strategy	X	
	Communications	X	
	Data Management Function		
	Business Case		
	Program Funding		
Data Management Strategy	Governance Management		
	Business Glossary		
	Meta-Data Management		
Data Quality	Data Quality Strategy		
	Data Profiling		
	Data Quality Assessment		
	Data Cleansing		
Data Operations	Data Requirements Definition		
	Data Lifecycle Management	X	
	Provider Management		
Platform & Architecture	Architectural Approach	X	
	Architectural Standards		
	Data Management Platform		
	Data Integration	X	
	Historical Data, Archiving & Retention		
Supporting Processes	Measurement and Analysis		
	Process Management		
	Process Quality Assurance		
	Risk Management	X	
	Configuration Management		

4.6.3 Knowledge Management

One of the challenges with knowledge management is that there are some one hundred published (and different) definitions of knowledge management (Dalkir 2017 p. 5) much due to the fact that there are so many professional communities involved with many claiming ownership of enterprise KM. For example, if the librarians, document managers, business intelligence staff, neural network creators, web content creators, database administrators and so on claim they are the enterprise knowledge managers, this creates confusion but is accurate as they all are. However, action research has confirmed that coordination amongst these communities is imperfect. Knowledge management is still immature.

4.6.4 Information Engineering Approaches

Finkelstein (1992, 2006), envisages creating enterprise architecture using an information centric approach as illustrated in Figure 35. Essentially the information subjects are identified along with their relationships and the processes are derived from the subjects (e.g.

manage “Licences”) and the relationships (e.g. Manage “People” who have “Licences). The technique is called either information or enterprise engineering. It is a fast and useful way of establishing revolutionary change where a process (or service) centric approach has led to a proliferation of services that, in turn, have generated an organization with stakeholders firmly committed to continuously improving their services, whether they are redundant or not.

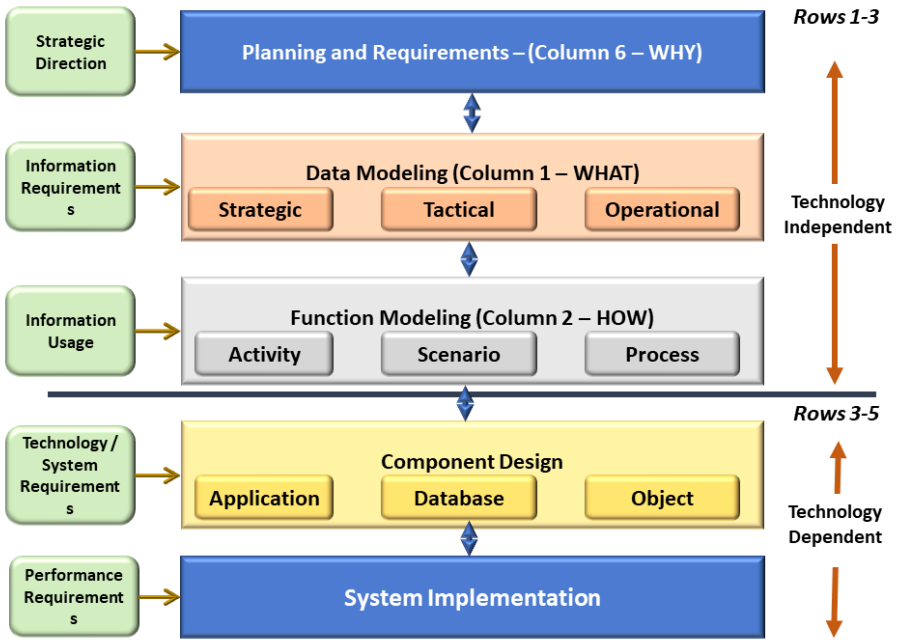


Figure 35 - Enterprise Engineering Approach (Finkelstein 2002 p. 1.11)

4.6.5 Military and Complex Organization Data Use

The military have the concept of a data-centric enterprise making information holdings available universally. Instantiation includes creation of the US Joint Information Enterprise (JIE) (US DISA 2014) to share information across enterprise segments (i.e. Army, Navy, Air Force and Marine Corps) in an effective and efficient manner and “evolving from a brittle, network-centric understanding of our information environment to a flexible data-centric environment enabling access to information at the point of need” (US DISA 2014 p. 1).

The US, NATO and the EU have focused on the sharing of information (a.k.a. information interoperability). In NATO and the European Defence Agency, the Multi-lateral Interoperability Program (MIP) has an information model that "provides the semantic foundation for information exchange in the Command and Control (C2) domain" (MIP 2019 p.1). Similarly, the US created the National Information Exchange Model (NIEM) to allow data sharing mainly. It is best thought of, "as a dictionary of agreed-upon terms, definitions, relationships, and formats that are independent of how information is stored in individual systems." (US Govt 2019) which is also used in other nations, such as Canada. Although NIEM originated in a defense/homeland security environment it now addresses multiple environments across the federal, state, local and tribal governments as well as industry.as illustrated in Figure 36.

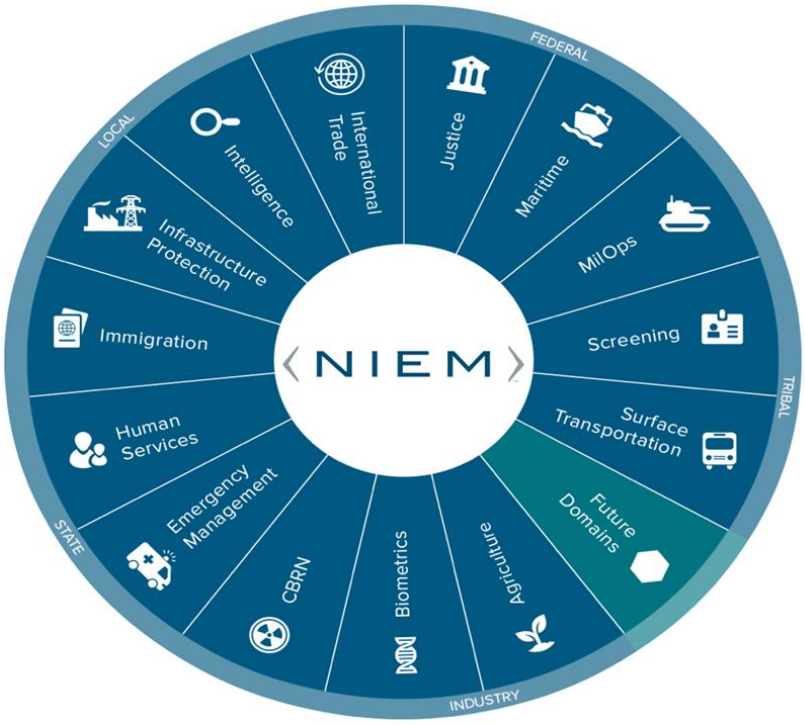


Figure 36 - National Information Exchange Model - Environments and Domains (US Govt 2019)

The European Union has created their own interoperability framework based on the delivery of services within and between the EU members. A primary feature is information sharing to improve public service delivery and lower costs as illustrated in Figure 37. Overall the interoperability framework is LOST standing for legal, organization, semantic and technical interoperability. The legal dimension is relatively new and handles, among other things,

privacy. The other dimensions basically correspond to business, information and technical interoperability found in standards such as TOGAF (The Open Group 2018 P. 243).

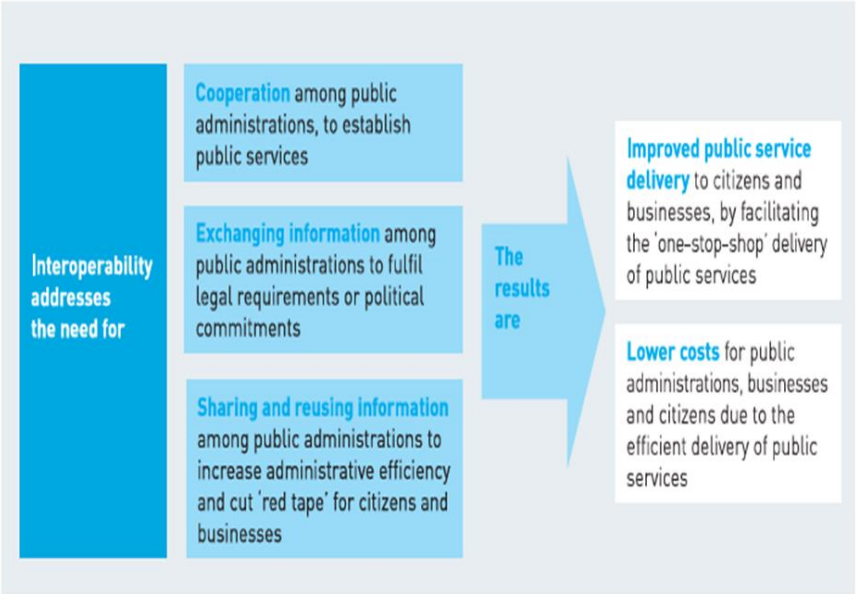


Figure 37 - European Interoperability Framework - (EU 2016 p. 4)

4.6.6 Data Management Assessment

The methodologies are solid for the management of data, but weak with respect to governance and are not addressing (in open sources at least) how to represent and share knowledge; a key asset for the digital enterprise. Table 9 contains an assessment of the various KM/IM/KM methodologies.

Table 9 - Assessment of Methodology Area 5 - Data / Information / Knowledge Management

#	*Coverage / Feature*	*Score (/5)*	*Comments*
1	Governance	2	Only weakly discussed, with the emphasis on operations and not holistic enterprise planning.
2	Management	3	Good coverage but lacking in indicators especially for non-database data.
3	Planning	3	Information engineering (IE) is very strong, as is DMM for the structured data. Still weak on the business end. IE provides good support for the creation of an implementation plan.
4	Building	3	DMM provides good advice for projects but is weak at the program and portfolio level. Opposite for IE.
5	Operations	3	DMM and especially DMBOK are very operations focused, maybe too much so as the database administration assessed in isolation from analytics and advanced decision support needs. Disconnect between physical and logical is major impediment when new business rules are created. Model driven architecture will really highlight this problem.
6	Audit, Verification, Monitoring	2	Other than some techniques and recommendations the methodologies do not address the key issues for audit.
	FACTORS		
1	Transition to a Knowledge-Based Economy	2	As mentioned in operations, the data environments will weakly support analytics and the gathering of insights.
2	The Relevance of Knowledge	3	The focus really is data and although the insights and business rules (e.g. decision trees) are key data elements to be maintained, the tendency is to look at data in tables.
3	The Relevance of IT	4	All of the standards are IT centric and recognize the use of IT to acquire, integrate and disseminate the data.
4	Continuous Innovation and Business Transformation	3	The data methodologies emphasize data lifecycle management but are weak in the areas of innovation and business transformation.
5	Leadership Versus Management	2	The overwhelming theme of data management is management with little thought of creating integrated environments. It is alluded to in the Information Engineering approaches but seldom used.
6	Scientific Versus Creativity Approaches	1	The focus is highly scientific with no mention of creativity approaches.

4.7. Methodology Area 6 - Portfolio, Program and Project Management

The principal methodologies involved in building are those associated with project management and the major international organization promoting standards is the Project Management Institute (PMI). Initially the institute promoted project management and published the Project Management Body of Knowledge (PMBOK) now in its 5th edition (PMI 2013a).

This focused on standardizing the project management process across industries (many industries and organizations already had a sophisticated , but unique, project management process) thereby laying a basis for a generic project management profession with an outcome of reducing the high rate of project failures in domains such as Information Technology (e.g. Standish (1995)).

PRojects In Controlled Environments (PRINCE) which is the main "rival" in the project management arena. PRINCE2® used to belong to the United Kingdom Office of Government Commerce (OGC) but has since been handed over to AXELOS which is "a joint venture company, created by the Cabinet Office on behalf of Her Majesty's Government (HMG) in the United Kingdom and Capita plc to run the Global Best Practice portfolio"[3]. There are differences between the two methodologies but not significant, except they are in competition with one another. Whereas Axelos is "for-profit", controls and profits from certification and addresses a whole portfolio of best practices, PMI is a not-for-profit[4], focusing on the project management profession. The global and cross-domain reach of PMI is also a major consideration.

It quickly became apparent that projects could not be managed in isolation prompting the creation of standards to manage programs and portfolios (PMI 2013b, PMI 2013c) which were defined as follows: "*A portfolio is a component collection of programs, projects or operations managed as a group to achieve strategic objectives....A portfolio exists to achieve one or more organizational strategies and objectives and may consist of a set of past, current, and planned or future portfolio components. Portfolios and projects have the potential to be longer term with new projects rotating into the portfolios or programs unlike projects that have a defined beginning and end*" (PMI 2013c Page 3). The key observations are:

a. Projects are transient with a finite lifecycle (PMI 2013a);
b. Projects are often delivered in increments constantly turning over to operations new services and/or products to support (PMI 2013a) forcing someone to handle the transition to fielding and ensuring that resources are in place in operations to sustain the project deliverable; and

[3] https://www.axelos.com/about-axelos
[4] http://www.pmi.org/About-Us.aspx

c. Program and portfolio management (PMI 2013b, c) are not transient and are tightly coupled to the corporate strategic objectives and includes strategic planning and operations, thus overlapping with standard business planning and operations management and underlining the need for business context to succeed.

The organizational context for Portfolio Management is explained in Figure 38 which illustrates that the portfolio includes strategic planning, programs, projects and associated operations.

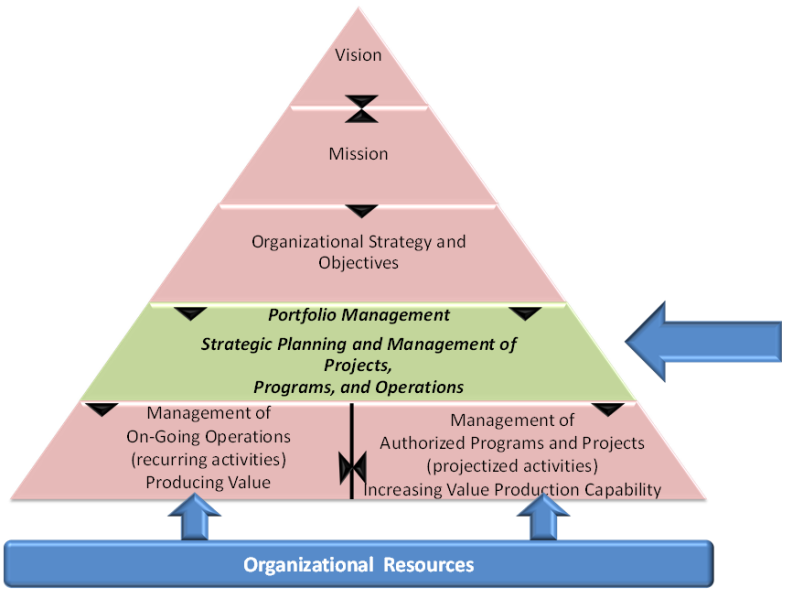


Figure 38 - The Organizational Context of Portfolio Management (PMI 2013c)

The differentiation between portfolio, program and project is well explained in Table 10.

Table 10 - Differentiating Between Projects, Programs and Portfolios (PMI 2013d)

Organizational Project Management (OPM PMI)			
	Project	Programs	Portfolios
Scope	Projects have defined objectives. Scope is progressively elaborated throughout the project lifecycle.	Programs have a larger scope and provide more significant benefits.	Portfolios have an organizational scope that changes with the strategic objectives of the organization.
Change	Project Managers expect change and implement processes to keep change managed and controlled.	Program Managers expect change from both inside and outside he program and are prepared to manage it.	Portfolio Managers continuously monitor changes in the broader internal and external environment
Planning	Project Managers progressively elaborate high-level information into detailed plans throughput the project lifecycle.	Program Managers develop the overall program plan and create high-level plans to guide detailed planning at the component level.	Portfolio Managers create and maintain necessary processes and communication relative to the aggregate portfolio
Management	Project Managers manage the project team to meet the project objectives.	Program Managers manage the program staff and the project managers; they provide vision and overall leadership.	Portfolio Managers may manage or coordinate portfolio management staff, or program and project staff that may have responsibilities into the aggregate portfolio.
Success	Success is measured by product and project quality, timeliness, budget compliance, and degree of customer satisfaction.	Success is measured by the degree to which the program satisfies the needs and benefits for which it was undertaken.	Success is measured in terms of the aggregate investment performance and benefit realization of the portfolio.
Monitoring	Project managers monitor and control the work of producing the products, services, or results that the project was undertaken to produce	Program managers monitor the progress of program components to ensure the overall goals, schedules, budget, and benefits of the program will be met.	Success is measured in terms of the aggregate investment performance and benefit realization of the portfolio.

In summary, project management has evolved over time to expand into the business planning, operations, program and portfolio domains to provide context for the project activity. There are several areas where the PMI standards are deficient in particular:

a. Finances. In all the PMI standards overall financial considerations are not well addressed. Costing is at the project level and precious little dedicated to ongoing operations and maintenance (O&M) capabilities and costs; a major challenge especially when projects use phased delivery (PMI 2013a Page 41).

b. Relationship CAPEX and OPEX. Projects are treated as projects and there is a great emphasis on business value. Little is mentioned on balancing and integrating Capital expenditures (CAPEX) (i.e. funding innovation) and replacement Operations and Maintenance expenditures (OPEX) (i.e. funding upgrades to existing services).

Table 11 - Assessment of Methodology Area 6 – Portfolio, Program and Project Management

#	*Coverage / Feature*	*Score (/5)*	*Comments*
1	Governance	3	The governance structures are premised on a project-based organization, which is not often the case. Also, innovative thinking and the relationship between O&M and Capital projects is not well defined.
2	Management	3	Management is still mainly project and business value focused. The need to address innovation is subsumed. PMI assumes that standard corporate management frameworks such as Risk Management are absent, and the Portfolio / Program / Project Manager has to establish them (e.g. PMI 2013d Process 9000 Page 175).
3	Planning	2	PMI is focused on project planning with guidance for planning at the program and portfolio level. It does not leverage standard and ignores often mandatory management frameworks such as Enterprise Architecture (e.g. US, Australian governments) whose raison d'etre is enterprise coherence, including the portfolio of projects. The portfolio management strategic planning and operations planning are mentioned but not detailed. The absence of holistic planning methodologies such as Capability Based Planning hinders coherence.
4	Building	5	The literature is focused on successfully executing and delivering projects, programs and portfolios.
5	Operations	1	The inclusion and management of operations is included at the portfolio level to ensure that there is coordination between the projects and operations that move the project deliverables into operations.
6	Audit, Verification, Monitoring	4	There is a solid Maturity Model (PMI 2013d) containing well-established best practices (a.k.a. control objectives) for use at the project, program and portfolio level.
	FACTORS		
1	Transition to a Knowledge-Based Economy	3	Successful project delivery is essential for the transition, and the focus on business value is very relevant.
2	The Relevance of Knowledge	2	The methodologies are focused on overall project management and the use of integrated data to allow for the successful monitoring of projects. It does not dwell on enterprise information / knowledge holdings resulting in knowledge being in project defined silos. The absence of enterprise (information) architecture to manage the information available to the enterprise in a holistic manner is a major shortcoming.
3	The Relevance of IT	3	The standards have been widely used in IT / CIO organizations as well as enterprises in general. IT is treated as any other resource.
4	Continuous Innovation and Business Transformation	3	The focus is on delivering projects and managing programs and portfolio to deliver the projects better. There is a solid emphasis on both stakeholders and business value and their constant monitoring that assists innovation.
5	Leadership Versus Management	2	The focus is solidly on management. Project leadership is a function of successful project delivery on time, cost and scope.
6	Scientific Versus Creativity Approaches	3	The entire management approach is dogmatic and based on analytical process decomposition. The use of phased project delivery is useful to adopt/adapt new approaches.

4.8. Methodology Area 7 – Operations Management

There are many methodologies in this area, but the following are in wide usage in the general and IT community:

a. ISO 55000, ISO 55001 and ISO 55002 (Physical Asset Management); and

b. ISO 20000 - ITIL 2011 (IT Asset Management); and

c. IT4IT (The Open Group 2017).

4.8.1 PAS 55 (ISO 55000)

The methodology covers asset management and is often used in government and utility companies. Figure 39 illustrates the core aspects of the methodology and as commoditized IT Services (e.g. data centres) become more and more like utilities with data being the output (rather than oil or electricity) these practices are becoming more useful so that CIO shops can focus on analytics and decision support.

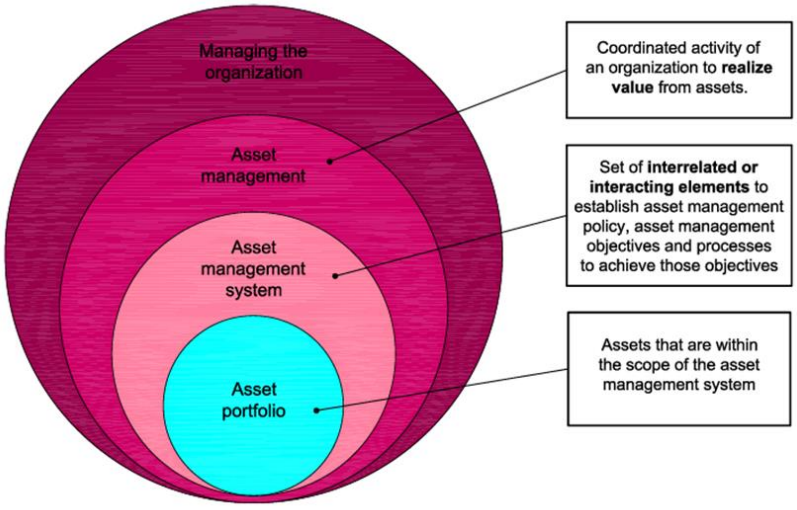


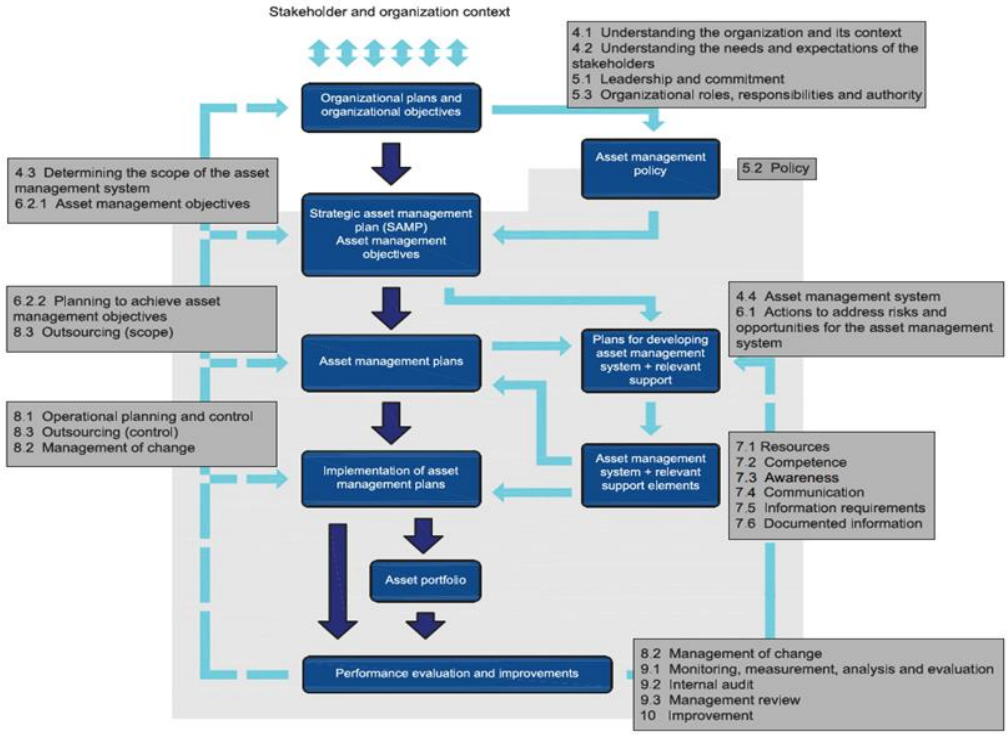
Figure 39 - ISO 55000 - Asset Management Key Terms (ISO 55000 2014 p. 4)

One of the key features of ISO 55000 is an asset management system, which conceptually varies little from the EA and its enterprise repository (e.g. TOGAF 9.2 The Open Group 2018) or the ITIL Service Knowledge Management System (ITIL 2011 ITSMF 2012). There are three key publications that have been formalized as international standards:

a. ISO 55000 (2014) – "*provides an overview of asset management and asset management systems (i.e. management systems for the management of assets). It also provides the context for ISO 55001 and ISO 55002*." (ISO 55000 2014 p. v);
b. ISO 55001 (2014) – "*specifies the requirements for the establishment, implementation, maintenance and improvement of a management system for asset management, referred to as an "asset management system*". (ISO 55001 2014 p. v); and
c. ISO 55002 (2014) – "*provides guidance for the application of a management system for asset management, referred to as an "asset management system", in accordance with the requirements of ISO 55001*" (ISO 55002 p. v).

Key elements in the Asset Management System and their relationship with implementation guidelines are shown in Figure 40 - Relationship Between Key Elements of an Asset Management System (ISO 55000 2014 P. 17 and ISO 55002 2014 P. 30)Figure 40.

Figure 40 - Relationship Between Key Elements of an Asset Management System (ISO 55000 2014 P. 17 and ISO 55002 2014 P. 30)



NOTE 1 Only the primary connections are shown to avoid over complexity.

NOTE 2 This does not aim to repeat the distinction between asset management and an asset management system: it is a connections view showing directions of influence.

NOTE 3 The grey highlighted box designates the boundary of the asset management system.

Figure 40 - Relationship Between Key Elements of an Asset Management System (ISO 55000 2014 P. 17 and ISO 55002 2014 P. 30)

4.8.2 ITIL 2011 (ISO 20000)

The Information Technology Infrastructure Library (ITIL) started in the 1990s as a series of best practices for IT Service Management issued by the UK Office of Government Commerce. ITIL Version 2 was a marked improvement that clearly addressed the operations portion of the IT service management. It could be applied to any type of service delivery and not just Information Technology. Its main strengths were that it documented best practices in client facing and internal processes (including business continuity) as well as enforced the creation of a configuration management database (CMDB). This CMDB maintained a grip on IT assets (called configuration items). This facilitated the task of Enterprise Architects who were not forced to create a CMDB to document the as-is technology and information systems architectures in organizations where ITIL was being used. However, in Version 3.0 and then ITIL 2011 the specification expanded from service management and became involved with the Planning and Organization as well as Building functions, thereby colliding with the Project Management Institute (Portfolio and Project Management) and Enterprise Architecture Methodologies.

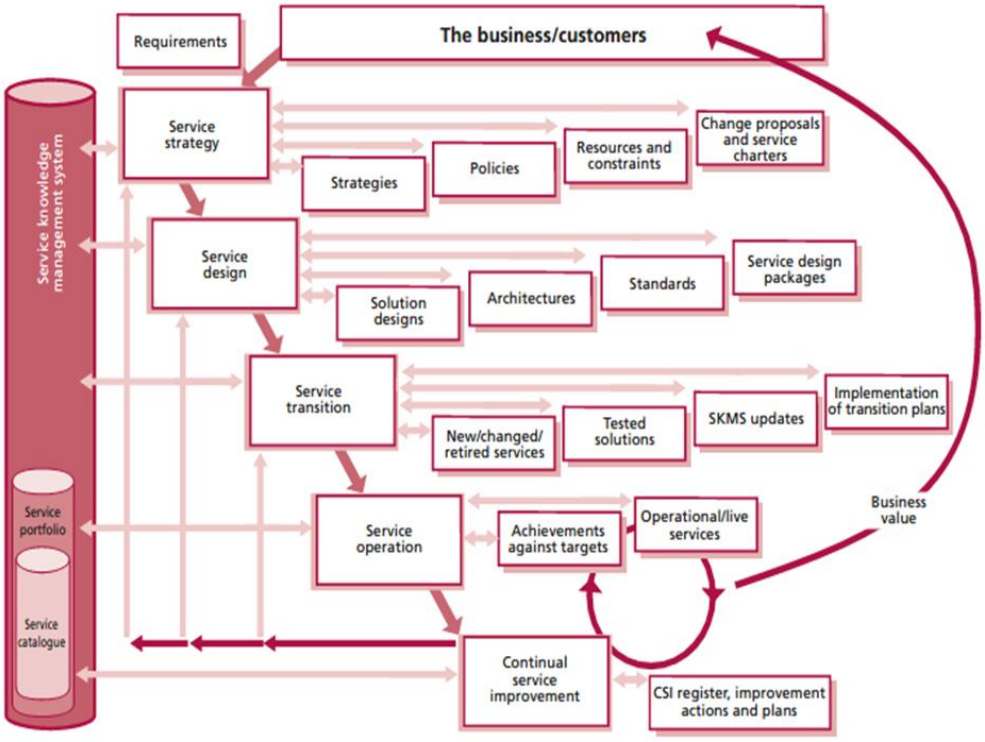


Figure 41 - ITIL 2011 Phases and Service Knowledge Management System (SKMS) (ITSMF 2012 p. 9)

The Service Knowledge Management System (SKMS) was a useful addition that added critical information about the services not previously found in the CMDB.

The main challenge with Version 3 and 2011 was that strategy was done on a service-by-service basis rather than holistically, somewhat akin to looking at the Enterprise through a straw. Add in continuous service improvement and you could have operations budgets expended on unnecessary improvements on services that could be at the end of their business value lifecycle.

The standard has also been handed over from government to Axelos and privatized which leads to intellectual property issues. The leveraging of the ITIL 2011 standard market position to compete in other domains previously addressed by other standards is an example of competition.

4.8.3 IT4IT (The Open Group 2017)

The Open Group felt that the current environment for IT Service Management, which was process and capability based, could benefit by a framework that was data-driven and architecture based and that would complement, or even replace, existing widely-used methodologies

such as ITIL (Axelos 2011) required. Specifically, the IT4IT (The Open Group 2017) reference architecture addresses the business of IT as follows:

> *The Open Group IT4IT™ Reference Architecture refers to the capability or capabilities required to manage the business of IT, covering IT end-to-end from plan, through build and operate. It assumes the principle that the business of running IT is industry-agnostic and that IT leaders share the same problems and opportunities in managing the service lifecycle effectively. At the core, these problems are rooted in IT structure, competencies, and capabilities and the missing link has been the lack of a business model for IT. The IT4IT Reference Architecture proposes that it is possible to establish an IT standard mapped to the existing IT landscape yet flexible enough to support the volatility inherent in the IT industry and accommodate changing IT paradigms (composite apps, agile development, mobile technology, multi-sourcing, etc.).(The Open Group 2017 p. 9)*

This standard was meant to complement the ITIL standard which was process centric and did not meet the needs of CIOs in the digital economy. In essence it uses capability-based planning and business value-based assessment in conjunction with an information centric approach to allow for the fielding of aligned IT services and infrastructure. The value chain for IT4IT is described in Figure 42.

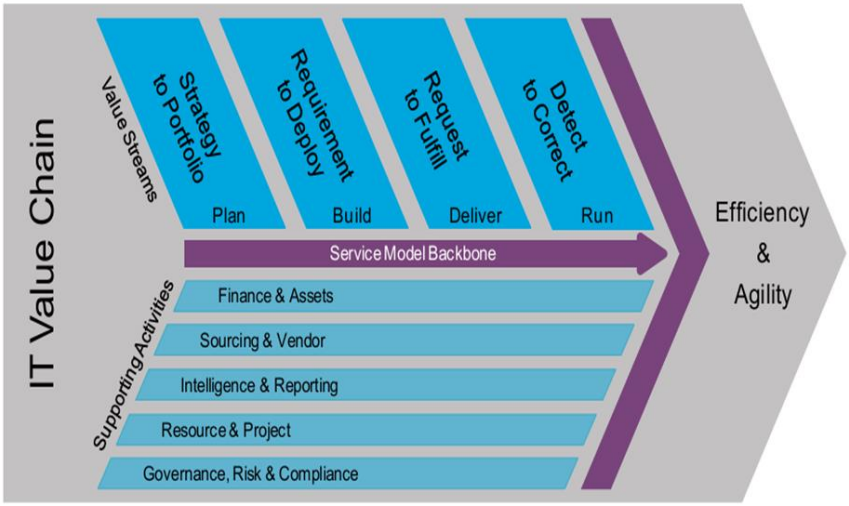


Figure 42 - IT4IT Value Chain - IT4IT Reference Arch V2.1 (The Open Group 2017 p.7)

The creators[5] of IT4IT (in The Open Group), meant for IT4IT to work with ITIL or work independently. The detailed IT4IT Level 1 reference model (Figure 43) components (a.k.a. objects as they encapsulate behavior) actually provides a basis for the structure of the Service Knowledge Management System (SKMS) described in the ITIL standard (ITSMF 2012 p. 9).

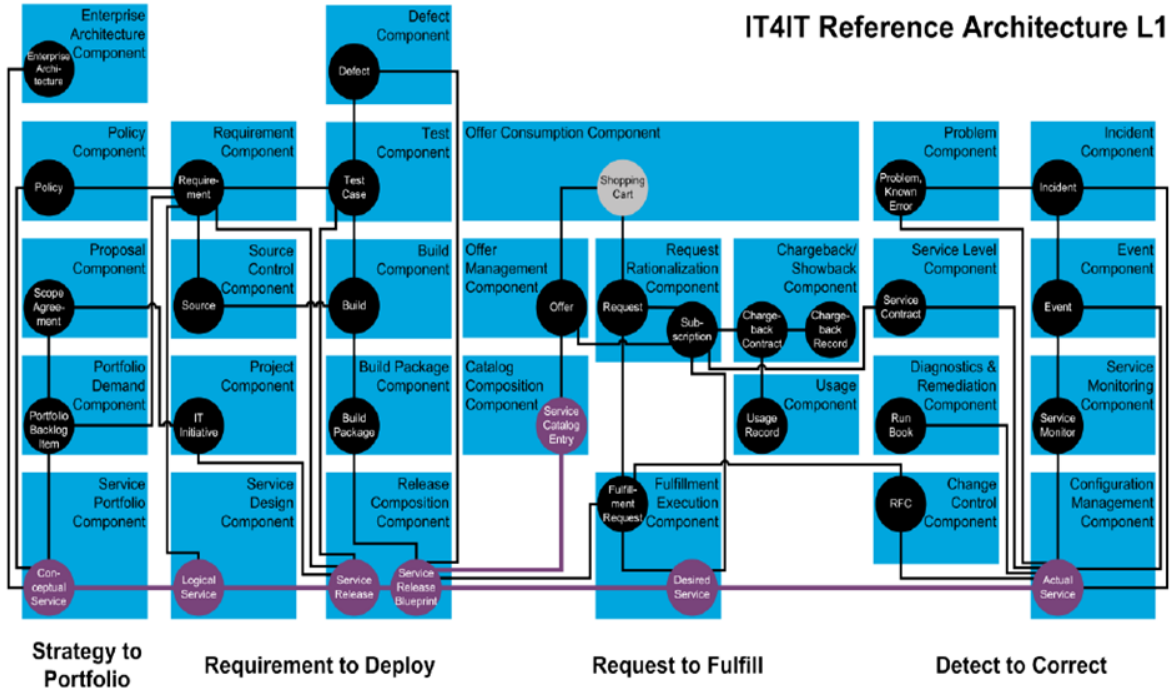


Figure 43 - IT4IT Reference Architecture Model (Open Group 2017 p. 32)

4.8.4 Overall Assessment of Operations Management Methodologies

The methodologies have evolved over the last 5-6 years to encompass a modicum of strategic thought. ITIL 3 first addressed service strategy at service by service basis from an operations perspective. In the subsequent ITIL 2011, there were few changes, but the Service Portfolio suddenly appeared in the Service Knowledge Management System (SKMS). The concept of service strategy is like looking at the enterprise through a straw and then from an operations perspective using operations and maintenance (O&M) resources. The questions

[5] The author conducted research and had private communications and working groups in The Open Group members meetings in 2016 – 2017. The author was in the first group of formally trained and certified IT4IT individuals.

such as whether the service is providing value from an enterprise perspective and whether it should be continued or replaced is not obvious. Furthermore, making a team and/or individual responsible for a service will lead to endless embellishments and a personal defence of the service, from a political perspective, making strategic change more difficult. IT4IT provides "top cover" for an ITIL implementation by more fully integrating the IT and business strategy and operations.

The world of the Internet of Things (IOT) is one of convergence where assets, such as power generators, aircraft engines, medical MRI scans and so on are being integrated (from a business and information perspective) into the enterprise technology infrastructure, rather than old stand-alone SCADA[6] systems, outside of CIO sphere of influence. Using analytics, enterprise integrated SCADA systems could indicate the need for engine replacement on landing or the discovery of a medical abnormality that needs to be addressed. Asset management methodologies (based on the ISO 55000 family) were looked at in isolation before, but now with the information and technology convergence inherent, or potentially inherent, in the IOT, management framework convergence between IT and IOT is recommended.

Based on action research, no integration at the management framework level has been achieved. Indeed, at a global energy provider, the CIO shop was deemed to get in the way of the technologists working with asset management. Detailed comments and assessment can be found in Table 12.

[6] SCADA – System Control and Data Acquisition which is a common term for what used to be stand-alone control systems (e.g. thermostat).

Table 12 - Assessment of Methodology Area 7 – Operations Management

#	*Coverage / Feature*	*Score (/5)*	*Comments*
1	Governance	3	The concept of governance is service-based and predicated on an OPEX view of the fiscal envelope. Continuous Service Improvement is an issue that unlike previous version of ITIL where the quality was a function of client needs, this could lead to service delivery in excess of client needs and taking fiscal resources away from innovative new services (CAPEX) or service delivery.
2	Management	4	The standards were created to support management and do a good job. For many companies where every plant/IT Organization, standardizing has benefits.
3	Planning	3	The standards provide a good basis for planning but are focused mainly on optimizing operations and maintenance, not the creation of new capabilities.
4	Building	3	Good for building for O&M projects.
5	Operations	4	Built to support O&M so is good there.
6	Audit, Verification, Monitoring	3	Implementation of the standards will greatly facilitate audit through the standardization of processes and documentation.
	FACTORS		
1	Transition to a Knowledge-Based Economy	2	Mainly concerned with keeping the lights on.
2	The Relevance of Knowledge	2	No real consideration of knowledge as an asset. Focus is on analytics to improve asset and data management.
3	The Relevance of IT	4	The standards consider assets (both physical and IT) to be primary and to be managed. Taking a plant lifecycle approach.
4	Continuous Innovation and Business Transformation	3	No real innovation, except for efficiencies in the conduct of operations and maintenance. No focus on new enterprise business operating models.
5	Leadership Versus Management	2	Focus is management (as the standards indicate) with a focus on increasing efficiencies, not “exploring” new markets or operating models.
6	Scientific Versus Creativity Approaches	1	Entirely scientific.

4.9. Methodology Area 8 - Monitoring / Verification / Audit

The main standard is the from IT Governance Institute (ITGI) COBIT 2019. (ITGI 2018) in the form of a set of processes to be monitored. One of the key features is the differentiation between governance and management, with the former working strategically and taking a leadership role, whereas management works at the tactical and operational level to run the existing business model. Specifically

"Governance objectives are grouped in the Evaluate, Direct and Monitor (EDM) domain. In this domain, the governing body evaluates strategic options, directs senior management on the chosen strategic options and monitors the achievement of the strategy.

Management objectives are grouped in four domains:

- *Align, Plan and Organize (APO) addresses the overall organization, strategy and supporting activities for I&T.*
- *Build, Acquire and Implement (BAI) treats the definition, acquisition and implementation of I&T solutions and their integration in business processes.*
- *Deliver, Service and Support (DSS) addresses the operational delivery and support of I&T services, including security.*
- *Monitor, Evaluate and Assess (MEA) addresses performance monitoring and conformance of I&T with internal performance targets, internal control objectives and external requirements." (ITGI 2018a p. 20)*

The objectives above are broken down into governance processes (EDM) and Management processes (APO, BAI, DSS and MEA) as depicted in Figure 44.

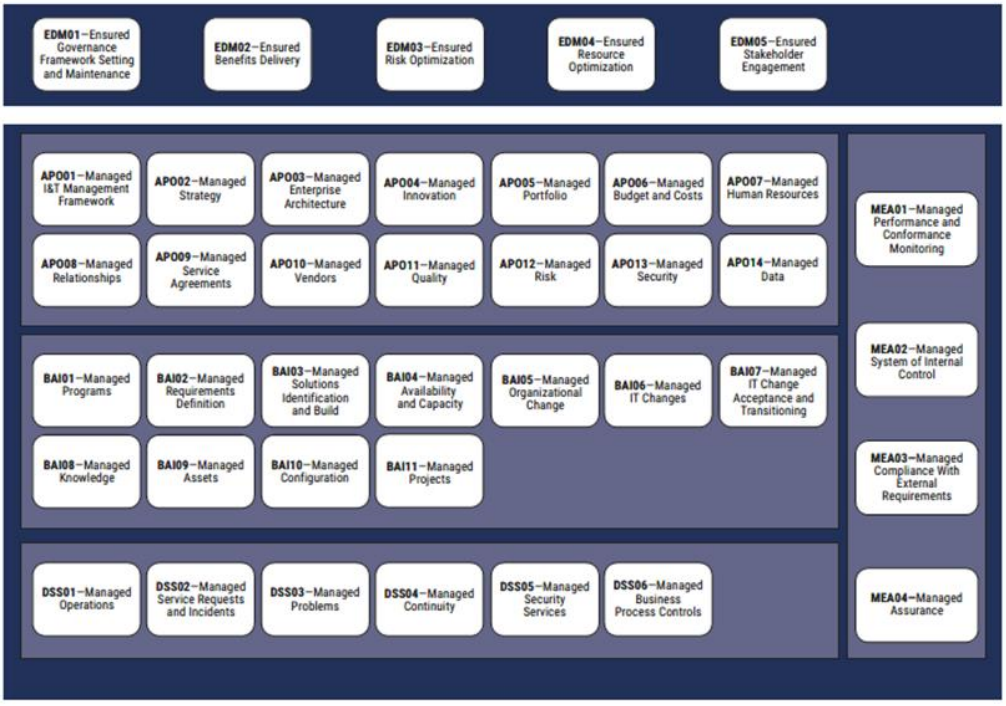


Figure 44 - COBIT 2019 Process Areas (ITGI 2018a p. 21)

They also take a capability-based approach calling the dimensions “components” of a governance system as illustrated in Figure 45.

Figure 45 - COBIT 2019 - Components of a Governance System (ITGI 2018a p. 22)

Table 13 - Assessment of Methodology Area 8 - Audit / Governance

Assessment of Governance Related Methodologies			
#	***Coverage / Feature***	***Score (/5)***	***Comments***
1	Governance	5	The main focus of COBIT is governance and management with detailed audit points for each one of the core processes. From a digital transformation perspective, the COBIT processes are very generic and can easily accommodate non-IT governance and management processes.
2	Management	5	Same as Above.
3	Planning	3	The processes check what has to be done for planning but does not get into the "how" in any detail.
4	Building	2	Again, the COBIT is for governance and management, but it offers best practices that include following methodologies such as TOGAF and Systems Engineering best practices.
5	Operations	3	For operations, the verification checklists are solid but other best practice frameworks such as ITIL and IT4IT are needed.
6	Audit, Verification, Monitoring	5	The rationale for COBIT is audit, verification and monitoring, so they are excellent. These processes can easily be ported into non-IT areas.
	FACTORS		
1	Transition to a Knowledge-Based Economy	2	COBIT 4.1 focused on information architecture, but COBIT 5 replaced information architecture with enterprise architecture. In COBIT 2019, the need to specifically address data was re-emphasized with a new process. It is still weak on detail outside of information systems, specifically analytics, internet of things and the like. It will need work to address all of the aspects of knowledge.
2	The Relevance of Knowledge	2	COBIT 2019 has re-emphasized the need for data, but the concept of knowledge is minimally addressed.
3	The Relevance of IT	5	The IT Governance Institute sponsors COBIT that makes IT and data central to the entire framework.
4	Continuous Innovation and Business Transformation	3	Innovation management is a key process but is limited, to a degree, to the IT aspects.
5	Leadership Versus Management	3	The adherence to COBIT will allow for a solid understanding of the existing and target IT infrastructures but relies on enterprise architecture to handle enterprise-wide issues. With EA in the CIO organization, this will not work well. Innovation is expected and the COBIT 2019 framework expects the consideration of culture, ethics and behavior, as well as personnel competencies (ITGI 2018 p. 22)
6	Scientific Versus Creativity Approaches	2	There is not much creativity in the application of the audit guidelines by design. It is scientific in nature, although some changes can be entertained, it is quite strict.

4.10. Matching Factors to Methodologies / Approaches

4.10.1 Comparing the Various Methodology Families

Based on the literature review, that covers a period of four years from 2015-2019, there have been major changes in the various areas of practice. With all the literature assessment

results in a combined table, Table 14. Table 14 brings together the analyses presented previously in Tables 4, 5, 6, 7, 9, 11, 12 and 13, and uses the rating scheme presented in Section 4.1.3 and colouring described in Section 4.1.4. Considering the evolution of the literature, the following observations become relevant:

a. No one set of frameworks address all the digital transformation challenges;
b. There is a considerable overlap between the various frameworks;
c. The various frameworks, over time, are expanding their scope into areas addressed by other frameworks;
d. As the frameworks expand and overlap, the common areas are not addressed in a coherent manner;
e. The business planning frameworks are created but once published, rarely evolve, but are replaced;
f. EA is evolving rapidly to accommodate change, but the documentation is technical and the EA effort, with rare but notable exceptions (e.g. US Defense) is hidden in the IT organization;
g. Digital leadership and business design have solid concepts that should be incorporated into all the other frameworks;
h. There is still a business-technology alignment issue that will only get more challenging as more technologies become software driven and SCADA[7] data is gathered and used;
i. Knowledge, Information and Data are at the heart of a digital enterprise, however essential concepts are incoherent, and management is fragmented;
j. Interoperability (sharing) of at least data, is well addressed (e.g. National Information Exchange Model, EU Interoperability Framework);
k. Management innovation is needed to sort out how these frameworks can work together to facilitate digital transformation.

[7] SCADA – System Control and Data Acquisition

Table 14 - Overall Comparative Analysis

#	*Methodology Area →*	*Digital Leader-ship*	*Planning Business (Balanced Score-card Family)*	*Business Design*	*Infor-mation Mgt / Ar-chitecture*	*Enterprise Architec-ture*	*Building Portfolio/ Project Management (PMI)*	*Running Operations Management ITIL*	*Audit COBIT 5*
	FOCUS AREAS								
1	Governance	4	4	3	2	2	3	3	5
2	Management	3	3	3	3	4	3	4	5
3	Planning	3	3	3	3	4	2	3	3
4	Building	2	2	2	3	3	5	3	2
5	Operations	1	3	2	3	1	1	4	3
6	Audit, Verifica-tion, Monitoring	1	4	2	2	3	4	3	5
	FACTORS								
1	Transition to a Knowledge-Based Economy	5	3	5	2	2	3	2	2
2	The Relevance of Knowledge	2	3	3	3	2	2	2	2
3	The Relevance of IT	3	4	3	4	4	3	4	5
4	Continuous In-novation and Business Trans-formation	5	1	4	3	3	3	3	3
5	Leadership Ver-sus Management	4	3	5	2	2	2	2	3
6	Scientific Ver-sus Creativity Approaches	4	1	5	1	1	3	1	2

4.11. Conclusions

4.11.1 Research Questions

The questions have been iterated many times and the initial thrust focusing on e-Government was generalized to e-Business. The main reason was that government provides different services in different jurisdictions and countries. For example, health (a huge service offering) may or may not be a government service depending upon which country is being examined.

Furthermore, the questions were simplified and reduced to two. After an in-class peer review the initial questions were found to be potentially ambiguous, too complicated and too numerous. The problem is relatively well understood in corporate boardrooms where siloed methodologies are creating confusion, but one has to find out whether there is a holistic management structure/methodology that can be used (and not re-invented) and secondly assess the extent the various siloed methodologies have recognized the need for a more holistic approach to enterprise management.

4.11.1.1 Question 1: Is there a holistic management structure that allows enterprises to innovate and evolve over time?

First the concept of "holistic" must be better explained. Holistic is meant to include the business functions that govern, manage, plan, build and run (operate) the enterprise.

The best fit discovered so far was the US Government Common Approach to Federal Enterprise Architecture (US Government 2012), shown in Figure 46, whose main aim was to effectively and cost-efficiently align IT with the business. It is not trivial and is influenced by defence, systems engineering, strategic planning and budget management.

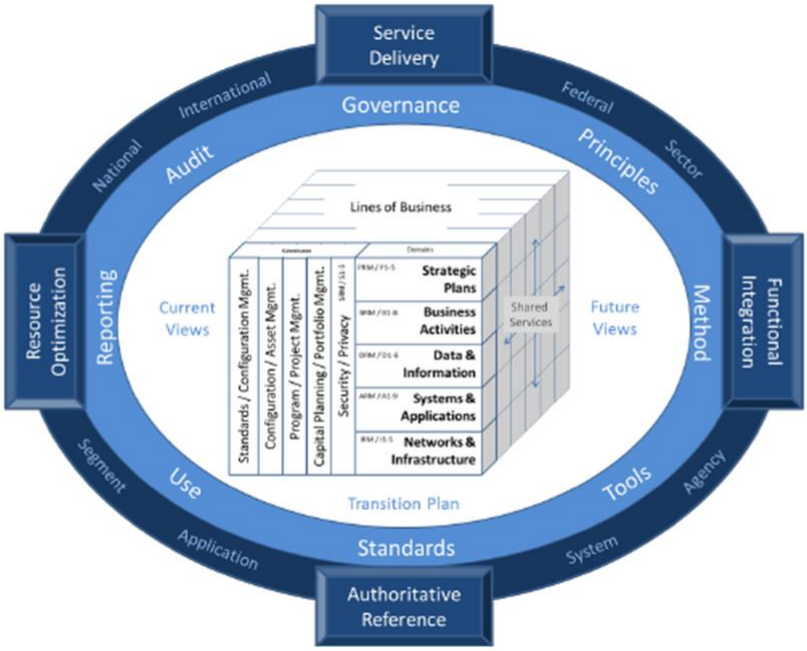


Figure 46 - US Government - Common Approach to Enterprise Architecture (US Government 2012)

The Common Approach has definite executive sponsorship (US President) and provides support for:

a. Governance - Moderate (especially audit support);
b. Planning (Capital Planning and Architecture)- Good;
c. Building (Program and Project Management) - Very Good; and
d. Operations - Limited.

Notably the methodology called out is Enterprise Architecture which has been granted a significant role outside of the CIO realm in "Executive Direction and Management," as illustrated in Figure 47.

The Federal Enterprise Architecture has been the chosen vehicle to deliver US e-Government, and, although many aspects are still aspirational, the implementation of the common approach is audited annually in each government agency and department.

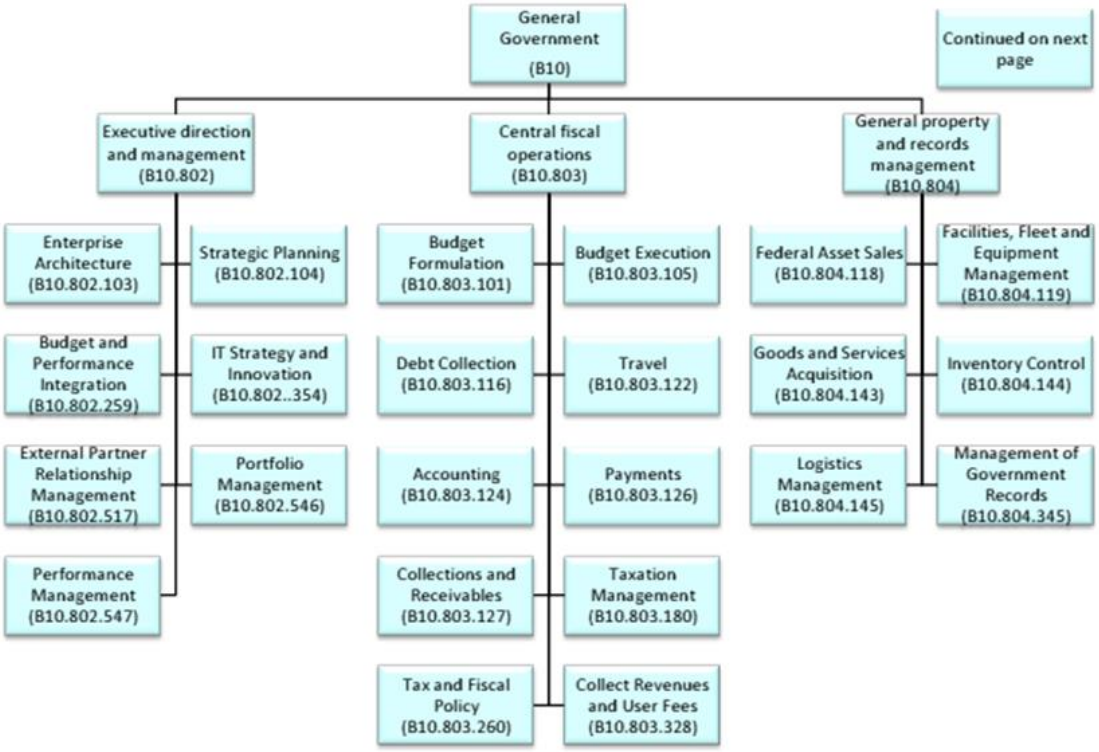


Figure 47 - Placement of Enterprise Architecture as Key Service in General Government Executive Direction and Management Function (Source: US Federal Enterprise Architecture Framework V2 P. 342 dated 29 January 2013 www.whitehouse.gov)

The Australian Government Architecture Versions 1 to 3 (AGIMO 2007, 2009, 2011) have followed the US lead, and there is a similar recognition that the EA function is part of corporate management and not just a staff function within the CIO group. Note that in the US DoD, approval of any funds is predicated on the use of the DoD EA and its work products / artefacts. The EA is integrated into the main planning functions throughout DoD. The work by Thomas Barnett (2004 and 2005) outlines a very pragmatic notion of conflict in the 21st century requiring a "*whole-of-government approach"* to deliver long-term solutions, especially in foreign entanglements. He preaches an in-depth knowledge of government capabilities (kept up to date in the Enterprise Architecture) to get the right resources in-theatre at the right time. The US DoD domains are illustrated in the Figure 48.

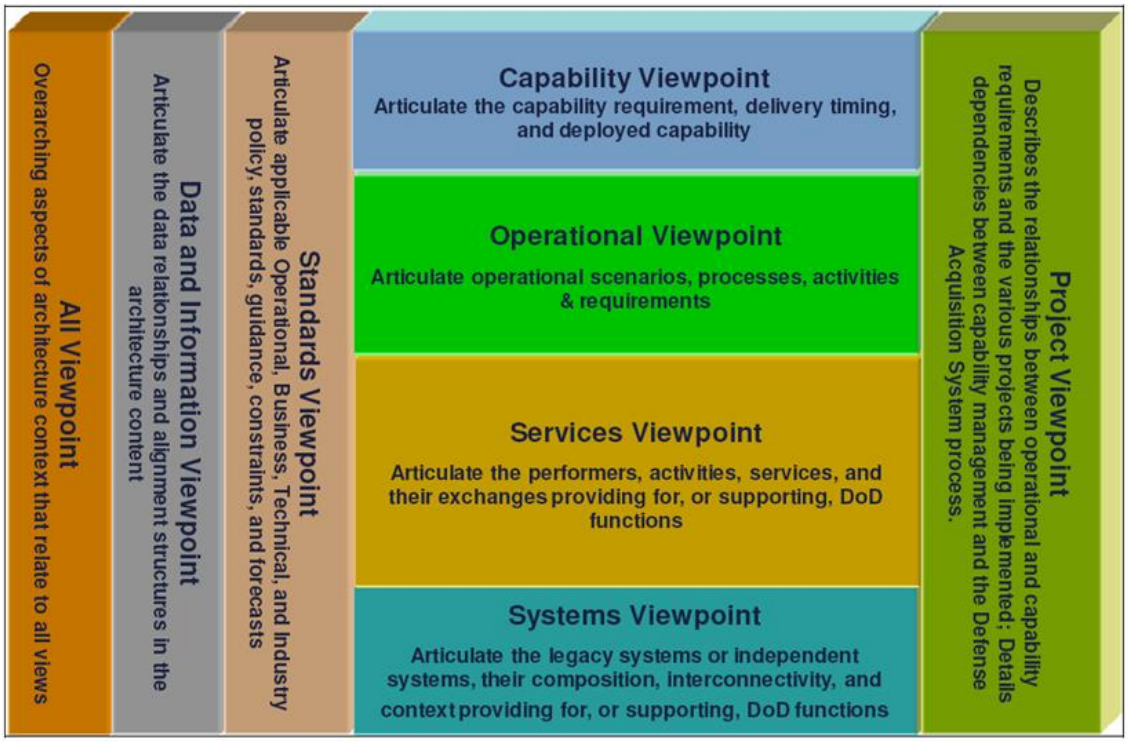


Figure 48 - US Defense EA Framework (US DOD 2009)

Both the common approach and the DoD frameworks have little or no support for continuous innovation or business transformation. Their data domains consist mainly of information exchange protocols (e.g. National Information Exchange Model – US Government NIEM) rather than the creation of a somewhat unified environment. Currently the US DoD is leading the effort on a Joint Information Environment (formerly the Global Information Grid) that will simplify information sharing. It has weak support for knowledge, information, and data management. However, the US DoD has an excellent underlying meta-model that links all the concepts and lays the basis for a set of successful viewpoints (perspectives) that have been in constant use for more than 15 years.

The US Government Common Approach to Enterprise Architecture appears to be a solid candidate upon which to conduct detailed research, and to extend and potentially create an Open Enterprise Management Framework. Care will have to be taken to ensure that the methodology is generalized for use elsewhere in the world.

4.11.1.2 Conclusions

After having reviewed the literature there is no accepted, holistic management framework, but those used in the US Government provide a good start point.

4.11.2 Question 2: Is there a recognition that there is a need for a holistic management structure?

IT was one of the first horizontal business functions that had to service all of the lines of business. Enterprise Architecture was initially conceived as an Information Systems Framework (Zachman 1987 IBM Systems Journal) but was converted to Enterprise Architecture Framework to bring order to spiralling IT Costs (e.g. CHAOS Report Standish 1995)[8] . An EA Framework has become a de facto holistic framework, but it is not widely accepted, understood and anchored in the IT Organization[9].

From a business perspective, the need for a holistic approach is also appreciated and best articulated through Roger Martin and his concept of Integrative Business Thinking and Design ("Opposable Mind" and "The Design of Business"). Also, Jeanne Ross et al. in the seminal book "Enterprise Architecture as Strategy", looks at a holistic approach but is constrained from moving into business because of her affiliation with the Centre for Information Systems Research at the Sloan School of Management at MIT. Similarly, all the other organizational bodies of knowledge are moving into the integration void, creating market confusion. Figure 49 (Weisman 2013b) is based upon COBIT 2019 Standard (where COBIT stood for Control Objectives for Information and Related Technology) clearly displays how the various professional best practice guideline are moving into the void. Confusion and friction are created when the voids/intersections are completed differently, and business lines are using different approaches.

[8] The Standish Group research (1995) shows a staggering 31.1% of projects will be cancelled before they ever get completed. Further results indicate 52.7% of projects will cost 189% of their original estimates. The cost of these failures and overruns are just the tip of the proverbial iceberg. The lost opportunity costs are not measurable but could easily be in the trillions of dollars.

[9] Ongoing research in the Canadian Government offers a good example where EA has been around since 1999 (Federated Architecture Program) but is only solidly implemented in a few departments now (2019) and rarely outside of the IT Organization.

There is a massive move by multiple methodologies to become the key player. As their methodologies have evolved, they realize that an integrated approach is the only way that they can deliver their set of best practices.

There has been little or no effort on the part of many of these siloed best practices to harmonize their offerings. This is in part because of their complexity and in part due to the rush to publish and 'plant their flags on the disputed hilltops' and hence claim to be authoritative.

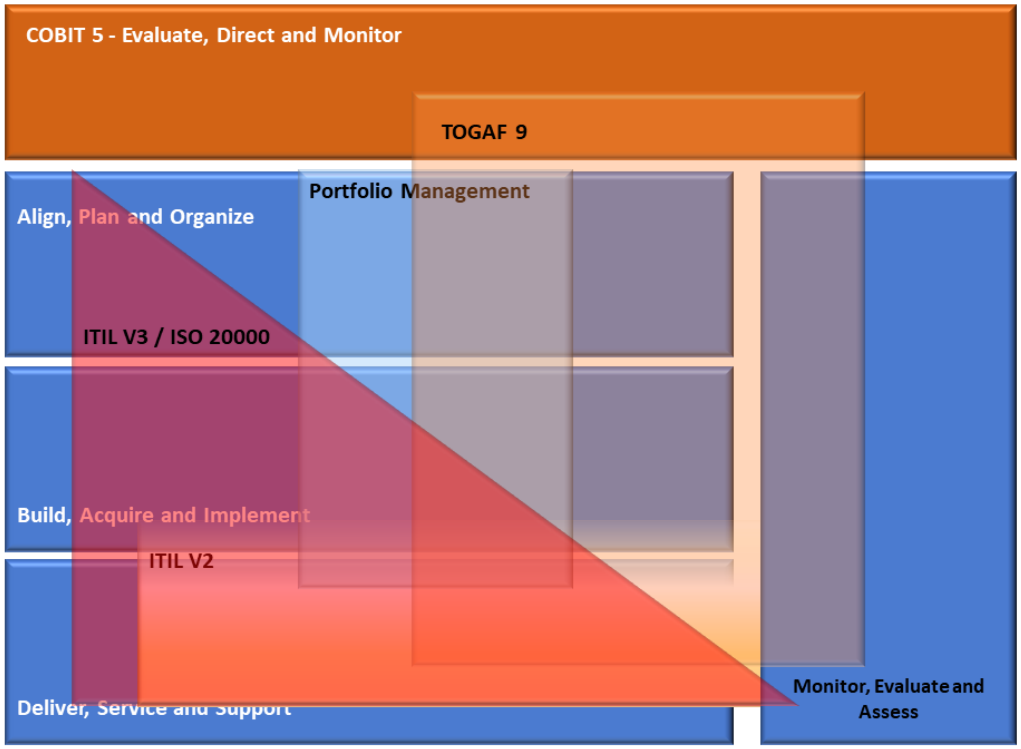


Figure 49 - Conflicting Management Frameworks (Weisman 2013b based upon COBIT 5 Standard 2012)

4.12. Identification of Several Major Issues for Digital Transformation Success

In answering RQ1 and RQ2, there were several issues that required a deeper analysis. These issues were multi-disciplinary and required a different approach to address the concerns of the stakeholders in that domain.

One of the main findings with respect to RQ1 and RQ2 was that there was no one methodology that fully addressed all of the factors and business focus areas, but that enterprise architecture (EA), used extensively globally, was a solid foundation for such a DT methodology or collaborative framework.

There were four main findings that were each addressed in Chapters 5-8. Specifically, there was a need for:

a. There is a great deal of creativity involved in successful DT, and business design complements standard scientific method and inquiry with artistic method and inquiry. It also provides a basis for assessing the different mindsets and approaches within the enterprise and the need to use both. This is discussed in detail in Chapter 5.
b. The business-technology divide is a constant theme in the literature where the CIOs are always worried about aligning their IT/ICT with the business. In DT this divide cannot be allowed to exist as technology is but one dimension in achieving success. It is not about alignment but integration. Chapter 6 addresses this issue and proposes the use of EA as a strategic business technique used throughout the enterprise to provide a coherent basis for dynamic change.
c. The integration of EA and systems engineering (SE) is a requirement to link DT and digitization. Essentially this need is recognized in INCOSE Vision 2025 (INCOSE 2014). Ironically there is no mention of EA in this visionary document, but the rationale for the vision led to the creation of EA in the first place based on SE methodologies. The associated issues are discussed both quantitatively and qualitatively in Chapter 7, as this thesis finds that the major impediments to EA/SE integration are subjective and need to be addressed.
d. Last, but not least, is the need to harmonize the various management frameworks within the enterprise. DT does not work if the core business functions

(govern-plan-build-run) do not work together. Chapter 8 illustrates the need for the frameworks to be coherent using case studies. Again, the use of EA to co-ordinate how the various assets of the enterprise work together is highlighted.

Chapter 5. Integrating Business Design into Enterprise and Systems Architecture

This chapter is based on material submitted to a journal targeted at the engineering management community.

5.1. Introduction and Background

There are numerous general strategies or ways of thinking that can be used in digital transformation. In this chapter we will examine several of these and conclude that they should be integrated. Three such strategies useful in business and government are business design, enterprise architecture and systems engineering. We will also consider integrative thinking, the reliability mindset versus the validity mindset, and the artistic method versus the scientific method.

Using a case study running through the paper, we will see that taking a narrow rather than a holistic perspective tends to lead to failure in attempts to undertake digital transformation.

5.1.1 A Case Study: A Real-Life Digital Transformation Challenge

Throughout this chapter we refer to a case study, and its derivatives, in digital transformation within large, federal government department in Canada. They wanted to change from a program-driven paradigm, where citizens had to apply ("pull") for each individual program across multiple jurisdictions to a life-event driven paradigm where a bundle of multi-jurisdictional services would be provided ("push") in response to a citizen life event (e.g. birth, death, unemployment, becoming a senior (turning 65), and so on). In eGov terms, the intent was to go from a Stage 4 – Transactional ("Users can actually pay for services or conduct financial transactions online" focusing on discrete services at all levels of government) to Stage 5 – Seamless ("Total integration of e-functions and services across administrative and departmental boundaries.") (UN 2001 p.10 Box 5).

The vision of life-event driven service delivery was unambiguous, but the journey to get there federally, let-alone in conjunction with very independent jurisdictions was fraught with risk. The need to re-orient the service delivery paradigm for recipients and transform the public service nationally to focus on life events versus individual programs, was a challenge, but adapting or replacing the extensive, existing and siloed systems and technology base was daunting. Further complicating matters were two major factors namely the politics and architecture for the sharing of recipient information as well as the existence of unique bilateral arrangements between the levels of government for most programs.

We will refer to this case study, and its many derivatives, in various sections of the chapter. The observations we gathered and synthesized that constitute the case study all started some 15 years ago and are still, ongoing as of late 2019.

5.1.2 Challenge and Methodology

The difficulties encountered by the subject digital transformation initiative are far from unique. Fifty per cent of digital transformation efforts fail (Forrester 2019) as do 50% of software projects (Guillaume-Joseph and Wasek, 2015). There are always obvious causes such as inadequate business requirements and poor project management, but this paper resolves that there may also be a deeper causation that current technology methodologies do not address.

There were several layers of management in the case study with different mindsets and concerns. The executive level envisaged a new model and service delivery paradigm and a senior management level who focused on making the existing model more efficient.

The concepts underlying “business design” provide a basis for re-evaluating the way that these initiatives were, and still are, addressed. They complement traditional systems analysis and design techniques and provide valuable lessons learned for both business and technology specialists engaged in digital transformation.

This chapter will first highlight the conventional approach adopted then describe the salient features of business design, illustrating how each of them could have positively impacted the case study. The paper concludes with recommendations for future integrative work for the fields of enterprise architecture, business design and systems engineering.

5.2. The Conventional Approach Taken

5.2.1 Enterprise Architecture and Systems Engineering

In our case study, the approach was highly influenced by both enterprise architecture and systems engineering methodologies.

Enterprise Architecture (EA) is, essentially, an offshoot of systems engineering and as typified in approaches such as GERAM (IFIP-IFAC GERAM 1999), US Common Approach to EA (US 2012), TOGAF (The Open Group 2009, 2011, 2018). The key differentiator is that EA no longer deals with a discrete system but elevates the problem space to the overall enterprise. This holistic perspective was initially driven by the goal of making the IT investment efficient through the re-use of technology (software, hardware and data) components. For example, instead of tens of email or word processing components, there would be one, reducing costs and enabling the sharing of digital data.

In government, EA was initially known as Enterprise IT Architecture (EITA), which explains why EA staff are most often in CIO organizations. Specifically the US Information Technology Reform Act (a.k.a. Clinger-Cohen Act – US 1996) created CIOs in the US federal government and authorized them to create an "information technology architecture" defined as " … an integrated framework for evolving or maintaining existing information technology and acquiring new information technology to achieve the agency's strategic goals and information resources management goals." (US 1996 P.8). Initial automation efforts focused on automating the manual processes and structuring data to produce reports and for that traditional systems engineering, and EITA techniques (e.g. Technical Architecture for Information Management – US DOD 1994) were adequate. However, when technology was being leveraged to enable business transformation, EA came to the fore. Specifically, the US Federal Enterprise Architecture Framework V1.1 (CIO Council 1999) was issued to "act a road map for the Federal Government in achieving better alignment of technology solutions with business mission needs" (CIO Council 1999).

The business (or digital) transformation challenge to systems engineering was recognized by the International Council on Systems Engineering (INCOSE) that published Vision 2025 (INCOSE 2014). This vision was then mapped to current EA frameworks (Weisman and Lethbridge 2019a) where it was clearly indicated that EA enabled Vision 2025 and addressed

many of the challenges identified therein. Notably there is no mention of EA in the INCOSE Vision 2025 (INCOSE 2014) document. This is part of a larger issue of competing (as compared to collaborating or complementary) business and technology management frameworks addressed in Weisman, Lethbridge 2019b and Weisman 2019.

5.2.2 Model Based Frameworks

Both systems engineering and enterprise architecture (EA) are model based. EA frameworks and languages, such as TOGAF and ArchiMate (The Open Group 2018 and 2016), address complexity by creating high level enterprise models at different levels of abstraction and multiple perspectives (e.g. business, security, data, privacy). These EA models, in turn, enable the creation of coherent system models, in the context of model-based systems engineering (MBSE). MBSE is formulated to enable detailed execution of the models and, in the software world, the automatic generation of the requisite code.

EA takes a holistic view of the entire problem space and is business-driven, focusing on describing what constitutes business value. EA clearly defines all assets available to the enterprise (such as information, people, buildings as well as technology), their inter-relationships and evolution over time. This potentially enables all members of the enterprise to plan by sharing the EA models using a shared repository, permitting either centralized or de-centralized planning as well as the consistent analysis of potential business scenarios.

5.2.3 The Business Challenge

The challenge is getting the business part right when the EA team is still found in the Chief Information Officer (CIO) organizations. Often “business” architects are technologists with some analytical training. This results in their technical orientation dominating their analyses that invariably do a poor job of articulating enterprise business requirements and opportunities. Often, they revert to systems analysis focusing on individual systems at the project level. This in turn hampers the integration or federation of the systems at the enterprise level, which is one of the fundamental goals of EA.

Also current business approaches, such as the Balanced Scorecard (Kaplan 1996), Strategy Maps (Kaplan 2006), the Business Analysis Body of Knowledge (IIBA 2015) and the Business Model Generation (Ostwalder et al 2010), are still not providing the entire picture

with respect to leveraging technology as a means of achieving sustained innovation and competitive advantage. Other methodologies such as ITIL and Six Sigma are based on continuous service / product improvement and are generally do not result in new services, products or ways of doing things.

This was key in our case study on digital government transformation, as the opportunity was a function of out-of-date technology. The intent was to leverage technology to improve the delivery of services and not just replace the obsolete technology with new technology leaving the business processes, policies, agreements and management structures fundamentally intact.

The frameworks available in the business, EA and systems engineering world were inadequate to meet this high-level intent by departmental and governmental leadership.

5.3. Business Design

Business Design is a business approach to enterprise transformation. It is a business conceived and business led way of creating a "fit for purpose" business architecture.

The core underlying concepts (Martin 2009a and 2009b) are not dissimilar to EA (e.g. Integrative thinking, architecture, models) and provide many of what could be considered the non-functional dimension to more standard business analysis. Both enterprise architecture and business design are about business transformation (i.e. moving from an existing state to a future one), but the former takes a different approach. As previously mentioned, systems engineering has also noted the need for the holistic context EA provides in Vision 2025 (INCOSE 2014).

Business design is anchored in product design concepts and many of those are related to emotion rather than a "logical" assessment of what is required. For example, what differentiates one cell phone or car from another is often an emotional appeal to a human need, be it ego, aesthetics, group inclusion not a triple integral or graph that display irrefutably that one product or service is better than another.

A more recent definition and assessment of business design is from Ross et al (2019)[10] as: "We define digital business design as the holistic organizational configuration of people

[10] Based on a pre-publication manuscript graciously sent by Dr. Ross and MIT "Designed for Digital: How to Architect Your Business for Sustained Success" to be released in October 2019

(roles, accountabilities, structures, skills), processes (workflows, routines, procedures), and technology (infrastructure, applications) to define value propositions and deliver offerings made possible by the capabilities of digital technologies." (Ross et al 2019 p.5)

There are several core features of business design that are key and consistent across much of the literature on business design and I will briefly describe each one of them with snippets from the case study and then summarize their overall impact.

5.3.1 Reliability Versus Validity Mindsets

One of the main challenges with Business Design and EA is to sell and resource the vision, the plan, the architecture, the design, and how it will be executed. According to Martin (2009a, b) in Business design there are two key "mindsets", namely Reliability and Validity.

The "Reliability Mindset" is generally consistent, predictable and algorithmic. There is a persistence of the past that attempts to eliminate bias, and much is data-analytics based. Practitioners have honed systems analysis competencies as well as managerial skills that are built and rewarded. Many of the EA, systems engineering, process improvement (e.g. Six Sigma) and operations management (e.g. ITIL) methodologies are reliability based and tend to focus on enhancing an existing business model.

The "Validity" Mindset is focused on producing outcomes to meet a certain objective. Analysts deal with heuristics and wish to break with the past. They understand and manage risk and feel comfortable with little supporting data to substantiate their enterprise option. They do have honed intuitive skills and focus on looking for new business models and products.

In our case study, high level management and the consultancies, were generally validity based and the senior management and CIO staff were reliability based.

5.3.2 How Do People Reason

One of the main assumptions in systems engineering is that people are logical, rational and apolitical; however, they are not. This assumption is reflected in terms such as human "actors" and endless systematic architecture artefacts that are focused on specifying exactly who does what, how, when, where and sometimes why.

Business design is a way of conducting business and EA that is more flexible with the focus on innovation and creativity; indeed, it addresses those "non-functional" requirements key for success.

The reliability mindset, as typified in enterprise and systems engineering, mainly rely on declarative reasoning, both deductive and inductive as described below:

Deductive reasoning is normally used in business analysis and is based upon a pre-existing model. The logic is often Boolean but can also statistically deal with uncertainty. It captures the rules and core relationships of the enterprise (e.g. accounting) or profession (e.g. cancer diagnosis) and links them together in decision trees and algorithms using business rules (e.g. IF..THEN). Normally deductive reasoning is causal in nature.

Inductive reasoning is based on examining facts, looking for correlations and extracting business rules. It deals with extrapolation based on a best fit with most of the existing data and discards outliers. It is the basis for data mining and the exploitation of what is now often called "Big Data". Normally this relies on correlation as opposed to causation.

Both modes of reasoning tend to use the past to predict the future.

The validity mindset leverages both deductive and inductive reasoning as well as abductive reasoning (Pierce from Martin 2009a) which is core to business design. It deals with the "Inventive construction of theories", based on how entirely new models can be conceived, in turn based on inquires on what could be. Unlike inductive reasoning and deductive reasoning that are highly dependent on predictive analytics, it deals with the "outliers". Rather than extrapolation from the past, it looks at valid possibilities for the future.

In the case study we are referencing throughout this paper, conceptual abductive reasoning was used to present to senior management and CIO staff that were strictly focused on deductive and, to a lesser degree, inductive reasoning. Going from Stage 4 to Stage 5 e-Gov (UN 2001) was a difficult task as few, if any governments had achieved Stage 5; there were no models to reference or re-use, and it was "Blue Ocean" (Kim et al 2015). It led to an impasse as these members were very concerned about the risks associated with what amounted to revolutionary change in going from conventional well-understood program centric delivery of services to integrated, multi-jurisdictional based on life events.

5.3.3 Wicked and Hard Problems

The nature of problems often addressed by business design are often termed as "wicked", not just hard. Hard problems can be very complex but can be handled by standard analytical methods that are based on scientific method. However wicked problems are often "ill-defined and unique in their causes, character, and solution." (Martin 2009b p. 94). Further, according to Martin (2009b) They are typified by their causes being deeply ambiguous, they do not fit neatly into any category, they are ill-understood, and it is difficult to tell when the problem is solved. The very nature of the problem must be determined, in fact problem setting as well as solving.

In government, another description is that "when many legitimate viewpoints exist, and a variety of dimensions – economic, social, moral, etc. – are of import, the very notion of "goals" is unclear, … we are beyond concerns of optimization and consistency, but also beyond the powers of arbitration of science; we are in the world of wicked problems … where policy problems cannot be resolved by the scientific method." (Paquet 2013 p. 60).

The government case study in this paper was a "wicked" problem that ended up being challenging because standard analytical techniques were inadequate. Also, at the time, there were no pre-existing models that could be leveraged as a basis for framing and solving the problem. Wicked problems can be better addressed through emerging techniques, such as design thinking, in areas as varied as organizational or cultural studies (Ney et al 2015).

5.3.4 Integrative versus Conventional Thinking

Integrative thinking is defined as the meta-skill of being able to face two or more opposing ideas or models and generate a creative resolution of the tension in the form of a better model that contains elements of each model, but which is superior to all (based on Martin 2009a). It is visionary and has risk. It is in opposition to traditional trade-off analyses where the choice is often one option versus another (INCOSE 2016 p.359)

Conventional Thinking tends to focus on refining the existing model to drive through efficiencies. It is a system approach where focus is on each piece rather than the whole. Overall it is more familiar or "comfortable" and seems to have less risk.

The high-level concepts of Business Design and EA, such as TOGAF (The Open Group 2018) and the US Common Approach to Architecture Federal EA (US 2012), are virtually the

same: both are integrative in nature and both look to architecture to provide structure. Both look to avoid conventional thinking and create an overall vision into which the various individual parts fit. Problems arise when EA is misused as a framework to provide consistent architecture descriptions for the various projects without providing an overall context for their architectures.

As described in Martin (2009 p.47 Figure 2), integrative thinking focuses on the key features of salience, causality, architecture and resolution and a holistic assessment of the problem space rather than a de-centralized de-composition of the problem space into discrete parts that are solved individually. Another perspective on integrative thinking is found in Riel and Martin 2017 (p. 65) that is model based. It focuses on examining existing models, combining their best elements into a new model and then prototyping to validate and demonstrate the proposed way ahead. Integrative thinking, especially the model-based approach, is virtually identical to that espoused by many mature EA frameworks, such as TOGAF (The Open Group 2018) or COA (US 2012). Notably the documentation on business design mentions architecture but leaves it at that: essentially most EA methodologies could fill the gap. The essential difference between EA and business design is the way that the results are communicated.

In our ongoing case study, the senior management and CIO staff tendency was to "chunk" out the problem space and focus on replacement of existing systems, demonstrating conventional thinking. The senior leadership and consultancies conducted integrative thinking (using EA). They were ready to look at the overall service delivery paradigm, change it (including legislative change) and then propose a new business model. It was not focused on a one-to-one replacement maintaining the existing business model.

5.3.5 Artistic Versus Scientific Inquiry and Methods

Even though the goal of Integrative thinking is at the heart of both EA and Business Design, the core analytical approaches often differ significantly. Typical systems analysis techniques fall short when confronted with "messy" problems (Martin 2009a, b) where quantitative thinking is either not applicable or not enough. The old dictum "Not everything that can be measured matters and not everything that matters can be measured," is often true in

many areas, be they compassionate health care, creating the next "cool" techno gadget or helping a failed state get back on its feet. Indeed, in these scenarios there are quantitative measures, but there are many more qualitative measures that must be considered.

Indeed "When dedicated to the quantity-driven approach of scientific inquiry, we chronically overlook valuable qualitative aspects of the world." (Austen 2014)

Upon reflection, business design embraces mainly, but not exclusively, artistic inquiry and method whereas science and engineering focus on scientific inquiry and method. Details distinguishing the difference between the two approaches follow.

Artistic inquiry differs from scientific query as shown in Table 15 (Austen 2014). Even though the concept is presented as an "either/or" proposition, often the two types of inquiry are best pursued as part of an overall business analysis or architecture.

The challenge is that most analytic techniques (e.g. UML, Structured Analysis, ArchiMate) are scientifically biased and make it challenging to conduct artistic inquiry. Furthermore, the validation of the models by the business was a challenge as the modeling techniques are opaque. For example, in Durantin et al (2017 p. 46) it was found that only 25% of project stakeholders (including other engineers and scientifically trained staff) were able to read the models created using the System Modeling Language (SysML). Compounding this methodology challenge, many (if not most) science and engineering schools, do not teach artistic inquiry concepts. As these schools furnish the preponderance of analysts and architects, especially in the technology related organizations, many qualitative questions, options and opportunities are not discovered.

Table 15 - Ten Differences Between Artistic and Scientific Inquiry (Austen 2014 P. 63)

Artistic Inquiry	*Scientific Inquiry*
1. Results are expressed.	1. Results are stated.
2. Validity depends on the power of qualitative forms to shape our conception of the world	2. Validity depends on bias-free methods and conclusions
3. Captures undergone, felt experience and its meaning	3. Reports on low inference measurable observations
4. Generalizations are formed by qualitatively vivid single samples	4. Generalizations are based on sound statistical samples.
5. Results are presented in a variety of expressive formats and forms.	5. Results are presented in standardized reports using objective language and statistical findings
6. Says what needs saying by combining facts and fiction	6. Reports only the facts
7. Generates heuristics that provide ineffable forms of understanding	7. Generates algorithms used to predict and control future events.
8. How data are collected and presented depends upon the investigator's unique approach	8. Data is collected and reported with investigator-neutral methods and instruments
9. Knowing is rooted in emotion.	9. Knowing is emotionally neutral.
10. Aims at creating meaningful understanding.	10. Aims at making true statements about the world.

Scientific versus artistic method also vary as summarized in Table 16 from Austen (2013).

Table 16 - Artistic and Scientific Methods of Empirical Research (Austen 2014 p.65)

Basic Artistic Method	*Basic Scientific Method*
Experience Qualities	Ask a question
Generate Possible Relationships Between Qualities	Do Background Research
Undergo Experience to Create Further Understanding	Construct a Hypothesis
Create and Connect Qualities as Experience Tests Understanding	Conduct Experiments and Collect Qualitative Data
Begin Shaping Understanding into an Expressive Form	Analyze Results and Draw Conclusions
Present Understanding in a Qualitative, Expressive Form	State Results in Standardized Formats

The two methods and inquiry approaches are not mutually exclusive. In both EA and Systems Engineering (e.g. TOGAF 2009) one systematically assesses stakeholders' concerns and quantifies them to reflect them in the analysis and EA Framework. These concerns are not evident. In one case study (distinct from our main case study), the aim was to conduct surveillance on a national property. The prototype revealed an approach to secretly detect all intrusions, when the stakeholder indicated that they wanted the transgressor to know that he was detected. The "messiness" of the problem was discovered and a very "inefficient" requirement (from a system engineering perspective) was added; namely a visible physical presence to

notify the trespasser and tell them they had entered national property. A more "artistic" business design approach would have been better to address the need to make the public servants "feel" that they had the surveillance issue under control in accord with the national policies and mores.

In our main service delivery case study, the use of a more artistic approach would have been beneficial from several perspectives. Already, a typical process centric approach had been abandoned when senior management protected their processes that were mapped to services that were in turn mapped to resources then mapped to organizations they controlled. Impacting the empires led to resistance (a.k.a. "turf wars"). An information-centric approach using information engineering (Finkelstein 1989, 1992, 2006) techniques was adopted to promote holistic innovative thinking and change the paradigm. This resulted in a revolutionary approach to solving the multi-jurisdictional service delivery "wicked problem". The challenge was that the model presented in Figure 50 and walked through at a key executive meeting was not understood.

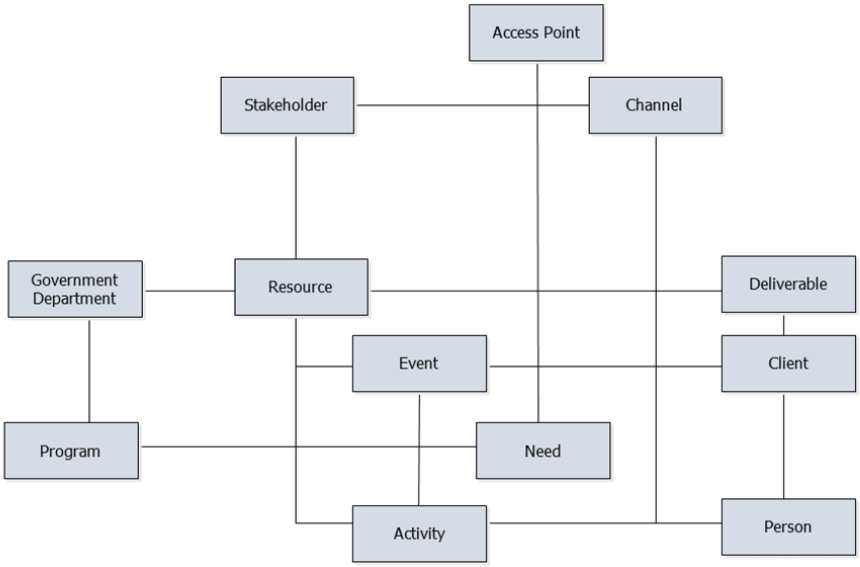


Figure 50 - Conceptual Subject Area Model

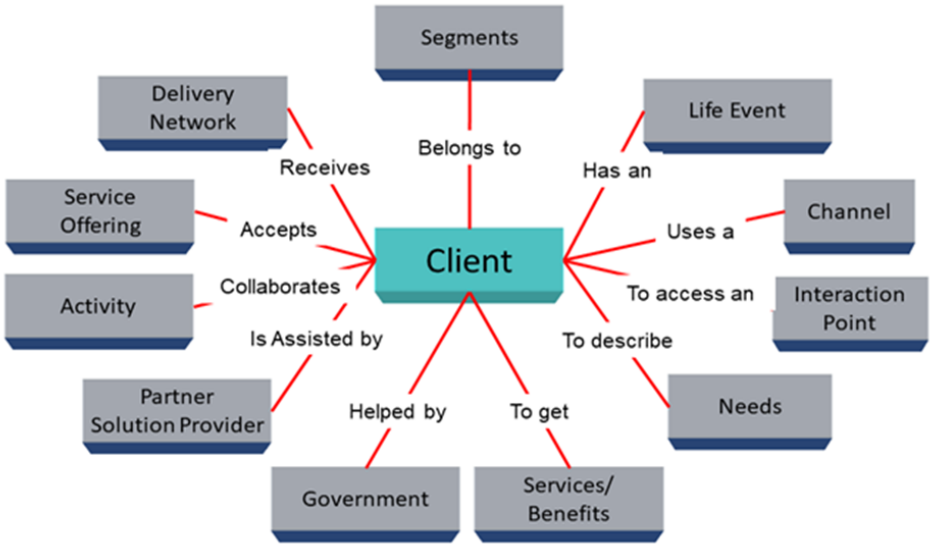


Figure 51 - Client Centric Story Model

So, the scientifically correct model outlining the key subject areas, as illustrated in Figure 50, solicited nods but it did not speak to the management team and buy-in was delayed. Some 18 months later the artistically correct client centric model in Figure 51 contained virtually the same subject areas but told a story. The Client was at the heart of the model and the story was that clients belonged to a client segment (e.g. citizen, resident, business and so on) and then they had a life event. The client used a channel to access an interaction point where they described their needs. The needs were then translated into available services or benefits that were provided by the governments and their partners. Then an activity occurred to consolidate and integrate the benefits in the form of a service offering that, once accepted, was delivered using a delivery channel. The actual "correct" conceptual subject area model Figure 50 was used for implementation.

The need and a way to combine artistic and scientific should be part of any EA or Business Design effort as illustrated in the following section.

5.3.6 Realizing Business Design

There are several ways of realizing business design. Fraser (2012a) has elaborated the three steps (or "gear") concept of business design, breaking down the activity as:

a. Step 1 – Empathy and Deep Human Understanding;
b. Step 2 – Concept Visualization; and

c. Step 3 – Strategic Business Design.

Note that the "architecture" of Integrative Thinking (Martin 2009a) is gone (or replaced by Design).

Fraser (2012a, b) places a great deal of emphasis on the human dimension with activities such as deep need finding and inspiration. The analysis is both scientific (quantitative) as well as artistic (qualitative). The need for empathy with customers and citizens is well covered in Battarbee (2015).

The concept of empathy and deep human understanding are often subsumed by engineers and scientists in the pursuit of what is logical, effective and efficient. In our ongoing case study, the key issues were "fear" and "comfort zone". The fear of a revolutionary as opposed to an evolutionary approach was not fully appreciated in that there were valid concerns about the ability to continue delivering services during the transition. For example, the "traditional" help desk, manned by junior staff for a very specific program, would be replaced by senior staff at a service desk catering to client segments and advising with respect to a wide range of life event-based services/benefits. The focus was the client journey rather than also taking into consideration the service delivery journey as well.

From a "comfort zone" perspective, in the case study, many of the management team were very experienced but on the cusp of retirement. A turbulent business (or digital) transformation was not to be looked forward to. Added to this were the top-level anticipation of legislative change which senior management was not eager to pursue given the political uncertainty attached to new laws. The major impact of these factors was not fully appreciated in the elaboration of the architecture and plan.

Business design promotes concept visualization with the focus being the creation of a vision based on the assessment of multiple potential ideas and concepts. The main vehicle for this visualization is prototyping. Often the innovative idea is couched in the term "mystery" that the business must unravel. Through analysis many of the concepts are couched as rules of thumb or "heuristics" (e.g. non-algorithmic business rules with degrees of uncertainty) and finally many are distilled into algorithms that are candidates for automation. Martin call this the Knowledge Funnel (Martin 2009b) but similar techniques have been in use in expert systems analysis for decades in terms of heuristically exploring alternatives (e.g. Winston 1985 P.88).

As previously noted, in the case study, as the key model (Figure 50) was ill-understood. The "prototyping" consisted of a walk-through of illustration graphics showing how the model could accommodate various life events and support the new service delivery paradigm. That did not work as the original models were incomprehensible to most stakeholders. There was apprehension whether the new paradigm would work and there was obviously no iteration in the prototyping cycle. The presentation was totally based on logic and there was no empathetic attempt to address issues that would impact the executive audience, including whether their jobs/empires were gone, or their work made much more complex.

Further in business design, once the concept and vision have been established the need is to create a plan as a basis for action. The concepts from Fraser (2012a, b) do not differ greatly from standard EA techniques (e.g. "Quick Wins" in TOGAF [The Open Group 2011])) or strategic concepts such as the Foundation for Execution (Ross et al 2006 p. 10) where EA acts to validate the business strategy/plan activities. In the case study, most of the effort was spent describing the target architecture whereas the key concerns of senior management were how to get there. Although this difficult area is (now) better addressed by EA, the subtle difference is that in EA (e.g. Ross (2006), TOGAF (The Open Group 2018)) analysis is scientific and quantitative, whereas in business design is more qualitative and empathic. Specifically, logic in EA might dictate a more direct and efficient transformation plan, whereas business design would focus on a more indirect but effective one. In the case study, the latter might have worked.

5.3.7 Concepts and Characteristics of Exploration and Exploitation

Another key concept of business design is the differentiation between exploration and exploitation. According to Martin (2009a, b) there are two themes associated with analysis, namely exploration of new ways of doing business or exploiting the existing business. EA invariably tends towards exploitation with inductive and deductive reasoning. However, when coping with competitive pressures and pushed by the merciless S-Curve of continuous innovation (e.g. Nunes and Breene 2011), many business leaders, primarily in the private sector, are always looking at exploration. Table 17 highlights some of the characteristics between the two themes.

Table 17 - Themes - Exploration versus Exploitation (Martin 2009b p. 20)

	Exploration	***Exploitation***
Organizational Focus	The Invention of the business	The administration of the business
Over-riding Goal	Dynamically moving from the current knowledge stage to the next	Systematically honing and refining within the current knowledge state.
Driving Forces	Intuition, feeling, hypotheses about the future, originality	Analysis, reasoning, data from the past, mastery
Future Orientation	Long-term	Short-term
Progress	Uneven, scattered, characterized by false starts and significant leaps forward	Accomplished by measured, careful incremental steps
Risk and Reward	High risk, uncertain but potentially high reward	Minimal risk, predictable but smaller rewards
Challenge	Failure to consolidate and exploit returns.	Exhaustion and obsolescence

The attitude towards risk is a major challenge. It inhibits companies from moving innovatively and staying in exploitation mode as long as possible. A prime example of exploitation is Kodak, a major company that held the patent for the digital camera, but refused to move from their "dominant dogma" (Prahalad, C.K. and M.S. Krishnan 2008) of film; indeed, it had become the basis for their entire company organization and it drove them into obsolescence (Hamel 2007).

In our case study, risk was a major concern and the previously alluded to "comfort zone" led to senior management wanting to exploit the existing business model using updated technology, rather than use the technology to enable a different business paradigm. One of the challenges in government is that the notion of competition is rarely present; it takes leadership to change business models and attention to qualitative issues is key to success.

5.3.8 Management versus Leadership

Business design literature does not directly address management and leadership, but they are key to making digital or business transformation work.

The definitions and differentiation between management and leadership vary, but the ones used in "Leading Change" by John P. Kotter (Kotter 1996 p. 26) have a degree of acceptance.

a. "Management deals with planning and budgeting to create a resourced plan, organizing and staffing as a structure to accomplish plan requirements and then control-

ling and problem solving to handle unexpected issues. Thereby management produces a high degree of predictability and order to consistently produce the short-term results expected by various stakeholders.

b. Leadership establishes direction in the form of a future vision, aligns people to create teams and coalitions to support the vision and motivating and inspiring people to overcome hurdles to change. Thus, leadership produces change, often to a dramatic and useful degree." (paraphrased from Kotter 1996 Exhibit 3)

In the paper case study, senior management were expert managers of the organization and knew the business inside out whereas the executive leadership and consultants had considerable government experience. Senior management represented management excellence for the existing business operating model, which was decades old and only partially leveraged technology. Conversely the executive leadership exuded confidence in a new model that changed service delivery from that of citizens having to apply for each one of thousands of programs to automatically push the benefits to citizens eligible based on integrated corporate knowledge of the citizen ("client") using technology.

5.4. Organizational Tensions Between Reliability and Validity Mindsets

Upon reflection, the case study, and its derivatives, demonstrated that the business design differentiation between the reliability and validity mindsets was very useful and was indicative of many issues encountered in this government service delivery modernization case study. The mindsets enabled the categorization of associated qualities that would guide the leadership approaches to realize digital transformation. They are equally applicable to the private sector as will be explained below.

Within an organizational executive team with different "mindsets", tensions arise between visions of reality. In the case study, the executive vice president equivalent, a select set of senior managers and a set of consultants had a visionary, validity mindset. The audience were the vice-presidents who were promoted as a function of sustaining service delivery in the current legislated paradigm. They owed their positions to managing a reliable, consistent set of services and collectively they had the power to block the new approach. Their mindset had permeated the architects working for them.

Using the business design concepts previously elaborated, the tensions are summarized in Figure 52 followed by a short description based on the case study.

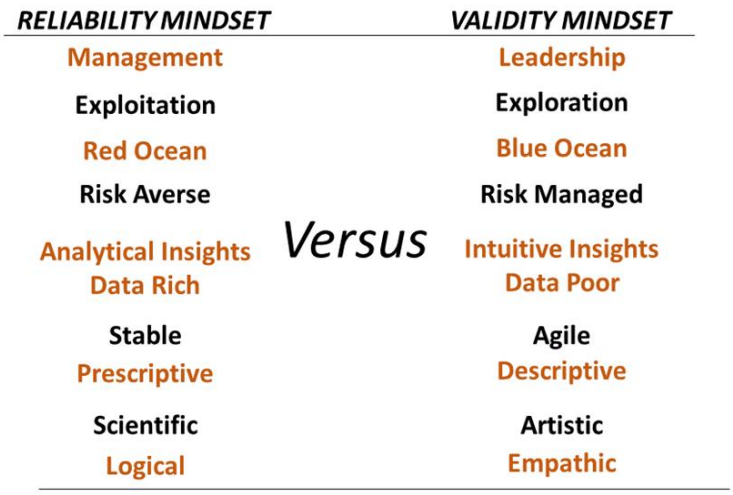


Figure 52 - Organizational Tensions in Addressing Wicked Problems

5.4.1 Management versus Leadership

Clearly leaders must be capable of validity thinking as well as have the personalities to enact change. They also need to communicate direction and inspire people. In the case study, communication was hindered by using ill-understood modeling notations that resulted in friction rather than the creation of a management coalition to realize the vision.

5.4.2 Exploitation versus Exploration

In the case study, the reliability-oriented senior managers were reluctant to abandon the existing model and wanted the transformation effort to focus on the improvement and exploitation of the existing services, including the rationalization of the aging IT.

The validity-minded executive leadership wanted to explore new methods of service delivery.

5.4.3 Red Ocean versus Blue Ocean

This concept from Kim and Mauborgne (2015) considers that Red Oceans are characterized by intense competition using a well-established business model, whereas a blue ocean

is characterized by a move of an enterprise into a new market space with a minimum of competition.

In the case study, reliability-focused senior management focused on continuous service improvement (e.g. ITIL 2011) rather than realizing that the fundamental model with which they were comfortable was no longer relevant. The validity focused executives and their consultants looked at innovation in the marketplace and intuitively realized that the current model for Stage 5 – Seamless was non-existent.

Government is a particularly difficult place to drive change as there is not much competition to deliver government services (even though that is evolving in cases such as postal delivery).

5.4.4 Risk Averse versus Managed Risk

Reliability-focused individuals generally dislike risk and quantitatively seek ways to minimize it. For them (in this case study) they were not uncomfortable with the vision, but the target architecture proposed by the validity minded executive made them very uneasy. It was a drastic revamping of service delivery. The key lesson learned by the executive and consultants was that there should have been a detailed implementation and migration plan, to show an orderly transition to the new architecture to assure the reliability-based senior management of its feasibility.

The challenge was that in a "top-down" innovation initiative, the ability to formulate a detailed implementation and migration plan, before getting the vision confirmed is virtually impossible. However, a high-level roadmap (e.g. TOGAF Phase A The Open Group 2018) is feasible and active prototyping (as per business design) is a way to assuage the reliability mindset.

Governments also have numerous policies and legislation that must be respected for transformation to take place. Risk averse practitioners preface these policies with numerous (~10-15) other policies that also must be respected to "reduce" the risk of error. In the case study, tens of policies and pieces of legislation were meticulously analyzed over several months for requirements (classified as business, information and technology) to determine what must be done and conversely not done (constraints). Intuitively the validity thinkers realized that there were no insurmountable issues, but the reliability thinkers wanted assurances.

Regardless this analysis was needed by both the enterprise architects and systems engineers. The enterprise architects used it to determine what was doable within the current policy framework, as well as identifying what policies or legislation would need to be altered. The systems engineers would need the resultant analysis to detail their solution architectures.

5.4.5 Analytical Insights (Data Rich) versus Intuitive Insights (Data Poor).

The advent of analytical insights generated from data-warehouses (with or without "Big Data") offers many opportunities to look at what has happened to determine how to proceed in the future. This is a time-proven way of gaining analytical insights to improve services and is favored by reliability thinking individuals (senior management in this case study) to substantiate their strategy of incremental improvements.

The validity individuals (executive leadership and consultants) also reasoned intuitively but with a limited amount of data to substantiate their vision and proposals. Often prototyping and the incremental execution of the visionary plans (e.g. Ross et al 2008, TOGAF 2018) promotes success and makes up for the lack of data.

5.4.6 Stable versus Agile

The reliability mindset tends to value stability, especially in a government setting where the current service delivery satisfies the complex web of government legislation.

Indeed, in the case study, senior management was quite comfortable with the existing "system" and would have been happy to just update the existing obsolescent technology infrastructure and leave the business as-is. The validity executive leadership viewpoint was much more agile. Rather than spending $500Million to create new "old" systems, the executive regarded it as an opportunity to renew service delivery based on revised legislation, but the reliability senior management considered legislation to be immutable.

5.4.7 Prescriptive versus Descriptive

There is a tendency for reliability-based personnel to be more prescriptive and they tend to have a systems analysis/engineering viewpoint. They dread mistakes and avoid risk by making detailed analyses, often falling into the trap of "analysis paralysis". Presentations are

a continuum of slides containing minute detail that is often not comprehensible. Everything is based on minutely specified templates which are carefully filled in. Often the resultant plans are inflexible and are rapidly overtaken by events. A classic case was in Levette (2005), where he illustrated the example of a 25-centimetre-high stack of design documents in painstaking detail for the target state of select Canadian government services in some ten years' time. His comment was that it was obsolete the minute it was printed, let alone ten years hence. Reliability prescriptive thinking drove the creation of these expensive documents that the rapid pace of technology change rendered 90% of the document useless.

Validity based thinking results in a limited, "just enough" amount of rigour that focuses on outcomes, instead of detailed process, relying on competent, de-centralized decision-making. The concept of abstraction allowing for conceptual, logical and then physical transition architectures in tiered time slices, was embedded in EA frameworks such as TOGAF (The Open Group 2018) with the intent of creating "just in time" and "just enough detail" architectures to support incremental rather than waterfall delivery.

In the case study (and derivatives) there was a need for a conceptual model of life events and of the attributes of a citizen. The prescriptive engineers created two slides one with 1400 life events and another with 400 attributed entities related to citizen. They were complete and illegible. These were reduced to 12 key life events and some 10 main citizen attributes on office automation graphics software that were easily consumable by the management office.

5.4.8 Scientific Versus Artistic

Not surprisingly, the scientific mindset prevails in the scientific communities (e.g. CIO) and the artistic in the business communities. This is a generalization, but engineers do not like having their bridges fall into the water and as 80% of start-ups fail within 18 months [Wagner 2013] engineers generally feel that the scientific method and inquiry is much more reliable.

In the case study, there was a need to get an emotional response to get participants energized and excited to tackle the "wicked" problem of Stage 5 – Seamless e-Government (UN 2001). The presentation was logical, and the audience started thinking of why it would not work before it ended. The implementation issues were trivialized, exacerbated by the fact

that the main presenter was a “world-class expert” consultant who would not participate on the actual digital transformation.

The scientific method puts a premium on deductive and inductive reasoning, whereas artistic methods focus on abductive reasoning. Balancing the scientific and artistic approaches is conducive to long-term success in business and government.

5.4.9 Logical versus Empathic

As previously described, empathy entails a deep understanding of individual and group needs and may include. but is not limited to, a “logical” analysis of said needs. The scientific method tends to focus on the user journey or user experience, particularly with respect to end clients. However, the reality in digital transformation is that the users not only consist of clients but also include service delivery, the management ranks and, emerging, intelligent systems. Foregoing the latter for now, the major impediment to effective transformation and improved service or better profitability may well be unmotivated and uninspired employees and management, regardless of how thrilled end-users may be. There is increased emphasis on user experience and user journeys in the scientific realm.

Validity thinkers tend to be more empathic than reliability thinkers. The latter are primarily concerned with the constant discovery of efficiencies in the exploitation of the existing business model, whereas validity thinkers are working on the next business model and need to be able to motivate and inspire stakeholders to transform.

5.5. Conclusion: What is the Impact of Business Design on EA and Systems Engineering?

Business design is an intuitive, descriptive, heuristics-based approach to create a vision that can motivate stakeholders to implement a new environment or service or product. It is easy to comprehend and immediately communicates value. Will it succeed without EA and one or more accompanying systems engineering analyses (e.g. CESAM 2017, INCOSE 2016); probably not.

5.5.1 Systems Engineering and EA

There are unnecessary tensions between systems engineering and EA. As previously noted, EA came from the systems engineering world (e.g. TAFIM [US DoD 1994], which was the ancestor of TOGAF [The Open Group 2018]) to solve the macro issues associated with large, complex environments. EA used the models describing the resolution of the macro issues to enable a hand-off to micro design or engineering tasks using more granular methodologies. Yet Vision 2025 (INCOSE 2014), the CESAMES Systems Architecting Method (CESAMES 2017) and the Systems Engineering Body of Knowledge (INCOSE 2016) discussing the handling of large, complex environments yet make no mention of EA and the 30-year body of frameworks and lessons learned.

Although the Vision 2025 (INCOSE 2014) document outlines a solid case for systems (engineering) thinking as applied to major global challenges. Some of the actual methodologies such as CESAMES 2017, claim to solve the world's issues using an electric toothbrush case study including mathematical models related to the environment and linked to state transition diagrams. This highlights the very difficulties experienced by business personnel with technology experts as business concerns are often "wicked" problems, for example meeting Paris Accord Climate Goals or achieving Stage 5 – seamless eGov (as per the major case study in this paper). Business often deals with modal as well as Boolean logic, integrative thinking rather than trade-offs, effectiveness as well as efficiency and with heuristics as well as algorithms.

Notably the MITRE Systems Engineering Guide (MITRE 2014) provides a more end-to-end analysis that incorporates the US DoD Architecture Framework (US DoD 2009) whose EA constructs are mandatory in the US Department of Defense. Conversely the EA methodologies reference system engineering throughout. The Architecture Modeling Language Archimate (The Open Group 2016) is a high-level language with which to implement EA Frameworks such as TOGAF. It captures business concepts, is readable by business staff and is designed to hand-off to the more granular languages used by systems architects such as the Unified Modelling Language (UML), Systems Modeling Language (SysML) and Business Process Modeling Notation (BPMN).

5.5.2 Business Design and EA

In the same vein, business design literature makes little mention of EA and some mention of systems thinking (not engineering). This is not too surprising as business design comes from the business schools and EA comes from IT/systems engineering world. Having said that, at The Open Group conference in Toronto (Canada) the Rotman School of Business Designworks (Leung 2009) presented a high-level linkage between business design and EA as illustrated in Figure 53. It shows EA focusing on IT which is no longer the case as global standards such as TOGAF (The Open Group 2018) have realized the criticality of getting the business architecture sorted out. For example, in 2009 TOGAF Version 9 incorporated capability-based planning, risk management, management framework interactions, and business value, to name a few, using business planning methodologies. In the US government, the Common Approach to Federal Enterprise Architecture (US 2012) extensively covers numerous domains in an end-to-end methodology.

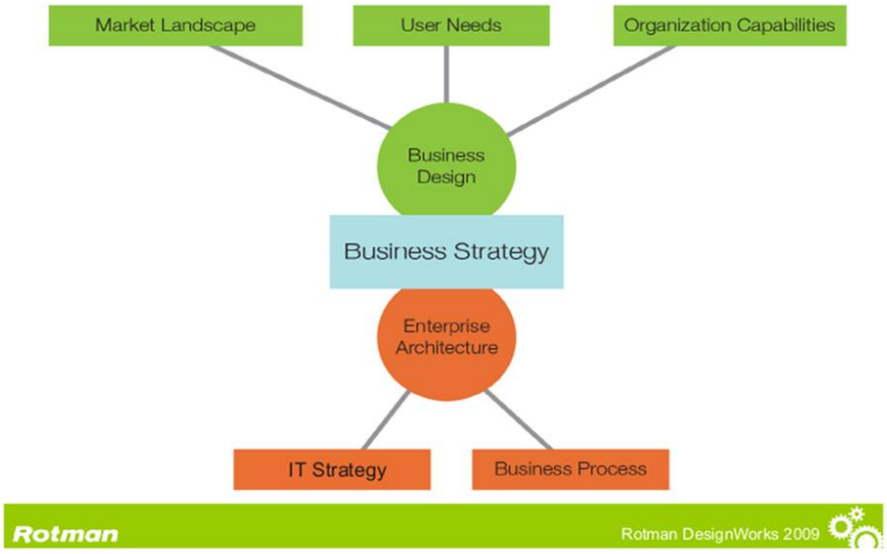


Figure 53 - Bringing EA and Business Design Together (Rotman 2009)

Figure 53 is also misleading in that business design is used for more than strategy (e.g. Fraser 2012 a, b) and drills down into the systems level with extensive prototyping, design and implementation including IT and business processes, just like in product design. This approach could work if EA, systems engineering, and business design are completed in an integrated manner. Although one of the initial goals of EA was indeed to standardize platform services across an enterprise, enabling enterprise sharing of applications and data, it has been expanded

(e.g. TOGAF 7 (2001) to TOGAF 9.2 (2018)) to address holistic enterprise transformation, including the generation of business strategy.

EA and business design are realistically two sides of the same coin. Both frameworks are holistic with the shared aim of conducting integrative thinking to create new business models. Conducting these activities in isolation brings incoherence and disables effective systems engineering. All three methodologies require each other, yet their siloed formulation in business and engineering schools as well as professional associations (e.g. The Open Group), where often they do not even reference each other, hampers the realization of synergistic benefits of their integrated application to the enterprise.

EA and business design practitioners complement each other with the former tending to use scientific and the latter artistic method and inquiry. EA is more reliability based whereas business design is more validity based. Both focus on creating a model and determining how the pieces fit together over time. Given the pervasiveness of technology and its criticality in realizing business value, it is not helpful to create intellectual silos separating business and technology thinking.

Practicing EA and business design together creates a healthy tension that ensures constant innovation and ensuring the enterprise remains viable during the transition. Figure 54 illustrates another more realistic way of the integrated use of EA and business design than Figure 4. Based on the case study used throughout this paper, this integrated approach would have saved much time and effort, as partially indicated in Figure 50 and Figure 51, which cost the program some 18 months, but in reality the inability to communicate effectively the new business model disabled its fielding. Changing business models in any complex enterprise, such as government, may take up to ten years to implement and when a transformation window is missed, it may take another decade before a new attempt is possible.

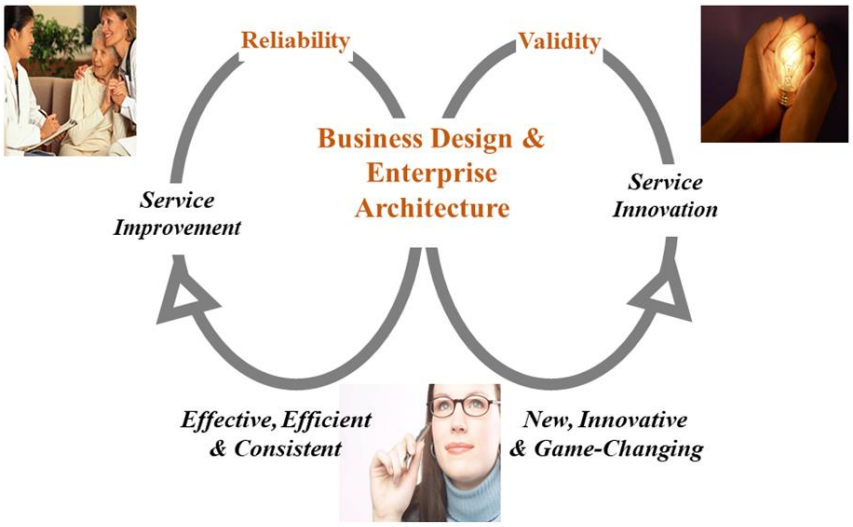


Figure 54 - The Necessary Business Design and EA Mindset

5.6. Enterprise Rather than Business or Technology Driven

A principal feature of business design, EA and systems engineering is that they are business driven frameworks (e.g. TOGAF Architecture Development Method [The Open Group 2018]). This is at the heart of the business design proposal (Figure 4) where business design delivers business strategy to EA (albeit with some IT input) that gets on and implements it in conjunction with systems engineering.

In the case study, the business transformation and strategy were premised on a foundation of the innovative application of existing technology with which to deliver services domestically across jurisdictions. To a large degree, it was technology driven rather than business driven.

Business may not be aware of the potential of current and emerging technology, whereas the technology organization may not be aware of what potential business value could be delivered by technology.

It would be safe to say that much (if not most) competitive advantage or improvement to service delivery is technology based; hence it is imperative that the business and technology collaborate closely to formulate a coherent business strategy that leverages all assets available to the enterprise.

In practice this is rarely the case. Enterprise management silos typified by the business design / EA split are further exacerbated by the split between EA and systems engineering previously discussed. In a recent EA practitioners conference in Ottawa, a former chief enterprise architect (Doucet 2019) claimed that EA was generally not empowered and, as projects had the funds to execute architecture, then architecture should be elaborated at the project rather than at the enterprise level. Notably project architectures are normally systems engineering driven. Essentially this cuts out holistic enterprise architecture direction except at the policy level. This tendency contradicts the intent of the US and Australian EA frameworks where the EA cell is part of corporate Planning and Budgeting (e.g. Australian Government Architecture 2009), rather than in the CIO organization as is currently prevalent.

This calls for management innovation and collaboration between the various organizations involved in business and digital transformation.

5.6.1 Fielding New Business Models – The Real Challenges EA and Business Design can Address

The difficulty of fielding a new technology-enabled business model in a complex environment is well illustrated in Figure 55. This figure from Van de Velde (2003) is a bit dated, but still reflects the challenges surrounding the implementation and derivation of business value from new technology, as typified in the case study used in this paper.

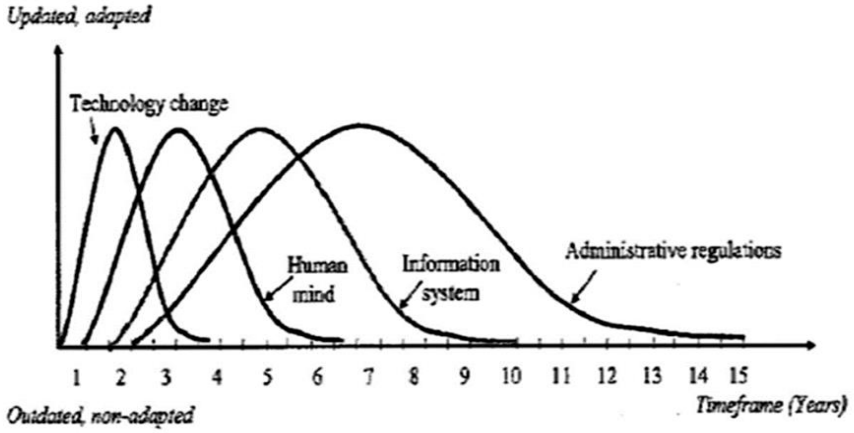


Figure 55 - Impact of technology change on human mind, organization and administrative regulations (Van de Velde et al 2003 Figure 1.10)

If there is any worthwhile service to be rendered by business design, EA and systems engineering it lies in reducing the time elapsed between technology change to the formalization

of relevant regulations. Targeting the timeframe, it would be a solid goal to reduce the years to months, in part to ensure that obsolete technology does not underly the enterprise transformation. This can only be achieved by a close working collaboration between technology and business. As an aside, a large organization may have hundreds of projects running concurrently and their perspective is akin to looking at the enterprise through a straw. Expecting projects to holistically understand the enterprise and then collaborate and create interoperable services thereby introducing risk into the managed time, cost and scope dimensions of project management, is unrealistic. The impact and effectiveness of project-driven EA (Doucet 2019, Slide 4) is tactical and not strategic.

From a case study perspective, the risk introduced by the curves in Figure 55, created unease amongst the reliability-thinking senior management and was not well understood by validity thinking executive leadership. Senior management preferred to create loosely coupled, project-based systems to replicate the current way of doing business on an invisible (to the service delivery and client base) renewed technology base avoiding the human mind and administrative regulations curves. In essence new technology underlying old ways of doing business.

5.6.2 The Way Ahead

Business design involves a new set of business and general architecture skills that should be understood by all enterprise and system architects. Intuitive thinking complements standard analytical thinking to help solve both hard and wicked problems. Having both reliability and validity mindsets in the enterprise generates a healthy tension that ensures that decisions are well-thought out and risks managed in a consistent manner.

The following points should be considered for future work:

a. Business design concepts should be integrated into EA and system engineering methodologies.
b. EA and systems engineering concepts should be integrated into business school curricula
c. Restrict the exclusiveness of communities of expertise and encourage “cross-pollination” collaboration.

d. There is a need for a unifying framework that incorporates business design, EA and systems engineering
e. Ideally there should also be an overall framework for loosely unifying all concepts within the govern-plan-build- run cycle and reduces the time to market.
f. Also use “generalists” rather than just “specialists” in the CIO organization to ensure that all dimensions of so-called “wicked problems” can be taken into consideration.

Ideally members of the emerging knowledge-based enterprises will have a bit of both mindsets. Unfortunately, this is difficult. With the increasing specialization in education and the demise of the “generalist”, there are few, if any, institutions that promote both types of thinking.

Chapter 6. Enterprise Architecture: Bridging the Business-Technology Divide

This chapter is based on a paper entitled "Enterprise Architecture: Bridging the Business-Technology Divide" that was submitted to a business journal.

6.1. Introduction

Enterprises are increasingly dependent on technology to deliver competitive advantage, but their efforts, using the current management frameworks is failing. There are many underlying causes, but many of the symptoms are reminiscent of the late 1980s, when the first wave of information technology (IT) implementation hit a wall and an innovative approach was needed. Enterprise Architecture (EA) was created as a business-driven management framework to provide a holistic and more orderly approach to leveraging technology to benefit the entire organization rather than just individual services and processes. It deals with the organization of the digital knowledge, information, and data assets at the enterprise level. Unfortunately, EA has been misunderstood, relegated to the technology community where it has, with certain exceptions, languished.

This chapter examines the business and technology issues and recommends that it is time to resurrect EA as a rigorous business planning function. When effectively implemented by leaders who are technology-competent and think strategically, EA enables enterprises to manage their diverse physical and intellectual property assets and selectively inject technology into the organization in an innovative, agile and efficient manner. Thus implemented, EA also bridges the business–technology divide by introducing technology competence earlier in the business planning cycle and making technology specialists active participants in the business.

The chapter contents are based on both experience and research, conducted by the author who has worked for more than 30 years incorporating "new" technology into large enterprises. Starting as a military expert in plans and operations, the author was immersed in a revolutionary defence R&D pathfinder effort for battlespace digitization in 1985. The author has used enterprise architecture (EA) since 1993, to bridge the ubiquitous business-technology

divide and since 2004 he has been an active member of The Open Group Architecture Forum, a major contributor to global EA standards, such as TOGAF, and is also very active in numerous professional associations.

6.2. The Digital Enterprise and Enterprise Architecture

In a company, everything is potentially digital, from the robotics or cash registers on the shop floor to client service and the corporate decision-making process. How to create and leverage this digitization requires a transformation in the way that corporations govern, plan, build and operate their institutions, not just the introduction of a clever technology. Compounding the problem of technology adoption, is the dearth of technology-competent executives resulting in management decisions bereft of the insight required to determine whether recent technologies will deliver business value and/or expose the enterprise to serious risk. Similarly, engineering and technology experts tend to be siloed into organization units that isolate them from business knowledge and decision-making.

This business-technology divide impedes the creation of a successful digital enterprise. It was partially addressed by the creation of architecture at the systems and enterprise level in the 1970s and 1980s. Architecture was also integrated into business planning methodologies to bring structure to planning at all levels of the corporation by the creation of the Office of Strategy Management (Kaplan and Norton 2008) and Integrative Thinking (Roger Martin 2009). The issue, as always, is how architecture can be defined, scoped and applied.

There is also a fundamental management weakness in creating a learning organization, as illustrated by stubbornly high 60% software project failure rate (Guillaume-Joseph and Wasek 2015b, p. 40) that has not improved since 1997. More importantly, the causes of failure are the virtually identical to those outlined in the PRISM report in 1986 (PRISM 1986). This indicates that potentially 60% of digital strategy fails. It also indicates that current practices either do not work or are poorly applied.

With global connectivity, (the “internet of things”) and digitization, stand-alone systems no longer exist. They have evolved from mechanical to electrical to software driven (Schäfer et al 2016) in areas such as avionics, assembly lines, sensors, appliances, as well as sales and marketing. The dependence on software for all technologies makes the failure statistics ever-more critical for enterprises looking to introduce innovative technology.

Given the convergence on software-driven technology solutions, IT-related frameworks should be appropriate to address technology issues in general. This convergence has also expanded the responsibilities of the CIO, who is now dealing with all connected systems, many of which were under the direct control of the lines of business. A small example is security, where hitherto isolated control systems (say for a city water plant) built on a dated operating system are now connected and vulnerable to a host of cyber-threats that can compromise the entire enterprise. This has understandably led to friction in the boardroom and the shop floor.

The question is how to effectively inject modern technology into the enterprise? Naively adopting the latest "shiny" technology, such as Analytics 3.0 and Artificial Intelligence (AI), may provide business value but will often lead to confusion, cyber-compromise or even bankruptcy. For example, $62 Million and five years were lost by Cancer Treatment Centres of America (Davenport et al 2018) experimenting with IBM Watson in a "moonshot". Most companies could not just write off losses of that magnitude.

Do we throw away existing techniques? Not necessarily. Throwing the "baby out with the bathwater" is a recipe for chaos rather than productive transformation. Adapting existing best practices to accommodate digitization opportunities is a solid approach we will pursue in this chapter.

6.3. Enterprise Strategic Management and Leadership

The first question is whether we have the necessary tools to handle digital transformation. Three stand-out, namely

a. strategic leadership;
b. an awareness and understanding of technology; and
c. rigorous planning in the form of architecture.

6.3.1 Strategic Leadership

Leadership has been defined in countless books, but fundamentally it involves being visionary, exploiting new business models and motivating people to move out of their comfort zone. Management tends to support and exploit the existing business model, making it more

efficient and effective. Leadership includes the exploration of new business models (Martin 2009 p. 18) to sustain long-term profitability and service excellence. Kodak was well managed but not well-led when it succumbed to "dominant logic" (Pralahad, Krishnan 2008 p.149) and discarded its patent on digital imagery, in the misinformed belief that film would be around forever.

Strategically top-down and bottom up leadership must be balanced, and innovations must be integrated. Summarizing work from Ross (Ross et al 2006), Westerman et al (2014a and 2014b), as well as The Open Group (2017), the need to recognize, change or adapt the corporate business model means that many key decisions must be made at the strategic level. Either that or the operational and tactical levels of the enterprise act independently to realize their business goals. This situation is not sustainable and strategic leadership is needed to encourage both bottom-up and top-down technology insertion.

Social dislocation needs to be addressed, even though it is hardly a footnote in the digital transformation literature. A duty of care towards your employees is a key leadership attribute and is reciprocated by employee willingness to transform. Although considered to be idealistic, once one has gone through a strike or two along with the long-term bitterness they engender, it far from irrelevant. It is estimated that 66% of US jobs are at high (47%) or medium (19%) risk of robotic takeover (Ross A. 2016 p. 38). A strategic approach determines what skills are needed or becoming obsolete. It prepares the company to deal with the situation, be it education, planned redundancy, lay-offs or any combination thereof.

Then there is the need to strategically manage risk. Anything new engenders risk, but now cyber-security and privacy are emerging as key issues. Although litigation is commonplace in traditional engineering domains (e.g. bridge collapse, dam failure) it has been relatively rare in information technology related matters. This is changing, with fines in the billions of dollars for violation of privacy rights legislation (e.g. Facebook EU Fine) and an emerging appetite to punish the implementors of insecure technologies or code (Rosenzweig 2018).

6.3.2 Technology Awareness

The boardroom must understand what technology can realistically deliver in terms of business value. The virtual absence of engineers, or those comfortable with technology, in the

modern corporate boardroom (except for a few high-tech companies whose products are the very technology other companies need) impedes holistic thinking. Creating a digital enterprise is corporate transformation and is much more than plugging in the latest technology or implementing the latest "silver bullet" to solve corporate challenges.

Many organizations still address technology in terms of information and communications technology (ICT), whereas digitization addresses the end-to-end insertion of technology and sharing of information from cash register to boardroom.

Technology should not be in a constant struggle to align itself with the business; rather it should be an integral part of business model and the provision of corporate business value.

In current models, IT is a separate process that is always aligning with the business. In the digital enterprise, technology is a (or the) prime driver of profitability.

In "Leading Digital", Westerman, Bonnet and McAfee (2014 P.17) studied some 391 large (<$500Million) companies in 30 countries to assess what makes some succeed and others fail. Their categorization of companies in the study is very insightful, but the upshot is that successful corporations look at digitization as something that must be addressed at the strategic level, with technology-conversant individuals as part of the initial planning team.

6.3.3 Architecture-Based Rigorous Planning

It takes planners conversant with technology to conceive ways to address the concerns of internal and external stakeholders (e.g. 3rd party information sharing) to maximize the benefits within market and regulatory constraints. In the public sector it takes similarly competent experts to clearly indicate what must be included in new policy or legislation to make better use of technology. It takes strategic leaders, for example, to change the corporate culture from a duty to protect to one of secure information sharing to "connect the dots" using the best available technology.

Involving technology-competent individuals from the outset in strategizing, is necessary to expedite the effective and efficient integration of innovative technologies, including cost-avoidance by re-purposing existing assets. A challenge is that 6.7% of engineers supervise more than 19 employees, and although they are organized and logical thinkers, many engineers have been accused of not seeing the "big picture" and not being "people" persons (ASQ 2014).

Consequently, few engineers are in a management or leadership position, allowing them to bring their technology expertise to bear at the enterprise level.

In one utility company, the financially focused (and trained) individuals in corporate management did not like the message engineers were giving them, so they fired them and carried on in pursuit of technological innovations they did not understand. Will this end well?

Technology integration challenges cannot be wished away or be banished by firing the bearers of bad tidings. They must be looked at in a holistic and rigorous manner realizing that leveraging technology is often a "wicked" problem. Engineers (and scientists) use architecture and design as techniques to simplify a complex environment and illustrate potential solutions and outcomes.

In business, the need for architecture is nothing new. Kaplan and Norton (Balanced Scorecard and Strategy Maps) created the Office of Strategic Management including the function Architecture Planning (Kaplan 2008 P.19). In the Office of Strategy Management (Kaplan and Norton 2008), the role of an architect was introduced to explicitly define the "philosophy of performance management and the processes required to execute" (Kaplan and Norton 2008 Page 19 Figure 1-4). Similarly, in his discussion of holistic integrative thinking Roger Martin proposes that architecture provides the ability to visualize the whole while working on the individual parts (Martin 2009 P.47). However, both widely used methodologies (Balanced Scorecard and Strategy Maps – Kaplan and Norton, Business Design by Roger Martin 2009b) and their derivatives, do not elaborate on the concept of architecture. If anything, they reinforce the need for integration, without realizing that architecture is all about integration.

Although deemed important, architecture is rarely incorporated into business planning. A notable exception is in defense, where the concept of data-driven, architecture-based planning has long been used to deal with complexity and to securely introduce new capabilities using the latest technology. (US DoD 2009 – Volume 1 – p. 29). The digital enterprise embodies transformation and it requires a coordinated approach through the Govern-Plan-Build-Run cycle to succeed. Enterprise Architecture may be of assistance to both the business and technology cadres, if only providing an integrated management environment data store that all executives have access to, instead of the individual data stovepipes in each organizational grouping.

6.4. The Role of Enterprise Architecture (EA)

EA was introduced to help everyone in the organization get a "grip" on integrating the technology. Has it worked? The answer is "no" because few are using it as it was conceived. When EA was formalized as such in the United States, the US Government created the CIO position in all government organizations (US Govt 1996) and then issued a strategic directive (US Govt 1996b) mandating the use of EA to realize e-Government and strategically manage information resources. So instead of being an integral part of an Office of Strategy Management almost all EA directorates in private and public sectors are now in the Chief Information Officer (CIO) organizations. So now they cater to their IT centric boss with IT Centric deliverables; many of which are unintelligible to the business leadership. This includes burying information in a mountain of automatically generated data as witnessed in a recent audit of a very large government department. The creation of Chief Data Officers, Chief Digital Officers and Chief Knowledge Officers, does indicate that many CIOs have been less than successful in meeting the demands of creating a digital enterprise.

To create and sustain a digital enterprise, integrated governance between planning, portfolio management, operations and IT is essential to ensure that the sage and timely investment in technology provides enterprise value while not exposing the business to unexpected risks. Too often, the rift between IT and other groups is widening not narrowing. Business planners transform through re-organization, rather than conducting a structured and informed cost-benefit analysis. In IT, the absence of actionable direction places the focus on cost reduction by focusing on technology efficiency rather than effectiveness. The CIO Organization is seen as a cost centre rather than a source of technology innovation that can move the company forward. Exacerbating the situation is that business and technology groups use their own terminology and modeling constructs that tend to be mutually incomprehensible.

Enterprise architecture is key to fostering corporate co-ordination and holistic thinking. Building a digital corporation without EA is akin to building a city without an urban plan – with each construction project separately negotiating with neighbouring properties zoning, architecture, water supply, sewage, electrical supply and so on. Minus the urban plan, chaos rules; for example, uncontrolled construction on flood plains would result in huge costs when the hundred-year floods occur.

Enterprise Architecture is a neither a business nor a technology function rather it is a unifying collaborative function.

EA provides explicit knowledge of all assets available to the enterprise, their relationships and their evolution over time. It is not just technical, but addresses all assets (such as people, facilities, data, technology etc.) and concerns. EA provides a holistic view of the enterprise, with stakeholders having viewpoints onto an integrated model, rather than just their own silo. Invariably, stakeholders have their own concerns about the enterprise and want to see how they are addressed in a way that is most meaningful and accurate and not by having to access ten different systems and getting conflicting information and data.

EA explicitly represents an intelligible representation of knowledge, that in the absence of architecture tends to be scattered as tacit knowledge in the heads of various employees, including managers and executives, or buried in inaccessible filing cabinets or databases.

As with other planning endeavours, there are three key EA components, namely:

a. a baseline view (architecture) of the enterprise;

b. an aspirational target view (architecture) of the enterprise; and

c. an Implementation and Migration Plan that transforms the enterprise from baseline to target in increments (a.k.a. transition architectures).

Strategically this provides structure to the Corporate Strategic Plan and tactically it provides transition architectures that structure the business plans and give unambiguous direction to those implementing capabilities / systems.

In their landmark work (Ross et al 2006 p.10) the “Foundation for Execution” envisaged EA as an adjunct to enterprise planning, rigorously refining strategic initiatives and extending the strategic direction into executable detail.

A principal characteristic of EA is that it embodies holistic and integrative thinking. Likening many enterprises to a puzzle (as illustrated in Figure 56) consisting of numerous pieces (a.k.a. silos), EA unifies the underlying parts into a whole that can be effectively managed and transformed to accommodate new business models. Although each stakeholder has their own perspective (e.g. management, marketing, finance, car division, avionics division and so on), they are looking at a part of an entire puzzle, rather than an individual disconnected piece.

Naturally these perspectives overlap but they are dealing with common and shared underlying data, providing consistency and coherence to enterprise operations. For example, in one national emergency management agency, management just wanted to know what assets (e.g. cargo trucks) were operational. The answers varied from system to system as did the meaning of the word "operational". An EA provided an Integrated Management Environment to which all five systems both contributed and extracted common integrated data. Similarly, Delta Airlines created a "central nervous system consisting of a shared information environment that was used by all services (Ross et al 2006, p. 53). The US Government is evolving an Information Sharing Environment to enable data-driven decision-making within and across agencies (US Govt 2007B, 2015, 2018) using common reference models (US Govt 1999, 2007, 2013 and 2013).

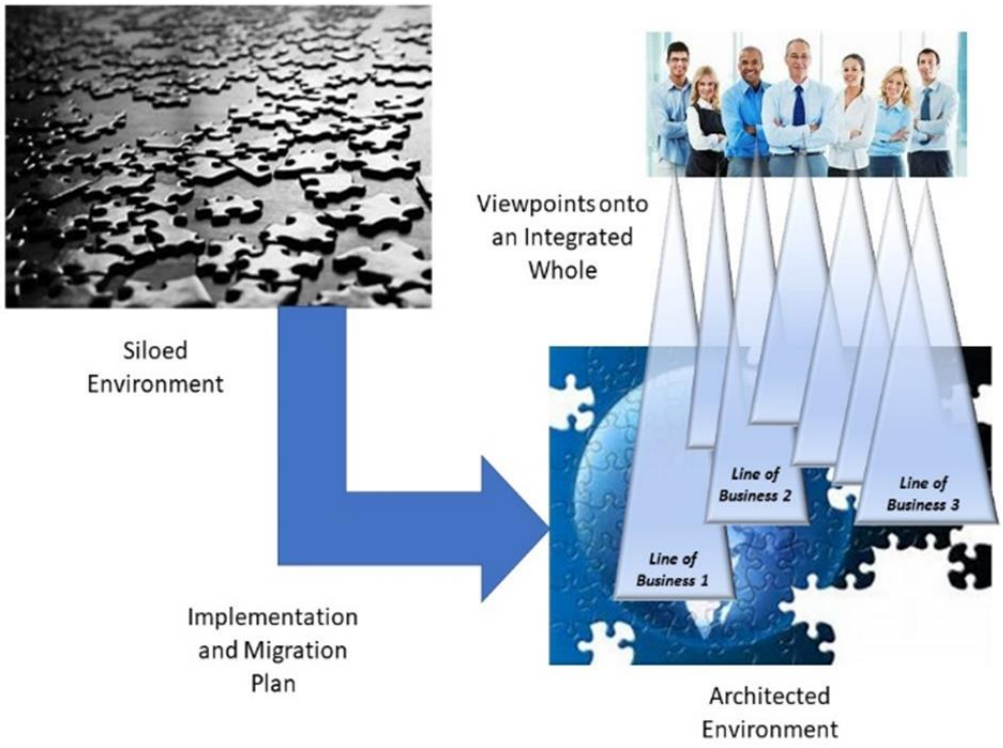


Figure 56 - Looking at Architecture - Putting the Pieces Together

As illustrated in Figure 56, the first challenge of EA is to create an overall view of the enterprise, to accommodate the various viewpoints and perspectives. Although the initial viewpoints were IT centric, they have evolved to address strategic execution and the puzzle has gotten larger as more concerns are integrated into the enterprise architected environment. Table 18 illustrates the evolving viewpoints over a period of some 25 years starting from 1988 to

a more business / technology flavour in 2013 & 2016, by addressing enterprise concerns such as strategic planning, portfolios and projects, human capital, budgeting, security and so on. EA frameworks today (e.g. The Open Group 2018) are overwhelmingly business driven which is useless if business is not involved. Note that ArchiMate (The Open Group 2016) is a structured enterprise architecture modelling language that has evolved to address the current issues and provides a common set of constructs that can be used by all stakeholders.

Table 18 - Evolving EA Viewpoints: Mapping among Standards

Typical Perspectives / Viewpoints	*Early EA Frameworks*[11]	*NIST (1989)*	*TOGAF 9 (2009)*	*DODAF 2 (2009)*	*FEAF V2 (2013)*	*ArchiMate (2016)*	*UAF / NAF 2018*
Motivation / Context				X		X	X Environment
Strategy / Plans				X	X	X	X
Capability			X	X			
Constraints							X
Operations							X
Interaction Scenarios							X
States							X
Human Capital					X		X
Business	X	X	X	X	X	X	
Information		X		X	X		X
Services							X
Processes							X
Information Systems		X	X	X	X		
Data	X	X	X	X	X	X	X
Applications	X	X	X	X		X	
Technology	X		X		X	X	
Standards				X	X		X
Security			X		X		X
Connectivity							X
Program / Project Management			X	X	X		X
Resources							X
Implementation & Migration			X	X	X	X	X (ROADMAP)

Lack of EA leads not only to poor co-ordination, but also to poor decisions. For example, it would be easy for an external management consultant to say the organization does not need a certain process and its resources, and so delete them without understanding why they

[11] Early EA Frameworks include TOGAF (V1-8) (The Open Group 2007), NIST (1989), FEAF V1.1 (US Govt 1999), Archimate (The Open Group 2016), Unified Architecture Framework / NATO Architecture Framework (NATO 2018)

were there in the first place. EA failure is often traced to the establishment of a tantalizing vision without knowledge of enterprise baseline or an implementation and migration plan to get there. Without all three components of EA, costing is impossible and significant financial overruns are commonplace.

With the "baby boom" generation retiring, the architecture, and the repository in which it is contained, provides an invaluable store of integrated corporate knowledge that was previously either not available or stored in hundreds of documents and applications (as comments) not accessible by decision-makers.

Mature architecture delivers strategic agility (as per Ross, Weill and Robertson 2006 p. 83), with the marshalled knowledge, information and data enabling businesses to recognize opportunities and act upon them faster than their competitors (In military terms, this is called getting inside your opponents' decision cycle). This could allow them to maintain a perpetual Blue Ocean (as per Kim and Mauborgne 2015) market space and jump the "S"Curve (Nunes and Breene 2011). Enterprise Architecture, however, is not the "silver bullet" with which to create the digital enterprise. There are also significant cultural and competency problems to overcome jointly by both the business and technology experts.

6.4.1 Where is EA – A Case Study

In the Government of Canada, where EA is a best practice, there are about 290,000 employees in 160 agencies and departments. EA is present in some 20 of these organizations (it is difficult to be precise due to the nature of the data available in open sources.) and in all but two (Health Canada and National Defence) they are embedded in the CIO organization (Canadian GEDS 2017). Therefore, most actual EA deliverables address IT and not the other dimensions of the digital transformation puzzle such as determining the service delivery paradigm, policies, value, business architecture, infrastructure and personnel hiring and training. Conversely, the business strategic plans, lacking solid technology input, are often platitudes with good intentions but little or no appreciation of what technology can bring to the enterprise.

That lack of rigour results in ill-defined objectives, poorly deployed technology and a "muddle-along" approach often leaving projects to sort out siloed solutions. As any given medium-sized enterprise can have as many as 200 projects being built in relative isolation based

on minimal project charter guidance, it is hardly surprising the resultant infrastructure is ponderous, highly complex, expensive and not fit for purpose.

However, there are many examples proving that EA can be made to work well. Several successful examples are discussed in EA as Strategy (Ross, et al 2006) where organizations such as Delta Airlines (*ibid* p. P.53), frustrated by inconsistent information, created a digital enterprise on a foundation of unified information based on nine data marts accessible by all information services. Similarly, UPS (*ibid* p.15) created a unified global package database to do the same. Both cases (Delta and UPS) date from 2006; this is not new. Ergo EA is either not being well-applied or is absent in most cases.

6.5. Before Adopting New Technologies, Understand the Issues of Old Technologies – EA and Strategic Management - A Case Study

Becoming a Digital Enterprise infers that the organization already has a grip on basic IT; this is not always the case. Indeed, many organizations are still battling with basic information systems issues, sorting out corporate services such as finance, human resources, pay and so on, as well as back-office services invisible to clients.

The Canadian Government had a strategic plan to provide shared IT (infrastructure and platform) and corporate services (applications and their data) leaving departments to focus on business applications and analytics. There are some 290,000 public servants (OAG 2017). For the government, having a complex diversified operating model, this made sense. But the execution was flawed.

With respect to corporate services, it resulted in a multi-billion dollar “issue” where decades old lessons identified (not learned and forgotten) were ignored, to implement what is essentially dated technology. Specifically, the Phoenix pay system, was slated, at a cost of some $(CAD) 195 M, to replace the 101 existing pay systems (OAG 2018, para. 1.4) in the Canadian civil service. It has so far experienced cost overruns of about 450% (CBC 2018) and simply does not work with 495,000 outstanding service requests for 150,000 public servants (OAG 2017). The Return on Investment has been consumed by the overruns, and costs are expected to again increase. Additionally, $16M has been allocated to assess the replacement for the system, after spending upwards of $1Bn to fix it.

Two observations:

a. the management of the project was poor; and
b. the argument that it was a purely government project is wrong as it was one of the largest IT companies in the private sector that built and implemented it (OAG 2018). The OAG just makes the issues visible whereas the same transparency is rare in the private sector.

Similarly, the Canadian Government created an Agency called Shared Services Canada to provide the IT underpinning for the government. They have many initiatives and picked projects to reflect IT efficiency (i.e. to save money) rather than provide genuine business value.

For example, the consolidation of the email system made sense from an IT perspective, but everybody already had an email system they were pleased with. In fact, there was no detailed analysis of what the transition entailed, contractors worked on a system-to-system basis and the project was well overspent before being stopped at roughly 15% completion. The cost estimates did not include the money that had to be spent by the various departments to accommodate the shared service (OAG 2015) and the ROI was consumed before even a small subset of the departments were on-boarded. Furthermore, many departments already had in place a much more effective information management regime, with email tightly coupled to document management) and refused to accept the inferior shared email service. This should not have come as a surprise, but it did. Planning failed.

Most notably, no Canadian citizens realized any benefits from either of these projects.

In conclusion, do not assume that the current CIO organization can handle old technology consolidation related issues, let alone new ones. EA allows technology issues to be injected at the onset of planning alongside a detailed assessment of all the aspects of the digital transformation including people, process and technology. Regardless of the technology being introduced, its potentially enterprise-wide impact requires an architecture assessment.

6.6. Getting the Right People on the Bus

The Digital Enterprise may be innovative but requires balancing both old and new business and technology concepts. The transformation will not happen overnight, and getting the right people is essential. In IT there is a competency challenge. By analogy, would one ask

a carpenter to design a skyscraper or a programmer to architect an enterprise knowledge architecture? Logically no, but the rapid increase in technology adoption and personnel shortage, has led to education/training shortcuts being taken.

Engineers and computer scientists are the product of four or five years of intensive study followed by a four-year apprenticeship for engineers. A four-month boot camp will not suffice as Google found out to its chagrin (McBride 2016). Another challenge is that globally, universities tend to emphasize STEM, to the detriment of management skills such as project management, strategic analysis, business cases, crafting value propositions, financial assessments and communications.

With the universal shortage of technical talent, personnel with narrow skill sets find their way into the CIO organizations, get promoted and make digital transformation challenging. For example, if a document management specialist or a programmer becomes CIO, they often do not have the breadth of knowledge to appreciate the import of modern technologies, let alone handle existing ones. HR strategies are needed to develop and educate potential leadership cadres.

Two competency areas are of concern in a digital enterprise, namely knowledge architecture and security (including cyber-security), both of which are standard Enterprise Architecture perspectives.

In a digital enterprise the key assets are knowledge, information and data and an architecture organize them for effective exploitation. On the business side, architecture-based knowledge management is often an afterthought. In MBA classes on business analytics, students are provided with tens of thousands of rows of clean data in a tool, not realizing that the provision of the data in the real world absorbs 90% of the time of business intelligence experts and that BI projects have a failure rate of some 60% (Moss and Atre, 2002 p. 5) or 70-80% in other sources. The challenge of getting a grip on these assets is exacerbated by the fact that there are more than 100 published definitions of “knowledge management” confusing both business and technology planners and architects (Dalkir 2017, p. 5). Creating an enterprise capability to leverage knowledge, information and data is not trivial and requires a wide array of talent.

Privacy, security in general and cyber-security are more than the detection of network intrusions but impact the entire enterprise, from business policies to security labeling of data

to encryption to procedures to monitor network activity. The recent Facebook and Cambridge Analytica scandal has cost Facebook $60B in market capitalization (Wittenstein 2018) in just two days and highlights the need for an architecture to not only collect and exploit the data assets but also to manage and protect them. From a legal perspective, "The cyber-security of the Internet of Things is a national security issue. It is long past time for the law to impose liability on those who write insecure code" (Rosenzweig 2018). Cyber-attacks are mounted by a wide range of actors threatening competitors who steal intellectual property and influence corporate decisions. The threat and potential criminalization of incompetent technology fielding makes getting the right people on the bus imperative but challenging idea as for every 10-30 cyber-security jobs there is but one qualified individual (Ross 2016, p. 137).

The issue of hiring or retraining also requires a rethink with the HR department. Firing and hiring is the easy way, but corporate knowledge (including networks) takes months or years to establish. Retaining this tacit knowledge makes re-training a better choice and it should be in the context of continuous learning as per mature methodologies such as Balanced Scorecard (Kaplan & Norton 1996). Furthermore, moving personnel around the enterprise and involving them in innovation will heighten awareness across the business-technology divide and facilitate the useful adoption of new technology. This also provides a balance to external consultancies promoting their solutions.

6.7. Conclusion - Heuristic Steps to Creating a Digital Enterprise Using EA

This discussion of what constitutes the business-technology divide, the business complexities of adopting new technology and the use of Enterprise Architecture to leverage new technologies has addressed many issues associated with creating a business value-driven digital enterprise. Indeed, the injection of Enterprise Architecture into business planning is a sorely needed management innovation (as per Hamel 2007). There are also general methods and conceptual techniques to develop a digital enterprise. A good example is the work by George Westerman, Didier Bonnet and Andrew McAfee "Leading Digital" (Westerman 2014a, 2014b).

Regardless, it requires the close cooperation of business and technology. The case studies above indicate that some of the simple, straightforward implementations of corporate IT

systems are still bedevilled by the same problems that confronted executives thirty years ago. Additionally, enterprises often mis-manage their knowledge assets, that even if provided with the end-to-end connectivity of the digital enterprise, they will not be able to reap the benefits of their investment, and indeed might open themselves up to cyber-attack.

Architecture, especially enterprise architecture (EA), offers business executives an opportunity to get an informed, data-driven "grip" on their assets. It is a rigorous approach to corporate planning that provides an informed coupling between the business and the introduction of new and profitable technologies. Creating and planning for the digital enterprise requires a high degree of coordination between business and technology from the strategic level to the shop floor. The challenge is that although architecture addresses the endemic failures in many companies and governments, it is unknown or mis-understood by both business and technology executives.

Heuristically, there are several steps that will assist executives and managers realize enterprise digitization and to close the business-technology divide. They are drawn from experiences in both the public and private sectors over the last 30 years and provide initial guidance to executives and managers.

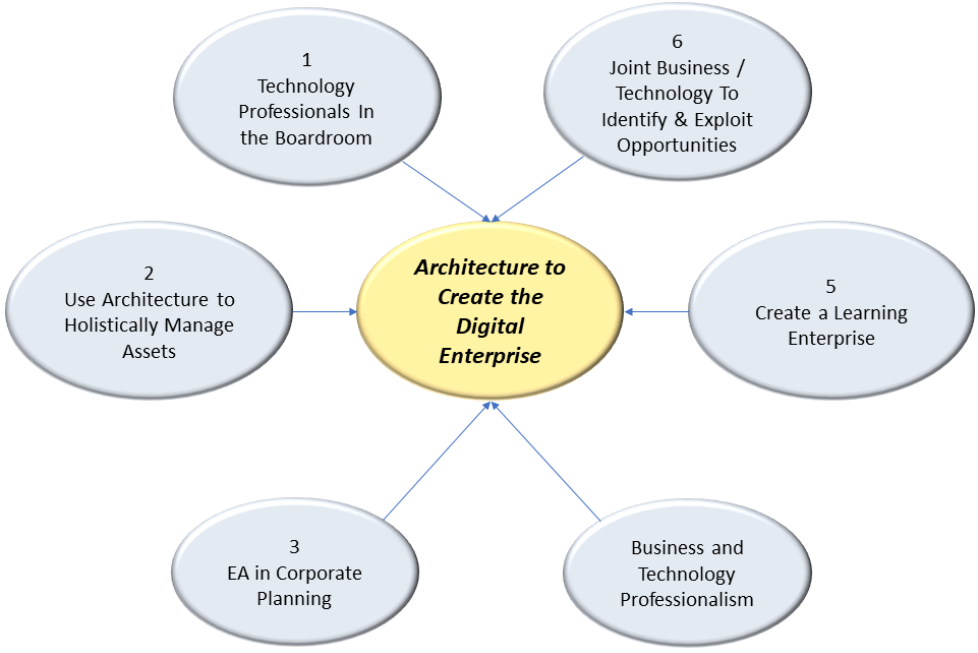


Figure 57 - Heuristic Goals to Help Create the Digital Enterprise

The following heuristic goals (as illustrated in Figure 57) could assist CEOs in determining their digitization approach:

Goal 1. *Technology in the Boardroom*. Get business-savvy technology professionals into the boardroom and ensure that they are engaged from the outset at the strategic level. Many problems and traps, from either immature and/or unnecessary technology can be avoided, as well as having both business and technology factors assessed with respect to potential course of action and respective returns on investment. Also, at the strategic level, promising technology should be assessed or demonstrated in a time- and cost-limited "sand-box" to help quantify potential business value.

Goal 2. *Architecture to Manage Assets*. Use Architecture to strategically, tactically and operationally manage corporate assets and their evolution in an integrated manner, bridging business and technology. From organization charts to data models to capability maps to interfaces between enterprise components, the creation of an Enterprise Architecture (EA) will assist in providing sound knowledge of what is there, what condition it is in, and whether it is still fit for purpose. It is an invaluable adjunct to planning at all levels and in all domains.

Goal 3. *EA in Corporate Planning*. Make EA part of a multi-disciplinary corporate planning group, not under the CIO. This is especially important with the advent of Chief Digital / Data Officers, let alone all CxOs as they work together to come up with a coherent vision and supporting business plans. The close-coupling of the Govern-Plan-Build-Run methodologies and processes are key to ensure effective strategic execution.

Goal 4. *Technology and Business Professionalism*. Hire and/or train relevant technology professionals capable of understanding business value at the strategic, tactical and operational level. Current individuals within enterprises potentially do not have the mix of technology and business skills necessary; either hiring new individuals who do or upgrading those within the enterprise should be assessed.

Goal 5. *Learning Enterprise*. Create a learning enterprise (as per Kaplan 1996 Balanced Scorecard) to assess and stay abreast of technologies and appreciate opportunities for business value. Training, and not just for skills but for also for professional development in other associated domains, will provide long term intellectual agility for the enterprise.

Goal 6. *Multi-Disciplinary Approach*. Create a multi-disciplinary approach to identify and exploit opportunities. Planning, at all levels, should be conducted across business lines and disciplines to ensure that a holistic appreciation of all factors is considered and actioned.

Chapter 7. Integrating Systems Engineering and Enterprise Architecture for Better Outcomes

This chapter is based on a paper submitted to an enterprise architecture / systems engineering journal. The material from the paper was lightly edited so as to be coherent with the thesis format.

7.1. Introduction

The International Council on Systems Engineering (INCOSE) has issued their Vision 2025 (INCOSE 2014) to expand and enhance the Systems Engineering (SE) profession. Despite the clear statement of SE Imperatives (INCOSE 2014) p. iv that included the "embracing and learning from the diversity of systems engineering approaches", Enterprise Architecture (EA) has been noticeable by its absence from the Vision paper as well as from the updated SE Body of Knowledge (SEBoK) (INCOSE 2016).

This paper describes the systems engineering roots of EA and maps the future state of the SE Vision (INCOSE 2014) to current best practices within EA Frameworks commonly used globally, focusing on TOGAF® (The Open Group 2018), the Generalised Enterprise Reference Architecture and Methodology (GERAM) (IFIP 1999), the Australian Government Architecture (AGIMO 2011), Enterprise Architecture Planning (Spewak 1992), the Zachman Framework (Sowa and Zachman 1992 and Zachman 1987), the US Common Approach to Architecture (US POTUS 2012) and the US DoD Architecture Framework V2.0 (US DOD 2009).

This comparison, based on the evidence on the convergence of EA and SE concerns, concludes that the collaborative re-use of existing and co-development of emerging EA techniques by INCOSE and the SEBoK (INCOSE 2016) would both allow SE to more rapidly meet its visionary goals as well as to simplify the global marketplace for architecture- and engineering-based approaches to creating digital enterprises.

The urgency of providing a coherent approach to SE and EA is highlighted by the current omnipresence of linked software-intensive solutions (INCOSE 2014 p.12) in digital enterprises ranging from sensors to System Control and Data Acquisition (SCADA) to transaction processing to analytical systems more commonly known as the Internet of Things and Big Data. This urgency is reinforced by the high rate (61%) of software project failures from many causes (Guillaume-Joseph & Wasek 2015), including methodology inadequacies (PRISM 1986), (Guillaume-Joseph & Wasek 2015) and (Weisman & Lethbridge 2019) that are still not addressed.

The approach in this chapter is supportive of but differs from Donaldson et al (2015) in that it systematically addresses every aspect of the INCOSE vision 2025 (INCOSE 2014) and shows how EA addresses (or not) each element. The paper also draws on open sources and an expanded EA framework (EAF), such as TOGAF (The Open Group 2018) whose version 9, issued in 2009, accommodated many of the EA framework shortcomings raised by Donaldson et al (2015).

We conducted action research in a large Canadian government department where the author was a strategic advisor to a directorate managing systems integration. This department dealt with the complexity described in Vision 2025 (INCOSE 2014), by creating and using EA. Part 4 of this paper provides observations on SE/EA harmonization resulting from the research.

7.1.1 Systems Engineering

Systems engineering is a rigorous and prescriptive technique to deliver systems especially in the domains of defence and aeronautics. As an engineering discipline, its primary output is a coherent family of specifications that can be directly built and implemented. Its focus (INCOSE 2016) has been the construction of individual systems. It has had difficulty coping with ever more complex systems and systems of systems (SoS) types of architectures (INCOSE 2014). Extensions to the SEBoK such as the MITRE Guidebook for Systems Engineering (MITRE 2014) describe ways of implementing the SoS approach as well as how EA can provide support. Earlier, the Generalised Enterprise Reference Architecture and Methodology (IFIP 1999) provided a useful taxonomy and reference model that adopted a holistic view of all enterprise assets including systems.

7.1.2 Enterprise Architecture

Enterprise Architecture (EA) was first conceived of as a generalization of systems engineering techniques to address the issues associated with the introduction of technology into enterprises in the late 1980s. Information systems were becoming increasingly complex (e.g. addressing business functions such as human resources rather than individual processes) and the resultant failure rate was unacceptably high at 61% in 1987 (Guillaume-Joseph & Wasek 2015).

The first frameworks, such as PRISM (1986) and the Zachman (Zachman 1987) framework, were initially called information systems frameworks (Zachman 1987) which then morphed into enterprise architecture with the advent of Enterprise Architecture Planning [EAP] (Spewak 1992) that transformed a static architecture taxonomy (e.g. Zachman 1987 and Sowa & Zachman 1992) into an implementable EA methodology. Both the Zachman framework and EAP were used to create the first US Federal EA Framework (US Govt 1999) to coordinate and provide context for the standards and guidance made mandatory by US federal government legislation called the Information Technology Reform Act (a.k.a. Clinger-Cohen Act) of 1996 (US Govt 1996).

The outcome of EA implementation is difficult to quantify but it was a mechanism, amongst others, to at least cope with an increasingly complicated environment. Subjectively the ability of EA (and other disciplines) to handle complexity has been outpaced by the increases in technology (e.g. massive wireless connectivity), the transformation of control systems from mechanical to electrical to software (Dassault 2016) and the advent of social media. This technology innovation has enabled an unprecedented ability to share data; however, the social and business innovation to take advantage of this capability is lagging. For example, aspects addressing the transformation of this data into useful information and knowledge respecting privacy and security are lacklustre.

Notably the failure of software projects is still at 61% in 2014 (Guillaume-Joseph & Wasek 2015) despite the increasing rigour of professional disciplines such as systems engineering, software engineering, information management, knowledge management as well as EA. A case could be made that the use of methodologies, such as SEBoK and TOGAF, mitigated some of the impact of the increased complexity by keeping the failure rate consistent at 61%, but that will have to be validated by more detailed research.

7.1.3 Chapter Outline

In the remainder of this chapter, we provide a comparison between the current System Engineering (SE) challenges and how EA addresses them. This is followed by a comparison of the current and aspirational goals of SE and how EA could provide support and then several further observations on SE/EA Harmonization. The concluding material discusses how EA and SE can complement each other. A glossary is included to address several of terms used.

7.2. Comparing Current and Future SE With EA

The SE Vision 2025 (INCOSE 2015) starts with listing several of the challenges associated with the current practice of Systems Engineering. Table 19 highlights the challenges as well as how Enterprise Architecture constructs and practices address these challenges.

In summary, EA, using sample constructs and best practices from the US Department of Defense Architecture Framework Version 2 (DODAF2) and the TOGAF, addresses these challenges to provide a solid context for coherent systems development.

The same challenges were encountered during the action research that informed and confirmed the comments in Table 19. Notably in the government department an EA was already in place at the corporate level, but it was not granular enough to address the concerns of the systems development community.

Table 19 - Current Challenges in System Engineering and EA Capabilities

Systems Engineering - Current (SE Vision 2025 (INCOSE 2014))	Enterprise Architecture - Today (e.g. TOGAF, DODAF, MITRE SE BOK)
Mission complexity increasing faster than ability to manage	Capability Based Planning (TOGAF (The Open Group 2018) Chapter 28) introduced to help address mission complexity by explicitly linking diverse enterprise services / systems. Understood and being addressed as extensions to current understanding of EA (The Open Group Meetings 2019)
System design emerges from pieces rather than architecture.	Holistic Architecture Based designed to integrate pieces. Does not get into System Design but focuses on interoperability (e.g. TOGAF (The Open Group 2018) Chapter 25) standards. Focus on creating coherent project charters to assure that the design pieces fit together (e.g. TOGAF (The Open Group 2018) Chapter 13)
Knowledge and investment lost at life cycle phase boundaries	Permanent cross-system repository in place. EA addresses this in terms of establishing cooperation between management frameworks (e.g. TOGAF (The Open Group 2018) p.20 and p. 144)
Knowledge and investment lost between projects	Permanent cross-system repository in place at portfolio level. (TOGAF (The Open Group 2018) P. 392) EA considers projects to be transient delivery vehicles and (best practice) keeps an independent repository containing the architecture artefacts. (TOGAF (The Open Group 2018) figure 37-1).
Technical and programmatic sides of projects poorly coupled, hampering risk-based decision making.	EA integrating technical and programmatic sides of projects at the portfolio level enabling enterprise risk-based decision-making. The government EA frameworks have EA working alongside strategic planning, budgeting (e.g. AGA 3.0 P.147 [1]) and providing the basis for architecture-based decision-making (DODAF 2.0 Vol. 1 p.13 (US DOD 2009)).
"Independent Technical Authority" – Inability to deal with risks.	Risk identification and management integrated into methodologies. Best practice for IV&V. Strong architecture and implementation governance techniques and in methodologies such as TOGAF (The Open Group 2018) Chapters 14, ®41, 42, 43 and 44.

7.3. Comparison of Current System Engineering (SE) Challenges With Enterprise Architecture (EA)

Table 20 is based on the SE Vision 2025 (INCOSE 2014) and highlights the issue, current state, aspirational state as well as how and whether Enterprise Architecture (EA) addresses these issues.

When examining Table 20, it is apparent that the aspirational systems engineering vision can be strongly supported by EA techniques in virtually all the dimensions of the future

SE vision. A primary source for the comparison was the MITRE Corporation Systems Engineering Guide that couples SE with EA in conjunction with the US Department of Defense tight coupling of EA into their planning and acquisition business functions.

These observations will be expanded upon in the subsequent sections.

Table 20 – Systems Engineering Aspirations and Enterprise Architecture Constructs

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
Foundations and Standards	Heuristic Body of Knowledge	More Rigorous BoK	• Heuristic and Rigorous BoK with the leading open standard being TOGAF (The Open Group 2018). There are many domain-specific standards such as the US Department of Defense Architecture Framework [DODAF] (US DOD 2009) and US Common approach to EA (US POTUS 2012) • DODAF (US DOD 2009) is highly prescriptive as a single domain framework; whereas TOGAF is more descriptive to facilitate extensions.
Applying Systems Engineering Across Industry Domains	Aerospace/Defence / Consumer Electronics	All Industry Domains	• EA (e.g. TOGAF (The Open Group 2018)) addresses all industry domains. • The MITRE SE Guide (MITRE 2014) combines SE and EA in the Defense DODAF context, although it could easily be considered as extensible. • Note that EA is mandatory in the US Governments (Federal and State) empowered by the US “Information Technology Reform Act” (US Govt 1996). • Government is a Diversified Business Model (as per (Ross et al 2006) that interacts with all government domains, that the US Common Approach to Federal Enterprise Architecture” (US POTUS 2012) is designed to bridge.
Applying Systems Engineering to Policy (p. 26)	Public Policy not leveraging a well-defined systems approach	Applying and Integrating Systems Engineering to Policy in other systems related disciplines.	• Created to provide policy makers, strategic and tactical planners with a systems approach. EA is integrated with other management frameworks to deliver integrated solutions. • These frameworks include governance, business planning, portfolio management, and operations management. (TOGAF (The Open Group 2018) Preliminary Phase –

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
			Architecture Development Method P. 59). • Systems Engineering is considered part of the solutions architectures in Portfolio and Project Management. EA defined as organizational logic (Ross et al 2006). • SE is focused on integrating with disciplines in the various industry verticals such as economics, human ecology and so on (INCOSE 2014 p.26) Also, EA is considered as a part of the Investment Planning Function, validating enterprise strategic objectives and implicitly leading to the creation of corporate policy. In this foundational model, systems engineering expertise is injected into strategic as well as tactical and operational planning (See Figure 63). • In the Australian Government Architecture (AGA 3.0) ((AGIMO 2011 P.147) EA is co-located with Strategic Planning, Budget Delivery, Budget Formulation, Business Improvement, Legal Advice, Outcomes and Outputs, Procurement Planning, and Workforce Planning.
Complex System Understanding	Increasingly complex systems beyond capability to manage and design. p.29	Standardized measures of complexity along with means to manage. Domain specific Models are used to illustrate complexity.	• EA was created to deal with complexity, but no distinct measures. • Defense EA Frameworks, using formal models, illustrate complex relationships using an integrated meta-model that is implemented in numerous commercially available tools. • EA is model-based and many, such as DODAF have a detailed meta-model-based repository with tools enabling architecture-based decision-making (DODAF2 Vol 1 p.13) with the architecture enabling complex ad hoc viewpoints (queries) to provide crucial information. • The Unified Architecture Framework (OMG 2018) p.2 figure 1.1 provides a comprehensive grid specifying the various viewpoints associated with the various view-types (e.g. interaction scenarios, information, roadmap) and domains (e.g. personnel, resources,

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
			projects). The UAF grid provides a complex, end-to-end system understanding. A major subset of the UAF is used in the NATO Architecture Framework (NATO 2018).
Value-Driven Practices in Developing Systems in 2025 and Beyond	Focused on systems in defence and aeronautical domains. p.28	SE is to be tailored to domain, scaled to project size, scaled to system complexity, adaptable and scalable. p.28	EA is designed from the outset to be adaptable and scalable across domains and from system to enterprise (i.e. from project to portfolio TOGAF p.189).
Leveraging Technology for Systems Engineering Tools	Limited use of computing and IT leveraging Office Automation. p.30	Fully integrated engineering environment.	• Numerous integrated environments available that model enterprises from the contextual, conceptual, logical, physical and functioning enterprises' level of detail. • There are a wide-range of EA tools that can be leveraged to provide the model-based context for SE. Gartner regularly puts out a Magic Quadrant detailing the tools as they evolve. https://www.gartner.com/doc/2859721/magic-quadrant-enterprise-architecture-tools
Collaborative Engineering	SE Practices are not well integrated with program management and discipline-specific processes such as hardware, software, etc. (INCOSE 2014 p.30)	SE to act as a key integrator role for collaborative enterprise engineering that span regions, cultures, organizations, disciplines and life-cycle phases. This will result in multi-disciplinary engineering workflows … ((INCOSE 2014) p.30)	• EA was conceived to be an integrator and work at the enterprise level to provide coherence and to describe the "organizational logic" (Ross et al 2006). • TOGAF (The Open Group 2018) conceives baseline and target architecture(s) to enable a gap analysis addressing all aspects of the transformational change (which is multi-disciplinary but not only engineering domains). • The capability- based planning approach (TOGAF (The Open Group 2018 Chapter 28) is used throughout the architecture development method (ADM) in TOGAF and can be used to address all enterprise dimensions.
System Design in a	Limited technical guidance	The Internet of Things extends	• Although EA pre-dates many of the the SoS issues, its roots in the military and

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
Systems of Systems Context	available to engineer complex systems of systems … with emphasis on architecture framework and standards (INCOSE 2014 P. 32)	the Systems of Systems (SoS) to include increasingly interconnected computers and users with a large set of new stakeholders leveraging value from the architecture. ((INCOSE 2014) p. 32)	its flexibility accommodates interoperability "the sharing of information and services" (TOGAF (The Open Group 2018 Chapter 29 p. 297). • The SEBoK goes considerably further and describes specific types of SoS approaches / architectures (MITRE 2014 p. 4)
Architecting Systems to Address Multiple Stakeholder Viewpoints	Systems Architecting is often ad-hoc and does not effectively architectural concerns from other technical disciplines	System architecting is well established and address broad stakeholder concerns associated with increasingly systems.	• EA is, by definition, cross-domain and addresses a wide range of stakeholder concerns that are addressed in a systematic manner. In TOGAF, the content of the EA Framework is a function of stakeholder concerns (using the definitions in ISO 42010 (2011) and the make-up of the enterprise content model (and supporting meta-model) (TOGAF (The Open Group 2018) P.320 and Chapter 30 p.283-285) is a function of stakeholder concerns. • Again, the Unified Architecture Framework (OMG 2017 p.2 figure 1.1 provides a comprehensive set of stakeholder viewpoints from all manner of technical and business domains.
Architecting and Design of Resilient Systems	*"Fault detection, isolation, and recovery is a common practice when designing systems so they can recover from failures … "((INCOSE 2014)* p.35)	*"Architecting will incorporate design approaches for systems to perform their intended function in the face of changing circumstances or invalid assumptions."* (INCOSE 2014 p. 35)	• EA looks at resilience as a quality of service as *"Reliability, or resistance to failure — Recoverability, or the ability to restore a system to a working state after an Interruption"* (TOGAF (The Open Group 2018) p. 310). • This is looked at for each service defined in the specific EA. • Furthermore, EA looks at defining enterprise wide ways of creating resilience (mainly as part of the domain architectures) as ***resilience can just as much be a function of a business process as a technological innovation.***

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
			• The MITRE SE Guide (MITRE 2014 p.155) dedicates several chapters to assurance.
Cyber-Security – Securing the System	*"Systems, personal and national security are increasingly being compromised due to the digitally nature of the infrastructure. Engineers are hard-pressed to keep up with … threats to cyber-physical systems. … often dealt with as an afterthought*…" (INCOSE 2014 p.36)	SE *"… routinely incorporates requirements to enhance systems and information security and resiliency to cyber-threats early … based on an increasing body of strategies, tools and methods."* (INCOSE 2014 p.36)	• EA looks at security as an architecture domain (or viewpoint in DODAF (US DOD 2009) with specific concerns that should be addressed. • In the TOGAF security guide (The Open Group 2016) chapter 5 p. 17 describes how security should be addressed in each one of the Architecture Development Method steps. • The Open Group also has a Security Forum that create associated products and methodologies such as the Open-Enterprise Security Architecture (O-ESA) (The Open Group 2011b).
Decision Support – Leveraging Information and Analysis for Effective Decision-making	SE, "*explores a limited number of design alternatives primarily based on deterministic models of performance, physical constraints, cost and risk*" (INCOSE 2014 p.37)	SE, "*rapidly explores a broad space of alternatives to maximize overall value, based on a comprehensive set of measures*." (INCOSE 2014 p.37)	• The term "decision support" in this SE context refers to the having the information to help determine and assess various design alternatives based on a set of measures. • In TOGAF Business Scenarios (The Open Group 2017) there is an assessment of options for the enterprise's problems and opportunities. • In EA, information for "decision support" is mainly related to stakeholders with respect to the provision of information to address their decision-making concerns. This is reflected in the DODAF 2 (US DOD 2009) as Operational Views (e.g. Semantic Data Model OV-3) and Information Exchange Requirements (OV-2) and in TOGAF as logical and physical data components TOGAF (The Open Group 2018 p. 285).
Virtual Engineering – Part of the Digital Revolution	"*Model-based SE has grown … to deal with the limitations of document-based approaches*."	"*Formal systems modeling is standard practice for specifying, analyzing*	• EA is already heavily model-based with models representing a variety of viewpoints in the respective generic or industry specific frameworks. • The EA Tools (previously described) are based on models (e.g. TOGAF (The

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
	(INCOSE 2014 p. 38)	*designing, and verifying systems and is fully integrated with other engineering models…broad spectrum of models for representing all aspects of systems*" (INCOSE 2014) p. 38)	Open Group 2018 p.339) to both populate and display the data in the repository as meaningful stakeholder viewpoints. Using architecture modeling languages such as Archimate (The Open Group 2016) visualization is possible as well as consistency checking. • The DODAF (US DOD 2009) places a strong emphasis on displaying stakeholder viewpoints (see Chapter 3 Volume 2 DODAF2 (US DOD 2009), where System Viewpoints are integrated with the viewpoints of other domains. • The concept of simulation and "what-if" analyses are enabled by the paradigm of architecture-based decision-making (see Figure 4).
Shoring Up the Theoretical Foundation	SE "…*practice is only weakly connected to the underlying theoretical foundation, and educational programs focus on practice with little emphasis on underlying theory"* ((INCOSE 2014) 2014 p.40)	"*The theoretical foundation of systems engineering encompasses not only mathematics, physical sciences, and systems science, but also of human and social sciences … normal part of systems engineering curricula, and it directly supports engineering methods and standards."* ((INCOSE 2014) p.40)	• EA is also theoretically weakly based and dependent upon practitioner heuristics, (a good analysis is found at (Kotusev 2016)). • Regardless, curricula have been developed at several universities, most notably at University of Pennsylvania [44] aided by the mandatory nature of EA in government in the Information Technology Reform Act [29]. • The roots of standards such as the TOGAF (The Open Group 2018) in military standards and business systems planning (Kotusev 2016) has tied EA to the deep knowledge in military and business schools in planning and operations. • EA forces a requisite amount of rigor in planning regardless of the domains being engineering or management centric. • What EA does provide is the linkage between all enterprise assets (or entities) as described in GERAM (IFIP 1999).
Broadening Role of the System Engineer	"*A typical SE role varies from managing requirements to being the*	"*The roles and competencies of the systems engineer will broaden to*	• EA had a broader portfolio-based role from its inception to handle the complexity of the "modern" enterprise as envisaged in PRISM 1986, Information

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
	technical leader on a project" (INCOSE 2014 p.42	*address the increasing complexity and diversity of future systems. The technical leadership role of the systems engineer on a project will be well established… also supports and integrates a broader range of socio-technical disciplines, technologies and stakeholder concerns … such as security, economic viability and sustainability* …" (INCOSE 2014 p.42)	Systems ([37] [23]) and in Enterprise Architecture [22]. • The incorporation of management concepts into TOGAF (The Open Group 2018) such as Capability Based Planning (Chapter 28), Business Transformation Enablement Assessment and Maturity Models (Chapter 26), Risk Management (Chapter 27), Enterprise Migration Planning Techniques (Chapter 24), Interoperability (Chapter 25) and Business Scenarios [47], and Stakeholder Management (Chapter 21) are cross-domain and partially address the socio-technical divide. • The DODAF ((US DOD 2009) Volume 1 P. 21) uses a multitude of viewpoints to also address other domains including the All (applicable to all viewpoints) Viewpoints, Capability Viewpoints, Operational Viewpoints, Project Viewpoints, Information / Data Viewpoints, Systems Viewpoints, Standards Viewpoints and the Services Viewpoints. • Often these Viewpoints are augmented by stakeholders to include an Acquisition set of viewpoints and others as required. TOGAF p.167 [Chapter 16] (The Open Group 2018) also highlights the role of Requirements Management and Trade-off analysis.
Essential Systems Engineering Competencies	"*The competency of today's systems engineers vary significantly in the depth and breadth of their systems engineering knowledge… often domain specific…"* (INCOSE 2014 p.43)	*"… more consistently defined and broadened to support the expanded systems engineering roles … to include leadership … SE foundation … knowledge representation, decision analysis and*	• The domain-specific issues associated with EA are not dissimilar to those of SE, since EA is not formally taught at many universities or colleges. • The inclusion in SE of skills such as leadership and knowledge representation (although this is down-played in the diagram directly below the aspirational vision ((INCOSE 2014 p. 43) is supported by EA. • Specifically (The Open Group 2018) Chapter 52 has a detailed list of competencies associated with key roles for those involved in the governing, managing and creation of an enterprise architecture. For example, there is a

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
		complex system understanding …" ((INCOSE 2014) p.43)	recommended set of competencies that members of the Architecture Review Board (cross enterprise non-technical) should possess. • Indeed, TOGAF (The Open Group 2018) Chapter 52 describes the roles of Architecture Board Members, Architecture Sponsor, Architecture Manager and Domain Architects (Specific specialties) and then specifies their depths of knowledge required for several families of competencies namely Generic Skills (including leadership, communication), Business Skills & Methods (Business Cases, planning), Enterprise Architecture Skills, Program or Project Management Skills, IT General Knowledge Skills (e.g. Asset Management, SLA's); Technical IT Skills (including Software Engineering, security), and Legal Environment (e.g. contract law, data protection, procurement law ((The Open Group 2018) P.467.
Building the Systems Engineering Workforce for 2025 and Beyond	"*Worldwide demand for SE … is increasing the need for high quality SE education and training…. A formal Graduate Reference Curriculum for Systems Engineering (GRCSE) defined … many practicing engineers … learned on the job*". ((INCOSE 2014) p. 44)	*"… life-long learning pipeline is in place to support it [SE] with individuals and [multidisciplinary] teams … SE thinking is formally introduced in early education. SE is a part of every engineer's curriculum … grounded in the theoretical foundations that spans the hard sciences, engineering, mathematics,*	• EA is generally practitioner-driven and the TOGAF in The Open Group is complemented by an ecosystem that describes case studies, new innovations and the like through a series of Guides, White Papers and Specifications across many domains. • Overall, EA follows Systems Engineering practices with the exception that it is often descriptive and captures heuristics that accords with the management schools work on Business Design that straddles the divide between "analytical and intuitive thinking" ((Martin 2009b) p.54). EA regularly confronts "wicked problems". • *"Analytical thinking alone, no matter how skilfully applied, isn't going to generate an answer to a wicked problem … [that] are messy, aggressive and confounding."* ((Martin 2009b p. 94). • Business Design recognizes the need for architecture ((Martin 2009a) p. 29) but does not elaborate. Notably business design roots are in practitioner

Aspects for Systems Engineering Future (SE Vision 2025)	Systems Engineering Current (Vision 2025)	Systems Engineering Future (Vision 2025)	Enterprise Architecture Today (e.g. TOGAF, DODAF, UAF, MITRE SE BOK)
		and human and social sciences" (INCOSE 2014 p.44)	case studies such as Proctor & Gamble (Lafley & Martin 2013). Business Design is based on deep empathy with the stakeholders and much in the way of prototyping to evolve enterprise system design often as a prelude to system engineering (Durantin et al 2016 p. 54).

7.4. Further Observations on SE/EA Harmonization

There are several salient observations, many supported by our action research, that would be worthwhile discussing in further detail.

7.4.1 The Move from Isolated Electronic Control Systems to Massively Connected Linked Software Systems – Complexity

When looking at the eight influential technology developments influencing future systems development listed in SE Vision 2025 (INCOSE 2014 p.9), six of them (specifically computational power, communications technology, miniaturization, human-computer interaction, sensor technology and software systems) are being directly addressed by EA; specifically, how to leverage and manage the technologies. As EA is an offshoot of SE designed to handle information and related technology systems, this is not surprising, especially as the nature of SE transforms into a software-based based model that is linked and sharing data/information within and potentially without the enterprise.

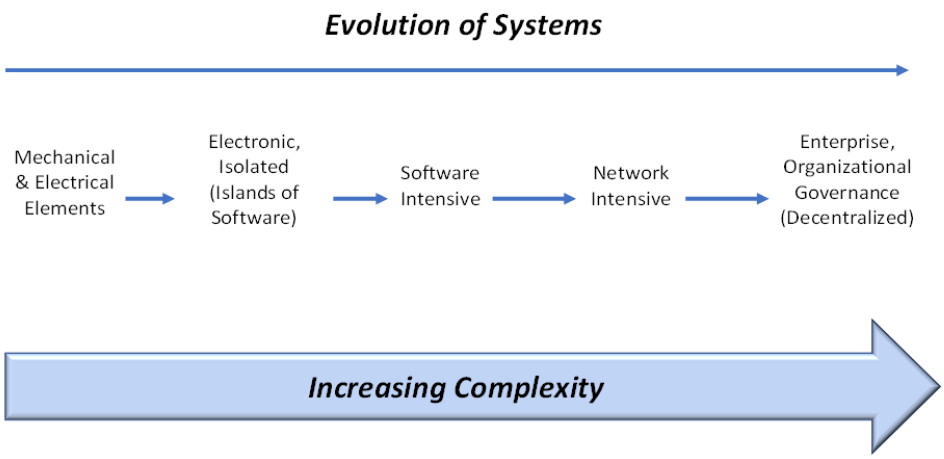


Figure 58 - Increasing Complexity with Evolution of Systems Engineering (based on (INCOSE 2014) p. 9)

This complexity is compounded by the integration of hitherto stand-alone control systems with information systems and social media. What are the implications of controlling a water purification plant through a cell phone app? Specifically, the water plant system may use an obsolete operating system vulnerable to host of cyber-threats. Once connected the system may inadvertently become the conduit for a cyber-attack that could compromise the entire enterprise.

There is now also a danger that the 61% (Guillaume-Joseph & Wasek 2015) software project failure rate from information systems projects could carry into mission critical control systems. This is a major concern that should be addressed by both the enterprise and system architectures.

7.4.2 Stakeholder Understanding

One of the SE challenges is that "When we look for ways to meet fundamental human needs, we see that the solutions often lead to large and complex systems – systems that can only be successful if they are socially acceptable and provide value to society" SE Vision (INCOSE 2014 p.2). Indeed, SE is, "an interdisciplinary approach and means to enable the realization of successful systems. It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions while considering the complete problem, from system concept exploration through system disposal." (INCOSE 2016 p.14) The question is how to ensure that the stakeholder needs are met.

In addition to pure EA, related work is being conducted in associations such as The Open Group and The Object Management Group (OMG) to both leverage technology and enhance the discovery and articulation of stakeholder needs and desires. (e.g. OMG Business Motivation Model and The Open Group – Open Business Architecture, TOGAF Stakeholder Management ((The Open Group 2018) P. 213) and Business Transformation Readiness Assessment ((The Open Group 2018) P.249).

In SE, a major challenge is communication between engineers and stakeholders. SE viewpoints (modelled using formalisms such as SysML) are not understood by 75% of the stakeholders ((Durantin et al 2016) p.47). Consequently, it is not surprising that expectations are unrealistic, and requirements change (Guillaume-Joseph & Wasek 2015), and are discovered only at the stage of advanced testing or even deployment.

EA has modeling notations that are easily mastered and meaningful to most stakeholders. Indeed, the DODAF (US DOD 2009) has entire sets of models that are completed by the stakeholders before being handed over to the technical staff for their models. In fact, the models are not handed over as much as the data from the stakeholder models is placed in a repository for technology re-use.

The Unified Architecture Framework (UAF) (OMG 2017) is an integration of the United Kingdom Ministry of Defence Architecture Framework (MAF) (UK MOD 2012) and the NATO Architecture Framework (NAF) [43] (which in turn are based on the original DODAF (US DOD 2009)) that addresses business, planning, operations as well as technology dimensions. It is an EA that can be used by all people within an organization. At a recent OMG conference in September 2018 in Ottawa, the UAF meta-model was explained using SE UML/SysML which was precise but ill-understood by the business audience potentially jeopardizing adoption of a well-thought-out framework. Communications is essential to get the resources necessary for the successful fielding of systems in an overall enterprise context. The best framework obscured by technical jargon, is not helpful.

To assist in communication, EA uses abstractions, (based on [37]) whereby viewpoints are created at various levels in the enterprise and targeted to convey meaning to and ensure coherence of various groups of stakeholders. The levels of abstraction are also useful to delineate the interface between EA and SE as illustrated in Figure 59.

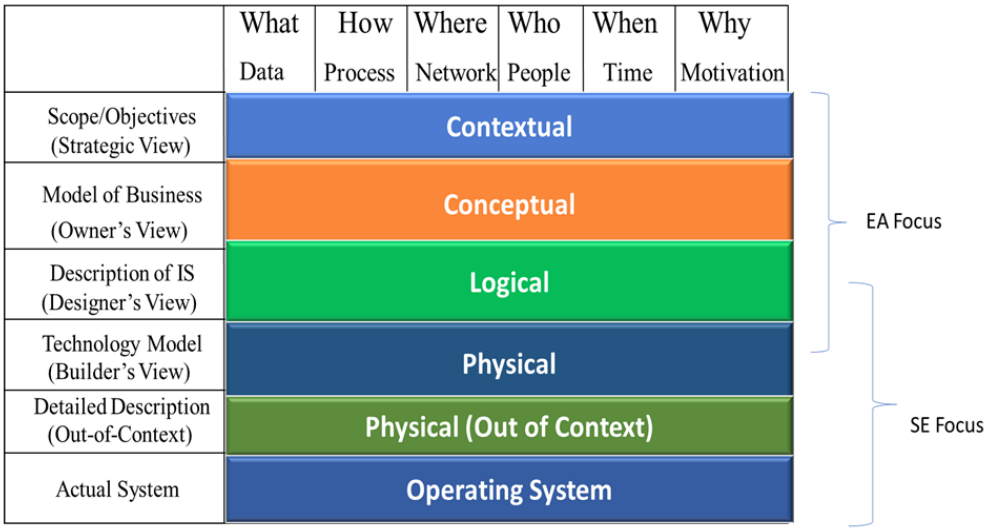


Figure 59 - Zachman Framework (Extended) - Levels of Abstraction and EA/SE Interface

Standard levels of abstraction, as per the Zachman Framework in Figure 59, are:

a. Contextual – what is in and what is not in the system under consideration, who the main stakeholders are and their principal concerns as well as what architecture domains are necessary to satisfy their needs. A high-level costing/budget could be included;

b. Conceptual – the aspirational overview of what is to be achieved, high level option analysis, and initial high-level architectures in all the selected domains (heuristically 10% of the architecture is completed). A more refined assessment of required resources should be included.

c. Logical – an implementation independent view of the architecture containing the requisite detail to coherently have technology experts derive solutions. At this stage industry could be canvassed in a well-formed Request for Proposal / Request for Quote (RFP/RFQ) for potential solutions that respect the prescribed architectural requirements that enable the solution to fit into the overall enterprise infrastructure. In TOGAF the logical level is planned in terms of services and requisite capabilities and expressed in terms of Architecture Building Blocks (ABBs);

d. Physical – an implementation-dependent view that determines what actual (physical) solutions (or Solution Building Blocks) will be implemented to address the requirements within the ABBs. In associated RFPs/RFQs, the need will be for industry resources to implement a given solution.

e. Physical Out of Context – is an extension of the Physical layer that deals with the detailed implementation of the SBBs, normally within projects.
f. Functioning Enterprise – addresses the actual operational resources running the enterprise. ABBs and SBBs may augment and/or replace existing operational resources.

Depending on the organization, the enterprise architects are often involved at the Contextual, Conceptual and Logical level and the systems engineers work at the Logical, Physical, and Physical Out of Context levels of abstraction. Commonly, the SE focus is the prescriptive design and physical implementation often in the context of a project or program, EA generally operates at the portfolio and above level scoping what should be done, getting stakeholder buy-in and then establishing standards and scoping projects so that their deliverables are effective, interoperable, efficient and coherent.

In the absence of a solid logical level architecture from the enterprise architects and systems engineers working together, coherent physical implementations are challenging (as confirmed by action research where EA was being introduced to provide the requisite coherence) and necessitate the creation of a logical architecture often by the SE staff who may well be unaware of the higher-level issues addressed at the contextual and conceptual levels. Consequently, systems engineers are distracted from building and operating systems, as they must conduct context setting tasks such as stakeholder management and visioning at the strategic level of the enterprise. For example, architecting and building an information-sharing environment is pointless when the corporate strategic direction does not specify its implementation, or enforce its use, and when it culturally manages the inclination to protect rather than share information.

7.4.3 Integrating Technology Expertise

With the need to have enterprises transform into digital enterprises by leveraging the increased connectivity and access to data, there is a need to have practitioners that can stagger the business-technology divide to involve them in enterprise level decision-making. EA, as displayed in Figure 60 (Ross et al 2007), was conceived to work collaboratively with business planners to lay the foundation for a successful digital enterprise.

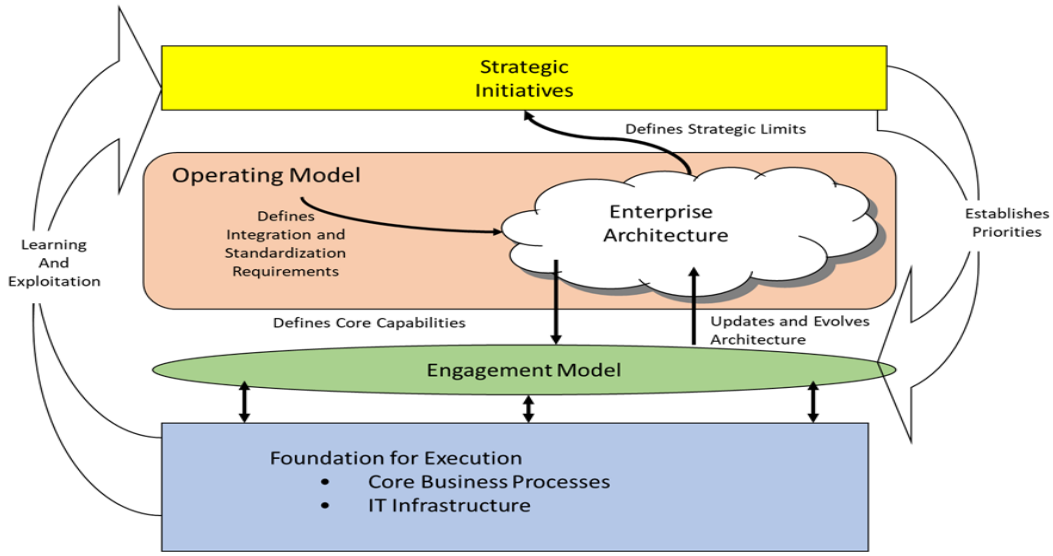


Figure 60 - Creating a Foundation for Execution (Ross et al 2007) P.10

Architecture Based Decision-Making is another major contribution of EA is that the enterprise architecture repository data, independent of project-specific databases, can be mustered for decision-making, especially in the complex situations often associated with defense related missions. This decision support paradigm is illustrated in Figure 61.

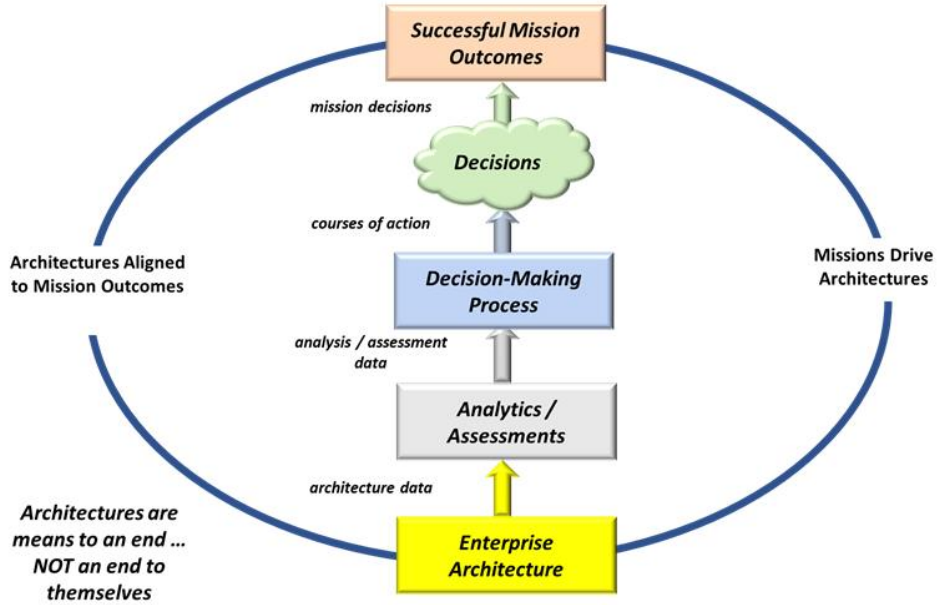


Figure 61 - Mission Outcomes Supported by Architectures (US DOD 2009 based on Vol.1 p.13)

The integration of both EA and SE into the business planning processes is key to ascertaining that the desired objectives are feasible from both a business and technology viewpoint. The adjunct to the desire to have architecture-based decision-making, is its operationalization within the enterprise. Another good example of this comes from the DODAF (US DOD 2009) where EA and SE are integrated from the outset within the planning process. Indeed, the engagement model (from Figure 59) is investment; in the absence of understood EA models describing the intent of the systems, no funds are allotted.

Figure 62 illustrates the United States Department of Defense EA/SE Synchronization in Defense Business and Technology. This is a template for EA/SE collaboration within an enterprise.

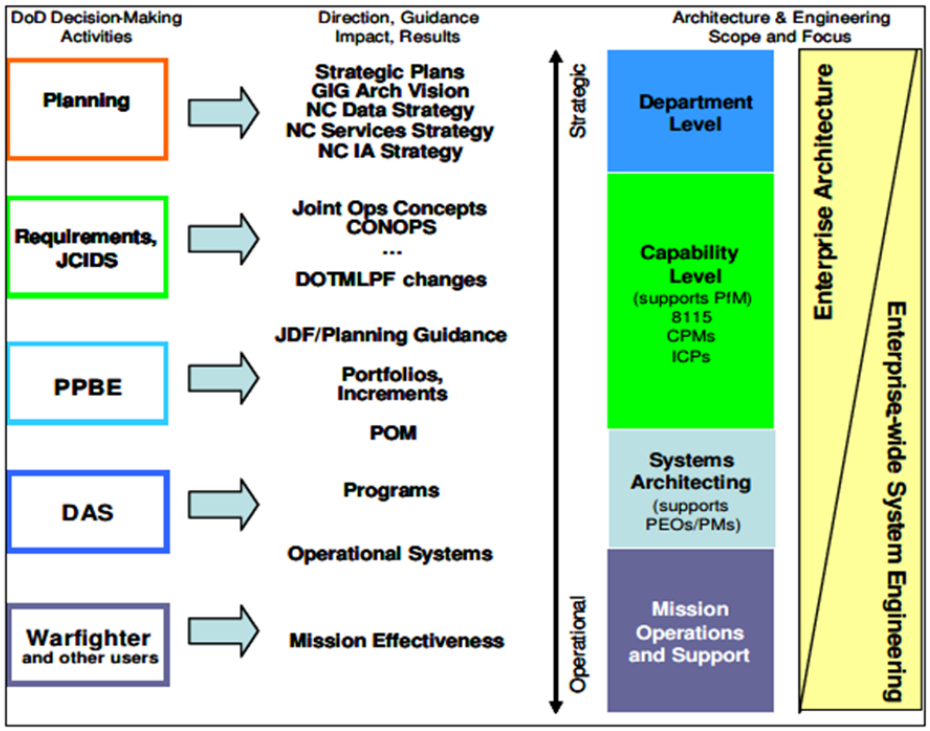


Figure 62 - EA/SE Synchronization in Defense Business and Technology Planning (US DOD 2009) p. 11.

7.4.4 Models are The Linkage Between SE and EA

There is a primary difference between SE and EA in that the former is project focused and the latter is portfolio focused (systems of systems). With the EA ideally working with the business planners, the systems engineers will receive well-formed project charters (TOGAF

Architecture Development Method Phase E – Opportunities and Solutions and Phase F – Migration Planning) (The Open Group 2018 p. 147) including contextual models that will facilitate the creation of project- and system-specific models including the system context. In practice, there is often a two-way flow of models both bottom-up making changes to existing systems and top down to describe new systems and the de-commissioning of existing systems. Figure 63 illustrates this dynamic.

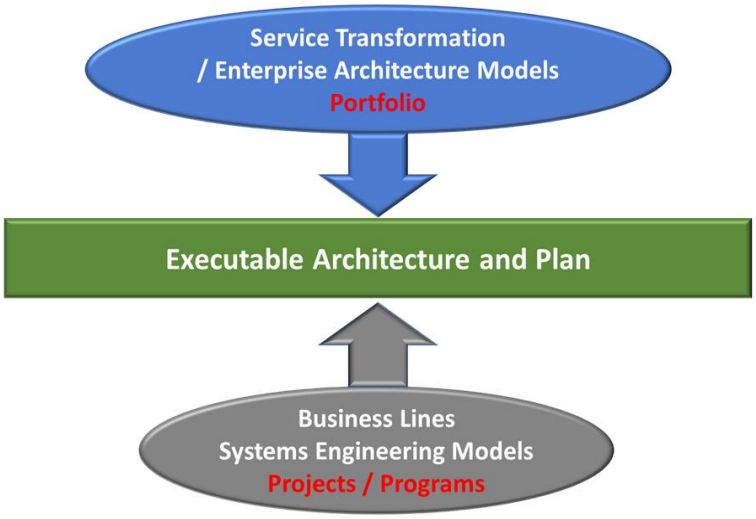


Figure 63 - Interaction of SE and EA in the Enterprise

7.4.5 Data as the Lifeblood of the Digital Enterprise

The issue of knowledge, information, data and meta-data management in support of operational, sensor, analytical and archiving systems is not really addressed in the INCOSE Vision 2025 (INCOSE 2014). Where decision support is mentioned (INCOSE 2014 P.37) it is with respect to modeling the system and assessing design options rather than the provision of data, information or knowledge to the stakeholders. The digital enterprise will make massive advantage of these holdings to support knowledge workers in a de-centralized knowledge-based environment. Indeed, the systems engineers, architects and analysts will hopefully end up settling on a common set of semantics (somewhat like (Durantin et al 2016) p.45) to communicate and represent the knowledge artefacts; examples include business rules.

Certain EAs (such as DODAF and NAF) have discrete data and information architecture viewpoints that are evolving to address issues such as enterprise information sharing environments (e.g. (The Open Group 2013) or Joint Information Environments whose mantra is,

"… evolving from a brittle, network centric understanding of our information environment to a flexible data-centric environment enabling access to information at point of need," (US DOD 2014) or Information Sharing Environments (US Govt 2015).

There is a tendency in business and technology to be process-, service- or system-centric rather than data-centric. One talks about Big Data (e.g. (Mayer-Schonberger & Cukier 2013 p.6) as if integration is trivial. However, common semantics and meta-data as a basis to integrate the data is often overlooked except at the system level; when an enterprise has hundreds of individually designed systems (including those that are connected (e.g. sensors, social media) with their own data and meta-data definitions, a holistic view of the enterprise is improbable. EA is central to establishing a common data and meta-data environment through the establishment of a discrete data / information architecture as described in TOGAF Phase C Chapter 10 (The Open Group 2018) or the defense architecture Data / Information Architecture viewpoints (US DOD 2009).

SE should be cognizant of stakeholder data, metadata, information and knowledge, and deal with it in any future SE environment.

7.4.6 Overcoming Software Project Failure

With SE control systems (SCADA) having become dependent on software development in conjunction with their connectivity with all manner of information systems and social media, there is a serious challenge with successful software project delivery. As discussed before, Guillaume and Wasek (2015) found that 61% of software projects fail; they have categorized the failure factors as follows:

1. *"Unrealistic project goals and expectations;*
2. *Changing or unclear requirements;*
3. *Insufficient technical knowledge;*
4. *Problematic technology;*
5. *Lack of executive support;*
6. *Insufficient user commitment;*
7. *Project cost overruns;*
8. *Project schedule delays; and*
9. *Insufficient project management and control." (Guillaume and Wasek 2015)*

There is a real concern of SE being impacted by the software failure rate associated with traditional information systems development as well as rapidly developed and fielded social media apps. SE normally deals with rigorously conceived mission-critical systems in areas such as avionics and plant control where 61% (Guillaume-Joseph & Wasek 2015) failure rate is clearly unacceptable. EA does address these failure factors, which is not surprising in that EA has its roots in SE and defense. Table 21 highlights how EA can address these key failure factors.

Table 21 - How EA Addresses Software Project Failure Factors

Failure Factors	EA Contribution to Reducing Failure Factor	TOGAF ADM[12](The Open Group 2018)
1. Unrealistic project goals and expectations	EA completes Stakeholder Management ensuring that stakeholders are fully conversant with and approve the work products to manage expectations Projects are scoped and resourced to succeed	Architecture phases A-D (Chapters 6-11) have stakeholder approval. Work packages based on Gap Analysis, assigned to projects in Phases E-G (Chapters 12-14).
2. Changing or unclear requirements	Requirements are managed centrally across domains including trade-off Analysis.	Requirements Management (Chapter 16)
3. Insufficient technical knowledge	EA determines "IT Ability to Execute" as part of Business Transformation Enablement Assessment.	Business Transformation Readiness Assessment (Chapter 26)
4. Problematic technology	Indirectly assessed in Opportunities and Solutions.	Phase E - Opportunities and Solutions (Chapter 12).
5. Lack of executive support	Directly addressed in Preliminary Planning (Request for Architecture Work) and in Phase A – EA Vision culminating in an executive decision (Statement of Architecture Work).	Preliminary Planning (Chapter 5) EA Vision (Chapter 6)
6. Insufficient user commitment	Directly addressed in EA elaboration phases B-D with Stakeholder Approval in each domain. The architecture does not proceed to implementation unless the stakeholders, including users, agree to it.	• Business Architecture – Ch. 7 • Information Systems Architecture – Ch. 8 • Data Architecture – Chapter 9 • Applications Architecture – Ch. 10 • Technology Architecture – Ch. 11 • Security Architecture [46]
7. Project cost overruns	Indirectly addressed in Architecture Transformation and planning in making sure that projects have clear scope and are adequately resources. Also, implementation governance continuously monitors the ongoing projects to make sure that the work packages are delivered. Intent is to get projects when they are failing fast so corrective actions can be taken.	• Architecture transformation in Phases E (Opportunities and Solutions – Chapter 12) and Phase F (Migration Planning – Chapter 13) • Architecture Implementation Governance Phase G – Chapter 14
8. Project schedule delays	Project progress is continuously monitored, and corrective actions taken as required.	Architecture Implementation Governance Phase G – Chapter 14
9. Insufficient project management and control	This task is normally handled by the Project Management Office and/or the Project Delivery Business Function. Architecture Implementation Governance provides input either directly or to the executive committee.	Architecture Implementation Governance Phase G – Chapter 14

Table 3 shows how EA can mitigate or address most of the main failure factors of software projects which are of mutual concern to both the SE and EA communities.

7.5. The Need to be Agile

The Agile movement has its roots in software development and the rapid, effective, efficient and continuous delivery of business value. Its most recent innovation looks at the application of agile at the enterprise level and is called SAFe® Version 4.5 (Leffingwell, Dean et al 2018) (Scaled Agile Framework for Lean Enterprises). Its Value Streams deliver endlessly in their own field of endeavour, but even the lean and agile movements have found a need for an EA to coordinate the deliverables and make sure that they work together.

They have coined their own lexicon and have created their own plan-build-run model, that has both adopted as well as cast aside best practices and lessons learned from the past. For example, getting away from the "waterfall" implementation is well understood and documented, but their downplaying the need to go from development to maintenance can be problematic in that once the business value plateaus (normal product cycle) it may be important for the value stream team to move elsewhere. It also assumes that software is developed, which may be true in the business application layer, but most other software is "commercial off the shelf" (COTS) either acquired as a package, out-sourced or cloud-sourced. COTS such as Enterprise Resource Planning (ERP) packages that address entire business functions (e.g. HR, finance, pay). The intent of COTS acquisition was to field rapidly and use them as a platform to generate more growth. The COTS software is not developed; rather it is quickly fielded as a large set of features to accelerate business value. Whether the software in question is a business application (e.g. Client Relationship Management) or a platform application (e.g. relational database management system or operating system) the main challenges are business specifically to adapt the enterprise to use the COTS. Is agile relevant in this respect versus using a project to deliver the system and effect the knowledge transfer from COTS subject matter experts?

The past CIO and indeed EA focus on efficiency (e.g. (Ross et al 2007 p. 93) led to an emphasis on shared services especially at the enterprise platform level. Agile is focused on

[12] TOGAF Architecture Development Method Phases / Activities

effectiveness (a.k.a. business value). The value streams are not focused on shared services nor common platform services. This has led to enterprises having several sets of platform services causing a long-term maintenance challenge, especially in terms of interoperability, updating, licensing, and skill sets.

Agile harkens back to the software development in the 1980s and 90s, where business-focused applications were first fielded and provided a major improvement in business effectiveness. Each system included the application, its data (and file management system), its own discrete platform services and infrastructure; in short, each value stream was autonomous, had an epic and supporting stories, had an agile release train fielding new business driven features on a regular basis. The challenges came when the applications were to be integrated and aggregated and shifted into maintenance. As the applications were developed in isolation, integration was problematic, costs were prohibitive and there were no maintenance organizations. This was exacerbated by the lack of management frameworks to cope with the initial enterprise digitization efforts. Ergo the creation of the post and organization of the Chief Information Officer, EA, as an adjunct to planning, for delivery project management frameworks (e.g. Project Management Institute, PRINCE2) and operations management frameworks such as ITIL. This is discussed in detail in (Weisman & Lethbridge 2019). Like many frameworks, the processes have become ponderous and Agile is in response to their process-centric rather than outcome centric focus.

Having said that, the maintenance / life-cycle support issue is critical for SE. Some of the SCADA systems were created and have been in-service since the 1960s. They are robust and work. Replacing them without a thorough specification process and operations management controls (e.g. maintenance of definitive versions of the software in an enterprise repository) and software development standards (e.g. code “understandability”, security protocols) may make the next generation of software less reliable.

In the agile methodologies, there is a recognized need for EA, but how EA is to be applied to enable the continuous fielding of business value is still a work in progress. The SAFe® (Leffingwell et al 2018) places EA at the portfolio-level coordination of numerous epics and value streams providing an overall architecture context that enables SE and agile value streams to deliver their value. From our action research, the EA would ideally be both above and within the portfolio level. Many system coordination problems were encountered

above the portfolio level in conjunction with strategic goals, objectives and actions. This is catered for in current EA implementation methodologies having a synchronized EA at several levels within the enterprise (e.g. (The Open Group 2018 Figure 18-3 p. 186 and figure 19-1 p. 194). In conjunction with the capability planning concepts and the delivery of capability increments delivered through project increments in transition architectures (The Open Group 2018 figure 28-4 p.268) the variance between EA and agile is not great. Indeed, these concepts were first introduced in TOGAF® 9.0 in 2009 specifically to make EA agile. Further work is ongoing within The Open Group®.

Future work would be best focused on standardizing the lexicon between at least SAFe®, EA and SE. Ideally the planning, project and operations management would also be included.

7.6. EA versus SE – Professionalism and Barrier to Entry

A crucial difference between SE and EA is the barrier to entry, from both an educational and experience point of view. In Canada an engineer must complete 4-5 years of university followed by 4 years of supervised experience before being allowed to practice engineering such as SE. In EA, the successful completion of a four-day course in a specific methodology, allows personnel to call themselves an "enterprise architect" and often people add the methodology behind their name (e.g. TOGAF) in the place of a degree or professional association certification. One just needs to look at LinkedIn for evidence of this.

This disparity in professional competence is problematic, leading to friction between EA and SE practitioners. In certain organizations and industrial sectors, the discrepancy has been addressed internally (e.g. Defense) but it remains a concern when engaging contracted personnel. This resolution is also far from perfect, as EA reports to the CIO in the clear majority of instances, the enterprise architects (EAs) are former system engineers (SEs) or other IT staff, creating issues given the multi-disciplinary nature of EA. Often the organization's EA is only the enterprise IT architecture further exacerbating the alignment of IT with the business and the clear linkage between IT and business value.

Globalization has also been challenging with respect to contracting and outsourcing. Companies draw their personnel from a global pool and educational accreditation standards and the resultant competencies of their graduates vary.

Professional organizations have addressed this using several different techniques:

a. Loose knit collaborations promoting educational standards and certifications (e.g. Canadian Information Processing Society (CIPS), the British Computer Society (BCS), the Australian Computer Society (ACS));
b. International standards and global communities of practice (e.g. IEEE, INCOSE, PMI, AFCEA); and
c. International competency and experience certifications for individuals, companies and governments throughout the world (e.g. The Open Group Open-Certified Architect Levels 1,2 and 3).

Finally, educational institutions are the repository of professional knowledge shared through both educational offerings and the sharing of new results through journals and conferences. SE is a concrete offering in many institutions of higher learning, whereas EA is supported by only a few (e.g. Pennsylvania State University). Enterprise Architects do not have a journal that is referenceable by the academic community and professionals (i.e. indexed by SCOPUS). As academic advancement and research is associated with the number of articles published and cited in refereed journals, and since EA does not have one, the result is that there is inadequate and rigorous EA research and development being conducted. Many methodologies are still anchored in the embryonic 1980s (Zachman IS Framework Version 1) and early 1990s (1992 Spewak EAP and 1992 Sowa) and are ill-equipped to handle the challenges of creating new enterprise environments and coping with the IT and information legacy infrastructure.

That begs the question, is EA a profession? By the criteria above (education, certification, effective global professional organization and university support) not really. A major consideration is that EA draws on many competencies. One does not graduate directly out of university as an enterprise architect, as applying EA requires a certain amount of experience and wisdom to understand the full import of enterprise transformation. EA is best addressed at the Master's level of educational focus, and for those possessing industry/government experience.

The system focus of SEs leads to precise systems working incredibly well, especially from a control systems perspective, but their overall business value from a holistic enterprise perspective is problematic. Ergo the need for an INCOSE Vision 2025, that infers that a high

level multi-disciplinary assessment is required to cope with a complex world; which is indeed the rationale why EA was created in the first place in the 1980s/90s. The lack of professionalism in EA prevents it from being effective, and the gulf between practitioners of EA and SE is understandable but is an impediment to EA living up to its potential.

7.7. Summary

This chapter has highlighted the similarities and complementary nature of Systems Engineering and Enterprise Architecture using the document "A World in Motion: Systems Engineering Vision 2025" (INCOSE 2014) as a basis for the comparison. EA in the context of this paper was mainly focused on the use of TOGAF 9.2 (The Open Group 2018) and the US Department of Defense Architecture Framework Version 2.0 (US DOD 2009). The former is a generic, descriptive, cross-industry domain framework and the latter is a detailed, prescriptive methodology tailored for the complex defense domain.

Table 19 has indicated how EA can help address the major challenges in Vision 2025. The extensive Table 20 has taken the current state and goals from Vision 2025 and described how EA can assist in filling the gaps to help SE achieve its future state. Each goal was assessed, and EA could be leveraged for all of them. Each recommendation was followed by a short clarification with references. Section 4 discussed several salient features, namely complexity in SE, stakeholder management, the integration of technology into business planning, the use of models in both SE and EA, the consideration of data / information and then the issues and impact associated with the high rate of failure in software projects. Table 21 discussed the numerous factors leading to failure and how EA could address or mitigate most of them.

7.8. Conclusions and Recommendations

EA is a methodology that can help manage the design and management of complex enterprise environments and the systems within them. Generally, SE is found at the individual system or project level whereas EA deals with the enterprise at the portfolio level. EA is a key enabler for the realization of INCOSE Vision 2025.

EA can provide solid support for the advancement of the SE profession and there is a great deal of complementary activity. EA provides SE with:

a. An architecture, i.e. shared structure and set of common services that all systems must use; and
b. An enterprise context for each system by providing well-formed project charters that are clear and are collectively approved by both stakeholders and their executives.

It is recommended that INCOSE and The Open Group work together to share work products and create a set of common terms.

The defense-specialized MITRE Systems Engineering Guide (MITRE 2014) has already integrated SE and EA for the defense environment. We recommend that it be generalized and used as a basis for generic SE/EA collaboration.

In SE, more emphasis should be placed on the exploitation and management of the key assets of the "Digital Enterprise" namely its data, information, knowledge and meta-data.

Both EA and SE should leverage the Business Design work (e.g. Martin 2009a, Martin 2009b) under development by the business schools as a means of gathering a coherent set of business needs and requirements.

The skillsets for both EA and SE are similar, and it would be beneficial if the two academic curricula be coordinated and refer to one another.

Moreover, it would be beneficial to coordinate and harmonize the lexicon and concepts of the various management frameworks (i.e. Govern, Plan, Build, Run) as well as key techniques such as agile.

7.9. Chapter Glossary

Term	Meaning
ABB	TOGAF® Architecture Building Block (Implementation Independent)
ADM	TOGAF® Architecture Development Method
AGA	Australian Government Architecture
COA	United States Government Common Approach to Architecture
CONOPS	Concept of Operations (Often used synonymously with Vision)
COTS	Commercial Off The Shelf
DAS	(US) Defense Acquisition System
DODAF	United States Department of Defense Architecture Framework
DOTMLPF	US Defense Capability Dimensions - Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
EA	Enterprise Architecture
EAP	Enterprise Architecture Planning

Term	Meaning
ERP	Enterprise Resource Planning (Package, Product)
GERAM	Generalised Enterprise Reference Architecture and Methodology
INCOSE	International Council on Software Engineering
IoT	Internet of Things
JCIDS	US Defense - Joint Capability Integration and Development System
MODAF	UK Ministry of Defence Architecture Framework (discontinued and work now carried on in the NAF)
NAF	NATO Architecture Framework
PPBE	US Defense - Planning, Programming, Budgeting, and Execution
PRISM	Partnership in Information Systems Management
SAFe®	·Scaled Agile Framework for Lean Enterprises
SBB	TOGAF® Solution Building Block (Implementation Dependent)
SCADA	System Control and Data Acquisition
SE	Systems Engineering
SEBoK	Systems Engineering Body of Knowledge
UAF	Unified Architecture Framework

Chapter 8. Managing the Management Frameworks: Enterprise Digital Transformation Using Enterprise Architecture Stewardship

This chapter is based on a paper submitted to a digital transformation journal.

8.1. Introduction

In this chapter we discuss conflicts among management frameworks that hamper enterprise architecture and digital transformation. We base our analysis on some case studies performed in the context of the Canadian Government and several other organizations.

8.1.1 Summary

Effective digital transformation is hampered by a management framework landscape with numerous redundant and conflicting best practices to govern, manage, plan, build and run the enterprise. Enterprise Architecture (EA) frameworks provides a holistic view of the enterprise for all stakeholders but these frameworks, such as TOGAF® 9.2, mention the need to coordinate the management frameworks but offer little guidance. This chapter highlights the issues and importance of management framework harmonization using five case studies from different organizations. These offer valuable lessons learned and a prediction that the incoherence of management frameworks will increase. This chapter concludes with the introduction of the concept of EA stewardship, where EA is a management technique and tool used by all, with a core EA organization coordinating and facilitating the completion of the EA by stakeholders. The EA stewardship focus is on coherence, interoperability and coordination, as well as executing the work not completed elsewhere.

8.1.2 Focus

In Section 4 of this chapter, we present several case studies derived from our work within the Canadian Government and through interactions with others in the field, often in meetings of the Association of Enterprise Architects. Our studies indicate that new and existing enterprise architecture (EA) endeavours have rarely (~20%) been successful and predominantly reside in Chief Information Officer (CIO) organizations. The case studies also indicate that there is often friction between the frameworks used by the EA Group and the other management frameworks (as well as among the other frameworks themselves).

The fundamental research questions are: Why is EA implementation not working well and, based on case study analysis, do techniques exist that would enhance the chances of EA success?

Recent articles in the IEEE Management Review (Guillaume-Joseph and Wasek 2015) have shown that the failure rate for software projects has not decreased since 1997 and stands at 61% despite major improvements in the management frameworks. The thesis of this paper is that the problem lies not in the individual management frameworks, rather it lies in how these frameworks work together. This paper expands on a presentation to The Open Group Conference in Boston (Weisman 2014).

8.2. Concepts and Definitions

For the purposes of this chapter, the following definitions are used.

Information technology (IT) is defined as the "lifecycle management of information and related technology within an organization" (The Open Group 2018). Using this definition, the chief information officer (CIO) has the primary responsibility of ensuring that quality information gets to or is accessible by the right people, at the right place at the right time. As the economy has transitioned from one that was industrially based to one that is knowledge-based (Ross, Alec 2016), the criticality of IT, and consequently the CIO, has increased.

Enterprise architecture (EA) has numerous definitions depending on the specific stakeholder viewpoint. For the purposes of this chapter EA is defined as the explicit knowledge of the assets available to the enterprise, their interrelationships, and their evolution over time (based on ISO 42010:2011). The three main components of an enterprise architecture are the

current state, the future target state(s), and the implementation plan to get from current to target state(s), preferably using a series of transition architectures (intermediate states).

8.3. Chapter Structure

For the purposes of simplicity, the management frameworks have been grouped by business functions, loosely based on those in COBIT 5 (ISACA 2012) and COBIT 2019 (ISACA 2018) and include Governance, Planning/EA, Building, Operating and Alignment activities. EA is singled out, since it is the subject of this paper.

The chapter will consist of a discussion of the families of management frameworks, a description of the problem space, several case studies, the proposed EA Stewardship method and concluding material. Due to the complexity of the frameworks, we do not attempt to assess each of them, and leave the reader unfamiliar with them to follow the various references.

8.4. Discussion of the Families of Management Frameworks

8.4.1 General

Management frameworks, especially in the IT Space, have evolved to manage the successful execution of corporate strategy by addressing the governance, planning/EA, building, operating and alignment functions. This simplistic interpretation of the complex governance and management processes within most medium-to-large enterprises suffices to illustrate the concept of enterprise architecture stewardship. Each one of these functions will be discussed separately in the following paragraphs.

8.5. Governance, Management and Audit

The ever-increasing complexity of IT coupled with high project failure rates in the 1980s and 90s spawned the creation of the IT Governance Institute (ITGI) and subsequently the Information Systems Audit and Control Association (ISACA). ISACA has estimated that the total wasted IT expenditure globally was $600B (ITGI 2008 P.7 Figure 2). Their Control

Objectives for Information and Related Technology [COBIT], the most recent of which is version 2019 (ISACA 2019) were put in place to improve the situation.

One of the most useful innovations of late is to distinguish between Governance and Management (ISACA 2012 P. 32) as illustrated in Figure 64. There was a tendency for governance to be overwhelmed by the "tyranny of the immediate," giving little time for any strategic planning. In industry, this split is typified by the appointment of Chief Operating Officer (COO) (Management focus) in addition to the traditional Chief Executive Officer (CEO) handling governance and strategic planning. These better enable the addressing of board and investor concerns such as the establishment of an agile, holistic, and coherent information and technology infrastructure.

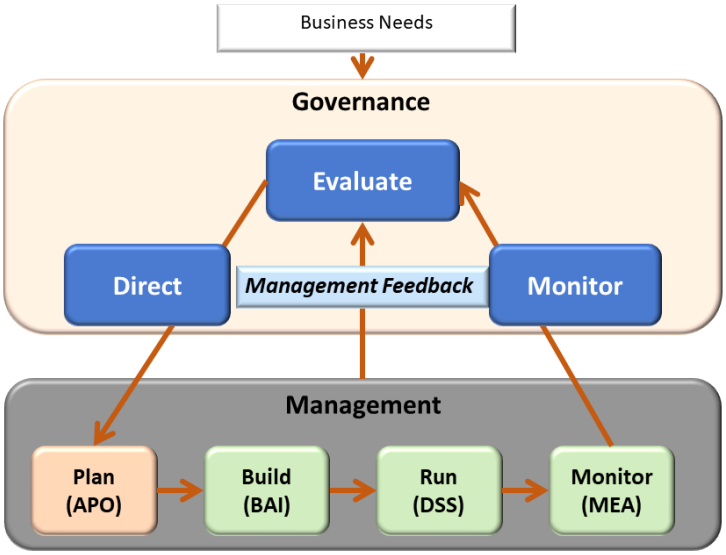


Figure 64 - COBIT 5 – Governance and management key areas (ISACA 2012 P. 32)

8.5.1 Planning - Enterprise Architecture and Business Planning

8.5.1.1 Enterprise Architecture

The need for an Enterprise Architecture (EA)-like framework was recognized in the 1980s (PRISM 1986) when larger scale information technology (IT) related software projects were consistently failing. There were two observations about architecture namely:

a. "Almost every information systems (I/S) organization believes that it has problems which can only be addressed by the development of an architecture.

b. No two I/S organizations mean the same thing by architecture when they express the above belief." (PRISM 1986 Page 1)

The nub of the issue was that the "underlying problem of architecture is that there is no context for making decisions about technology and its use" (PRISM 1986 Page 3 Executive Summary). Fast forward to 2019 and there is now, unlike in 1986, virtually no business function or process that is not supported by technology. Yet most of the same problems still recur with familiar root causes as illustrated in Table 1, that compares some of the 1986 PRISM report with the findings of Guillaume-Joseph and Wasek (2015) in software intensive projects.

Table 22 - Comparison IT-related project failure - 1986-2015

PRISM Report 1986	Guillame-Joseph, Wasek 2015
• Applications and their requirements are not yet known (PRISM 1986 Page 1)	• Unrealistic project goals and expectations • Changing or Unclear Requirements
• Evaluative criteria are unclear and undefined.	• Insufficient project management and control
• Often alternatives being evaluated are sufficiently different in nature as to be impossible to compare. (PRISM 1986 Page 1) • Rapid Change in technology, application requirements and organization that makes any solution quickly obsolete. (PRISM 1986 ES-1) • Excessive choice in the marketplace. (PRISM 1986 ES-1)	• Insufficient technical knowledge • Project schedule delays • Project cost overruns
• Future vendor offerings and developments are unknown (PRISM 1986 Page 1) • Technologies that are incapable of communicating with each other. (PRISM 1986 ES-1)	• Problematic technology
• Lack of organizational consensus and shared understanding about technology and its management. (PRISM 1986 Page 1)	• Lack of executive support • Insufficient User Commitment

The recurrence of the same failure factors after 30 years can be seen to indicate two things:

a. Management (Social) innovation still lags technology innovation; and

b. Technology management is and will probably continue to be a "wicked" problem that will require agile management that combines both descriptive and prescriptive techniques.

The PRISM Report (Page 5) then came up with the first "framework" defining architecture in terms of inventory, principles, models and standards for four main architecture areas of interest, namely organization, applications, data and infrastructure.

Subsequently in the realms of Systems Engineering (e.g. GERAM in IFIP 1999), and Information Systems frameworks (Zachman 1987, Sowa 1989), the scope of EA has expanded from a taxonomy (Zachman 1987) to an implementation framework (Spewak et al 1992) including project management and implementation planning. In response to issues related to making more effective use of IT, the US Government passed the IT Reform Act in 1996 mandating both the creation of enterprise Chief Information Officers in government and the need for enterprise level IT architectures providing interoperability standards and a modular framework for procurement (US Govt 1996). Enterprise IT Architecture gave way to Enterprise Architecture due to the omnipresent nature of IT and its impact on business (Spewak 1992, Sowa and Zachman 1992) The US Federal Enterprise Architecture Framework [FEAF] (US Govt 1999 P. 21) directly linked the Zachman Framework (Zachman 1987, Sowa and Zachman 1992) and Enterprise Architecture Planning (Spewak et al 1992). The US FEAF evolved into direct support to enterprise planning and operations (e.g. US DOD 2009 - DODAF 2 and US POTUS - COA 2012).

This expansion was to address the fact that the EA could not be developed in isolation and that it impacted many other business functions.

In the US FEA, EA is part of Service Support / Planning and Budgeting Function alongside strategic planning, business improvement, budget formulation and so on. In short, its role is alongside enterprise planning. In practice, most enterprises locate their EA team in the Chief Information Officer (CIO) organizations where the overall approach to EA was based on systems-engineering principles and techniques such as GERAM (IFIP-IFAC GERAM 1999) and TOGAF® (The Open Group 2018). The scope of EA in the US Common Approach to EA (US 2012), and novel approaches such as LEAD[13] are tightly coupled to the business.

[13] http://www.leadingpractice.com/certification/lead-enterprise-architect/

In France, civil engineering urban planning inspired "Urbanisme" (Club Urba-EA 2006) which is an early form of Enterprise Architecture.

Most EA methodologies use the three-layer architecture model of Business, Information Systems and Technology (e.g. The Open Group 2018, US Govt 2012, Sowa and Zachman 1988, Open Group 2013) and then many (The Open Group 2018, US Govt 2012) expand into migration, implementation and governance, most notably TOGAF and the government architectures. The Archimate architecture modeling language version 3.0 (The Open Group 2016), complements the TOGAF® 9.2 standard (The Open Group 2018) and supports the "motivation" layer incorporating core business concepts such as outcomes, capabilities, courses of action (a.k.a. options), requirements and resources.

The academic literature concerning EA is dispersed (e.g. the Journal of Enterprise Architecture is not in SCOPUS) but there is a wealth of practitioner literature of varying quality and overwhelmingly aimed at the Chief Information Officer (CIO) organizations.

Despite the tremendous efforts expended in EA, the primary outcome of IT implementation success has not improved. Software project failures alone are still at 61% in 2013 which is the same level as in 1997 (Guillaume-Joseph, Wasek 2015).

8.5.1.2 Planning - Standard Business Concepts

Current approaches, including Balanced Scorecard (Kaplan 1996), Strategy Maps (Kaplan 2006), Business Model Generation (Osterwalder 2010), and Strategy Canvas (Kim and Mauborgne 2015), are widely used with a form of the Balanced Scorecard being present in almost 95% of all companies worldwide (Kaplan 2013). Also, in common use are tools such as the Value Chain (Porter 1985) and Capability Based Planning (Davis 2002, The Open Group 2018) which is extensively used in defense. A challenge is that these methodologies are still not providing the entire picture with respect to sustained innovation and competitive advantage, ergo the rise of numerous other "Silver Bullet"[14] methodologies in multiple domains including those associated with technology.

In the COBIT 5 and 2019 model (ISACA 2012 P. 32) a concern is that the Plan function is part of the Management Layer; whereas (e.g. military, industry, government) it is often split

[14] Simplistic methodologies that allegedly provide holistic solutions for minimal effort; they seldom work or are not scalable across multiple domains.

between the two with strategic planning in Governance and tactical/operational planning in the Management function. It varies from organization to organization. If the Plan function is in Governance, then there is a danger that the planners become oblivious to operational concerns. If it is in Management, the planners often sacrifice strategic direction in the pursuit of operational goals. When looking at some key literature (e.g. Kaplan et al 1996, 2004, 2006, 2008), the advantages of a formal strategy execution process[15] are clearly displayed (Kaplan 2008 Figure 1-1 and Figure 1-2 Pages 4 and 5) with 70% of industry winners having one and 73% of losers not having one.

From an EA perspective, notable is the presence of an architect (along with the Integrator and Process Owner(s)) in the proposed Office of Strategy Management (Kaplan 2008 P. 19), that appears to occupy the Governance/Management transition layer (ISACA 2012 P. 32). This also is the same concept as Martin (2009a) in his illustration of integrative thinking. The responsibilities of Kaplan's architect are to "Define and clarify the philosophy of performance management and the processes required to execute" (Kaplan 2008 Page 19 Figure 1-4). This is at variance with the more traditional role of the enterprise architect (e.g. Open Group 2018), so when establishing an EA practice, it is important to clarify roles and positions in accordance with the strategy, planning and governance frameworks in place.

Another vision of the linkage between business strategy and planning is illustrated by Ross et al (2006), whereby enterprise architecture is used to "define strategic limits" (i.e. help create, validate and refine business objectives). (Ross 2006 Page 15 Figure 1-3). This is also reflected in TOGAF® 9.2 which has business capability planning consisting of Business Planning and Enterprise Architecture (The Open Group 2011 Figure 6-3 Page 63).

The linkage between EA and Strategic / Business Planning is illustrated by the decoupling of EA from a CIO function to a business function working in conjunction with strategic and investment planning (e.g. US POTUS - 2012 and AGIMO 2011 - AGA). In industry, the use of EA as an adjunct to business planning is illustrated in models such as a Foundation for Execution (Ross et al 2006) where EA is used as a rigorous confirmatory check (with respect

[15] In Kaplan 2008, a formal strategy execution process consists of the following sub-processes: 1. Translating the strategy, 2. Managing strategic objectives, 3. Aligning organizational units with the strategy, 4. Communicating the strategy, 5. Reviewing the strategy and 6. Updating the strategy.

to feasibility, cost, cost/benefit analysis, and so on with respect to the business goals and objectives. In the future, IT will become even more complex and invasive using techniques such as Big Data, the Internet of Things, to create or enhance knowledge-based services such as genomics, robotics, digital currency and the like (Alec Ross 2016).

The importance of EA was highlighted by making it mandatory for use in the US Federal (and subsequently state) government through legislation (US Govt 1996) with the creation of CIOs. Organizations such as the Office of the Management of the Budget (OMB) (US POTUS - 2009) annually audit and measure the performance of the EA in all government institutions. In defense organizations, the concept of architecture-based planning (US DOD 2009) is widely accepted and used and is tightly coupled with planning, acquisition and procurement activities.

A major challenge, that EA attempts to reconcile using visioning and levels of abstraction, is the business analysts' tendency to "drill down" to too great a level of detail using structured analysis techniques such as the Business Analysis BOK (IIBA 2015) and Business Architecture BOK (Business Architecture Guild 2015)[16] prematurely before looking at all viable options including the use or re-use of existing or available resources.

The following section represents a unique perspective of business planning called business design which is akin to the methodologies described in this section.

8.5.2 Planning - Business Design and Enterprise Architecture

Business design (Martin 2009a, b), elevates product design to the business level and was conceived to discover what processes and mindsets produce continuous innovation. Essentially It is management innovation as discussed in Hamel (2007). It is also a reaction to the methodologies that focus exclusively on efficiency (e.g. Six Sigma, Total Quality Management) with carefully managed risk, and with extensive analytical support. Business Design introduces corporate innovation effectiveness that is "messy", risky and has weak analytical

[16] In one case, a $(C)250 million project had a major cost and time overrun, whereby the budget was exhausted in the analysis phase before anything was physically bought and implemented. The actual purchase was a large application (ERP) with all the processes and data structures more or less provided. Rather than reduce risk by using the proven ERP processes, the "sunk cost" effect had contractors rewriting the ERP to reflect the business analysis.

support because it is moving the company in a new direction. The efficiency-based methodologies tend to be operations-based to "exploit" the existing services focusing on reliability, whereas business design also "explores" for new services focusing on approach "validity". Martin readily acknowledges that Business Design includes both exploiters with a reliability mindset as well as explorers with a validity mindset. Notably, Enterprise Architecture (EA) also focuses on both reliability and validity (although those terms are not explicit) with an emphasis on business transformation and information technology enhancement while moving from the baseline to target architecture(s).

There is considerable similarity between Business Design and EA. However, both the EA frameworks and practitioners are often system engineers and can tend towards a "reliability" bias. Pure business design practitioners are more "validity" biased dealing with concepts associated with "wicked" problems. Both business design and EA call for a combination of reliability and validity thinking to deal with the definition of a solid future state and a feasible implementation and migration plan to underpin a successful business transformation while remaining profitable in the interim. EA uses systematic techniques such as a Business Scenario (Open Group 2011, Page 271) to cope with "wicked problems" and often produces crowded graphics to ensure "completeness" whereas business design will present an image (e.g. Austen 2014) to show empathy with clients (Fraser 2012) and create an emotional appeal that satisfies deep client needs.

The key takeaway is that Business Design and EA are both based upon integrative thinking and incorporate the concept of architecture (Martin 2009a Page 47). The challenge is that the term "architecture" is not explored in any detail, providing an opportunity for EA and Business Design practitioners to work together.

8.6. Information Governance, Management and Architecture

Knowledge, information and data are essential assets of a knowledge-based or digital enterprise, but the actual governance, management and supporting architecture are disparate and poorly defined. With the emphasis on knowledge, the need to handle this key asset in the digital enterprise is evident. This is especially relevant with the market advent of "Big Data",

that is typified by large volumes of diverse dynamic data that are processed, refined (a process called "datafication" (Mayer-Schonberger et al 2013 P.15)) and "mined" for insights,

An extensive definition of what constitutes an information resource is taken from the Canadian Government as follows:

"Any documentary material produced in published and unpublished form regardless of communications source, information format, production mode or recording medium. Information resources include textual records (memos, reports, invoices, contracts, etc.), electronic records (e-mails, databases, internet, intranet, data etc.), new communication media (instant messages, wikis, blogs, podcasts, etc.), publications (reports, books, magazines), films, sound recordings, photographs, documentary art, graphics, maps, and artefacts." (Canada Treasury Board Secretariat 2015)

There are often several communities of interest with differing qualifications and perspectives on information namely:

a. Structured Databases usually managed by those in the computer sciences/engineering (CIO shop);
b. Document Management managed and run by those with a library science background;
c. Web Content managed and run often by those in corporate communications; and
d. Records and Archives managed and run by archivists and library scientists.

Most recent "standards" include the Data Management Body of Knowledge (DMBOK) (DAMA 2017), and the CMMI Institute Data Management Maturity Model (CMMI 2014) and there are several extensive standards that deal with the minutiae (e.g. ISO 11179 Meta-Data Registries), but these many camps make a holistic Enterprise Information Architecture difficult to create. The DMBOK and CMMI models essentially address structured data with the former also including chapters on document and web content management. Records and archive management are not really addressed. A White Paper (Open Group 2013) provides a more holistic view of Information Architecture including definitions that cross the interested parties.

Even nomenclature is a challenge; the author had to change the name of a government-wide information stewardship methodology to 'data stewardship' because it was feared that

those working on structured data in databases would not adhere to it[17]. In an enterprise, there may be several information related management frameworks in play at any one time, particularly Information Governance, Information Management, Data Management and Information Architecture. Often, they will conflict, and have redundant deliverables, such as the information / data lifecycle, as illustrated in Figure 65.

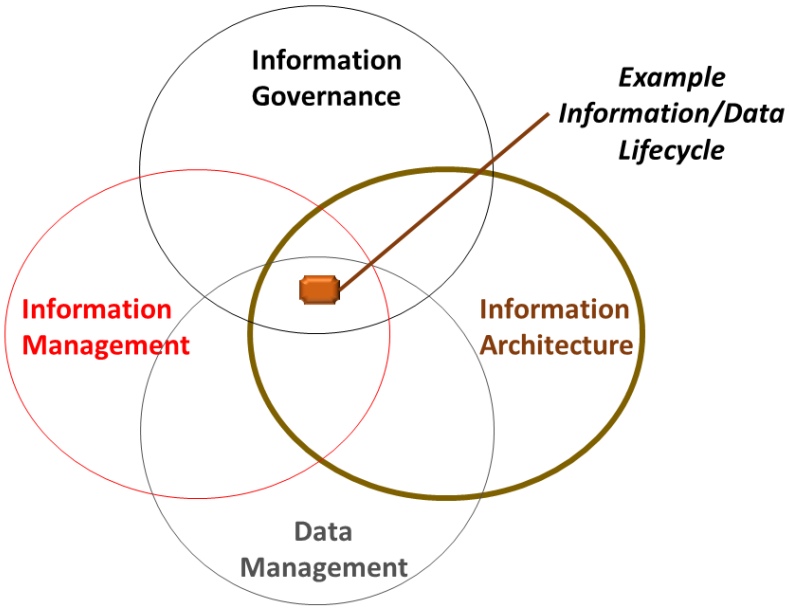


Figure 65 - Information/data governance, management and architecture frameworks

From an EA perspective, it is important that these frameworks, if they exist, be discerned at the outset and reconciled. The Enterprise Information Architect, considering the different work products the frameworks produce, needs to ascertain what is already available, before starting anew.

8.6.1 Building - Project, Program and Portfolio Management

The primary vehicle to build and deliver new capability is a project, and the "project management" function is dominated by two main standards namely the Project Management Body of Knowledge (PMBOK) (PMI 2013a) and the Projects in Controlled Environments (PRINCE2®) standards. The former is stewarded by a not-for profit organization called the Project Management Institute (PMI)[18] and the latter was conceived and developed by the

[17] Unfortunately, the name of the government and organization cannot be disclosed.
[18] www.pmi.org

United Kingdom government Office of Government Commerce (OGC). The PRINCE2® standard has been handed over to Axelos a government/private sector joint venture company.

To implement these standards, project management offices were established and common training for project managers was rolled out within enterprises. The original scope of managing projects has expanded to include programs and portfolios (e.g. PMI 2013a, 2013b and 2013c). The same is true of Axelos[19] that manages a family of interoperable standards pertaining to project (PRINCE2®), program (MSP®) and portfolio management (MoP®) supported by a standard for the establishment of portfolio, programme and project offices (P3O®).

Projects are driven by a set of requirements (contained in a charter) and normally create a solution architecture to address the them. The primary concerns of a project manager are time, cost and scope making projects self-centric rather than enterprise centric. The two major causes of project failure are "Unrealistic Project Goals and Expectations" and "Changing or Unclear Requirements" (Guillaume-Joseph and Wasek 2015) indicating that charters are poorly conceived and written.

As a means of improving the clarity and coherence of individual project requirements, portfolio management was conceived. Portfolios are commonly aligned with a specific business function and may include strategy plans, and operational services as well as projects.

Significant, from an EA perspective, is that both the Axelos and PMI offerings use the concept of portfolio to include planning (including architecture) and operations (PMI 2013b, c) as well as the standard portfolio of projects. Therefore, portfolio architectures should be coherent with the enterprise architecture and coordinated with the operations and maintenance projects.

8.6.2 Systems Engineering

Systems engineering can be defined as "an interdisciplinary collaborative approach meant to enable the realization of successful systems by considering its complete lifecycle. It is based on the concept of 'a system': 'an interacting combination of elements to accomplish a defined objective (ISO 24765)' "(Durantin et al 2016 P.44). The methodologies associated

[19] www.axelos.com

with systems engineering are normally used at the project level to provide solution architectures for individual systems. In fact, enterprise architecture was initially an extension of systems engineering raised to a higher level as exemplified in GERAM (IFIP 1999).

The challenge at this level was that the resulting systems had difficulties being integrated, which was not a problem when many of the control systems were autonomous; however, when the systems evolved from mechanical to electrical to software-based (Shäfer 2016 p.4) and connectivity enabled large scale data integration (a.k.a. an aspect of Big Data) across systems in support of enterprise analytics, there was a need for a higher level systems design that closely resembles the rationale of Enterprise Architecture. This is clearly alluded to in the INCOSE Vision 2025 (INCOSE 2014) where the six systems engineering challenges (INCOSE 2014 P.20) are very similar to the rationale for higher level of IT systems engineering called enterprise architecture (e.g. PRISM 1986 Table 1). The trend towards software in control systems closely links software and systems engineering, making the observations for IT systems relevant to formerly mechanical (e.g. cash register) or manufacturing systems (e.g. assembly line).

8.6.3 Operations – (IT) Service Management

From an IT service management perspective, standards emerged from the United Kingdom Office of Government Commerce (OGC) to standardize the associated processes and techniques, as well as lessons learned, resulting in the conception and issuing of the Information Technology Infrastructure Library (ITIL®) Version 3 (UK OGC 2011) and its sustainment has been privatized through Axelos (www.axelos.com). The ITIL® V3 components include service strategy, design, transition, operation and continual improvement, which is a departure from the original scope of service operations in Version 2. The ITIL standards are in use globally and are being updated in ITIL V4 (Axelos 2019).

IT Service Management, in virtually all organizations in all industrial domains, underpins the governance and management frameworks and dominates the organizations' operations and maintenance spend (OPEX) that includes the major part of the CIO budget. The Service Knowledge Management System (SKMS) in ITIL V3/2011 provides a common repository for IT assets and is a significant extension to the Configuration Management Database (CMDB) from earlier versions of ITIL From an EA perspective, the IT service management discipline

allows for the formulation of an excellent baseline architecture using its associated data environment including "pipeline" services (services that are planned), service performance levels and the incident log. This data provides EA with insights with respect to what is and is not working in the enterprise as well as a crucial part of the baseline state for change. The challenge is that ITIL can result in bottom-up strategy development, leading to local rather than global optimization as well as its procedural focus.

More recently The Open Group has created and promoted the IT4IT standard for managing the business of IT (Open Group 2015, 2016b). IT4IT can be used either in conjunction with ITIL V3 or on its own. This is an emerging standard that is outcome and data focused. Its simplicity and focus on business planning, and project management as well as operations management for IT makes it attractive to CIO organizations.

8.7. Description of the Problem

All the management frameworks have realized that they cannot work within their original mandate and have expanded in scope considerably, often in isolation from the other frameworks, as will be described later in this section. By way of illustration, COBIT 2019 (ISACA 2018), has enterprise architecture (EA) as a control process and refers directly to the TOGAF 9.2 (The Open Group 2018) standard. Contrary to this example is the Portfolio, Program and Project Management Handbook set (PMI 2013 a, b, c) that makes no reference to EA, even though key outputs of EA as in TOGAF 9.2 (The Open Group 2018) are requirements, as well as portfolio and project charters.

8.7.1 Understanding Both the Opportunity and Problem

As described in the previous section, there is a significant overlap in the various management frameworks. This is graphically illustrated in Figure 66 taken from the COBIT 5 (ISACA 2012) audit framework. The audit framework is useful as it provides a backplane to all the management frameworks with the intent being to audit them in a coherent manner. The figure qualitatively shows how the frameworks overlap inviting more detailed analysis.

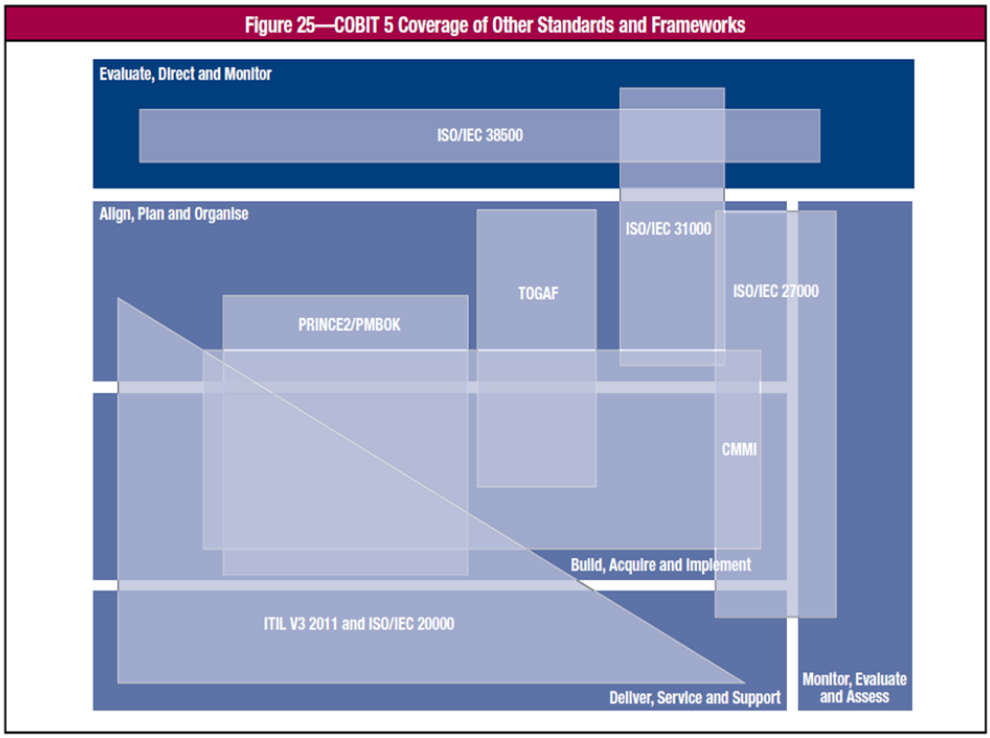


Figure 66 - Overlap of standards (ISACA 2012 Figure 25 P.61)

A more detailed analysis of the core governance and management functions versus the methodologies is provided in Table 23. This clearly shows that many of the methodologies are addressing the same governance and management functions. If these "best practice" methodologies are implemented independently, then the risk is that there will be "friction" at the intersection sets. This results in major redundancies, probably inconsistent plans and architectures, inconsistent data in the supporting repositories, and fruitless "turf battles". There will also be governance frustration at the inability to have the informational basis to conduct integrative thinking (Martin 2009a) and make informed decisions linking strategy to execution (Kaplan 2008).

Table 23 - Areas addressed by management frameworks

Methodologies	*Core Governance and Management Functions*					
	Govern	*Plan*	*Arch*	*Build*	*Run*	*Monitor*
Business Planning	x	x				
Enterprise Architecture	x	x	x			X
Info Gov, Mgt & Arch	x	x	x	x		
Project Mgt			x	x		
Program Mgt		x	x	x		
Portfolio Mgt	x	x	x	x	x	x
Ops Mgt ITIL V2	x				x	
Ops Mgt ITIL V3	x	x	x	x	x	x
Audit COBIT	x	x	x	x	x	x

A challenge also exists in terms of processes, and the required personnel competencies, internal to the methodologies. The positive aspect is that most of the methodologies address many of the processes (e.g. risk management) regardless of redundancy, the negative is that the various methodologies may conduct the same processes for the same issues differently.

Table 24 illustrates several knowledge areas and how selected management framework methodologies have an overlap in these core competencies. The knowledge areas originated in the Project Management Body of Knowledge (PMI 2013a).

Table 24 - Methodology Knowledge Areas

PM Knowledge Areas	Governance (COBIT)	Business	EA TOGAF 9	Portfolio Management	Operations Management	Solutions Management
Stakeholder / Communications Management	x	x	x	x	x	x
Scope Management	x	x	x	x	x	x
Quality Management	x	x	x	x	x	x
Human Resource Management	x	x	x	x	x	x
Integration Management	x	x	x	x	x	x
Risk Management	x	x	x	x	x	x
Cost Management	x	x	x	x	x	x
Time Management	x	x	x	x	x	x
Procurement Management				x	x	x

Table 24 illustrates that many of the core EA skills are available and probably being practiced in the other methodology knowledge areas (if they are present within the enterprise). The challenge is that they are not necessarily being conducted in the same manner. For example there are several different risk certifications, including ISACA CRISC (Certified in Risk and Information Systems Control) (ISACA 2015), PMI Risk Management Professional (PMI-RMP) (PMI 2015), Axelos Management of Risk (M_o_R®) (Axelos 2010), The Open Group FAIR (Factor Analysis of Information Risk) Certification Program (The Open Group 2014), not to mention the Global Association of Risk Professionals (GARP) as well as the ISO ISO 31000:2009 Risk management -- Principles and guidelines. It is not that one risk management methodology is better than another; risk management in an EA context must be performed in a coherent way with the other risk management practices in the enterprise.

Many organizations (e.g. Axelos, The Open Group, ISACA) offer multiple certifications covering several of the key management frameworks. Internally, many of them (such as Axelos https://www.axelos.com/best-practice-solutions), harmonize the management framework and key competency standards so that they work well together. (Remember Axelos is a

joint venture with the UK Government that created many of the standards in the Office of Government Commerce (OGC)).

8.7.2 Analytical Conclusions

All professional organizations are realizing that they cannot succeed on their own and all are moving into the "empty space", which is in fact not empty but occupied by several other professional associations. Some associations clearly refer to another methodology written by another organization, (e.g. ISACA COBIT 5 deferring to TOGAF for Enterprise Architecture) whereas others (e.g. PMI 2013a, b and c) ignore EA altogether. The Axelos / UK Government body of standards is the most closely integrated set of professional standards and provide a degree of methodological coherence.

It is best when establishing an EA practice, to conduct an enterprise scan to assess existing methodologies and only introduce new ones when necessary. Regardless the methodologies should be harmonized, which is made easier when adopting a family of standards that have been already coordinated.

Clearly a key skill in the Preliminary Planning Phase in the TOGAF Architecture Development Method (Open Group 2011) is the coordination of the key frameworks and positioning EA to succeed.

8.8. Resolving the Integration – Participation Action Research (PAR) Studies

This section briefly covers four PAR studies that illustrate the coordination of the management frameworks and the positioning of EA to provide value. The case studies are in government as there is less of a challenge in sharing their solutions.

In all cases, there has been a challenge integrating the management frameworks. The author was either the project manager, executive mentor and/or chief enterprise architect in these case studies.

8.8.1 PAR Study 1 - Large Commonwealth Government Organization – De-Centralized EA

In this very large government department, there were already many frameworks in place, specifically covering business planning, portfolio management and operations. EA was being introduced as a "best practice" in government along with a new outcome-based planning methodology.

The approach taken focused on the key EA deliverables. In fact, many of the EA work products were already completely or partially being delivered through the other management frameworks. The value proposition of EA was the provision of integrative thinking and end-to-end coherence. After analysis, Figure 67 shows a collaborative way ahead for the CIO organization with various organizations being tasked to deliver their specific work products.

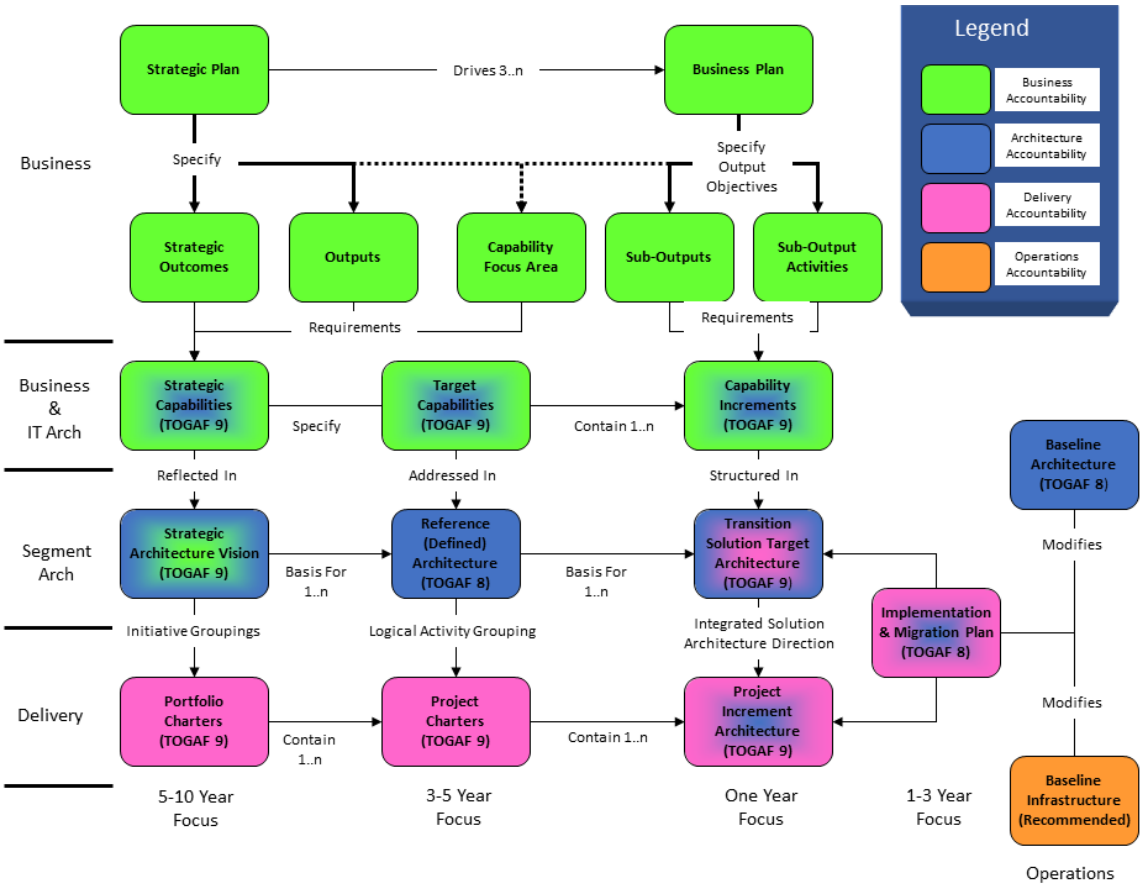


Figure 67 - Integration Case Study 1 - Large Organization

The diagram illustrates the way that the various enterprise segments could collaborate and jointly deliver the EA. No stakeholder positions were lost, no radically new changes were required, and the EA directorate was kept small, focused on architecture, and played a key role in coordination as well as the provision of a common repository for quality decision-making.

8.8.2 PAR Study 2 - Large State Government Organization – Architecture Based Planning

The second case study involves a large state department/office where the new first deputy commissioner (deputy minister in Westminster style government) had disjoint management in the CIO organization. The need was to create an integrated management framework that incorporated IM/IT governance, planning, architecture, and operations as well as a conceptual architecture.

Figure 68 illustrates the integrated management framework that incorporated a TOGAF based EA (part of IM/IT planning) with governance (based upon IT Governance Institute best practices), a Project Management Framework (based upon PMI) and operations (based on ITIL V2).

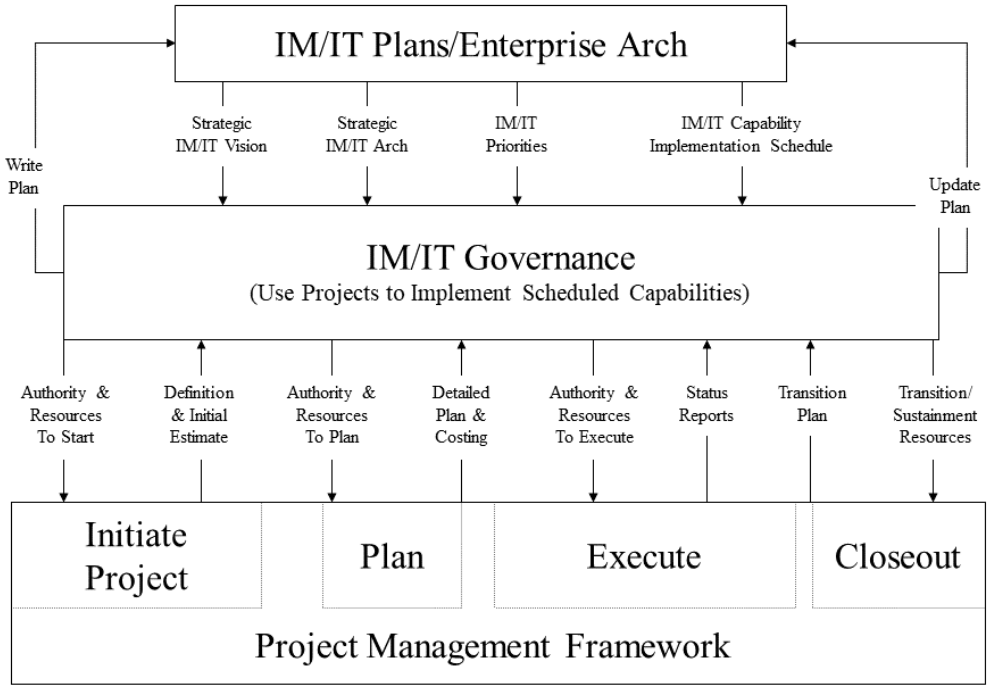


Figure 68 - Aligning the Frameworks / Initiative Synchronization – Case Study

A major feature of this management framework was the integration of EA and IM/IT Plans. In fact, the plans cell acted as the portfolio management office and controlled the funds. For projects, whether they were tactically or strategically generated, it meant that if they did not comply with the EA, then their funding was cut. This avoided a great many issues and ensured that the project design was consistent with the EA. Another feature was that it did separate governance from management through the committee structure, allowing the corporate executives (the IM/IT Steering Committee) to make strategic decisions, while a management layer did the day-to-day work.

Also, note that the term Information Management/Information Technology was used to ensure that the CIO members did not forget that one of their primary roles was to manage information / data as a core enterprise asset.

The State Office won the New York State Information Resource Management Gold Medal for the work in establishing a solid management framework in a relatively brief time (four months).

8.8.3 PAR Study 3 - Large Diversified Government Department

This organization conducted a large modernization, integration and interoperability effort in the 1990's where much of the business transformation effort included the introduction of state-of-the-art technology, with an emphasis on information technology. Disparate IT organizations were integrated into one centralized information services organization to enhance effectiveness and decrease costs. The EA effort was located within the new CIO business line and was integrated with planning to enable architecture-based planning.

There were three factors that created significant challenges to the CIO organization:

a. the extremely diverse nature of the enterprise;
b. the introduction of technology staff who were not familiar with the overall enterprise; and
c. extremely strong project management and systems engineering cultures and organizations within the enterprise.

Over a period of ten years, dissatisfaction with business value realization resulted in the CIO organization being relegated to supporting the corporate functions, with the business lines, again, being responsible for direct business and IT support. The business line staff were

knowledgeable and experienced with respect to the conduct of their specific operations, resulting in the achievement of tactical business value. The organization reverted from one CIO, to fifteen CIOs; a similar situation to when the enterprise CIO organization was originally created. The corporate EA effort became focused on the creation and maintenance of a coherent EA framework (instead of an architecture) with a supporting set of architectural product templates and licences for an enterprise tool. EA became loosely coupled with planning and the models were used by project management to describe scope and get approvals. Within the projects the systems engineers used the EA framework, but, in the absence of an overall enterprise architecture, used their own locally optimized models in their creation of solution architectures. There was no longer any over-arching EA at the organization level to coordinate the various initiatives.

After another decade, the systems engineers in the projects recognized that they needed an enterprise-level architecture to provide coherence to the hundreds of projects and systems they were delivering. Consequently, the systems engineering community is in the process of creating another EA function to deliver an enterprise architecture rather than framework with the emphasis being on interoperability.

8.8.4 PAR Study 4 - Municipal Government

Municipal government is very complex, and the business model is again very diversified. Enterprise architecture was created within the CIO organization with a view to enhance the efficiency and effectiveness of the IT infrastructure in support of overall business transformation. The EA focus was initially strategic and integrative. A major management perspective was that the effort was too theoretical and conflicted (overlapped with) the group conducting business transformation. Furthermore, there was a tactical, project focused culture within the enterprise. Not surprisingly the EA effort was subordinated to the solutions development group within the CIO organization where they provided limited support to projects. In a recent cost-cutting effort (2016) conducted by a new CIO, the EA cell was disbanded, all EA processes were abandoned, and systems architecture was instead used at the project/system level.

8.8.5 PAR Study 5 – Development of International Standards

The author is heavily involved in the development of international open standards in areas related to digital transformation, specifically in enterprise architecture, and knowledge management and architecture. In 2019, work was conducted to address information/data in the context of a business standard. The author researched and came up with well-established and globally accepted definitions and terminology from both the information (formerly library) and technology sciences (including ISO). These were rejected out of hand as coming from information technology and new definitions, at variance with the essence of the accepted ones, were invented and inserted. This creates confusion when transitioning the business needs into architecture, design and implementation.

This is just one instance of standards organizations working either in isolation or in silos within a standards body. It happens frequently with notable exceptions such as where the ISACA COBIT® 2019 (formerly the Control Objectives for Information and Related Technology) standard directly refers to enterprise architecture specifically TOGAF® (formerly The Open Group Architecture Framework) (ISACA 2018 P.74, 75, 76, 77, 78, and 79).

8.8.6 PAR Study Summary

These five case studies are based upon personal experience and happened in the 1993-2019 timeframe. Throughout this time, all the management frameworks were/are still maturing. Initially their scope was limited, and they were easier to integrate. Since then they have all expanded their scope and now they encompass a much larger part of the Govern, Plan, Build and Run landscape making for considerable redundancy and complicating coherent enterprise management.

The standards, upon which the management frameworks are based, are now competing with one another to improve market share through incoherent extensions into the same areas, to complete their version of end-to-end service delivery. This complicates if not compromises, effective digital transformation. Often the owners of the various management frameworks compete for primacy and resources. Enterprise leaders become embroiled in refereeing between champions of one methodology versus another, rather than achieving business value.

As EA highlights overlaps/inconsistencies this leads to friction with the champions and EA is either subordinated to a framework or dissolved.

Another factor within this timeframe has been the professionalization of IT personnel. An unintended consequence has been the creation of technology frameworks with accompanying semantics and techniques that are unintelligible to the business (corroborated by Durantin 2016, p.47). There is also a tendency for IT professionals to think in project and individual system terms rather than strategic portfolio or system of system terms for which EA was conceived. The systems engineering community has recognized the need for a higher-level perspective of the problem space in their Vision 2025 (INCOSE 2014) that called for a holistic approach that EA embodies. Not once was the term "enterprise architecture or EA" used in Vision 2015, despite its focus on product and system architectures.

To summarize the case studies the following salient points are important:

a. Case Study 1 - EA became part of an end-to-end process integrating the management frameworks;
b. Case Study 2 - EA was integrated with planning to enable architecture-based planning;
c. Case Study 3 - EA became limited to framework creation and management but is now being revived to enable a system of systems approach;
d. Case Study 4 - EA was a separate function whose business value was not appreciated; and
e. Case study 5 – The reconciliation of the management frameworks, including EA, is not getting any better and may be worsening.

From a technology and business perspective, the ubiquitous connectivity, enhanced processing power and advancement in artificial intelligence/analytics has resulted in what is more commonly known as "Big Data": a key enabler for competitive advantage and enhanced service delivery. Previously autonomous systems can all be interconnected with the acquired data serving multiple purposes. This is at the heart of the digital enterprise and requires a new business outlook to manage the enterprise.

8.9. A Heuristic EA Stewardship Method

Every enterprise, either private or public, has its own culture that is often influenced by the sector that it is operating in. In a diversified business model, there could be multiple

cultures, and this is especially true in government where, for example, the ministry of health will have a very different perspective on business than say the ministry of defence.

The concept of stewardship is differentiated from the concept of ownership in that a steward manages on behalf of the enterprise. In this case the director or manager for EA would coordinate an overall enterprise architecture ensuring its coherence and filling in any missing pieces. The enterprise architecture would be owned by the enterprise itself with numerous agencies contributing to its completion and thereby impart ownership throughout the organization. Stewardship is conceived to reduce friction and ensure that all relevant information is securely shared throughout the enterprise to provide enterprise leaders and managers the best possible basis for decision-making.

This methodology is based on the three main components of an enterprise architecture, namely an assessment of where the organization is (baseline architecture); an assessment of where it wants to go (target architecture (s)); and how it can to get there (implementation and migration plan). The case studies all indicated that the non-delivery of any one of these components renders the enterprise architecture less than useful. This is in line with standard EA methodologies such as TOGAF 9.2 (The Open Group 2018), specifically Preliminary Planning where the EA capability is assessed.

The EA stewardship method must be generic enough to cover a wide range of industrial and government domains. The proposed methodology is heuristic and is expected to be customized and extended by professionals to meet the needs of the specific enterprise in question. Regardless, the method contains solid guidance that should be followed to avoid difficulties during implementation. As such it is an integral part of preliminary planning (Open Group 2018 - TOGAF® 9.2) that should be conducted prior to the start of an EA Effort within an organization.

The method incorporates the lessons learned from the previous section and blends them into a coherent whole. There are two threads that are applicable to all the phases and steps within the method.

a. **Enterprise Digital Transformation.** Formulating a baseline architecture state, target architecture state and an implementation plan, is transformational. The business transformation (e.g. Kotter 1996, 2014) and business design (e.g. Martin 2009a, 2009b, 2013 Lafley, Martin 2013) schools of thought have addressed many of the

soft "wicked" problems that CxOs have to confront when they advocate change. Digital business transformation considerations are sometimes "irrational", not easily modeled and should be taken into consideration by the analysts and EA practitioners who are all too often coming from the systems engineering domain (INCOSE 2016, Open Group 2018), where these qualitative factors are often sidestepped. Anyone having undergone a strike or labour unrest, will understand the wisdom involved in considering both quantitative and qualitative transformational aspects of any enterprise architecture. This method assumes that the analyses in all phases address both aspects of the EA.

b. **Enterprise Continuum (Based on TOGAF 9.2 2018).** When thinking of architectures and solutions, it is best to think in terms of existing generic, style-specific and industry-specific architectures before creating a new enterprise architecture for the organization in question. This stems from the 1980s when unique-to-department (if not solution) architecture resulted in very expensive and non-interoperable solutions. Re-using suitable architectures is also a risk-reduction mechanism in that the architectures have been used and often incorporate numerous lessons learned. The danger, mitigated by evaluation, is that you might end up using an architecture that is unsuitable (just as some commercial off the shelf (COTS) solutions) to the organization.

There are six basic steps involved, each of which will be discussed in some detail in the following section:

Step 1. Review the EA mandate;

Step 2. Define EA deliverables;

Step 3. Confirm major management frameworks and their interactions;

Step 4. Confirm with other involved planning stakeholders/frameworks;

Step 5. Validate governance;

Step 6. Establish EA value proposition;

Step 7. Establish Joint EA, accountability and investment framework; and

Step 8. Execute, learn and revise.

8.9.1 Step 1 - Review EA Mandate

After having been tasked with the establishment of continuation of the EA, it is imperative that the accountable individual understand the exact nature of the EA that is expected.

Often EA is initiated by a sponsor in governance who starts the effort for a specific reason; which must be well-understood. In the presence of a Request for Architecture Work (Open Group 2011 - TOGAF® 9.1) this task should be easier, but the significant investment of several employees with some consultants and potentially a tool often represents an annual investment of $500,000 to $1,000,000 by the company, and there should be expectations attached. If the sponsor is the CEO, the deliverables would differ from if the sponsor is the CIO (which happens in most cases). The rationale could be as simple as satisfying an audit point raised with the intent of increasing corporate transparency, or more complex such as aligning IT with the business or acting as a rigorous basis for business transformation.

Sometimes an EA is generated "bottom-up" by employees and managers recognizing that there are opportunities to be exploited using EA. Funding is often from Operations and Management (a.k.a. OPEX) and the first manifestation is the appearance of a tool with several employees being diverted from their primary tasks to learn and then populate the tool repository following a prescriptive methodology that may or may not be appropriate to the organization.

Whether the effort is top-down or bottom-up, there is an EA mandate that must be articulated. In the top-down scenario, it is often easier to discern than bottom-up, where the mandate may be tacit and should be extracted. By the time this phase is completed, there should be a good understanding of why EA is being done.

Having said that, heuristically, there may be no EA Mandate, especially in the bottom-up scenario or in the case of a languishing EA practice being propelled by momentum. Understanding this fact is imperative if the EA must be made relevant and provide business value as determined in Phase 6 - EA Value Proposition.

8.9.2 Step 2 - Define EA Deliverables

This phase does not have to be comprehensive, but complete enough to enable a collaborative discourse with the owners of the other management frameworks.

As previously mentioned, the fundamental EA deliverables are a baseline (a.k.a. as-is, current) architecture, a target architecture and a plan to transition from the baseline to the target architecture.

Understanding the EA Mandate (or lack thereof), one should identify and interview major stakeholders to determine the EA work products that they would find useful. It is important that the analysis stays at the macro level with just enough detail to engage the other management frameworks.

Again, the use of the Business Model (Ross et al 2006) (both baseline and target) is useful to determine who is a stakeholder, for example in a diversified business model possibly the scope will focus on integrated / interoperable corporate services, whereas in a unified business model the scope is enterprise-wide. Also, the deliverables will vary with respect to sponsor interests (e.g. CIO versus CEO).

Understandability of the EA models is key, as showing models using a standard such as SysML (OMG SysML) is not comprehensible for some 80% of the stakeholders (Durantin et al 2016).

The outcome for this phase should be a high-level list (a.k.a. catalogue, map) with the deliverables required for whom. This list will be updated during the analysis.

8.9.3 Step 3 - Confirm Major Management Frameworks and Their Interactions

What constitutes a major management framework is often a function of the strategic direction and business operating model of the enterprise. The major frameworks include business planning, project management, operations management and investment management. When assessing how EA can contribute the most business value these frameworks should be assessed. The following steps do not have to be executed in a particular sequence however the order is heuristic and recommended.

In many enterprises, not all of these management frameworks may be in place. In that case, EA may have a larger role to play than if they existed. This phase should determine what the impact of their absence is.

During all the steps there will often be a need to analyze strategic direction / methodologies and the retrofitting of a meta-model to discover the core elements. It is important that

the analysis stays at the conceptual level and discovers both quantitative and qualitative factors.

8.9.3.1 Step 3-1 - Confirm Portfolio/Project Management Framework

Most organizations today contain a Project Management Office (PMO) which is a good place to start. The intent is to see what deliverables are created and how they are formulated. Often this will be a function of their organizational maturity. Normally they will have a baseline (as-is) state, one or more target states (to-be and transitions) as well as an Implementation and Migration Plan. There are several lines of inquiry that can be pursued from an EA perspective:

a. Are the target architectures (often called solution architectures in projects) integrated, or a series of independent project architectures?
b. Are operations and maintenance projects controlled by the PMO?
c. What is the PMO mandate? Is it focused on the practice of Project Management and/or supervising the projects or both?
d. Is there portfolio management and does it encompass operational services?

8.9.3.2 Step 3-2 - Confirm Operations Management Framework

Operations Management should be a solid source from which to find the existing baseline architecture. Often this framework is disparate throughout the enterprise and there is little in the way of a common repository. In other cases, if the enterprise has their own internal framework, uses ISO 55000 for physical assets and ITIL (ISO 20000) for IT related assets, there will be a rich environment from which to assess the current and, potentially, future state of the enterprise especially if there is a well-architected repository.

It is important to understand how the enterprise operations management business function handles projects and their OPEX budgeting process. The line differentiating capital (a.k.a. CAPEX) and operations and maintenance (O&M or OPEX) expenditures is often not well defined and OPEX sometimes ends up defining the EA from a strictly bottom up perspective that is often removed from strategic plans for the enterprise.

The specific lines of inquiry should include:

a. Is there a coherent “as-is” architecture description?

b. Does operations management plan strategically and tactically, including implementation and migration planning?
c. Is there one or more “target” architecture(s)?
d. Is there OPEX project management?
e. What are the main management deliverables that they produce?
f. How do they control expenditures?
g. Are qualities of service defined and monitored?

8.9.3.3 Step 3-3 - Confirm Business and Investment Planning Framework

At the Enterprise level, guidance is most often given in the form of strategic plans (3-5 years) and annual business plans conforming to the corporate fiscal cycle and then enterprise principles and policies.

At a lower level business architecture / planning also addresses business requirements that determine necessary business services and the requisite qualities of service which are, in turn, used to formulate Service Level Agreements (SLAs) for both external and internal clients.

The maturity of the business and investment planning frameworks will vary significantly between companies transitioning from small to medium size and whether they are publicly traded or not. It is important that this step closely examine the state of these frameworks to determine whether enough coherent direction is available upon which to base an EA.

For investment purposes, at the end of this step there should be a clear understanding of how CAPEX and OPEX are managed and whether they are combined. As previously mentioned, potential operations management principles such as continuous service improvement, can be very costly and provide little if any business value.

The specific lines of inquiry should include:

a. Is there an enterprise strategic plan with well-established goals and objectives?
b. Are there annual business plans that detail outcomes and implementation details?
c. Is there an integrated control framework for investments including detailed definitions of OPEX and CAPEX?
d. Is there a defined set of business services and products delivered by the enterprise?
e. Are there qualities of service (and SLAs) for the business services and products?

8.9.3.4 Step 3-4 - Confirm Enterprise Architecture Framework

This step is executed in the case that there is an existing EA Framework and group of individuals completing EA. The main challenge is how relevant the EA deliverables are. Any existing agreements with the other major management frameworks should be examined.

Also, the EA function should be seen to be addressing the business transformation aspects of introducing new business models and/or disruptive technology. For example, the concurrent arrival of Cloud Services and Big Data, has often resulted in a major business and IT transformation changing the way that information/data is managed, and internal IT services are delivered.

Lines of enquiry could include:

a. Is the EA function responsible for managing the EA Framework and/or the actual EA?
b. Is the EA function coordinating the architecture of the ongoing projects/portfolios?
c. Is the EA function aware of current operations, SLAs and whether the qualities of service are being met?
d. Is the EA function following current business strategic direction?
e. Is the EA function working on future direction and addressing business transformation issues?

8.9.4 Step 3-5 - Confirm Alignment

This step is last, because one of the main items to discover is whether the portfolio / project and operations management frameworks conform to the strategic direction given to the business planners

Lines of inquiry could focus on the following:

a. Are projects aligned with business strategic direction?
b. Is the operations management function aware of the new services/project deliverables coming into service?
c. Is investment planning (i.e. project and operations funding) coherent along business lines and is CAPEX and OPEX being managed in an integrated manner?
d. Are multiple frameworks delivering the same thing (e.g. 2 or 3 Implementation Plans)?

e. Are the project architectures and deliverables interoperable in accordance with a set of enterprise standards?

f. Is governance information being shared and/or consistent across the management frameworks?

The best way to tackle this challenge is to outline a Responsibility Assignment Matrix (PMI 2013a p.262) (RAM), also known as RACI (Responsible, Accountable, Consulted and Informed) matrix [Jacka et al 2009] and establish who is delivering what, when and why. This RACI matrix, a sample in Table 25, will provide the basis for determining value the EA function will have.

Table 25 - Sample RACI Matrix based on Case Study 1 – Figure 67

Deliverable	Business	Architecture	Delivery	Operations
Strategic Plan	A, R	C	C	C
Business Plan	A, R	C	C	I
Strategic Outcomes	A, R	C	I	I
Strategic Capabilities	A, R	R	C	C
Target Capabilities	A, R	R	C	C
Capability Increments	A, R	R	C	C
Strategic Architecture Vision	R	A, R	C	C
Reference Architecture	C	A, R	C	R
Transition Solution Target Architecture	C	A, R	R	C
Implementation and Migration Plan	R	R	A, R	C
Project Increment Architecture	C	R	A, R	C

8.9.5 Step 4 - Confirm with Other Involved Planning Stakeholders/Frameworks

This step will include an analysis with any other management frameworks that may exist and be of import to the EA function.

Normally these would include:

a. Performance Management;

b. Requirements Management; and

c. Asset Management.

Lines of enquiry would include:

a. Are the performance measures aligned with business goals and the services being or soon to be delivered?
b. Is requirements management using an architected approach that can be leveraged for EA?

8.9.6 Step 5 - Validate Governance

Governance must be assessed from a perspective of how it is enabling the enterprise to have an integrated view of its assets, its future and the investments required to get there.

Governance will vary greatly, but the key is that it is coherent and has access to a consistent set of information upon which to base decisions. It is crucial that key governance structures have an escalation mechanism.

The lines of enquiry would include:

a. Who is currently responsible for providing any EA related deliverables?
b. Is the concept of stewardship used in the enterprise?
c. Does the enterprise and its executives have a strategic and/or tactical mindset?
d. Are there any boards, committees or working groups already approving EA related work?
e. Can the above management structures be leveraged for EA?

8.9.7 Step 6 - Establish EA Value Proposition

This is a crucial step and should be part of the fundamental EA charter. It should be both qualitative as well as quantitative, leveraging the preceding work as well as industry benchmarks. The value proposition should address how EA is going to enhance the effectiveness of the enterprise as well as ensure the optimal and cost-effective deployment of resources.

Stewardship strives to not duplicate existing work or processes but to complement them so that their outcomes are coherent. A good example is if the business uses strategy maps (Kaplan et al 2004) that they are integrated into the EA and used to focus business transformation including the acquisition and integration of new technology.

The lines of enquiry would include:

a. Are there existing enterprise audits highlighting incoherence requiring EA?

b. Why was EA started up in the first place? (or is EA a useful function/technique for the enterprise?)
c. Would EA be best integrated within another business function?
d. Are there opportunities to both improve quality of service/products as well as economise?

8.9.8 Step 7 - Establish Joint EA, Accountability and Investment Framework

After having established a value proposition, it is now time to determine where and how EA can best fit within the organization. At this point it is also useful to determine whether EA should be looked at as a business technique to be used throughout the enterprise or whether EA should be a separate function in support of the enterprise. Invariably it will often be a combination of the two. Therefore, it is important to determine who does what where.

The best way to do this is using a RACI matrix supplemented by a simple graphic. The RACI matrix will determine what the look what EA deliverables are completed by what organization and the graphic will display the flow and relationship between the deliverables.

One of the most important aspects of this step is to determine the best place for EA to be located within the enterprise. In most enterprises, EA is normally located within technology services under the CIO, given its origins that focused on managing the introduction of information technology into an organization. In government (e.g. AGIMO – 2009) it is recommended that EA be part of the Planning and Budgeting Group alongside Strategic Planning, Budget Formulation, Procurement Planning, Workforce Planning et cetera. The latter is highly recommended due to the ubiquitous nature of technology and the interdependence of virtually all elements within an enterprise.

There must be a repository/information store reconciling and integrating, as a minimum, the EA, planning, project management, and operations management information so that it could be used for enterprise management and governance decision-making.

8.9.9 Step 8 - Execute, Learn and Revise

This phase is based on a continuous assessment of how EA can improve the business value it is delivering and its quality of service. For this phase to be successful, there must be a

set of performance measures in place and preferably automatically acquired with the data going into the repository/information store.

8.10. Conclusions

The aim of this chapter was to provide guidance and clarification with respect to coordinating multiple management frameworks, an activity that is referred to in standards (e.g. Open Group TOGAF® 9.2 2018) and is often cited as one of the first things to be completed when planning an EA cycle.

The Digital Enterprise is more than information technology and embraces all manner of technologies such that there is virtually no business or manufacturing or communication or decision-making process that does not leverage information and technology. Technology and supporting interoperability have become central to competitive advantage and quality service delivery.

The first key message is that the various management frameworks in the Govern-Plan-Build-Run cycle do not work well together. Although they started well in discrete areas of endeavour (e.g. operations) they have ventured into areas addressed by other frameworks but each in their unique, but incoherent, manner. This creates confusion when it comes to the already complex task of enterprise digital transformation.

The second message is that EA is holistic, providing enterprise planners with a concrete perspective of the future, target and transition states. Case studies revealed that many EA cells have failed or been discontinued because they have transgressed existing organizational boundaries and duplicated, instead of complemented, existing work. Another challenge is ineffective communications, as many deliverables are unintelligible to business stakeholders and tend to focus on technology and detail. Their value is obscured by their presentation.

The third key message is that EA stewardship, versus "ownership" is a useful technique to promote collaboration and coordination amongst the management frameworks. The EA Cell maintains the EA framework and tooling on behalf of the enterprise and coordinate the work to create the actual EA by the enterprise.

EA was originally conceived to create "a road map for the Federal Government in achieving better alignment of technology solutions with business mission needs" (US Govt 1999) and has evolved from 1986 (PRISM 1986) to the present (e.g. The Open Group 2018)

to make enterprise digital transformation both efficient and effective. Arguably, EA has become more important than ever, but its inadequate implementation, often due to friction between the management frameworks, has contributed to an IT software failure rate that has hovered at 50% for more than 20 years (Guillame-Joseph and Wasek 2015).

In summary, EA stewardship enables enterprise holistic and coherent digital transformation, but it is a multi-disciplinary effort that requires leadership to recognize and harmonize the corporate management frameworks.

8.11. Future Research

The concept and realization of the promise associated with the digital enterprise will require a multi-disciplinary team effort to conduct management research; technology research is indeed far ahead, albeit in small well-defined silos. This work should leverage Westerman et al (2014).

EA should be revised to both adapt to the digital enterprise (versus merely IT) and to all stakeholders. The author is already involved with The Open Group to adapt TOGAF 9.2 (The Open Group 2018) to modernize the standard to accommodate more stakeholder concerns (including making it more consumable).

Architecture based planning (e.g. US DoD 2009 – DODAF 2.0) should be examined and leveraged in both business and technology schools.

Chapter 9. A New Enterprise Architecture Development Method

The current architecture development methods such as TOGAF 9.2 (The Open Group 2018) are based upon rigidly fixed architecture domains that reflect an information systems development technique and are loosely coupled with systems engineering. Research has revealed that the role and more importantly value of an enterprise architecture is in dispute. In several action research efforts, the EA function was deleted when the CIO faced budget cuts or, in one case, the CIO did not feel it useful. Notably in the latter case, EA was re-instated after several "messes" and has become mandatory across all government departments, but it is still found in the CIO organizations, subject to the biases of the CIO, and IT focused. Furthermore, EA is often not an integral part of the enterprise management frameworks and becomes the enterprise IT architecture. If EA is to be the basis of an integrative framework, its development must involve all members of the enterprise, so the architecture development method must be useable by all. A new, business friendly EA development method (EADM) is needed and is recommended in this chapter.

This chapter will be the basis for a white paper entitled "A New Enterprise Architecture Development Method" and be submitted as a Change Request to The Open Group TOGAF 9.2 Standard.

9.1. Description of the Problem

9.1.1 General

To elaborate on the comments in Chapter 5, many of the EA Architecture Development Methods (ADM) are based on the first three columns of the seminal Zachman Framework (Zachman 1987) and follow the EA Planning (EAP) methodology laid out by Spewak (Spewak 1992). Essentially there are three key areas of concern, namely business, information systems

(data and applications) and technology. Subsequently John Zachman and Steven Spewak consulted with the US government to create the first Federal EA Framework (US CIO council 1999), that embedded the areas of concern a.k.a. domains.

As discussed in Chapter 5, the term "business design" has partially replaced EA in the business. Specifically this is prefaced by the word "digital" in *that* "digital business design [is defined] as the holistic organizational configuration of people (roles, accountabilities, structures, skills), processes (workflows, routines, procedures), and technology (infrastructure, applications) to define value propositions and deliver offerings made possible by the capabilities of digital technologies.(Ross et al 2019 p.5)[20]

A major issue is the word "architecture", whose technical connotation has led the EA group being marginalized within the CIO organization and the "business" using analogous terms such as business design. Indeed *"… business design is sometimes referred to as business architecture. We are reluctant to use that term because, at many companies, architecture is seen as the IT unit's responsibility. Right now, if you have a business architecture function, it's probably buried in your IT organization (and having limited impact). Digital business design, in contrast, is a responsibility of senior executives in a company. It is how leaders ensure the company can execute its business strategy in a digital economy."* (Ross et al 2019 p.5)

This has now changed as EA has encompassed or underlain more domains and, for example, the US Common Approach to EA (US POTUS 2012) has expanded the EA as illustrated in Figure 69 - US Common Approach to EA (P.4 US POTUS 2012).

[20] Dr. Jeanne Ross and MIT have extended the courtesy of sharing a pre-release copy of the book "Designed for Digital" that should be released in October 2019

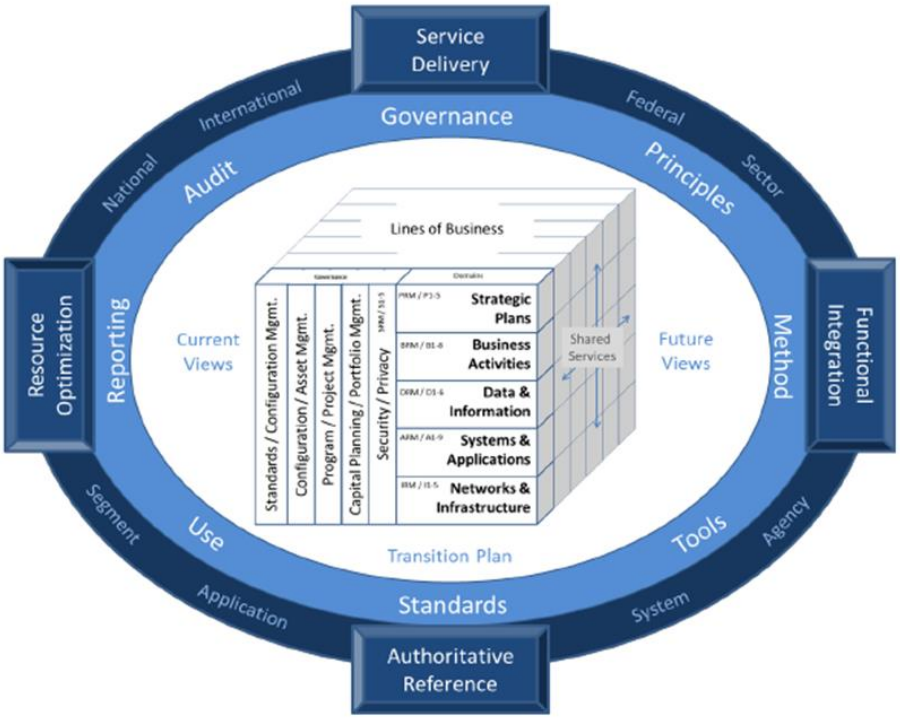


Figure 69 - US Common Approach to EA (P.4 US POTUS 2012)

As the matrix in Figure 73 shows, the problem space is two dimensional (domains and levels of abstraction) but many of the architecture development methods are one dimensional leading to difficulties during implementation. For example, The Open Group architecture development method, as shown in Figure 70, mixes areas of concern/domains and levels of abstraction leading to several issues:

a. The areas of concern/domains (business, information systems and technology) are fixed, causing issues when addressing new domains such as security;
b. The levels of abstraction (or detail) are ambiguous, making what is to be specified to what level of detail challenging;
c. The domains are in danger of being handed off to subject matter experts and siloed, whereas they have major overlaps and must be completed in a coherent / holistic manner (e.g. data, security) at all levels of abstraction; and
d. It is information systems / information technology centric.

Furthermore, the domains still reflect the concerns from 1987 and have not been updated to reflect the Zachman framework extension in Sowa et al 1992, let alone the increased dependency of business value generated by a much wider range of technology innovation.

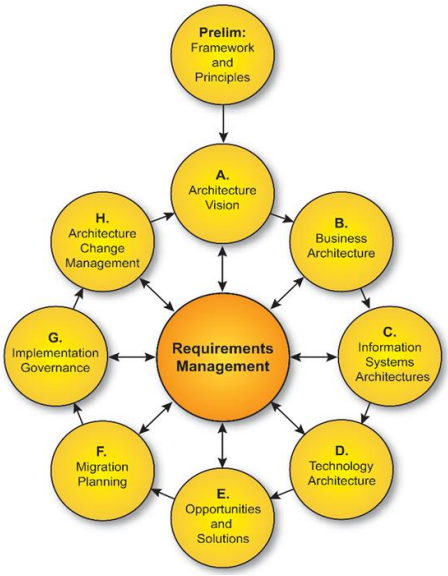


Figure 70 - TOGAF ADM (The Open Group 2018)

9.1.2 The Advent of the Internet of Things (IOT)

The digital enterprise is complex and widely read sources indicate that that it is a discrete step in the evolution of computing as follows:

"*The internet of things (IOT) … holds that, despite all of the changes the computer revolution has already wrought, it is only getting started. The first act … brought computing to governments and big corporations. The second brought it to ordinary people, through desktop PCs, laptops and, most recently, to smartphones. The third will bring the benefits – and drawbacks-of computerization to everything else, as it becomes embedded in all sorts of items that are not themselves computers, from factories and toothbrushes to pacemakers and beehives."* (Economist 2019)

As described in the previous section, many of the key EA frameworks are based on a partial information systems framework from 1987 (Zachman 1987), which would place it at the end of the first act. The IOT will require the consideration of many other areas of architectural concern, as will be discussed later in this chapter.

9.2. Looking at a New Approach to Enterprise Architecture Development

Enterprise Architecture (EA), or its analogue, business design, is simply a sufficiently rigorous technique that results in a coherent plan based on a thorough understanding of the current status of the enterprise. The method to create an EA must be a systematic way of continuously keeping the enterprise competitive and/or effective; it must be dynamic and constantly revisited to maintain its relevance.

There is also a danger that it falls victim to analysis paralysis, stuck in a never-ending cycle of requirements refinement. There must be an ability to scope and partition the architecture effort to rapidly produce the work products that in turn must be well understood and followed as part of a coherent planning process.

As TOGAF is used in 80% of Global 50 companies and 60% of Global 500 companies (Perez-Castillo et al 2019 p. 12), any new EADM should be readily adaptable by those familiar with TOGAF to be successful. This includes using as many of the existing TOGAF constructs as possible.

There is also the need for a multi-disciplinary analysis covering a wide range of concerns. These concerns vary depending on the business and the nature of what constitutes the enterprise. This is not self-evident with things such as a supply chain that can traverse multiple companies across the globe. Both the automotive industry and retail are good example of the latter. In digital transformation, the effort is much more than traditional information systems, but involves a wide range of sensors embedded in equipment such as medical micro-bots to rented jet engines to assembly lines to warehousing to utilities and so on. What is in common is that they share data / information to be ethically exploited for corporate advantage. Although the sensors or System Control and Data Acquisition (SCADA) are managed throughout the enterprise and these system synergies can only be exploited by coherent planning across all domains, many of which are not associated with the CIO organization.

The next issue is delivering the work products specified by the EA. In systems engineering the focus is on the “project” (e.g. as defined in SEBOK) but to deliver EA a wider range of tools are necessary such as portfolios. From a leadership perspective, digital transformation will invariably lead to changes in the workforce. As previously mentioned, up to 2/3

of current jobs will be lost (Ross A. 2016) to automation and conversely new skills will be required to sustain the new enterprise environment. EA cannot operate in a technical vacuum.

9.2.1 Definitions and Concepts

The following simple definitions are from or derived from existing works and will be used for the remainder of this dissertation:

a. *Asset* – "Assets are things that have actual or potential value" (IAM 2012)
b. *Enterprise Architecture* – An explicit representation of all assets available to the enterprise, their relationships and their evolution over time.
c. *Level of Abstraction* – A perspective (or viewpoint) presenting the requisite amount of detail to stakeholder. Abstraction is a "technique of providing summarized or generalized descriptions of detailed and complex content (TOGAF 9.2 The Open Group 2018 p.21) … abstraction levels are layered in nature, moving from high level models to more detailed level models."[21].
d. *Domain*[22] – Area of concern within the enterprise.
e. *Architecture Domain* – "The architectural area being considered" (TOGAF 9.2 The Open Group 2018 p.22)
f. Building Block – "*A (potentially re-usable) component of enterprise capability that can be combined with other building blocks to deliver architectures and solutions*." (TOGAF The Open Group 2018 p.24).

9.2.2 The Concept of Assets

The Institute for Asset Management (IAM) standard for asset management is embodied in ISO 55000 and an IAM document set. Their lifecycle management of an asset closely mirrors that of a product or system. What is unique is that the notion of *asset* encompasses both the physical (e.g. person, truck, server, application) as well as the more abstract such as brand and intellectual property. The concept of *asset* is better suited for digital transformation rather

[21] Private communication The Open Group Architecture Forum to Robert Weisman - September 2019
[22] Domain is an overloaded term, but still in common use. US Department of Defense in their architecture framework, DODAF 2 (US DOD 2009) no longer use domain but call it a view (perspective on an integrated architecture) in accordance with ISO 42010 (ISO 2011).

than terms such as component (ISO 42010 [ISO 2011]) with its' association with IT. Asset is a neutral term that is universally recognized across disciplines.

Asset management, as well as business design, are essentially EA but reside in different parts of the enterprise and digital leadership must bring them together to ensure that they are working together and not at cross-purposes.

9.2.3 Common Levels of Abstraction

The seminal Zachman Framework (Zachman 1987, Sowa et al 1992) started life as an information systems architecture framework. These papers introduced the concept of perspectives that presented the architecture to the different corporate stakeholders at different levels detail. These perspectives were linked to specific constraints and models and have evolved over time between 1992 and 2011 when the information systems framework (Zachman 1987 and Sowa et al 1992) became the Zachman Framework for Enterprise Architecture (Zachman 2011). A comparative look at the perspectives is shown in Table 26 and indicates the core changes.

Table 26 Characteristics of Zachman Framework Rows (Sowa et al 1992 and Zachman 2011)

Row	Perspective (Sowa et al 1992)	Perspective (Zachman 2011)	Constraint (Sowa et al 1992)	Model (Sowa et al 1992)	Model (Zachman 2011)
1	Planner	Executive	Financial / External	Scope	Scope Context
2	Owner	Business Management	Usage / Policy	Enterprise	Business Concepts
3	Designer	Architect	Structure / Operation	System	System Logic
4	Builder	Engineer	Technology	Technology	Technology Physics
5	Subcontractor	Technician	Implementation	Out-of-Context	Tool Components
6	Enterprise	Users			Operations Instances

The levels of abstraction are somewhat disjoint and very information systems/project focused, which is not surprising as the Zachman Framework in 1987 (Zachman 1987, SOWA et al 1992) was called an information systems framework not an EA framework. The term EA really started with Steven Spewak's use of the framework in his EA Planning (EAP) methodology (Spewak 1992).

For the proposed EADM (Table 27), the levels of abstraction, are a function of the level of detail. The stakeholder perspectives map to the levels of abstraction, but the latter are more useful as stakeholders may be interested in more than one level of abstraction.

Table 27 - EADM Levels of Abstraction

Level of Abstraction	Description
Contextual	This abstraction level is focused on understanding the environment in which an enterprise operates and the context in which architecture work is planned and executed. It answers why an enterprise undertakes architecture work, what is the scope of work, and the motivation in terms of values, goals, drivers and objectives.
Conceptual	This abstraction level is centered on decomposing the requirements to understand the problem, and what is needed to address the problem at a high level, without unduly focusing on how the architecture will be realized. It defines the strategic requirements and is usually modelled using capabilities to achieve the strategic outcome.
Logical	This abstraction level is focused on how to achieve the desired capabilities and adding on required capabilities needed to implement the conceptual capabilities. These capabilities can be generated and refined using service and/or information modeling techniques. The assets (e.g. buildings, information holdings, management framework, policies) required to effectively realize the capabilities should be logically grouped to provide targeted efficiencies.
Physical	This abstraction level is implementation dependent and deals with the actual assets required to implement the capabilities identified and refined in the logical view. In this view there may be a further decomposition of assets and delivery vehicles required to fulfil the logical architecture. This level will also include a business case / option analysis to determine the optimal suite of products. The context for this level of abstraction is still the full range of the enterprise.
Physical (Out of Context)	This abstraction level is totally implementation dependent and, based on an overall physical architecture, allows for the realization of specific assets without a total knowledge of the overall architecture. This is often used for individuals delivering a discrete thing, whether it be an in-flight video system screen to fit in the back of a seat or a new training plan. At this point the asset has not been incorporated into enterprise environment.
Physical (in Context)	This abstraction level describes the asset when it has been incorporated into the enterprise and is an integral part of operations.

9.2.4 Stakeholder Perspectives

The stakeholders in the existing frameworks typify those associated with systems engineering projects and talk of engineers, designers, technicians and so on. Is someone putting together an organization chart[23] or an assessment of skills in a new organization an engineer or scientist? Essentially no. The best way to determine who will consume the artifacts is to create a stakeholder map where stakeholders within an enterprise are identified along with

[23] The US Defence architecture (US DOD 2009) has an architecture product called an operational view – 4 (OV-4) which is essentially an organization chart. If EA is in the CIO and CIO staff prepare this standard business artifact, the chances that the OV-4 is either accurate or adopted is minimal.

their architectural perspective in terms of models containing the requisite architectural information (TOGAF 9.2 in The Open Group 2018).

In the proposed the generic classes of stakeholders listed in Table 28 are used for the EADM.

Table 28 - Generic Classes of Stakeholders

Key Stakeholder Functions	Description
Governance	These personnel are concerned with the setting of the goals, values, environment, constraints and resourcing of the EA endeavor at whatever level of the organization. They are primarily concerned with the Contextual level of abstraction.
Management	These individuals are concerned with the creation of objectives (quantitative) and a high-level overview of what is to be done, using key subject matter experts. They are concerned with the Conceptual level of abstraction.
Planning	These individuals get into implementation independent detail describing how the conceptual level of abstraction is to be realized. They are concerned with the Logical level of abstraction.
Implementation	These individuals take the logical constructs and create the supporting implementation dependent constructs, specifying products, detailed processes, resources (e.g. buildings) and the like.
Detailed Implementation	These individuals receive parts of the physical constructs and, based on their specification, can implement the details in the understanding that their work products will fit into the overall architecture. This is called the physical out of context level of abstraction.
Operations	These individuals run the enterprise assets and manage their architecture specification.

9.2.5 Capability Dimensions and Architecture Domains in the EADM

Capability-Based planning was conceived to make sure that all dimensions of a solution were considered, architected and implemented in a coherent manner. Capability is the ability of an organization to execute something. For a simple example fielding an expensive information system when nobody is trained to use it, from either a client or service provider perspective, is not executable (e.g. the Phoenix Pay System in OAG 2018). A capability is normally implemented in capability increments each of which fields discrete business value. Capabilities are normally considered in terms of dimensions that describe the areas of concern that must be addressed to create and field the capability. The author (who wrote the chapter on capability-based planning in TOGAF 9.0 (2009), 9.1 (2011) and 9.2 (2018)) created the diagram in Figure 71 to illustrate the relationship between the concepts. Note that the dimensions are not exhaustive but those in the figure have been grouped into people, process and materiel

with the latter category "materiel" expanding upon the use of technology common in software engineering. Defence departments have long used capability-based planning to handle complex endeavours and was found to be particularly useful in planning capabilities involving multiple business units.

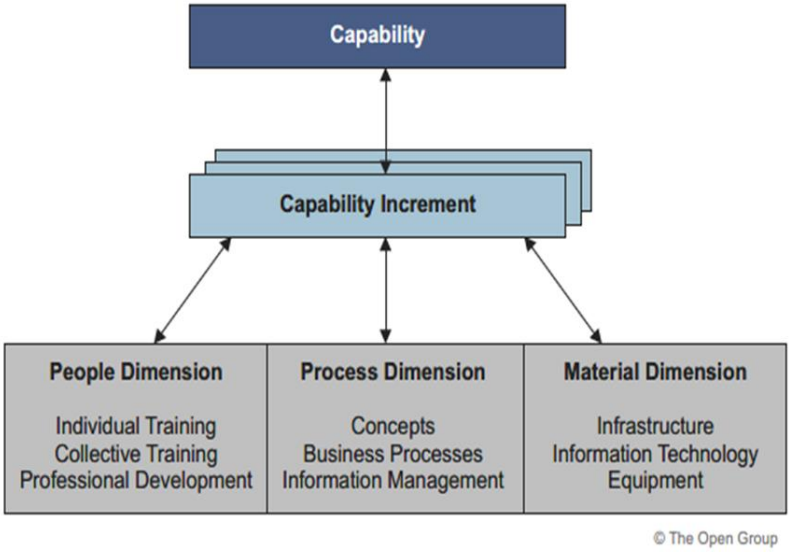


Figure 71 - Capability, Increments and Dimensions (The Open Group 2018 P.266)

Capability dimensions vary and when capabilities were introduced into TOGAF 9 (The Open Group 2009) the author divided the dimensions into three groups to reflect existing engineering considerations (i.e. people, process and technology) but changed technology into materiel to reflect that it is more than technology that is required. For example, a data centre requires a physical building, parking lots, office furniture, environmental controls and so on as well as the physical technology (e.g. servers, racks, cabling and so on)[24]. Other potential capability dimensions for strategic projects include PESTEL: Political, Economic, Social, Technical, Environmental, Legal (Business Evaluation) (NATO 2018 p. 24) or DOTMLPFI standing for: Doctrine, Organization, Training, Materiel, Leadership & Education, Personnel, Facilities and Interoperability/Information. (NATO 2007 p.6)

Architectural domains in EA have been based on the original Zachman Information systems Framework from 1987 and are based on the journalistic interrogatives, What, How,

[24] From an action research perspective, a defence department had an information fusion capability project requiring addressing all capability dimensions, including a cultural change to information sharing. The author acted as chief EA and co-PM.

and Where. The framework was expanded in Sowa and Zachman 1992 to include Who, When and Why, but by that time the business, data, applications and technology architecture domains were consolidated and implemented in numerous frameworks (e.g. US Federal EA Framework – US Govt 2013). Having a common set of domains that all must use in creating architectures is useful, but the existing domains (i.e. BDAT) are inadequate to create any substantial enterprise capabilities. The use of these information systems centric core domains in globally pervasive EA Frameworks (i.e. TOGAF 9.2 The Open Group 2018) is a major reason that EA is buried in the CIO organizations.

To support capability-based planning, the EA should have domains that correspond to the standard capability dimensions used in the enterprise. Trying to pre-determine all the possible domains leads to situations such as the Unified Architecture Framework (OMG 2017) whose completeness might satisfy the engineers, but its complexity makes it unwieldy. The fundamental dimensions in Figure 71 are based on usage in defence (based on a simplification of GC DND 2014). Another dimension that defence often includes is Research and Development as they are often ahead of industry and know what they want to do but are not sure how to get there. Technology in itself is not homogeneous but consists of some 250 emerging technologies of which only eight are associated with IT or the CIO organization, as per Figure 72. Depending on the industry and business model, there are a great many more technologies to consider in effecting digital transformation and creating the underlying architecture to provide effectiveness, coherence, and the requisite efficiency to achieve business value.

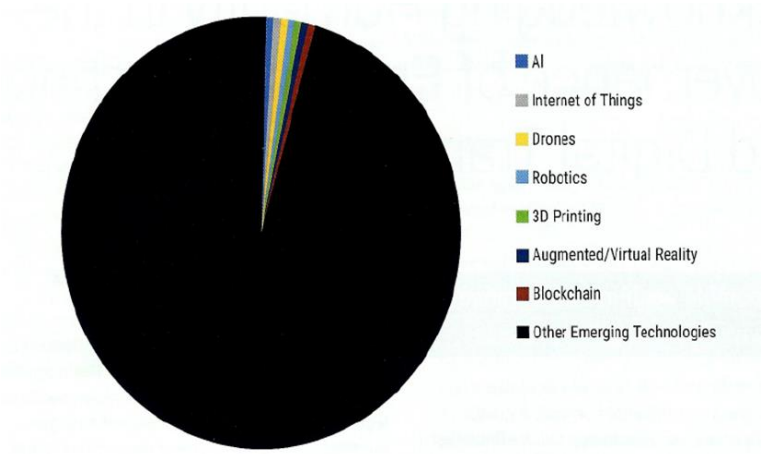


Figure 72 – Emerging Technologies - More than IT (Pearce 2019 and PwC 2019)

A realization of the pervasive nature of technology within the enterprise, has led to the expansion of the number of areas of interest or domains or views elaborated in Table 18. They are really no different than capability dimensions.

9.2.6 EADM Framework

The framework upon which the development method is based is as described in Figure 73. It ties together the concepts of levels of abstraction, key stakeholders and architecture domains. The latter are key areas of interest that are often based on capability dimensions.

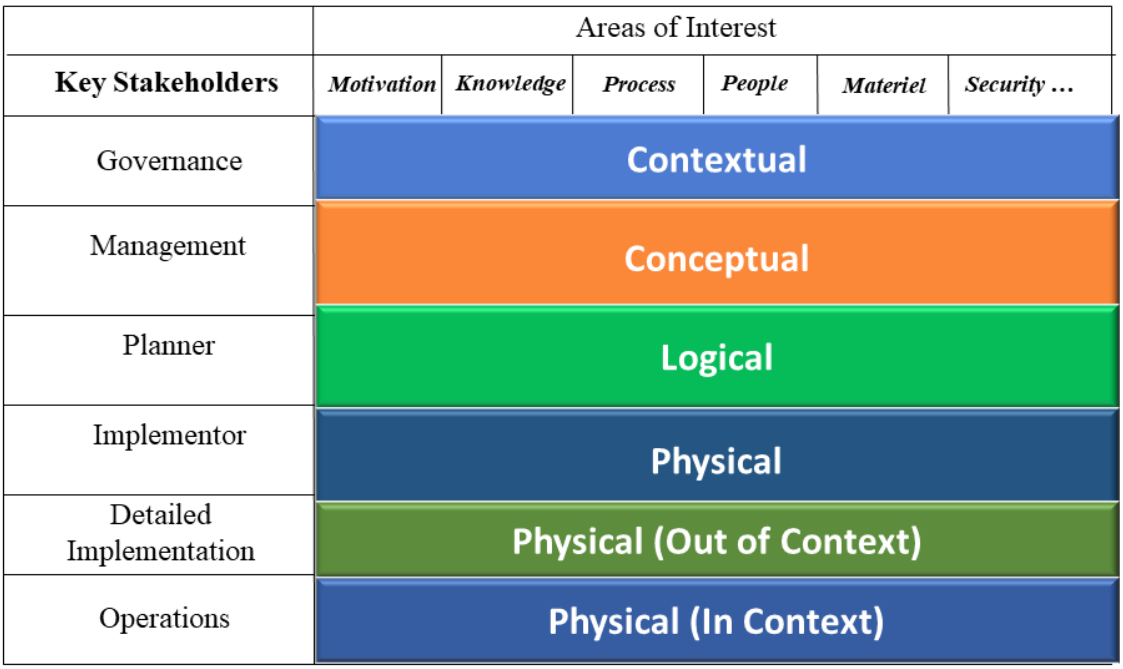


Figure 73 – EA Development Method and Levels of Abstraction (adapted from Zachman 1987, 1992, 2011)

9.2.7 EADM Delivery Vehicles

An architecture without a delivery mechanism is not much use. The focus on project management at organizations such as the Project Management Institute, has given way to thinking at the program and portfolio level.

The emphasis has also been on capital investment rather than enterprise strategic investment. During the action research, there was little or no coordination between capital and operations and maintenance (O&M) funded delivery vehicles, resulting in work at cross-purposes when significant O&M funds were expended on the continual improvement for a service

that was slated to be replaced by a capital funded project. For the purposes of the EADM, all delivery vehicles are intended to be for both capital and O&M funded endeavours.

The vehicles used in the EADM are specified in Table 29. Note that actions / initiatives were used to describe work conducted "under the radar" of project management scrutiny. In one action research organization, any work under $3M was a miscellaneous requirement and was conducted without architecture or project management scrutiny. The EADM captures these non-project initiatives as they need to be coordinated and integrated within the enterprise.

Table 29 – Vehicles used in the EADM

Vehicle	Description
Task	An assigned piece of work often to be finished within a certain time (based on Mirriam-Webster 2019) including policies, plans, directives and so on.
Portfolio	*"A portfolio is a component collection of programs, projects, or operations managed as a group to achieve strategic objectives."* (PMI 2013c p. 3)
Program	*"A group of related projects, subprograms and program activities that are managed in a coordinated way to obtain benefits not available from managing them individually"* (PMI 2013b p. 4)
Project	*"A project is a temporary endeavor undertaken to create a unique product, service or result" PMI 2013b P. 3*
Action (Initiative)	*"The accomplishment of a thing usually over a period of time, in stages, or with the possibility of repetition" (Miriam-Webster 2019)*

9.3. Enterprise Architecture Development Method (EADM)

9.3.1 General

A simplified architecture development method is proposed based on levels of abstraction and to differentiate it from the technical aspects it is now called an Enterprise Architecture Development Method (EADM) that leverages systems engineering best practices, including TOGAF and the Systems Engineering Body of Knowledge.

The key features of the EADM are:

a. It leverages best practices (e.g. TOGAF (The Open Group 2018)) and does not introduce new ways of doing business unless necessary (i.e. no reinventing the wheel);
b. It is cyclical, in that it is regularly revisited to ensure relevance with the overall business strategic direction;
c. It is based on levels of abstraction;
d. It is architecture domain independent, catering to any manner of area of interest;

e. It is based on collaborative work between architecture domains on the assumption that there is considerable overlap
f. It is integrated with the strategic, tactical and operational planning process;
g. It is tied to implementation / procurement; and
h. It is governable in terms of control / performance objectives and tightly coupled to the enterprise strategic direction.

The specific domains addressed are a function of the implementation but are intended to be completed in a collaborative and integrated manner.

The method, as shown in Figure 74, inspired by the TOGAF 9.2 (The Open Group 2018), is robust and flexible to accommodate the different architecture domains (a.k.a. areas of interest or concern) that prevail in different industry and government enterprises. It is also not restricted to the fielding of technology and can be used to address domains such as human resources where the demand for new competencies is incessant and the machine replacement of human skills unceasing.

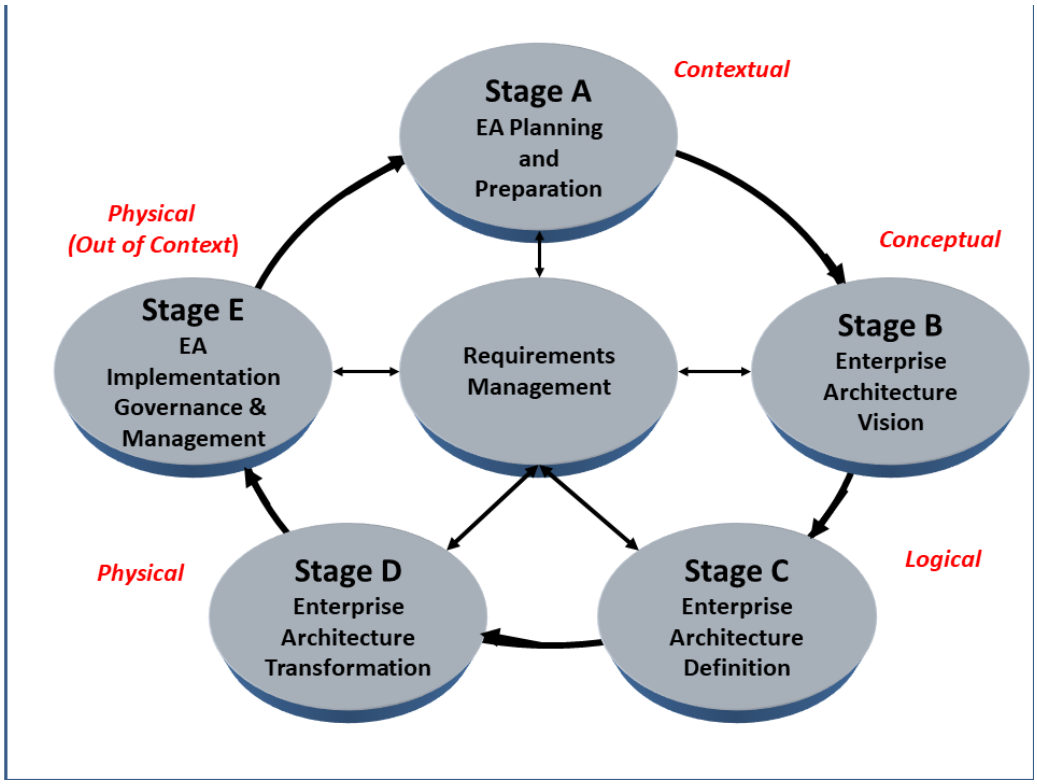


Figure 74 - Simplified ADM and Levels of Abstraction

The EA Planning and Preparation Phase consists of preparing to go through another architecture cycle to ensure that the EA remains fit for purpose. The phase essentially conforms

to the preliminary planning and principles phase in Figure 70 TOGAF ADM (The Open Group 2018), with the major change being that this phase is repeated every time that the cycle is initiated.[25] It recognizes that the EA coverage can vary depending on the business needs. This includes the introduction of multifaceted new technologies such as warehouse automation. The level of abstraction is contextual as this is where it is decided what parts of the business and architecture domains are to be addressed by the EA. Architecture partitioning (assigning a RACI for the components of the EA) is also determined as well as standards (|including tooling) for the establishment of a shared EA repository are confirmed. Existing enterprise values and principles are gathered and confirmed.

The EA Vision is conceived to provide an aspirational, high-level, integrated and costed conceptual view of the proposed EA. It is based on a business case approach assessing several EA options to achieve and/or drive the target goals and objectives of the enterprise using industry specific business value criteria.

The EA Definition is at the logical level of abstraction and is as implementation independent as possible. It conforms to the level of detail in phases B-D[26] in TOGAF 9.2, but is domain independent, working at the logical level across all enterprise domains.

The EA Transformation Stage is at the physical level conforming to the concepts elaborated in Phases E and F in TOGAF 9.2, but working across all domains, creating the physical solutions (solution building blocks) and creating an implementation and migration plan.

The EA Implementation Governance and Management stage addresses both the physical out of context (i.e. normally project or task driven) and physical in context (i.e. the implemented services and systems to ensure a smooth integration of new items into the enterprise. This includes the sunsetting of existing enterprise items and assuring that the new items can be integrated and sustained. During the action research one very large enterprise operations management line of business refused to accept any project deliverables until enough operations and maintenance funds and competent resources were made available. Additionally, in the absence of a coherent EA, there was a neglect of what services had to be discontinued and there was only a continuous set of new services to sustain. This is alluded to but not really

[25] This innovation was conceptually discussed and conceived with Dr. Bill Estrem (CEO Metaplexity) during The Open Group Architecture Forum meetings in 2015-2018.
[26] Phase B - Business, Phase C - Information Systems (including application and data architecture) and Phase D - Technology Architecture in the Architecture Development Method (The Open Group 2018)

addressed in most EAs, or, fully considered typified by the implementation of the government email system where the full implementation costs at user departments / agencies was not considered (Canadian Government OAG 2015 Exhibit 4.2).

Requirements Management is at the heart of the EADM as it is in TOGAF 9.2. In action research, this task is relegated to a clerical function of documenting the various domain architectures. Again, this assumes that the various domains are discrete, which they are not. In the EADM, the chief architect runs this function and ensures coherence between the various architecture domains ensuring both effective as well as efficient implementation. Part of this process would be automated using ever-more capable EA tools, that enable simulation and can identify areas where there are issues. The focus would be on integrative thinking (as in Martin 2009a) as well as often used trade-off analysis (as recommended in TOGAF 9.2). As shown in Figure 56, the Requirements Management function would be responsible for maintaining the coherence of the EA over time.

Another "new" feature is the inclusion of what US DOD calls All Views (DODAF 2009) that gives a holistic overview of a level of abstraction over all domains. This could be used to provide an overall understanding of what is envisaged by the target and transition architectures.

From an EA Stewardship perspective, as discussed in Chapter 7, the requirements management function would act as the hub for the de-centralized elaboration of the EA throughout the enterprise. It would accept EA inputs from the stewards responsible for domains, portfolios, projects and initiatives and assess their ability to "fit" into a holistic EA over time. The time dimension is key as EA is expected to be dynamic and continuously evolve.

9.3.2 EADM and Business Planning: Just in Time Implementation

In most organizations there are several layers of planning. Notably there is a strategic plan stretching 5-10 years and then there are the annual business plans that are often created both by the enterprise and by the lines of business. These plans correspond to the strategic and tactical levels in business and government. These drive the enterprise and serve to provide the rationale for all resource acquisition and allocation. Often the strategic plans are couched in terms of capabilities that cannot be realized in a short time horizon.

In the action research the realization of government life-event based multi-jurisdictional service delivery is a multi-decade, not multi-year capability. Technology volatility is driving many enterprises to shorten the planning horizons, but many of the business capabilities are highly complex social endeavours that use technology as an enabler, but the main challenges are cultural and sometimes legislative. The relationships between the various plans is laid out in Figure 75.

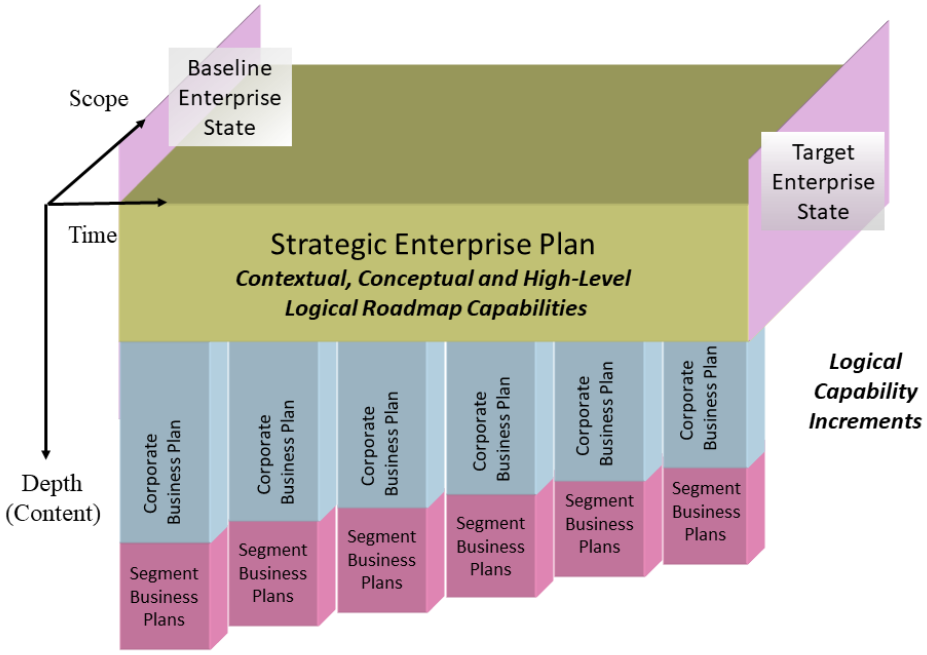


Figure 75 – Common Business Planning Relationships

When looking at EA, there are various levels of architecture addressing and corresponding to the levels of abstraction. As shown in Figure 76, the architectures can be aligned to the realization of capabilities, with strategic capabilities identified and then capability increments implemented in a deliberate series of transition architectures. This was first included in NATO (and is still present in NATO as shown in Figure 29) holistically presented in conjunction with the business management, architecture, project management and operations management frameworks in Weisman 2006 Slides 16 and 17, which was adopted for inclusion into TOGAF 9.0 (The Open Group 2009).

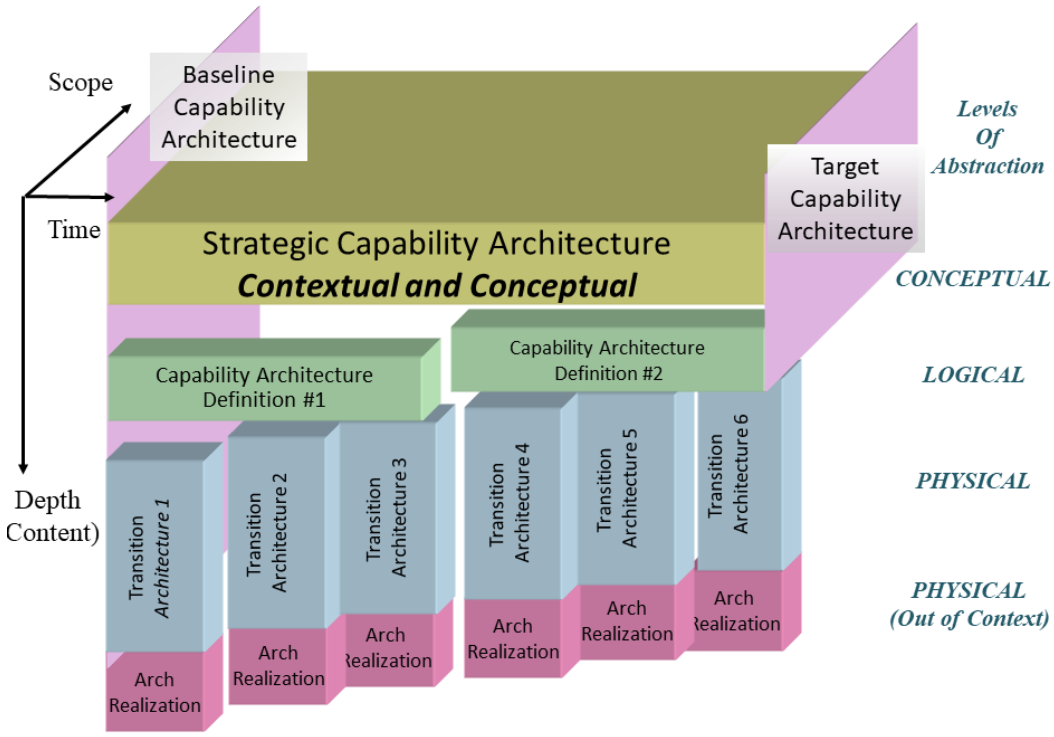


Figure 76 - Staggered Enterprise Architecture (based on TOGAF 9)

The current practice has the Enterprise and Segment (a.k.a. line of business) architectures delivered by the EA Cell as a CIO deliverable.

In the EADM, the recommended practice is that the architectures are delivered as part of the enterprise plans at the appropriate level of abstraction. Capabilities are viewed from an enterprise perspective and the key business and technology alignment is addressed from the start. The EA cell is used as an investment and planning asset, and, through stewardship, coordinates the planning cycle and enables collaboration using a common, shared information base (a.k.a. the EA repository). Any details specific to any capability dimension (e.g. IT, IM, Buildings) can be placed in a standard annex or appendix to the plans at the strategic (contextual and conceptual), tactical (logical) and operational (physical) levels within the enterprise. Notably this process partially mirrors that found in military planning, where capability-based planning is used extensively.

Potential relationships between the EADM products and their integration with business plans is shown in Table 30.

Table 30- Possible Relationships EA and Business Planning

EADM Stage products	Level of Abstraction	Integration with Enterprise Planning
EA Vision	Contextual and Conceptual	Strategic Enterprise Plan Integrated in to plan with details in an Annex.
EA Definition	Logical	Multi-year part in the strategic plan Incremental Parts in Annual Business Plan Body and annexes.
EA Transformation	Physical	In enterprise segment and supporting portfolio business plans
EA Implementation and Governance	Physical Out of Context and in Context	Operations Management annual plans Program and Project Architectures

9.3.3 ADM and Procurement

Procurement and costing provide opportunities to planners to get advice and realize the plans. In standards such as TOGAF 9.2 (The Open Group 2018) the issues of procurement are not addressed, rather they specify portfolios, programs and projects and they deal with costing and procurement. There are three main types of procurement envisaged in the EADM namely the Request for Information (RFI) and two types of Request for Proposal. These types of contracting vehicles are described as described in Table 31.

Table 31 - EADM Procurement Vehicles

Procurement Vehicle	Description	Comments
Request for Information	"*A Request for Information (RFI) or Letter of Interest (LOI) is used when detailed information and feedback are required from suppliers. Such requests might outline a potential requirement and request suppliers to describe their ability to satisfy the requirement and to provide ideas and suggestions … in developing achievable objectives and deliverables."* (PWGSC 2015)	This is not used often enough and industry can often indicate whether the vision is feasible and the benefit is worth the cost. Prototyping is recommended.
Request for Proposal (RFP)	"*A document that solicits a proposal, made through a bidding process."* (Govt of Canada 2015)	Standard vehicle that is reasonably well understood.
Request for Proposal – Solution and Implementation (RFP S&I)	A document that solicits a proposal based on one or more architecture building blocks and requests bids containing solution building blocks and the wherewithal to implement.	This allows industry to submit a bid and propose a costed solution and implementation plan.
Request for Proposal – Implementation (RFP Impl)	A document that solicits a proposal based on one or more solution building blocks and requests bids for resources and expertise to implement the SBBs.	This asks industry to implement a client solution, assuming that the client has assessed feasibility and costing.
Standing Offer	A standing offer is an offer from a supplier to a client that allows the client to repeatedly purchase goods and/or services, or a combination of goods and services at pre-arranged prices, under set terms and conditions, when required. (Based on ESDC 2017)	

The breakdown of the RFPs into RFP S&I and RFP Impl is new, but important. Action research has shown that many contracts are now shifting from "fixed-price and fixed deliverable" RFP S&I to "time and materials" RFP Impl or Standing Offers. The former led to time-boxed and scoped deliverables, regardless of whether they were in the context of agile or incremental delivery, whereas the latter leads to endless changes and missed deadlines. Fixed-price, fixed deliverable is feasible in the presence of an overall enterprise architecture; in its absence the enterprise is forced to deal with a series of incoherent project or portfolio-based architectures that require an additional integration and interoperability architecture to deliver enterprise business value. The EADM enables fixed-price, fixed deliverable contracting vehicles.

The RFI is a solid, under-used vehicle, often due to time constraints, that mitigates risk and ensures that the proposed conceptual architecture is feasible, as well as providing a more solid way to estimate costs.

In the EADM the RFI is normally issued during the EA Vision stage (Conceptual level of abstraction) to confirm feasibility, assess options and provide a solid baseline costing for any RFPs and/or tasks to detail the architecture and implement it. RFPs requesting industry solutions (RFP S&I) would normally be issued after the EA Definition stage (Logical level of abstraction) with the EA providing all the requirements (e.g. standards, constraints, techniques) that the industry solutions would have to meet. The RFP Impl would be issued after the EA Transformation stage, requesting assistance to industry and/or tasking internal resources. This is illustrated in Figure 77.

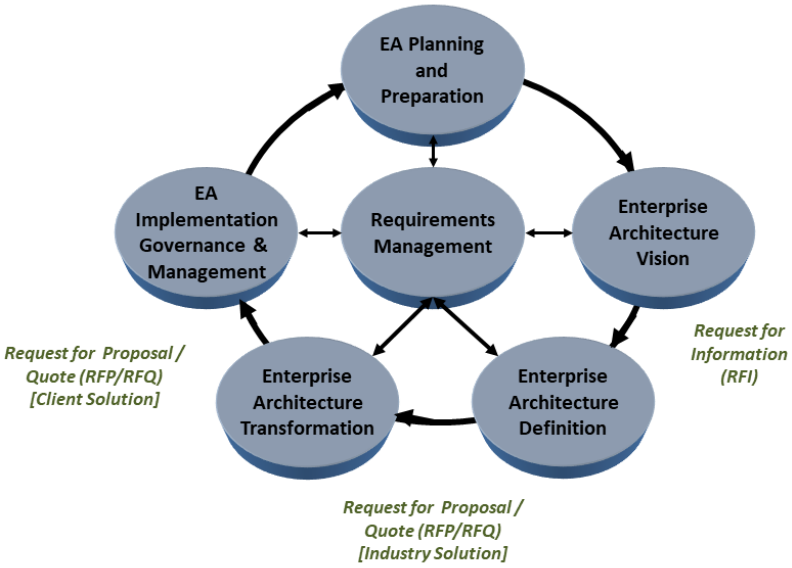


Figure 77 - EA ADM and Procurement

9.3.4 ADM and Governance

The governance respects both Governance (e.g. COBIT 2019 (ISACA 2018)) and EA standards such as TOGAF (The Open Group 2018).

The key change for the EADM is that there are actual governance and management gates in between the key stages, similar to that in between project phases. Governance is across domains and not strictly EA, or Enterprise IT Architecture, so often these checkpoints are subject to multi-disciplinary executive committee approvals rather than working group or architecture review board (ARB) ones as recommended in TOGAF. Regardless the working groups and ARB(s) would complete the preparation of presentations to the committee.

The remainder of the terms are from TOGAF 9.2 (The Open Group 2018) and are deliberately used to first take advantage of these proven best practices and facilitate the adoption of the EADM.

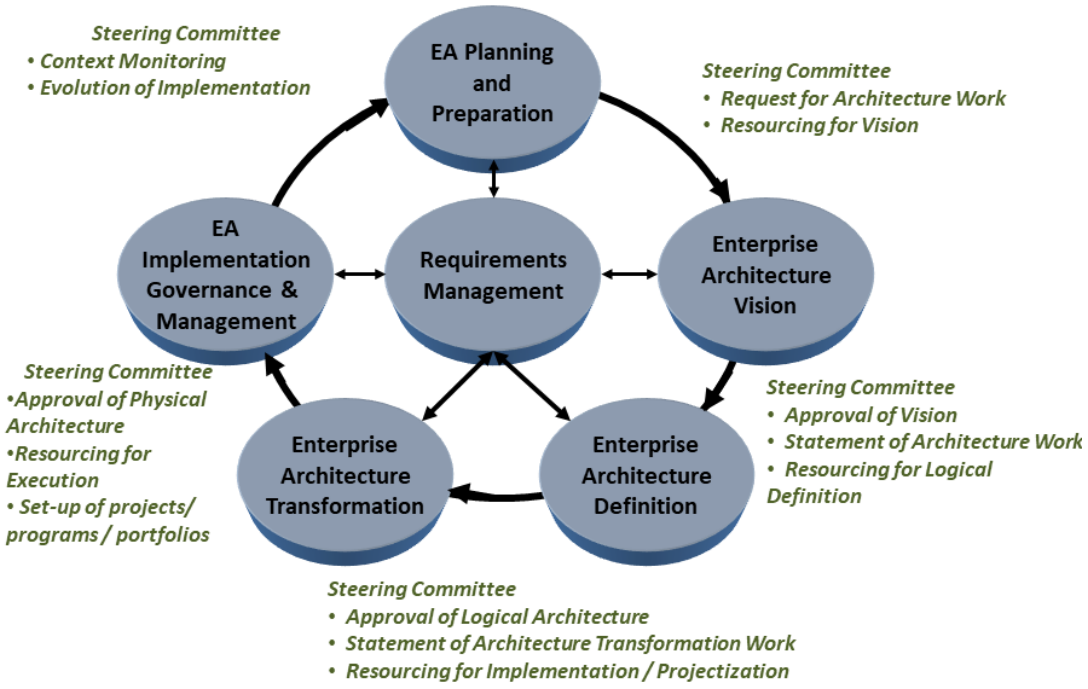


Figure 78 - Linkage EA and Governance

9.3.5 Concept of Building Blocks

Building blocks, as previously defined, are chunks of functionality that provide value and can be re-used. There are three basic sets of building blocks in the EADM as shown in Table 32.

Table 32 - EADM Building Blocks

Type of Building Block	Level of Abstraction	Notes
Architecture Building Block	Contextual and Conceptual	High Level
	Logical	Detailed but implementation independent
Solution Building Block	Physical	High level implementation dependent Solution for 1..n architecture building blocks
	Physical (Out of Context)	Detailed implementation dependent
Operational Building Block	Physical (In Context)	Operational and in use

The architecture and solution building blocks (ABB and SBB respectively) are from TOGAF 9.2, but the Operational Building Block (OBB) inclusion is new and is added in because the architecture of many SBBs are hidden from the enterprise. For example, cloud ser-

vices are widely available and can be used instantly to address all manner of enterprise concerns, but their internal workings are unknown. During action research, a specialized programmer consultant was inserting numerous of columns into an ERP database, ignorant of the ERP conceptual or logical structure which the ERP company would not disclose. This meant that a simple column (or data attribute) could be found in multiple places in the data environment and data quality would be compromised as there was no synchronization in the updates. The upshot was that employee addresses were a function of what part of the ERP was being asked. OBBs are also useful to help understand was is implemented, from a post-project architecture perspective, and ensure that duplication is minimized (action research clearly indicated that all redundancy could not be eliminated).

An example of the use of building blocks is illustrated in the following section.

9.4. Integrating the Concepts – The EA "Cube"

When developing an architecture using the EADM, it is useful to create a functionality grid for the EADM, called the EA cube for short. The first step was to determine the scope of the architecture models in terms of the delivery vehicles, in this case enterprise, portfolio, program, project or initiative. The EADM is new in considering holistic enterprise models consisting of 1..n portfolios as well as non-projects called initiatives which can be significant. There is no differentiation between capital and O&M projects as they have to be completed together under common governance.

The second axis are the levels of abstraction well-described above. The third axis includes the domains that are enterprise dependent, but normally include business, data/information, application, technology and security (BDATS). The outline EA Cube is described in Figure 79.

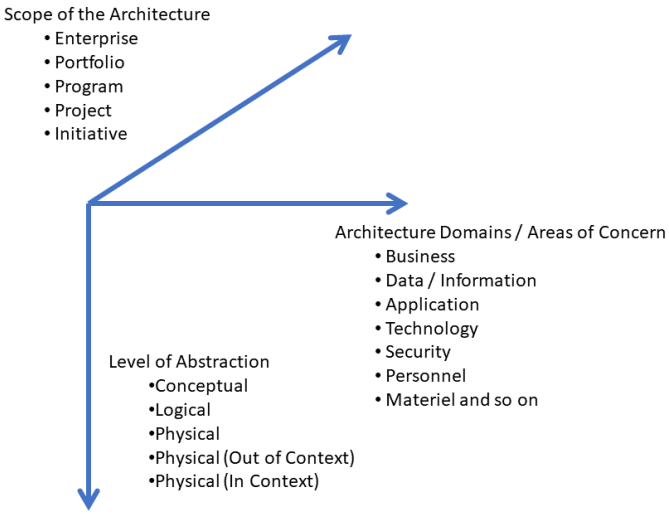


Figure 79 - EA "Cube" Outline

A complete EA Cube is described in Figure 80, where the enterprise delivery vehicles (i.e. portfolio, program and project) are specified as are the domains (BDATS). The EADM stages specify where the EADM products (a.k.a. artefacts) are created and what type of building block is specified. Additionally, the enterprise might consider it useful to version the architectures as illustrated in the complete EA Cube.

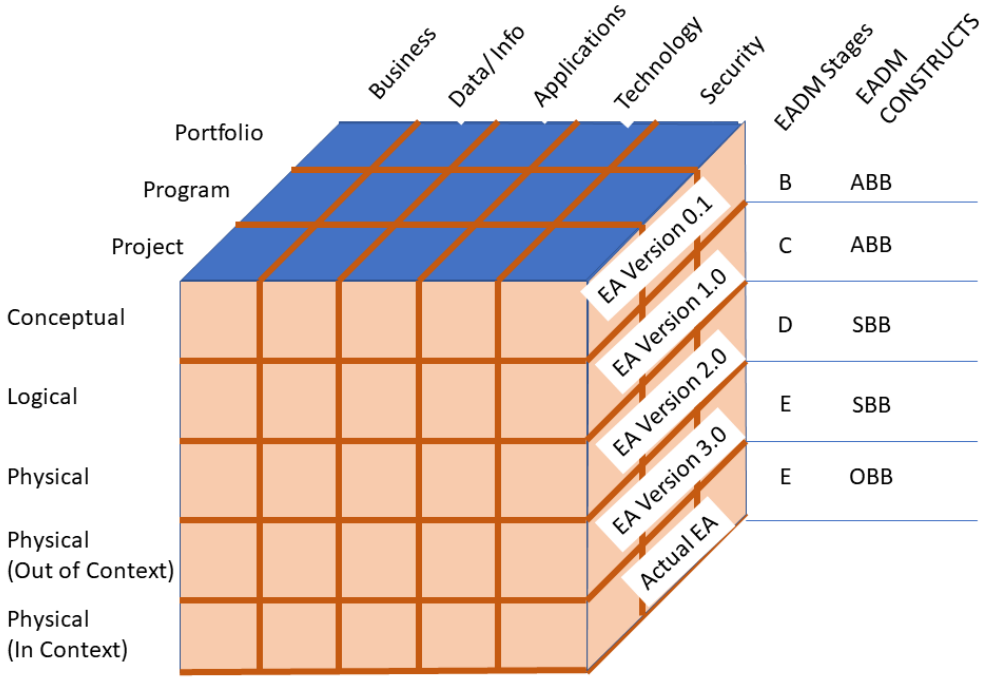


Figure 80 – Sample EA Cube – Completed

9.5. PAR Study – Health

Participatory action research (PAR) was carried out to complete a national health portal, with the simple mandate (context) given to provide trusted health information to citizens. This study illustrates several of the features of the EA Cube in Figure 80.

To create the EA vision, a capability approach was used, and three key dimensions were identified, namely clients, stakeholders and technology and then these three dimensions were expanded to come up with a functionality grid as shown in Figure 81.

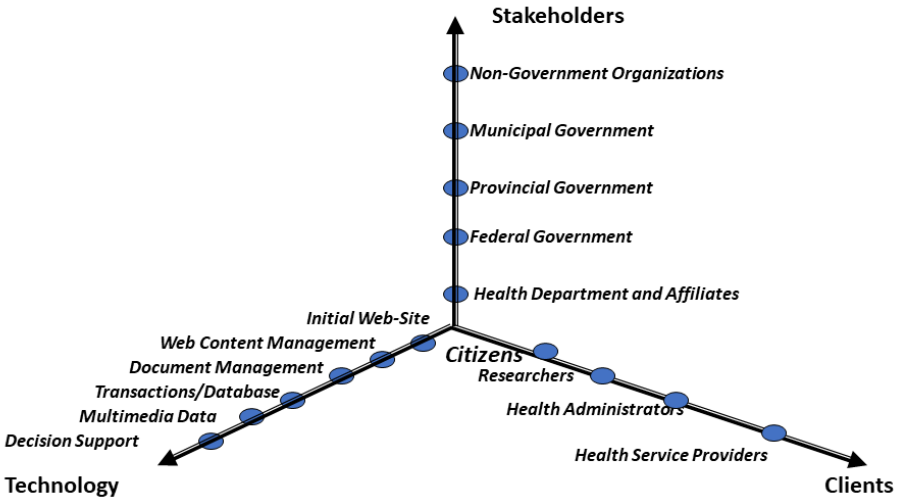


Figure 81 – Functionality Grid

This was followed by the drafting of a simple but compelling conceptual architecture vision where the current state, Figure 82, was described using the three dimensions in the functionality grid to highlighted the key elements. Essentially clients were surrounded by all manner of health information that they did not know was trustworthy, there were many types of technology being employed with little or no security. Also there were numerous stakeholders mandated to share information who did not cooperate or share information, duplicated technology and competed for limited funds. It was an ineffective and highly inefficient environment.

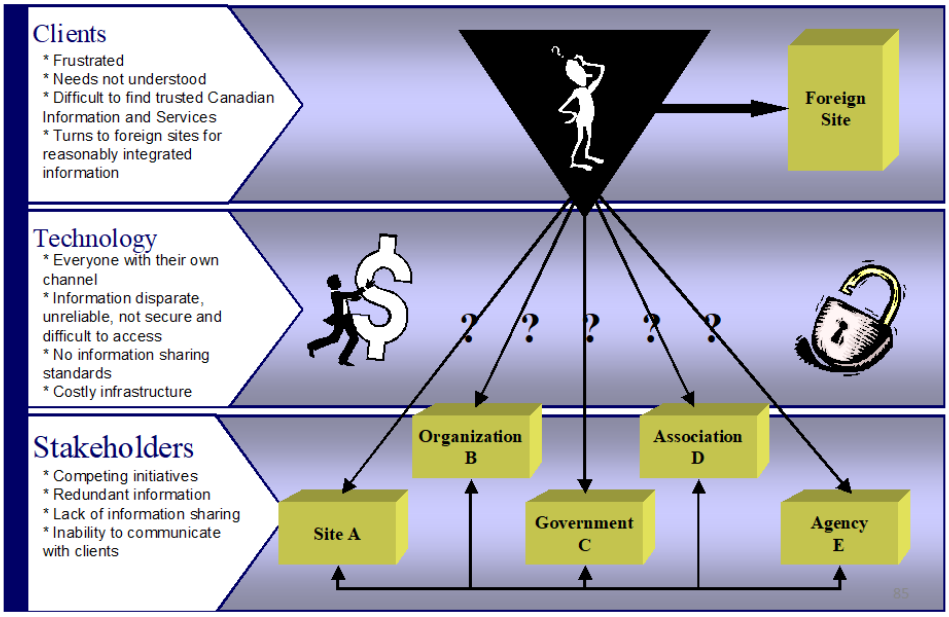


Figure 82 – National Health Information and Services – Current Situation

To illustrate the concern for security, in the current state there were also bad actors that enticed clients to their sites (overwhelmingly web) and then captured their personal indefinable information (PII). So, when a client went to a cancer site, the PII were captured, sold and the individual could be refused life insurance because their PII had been bought by the insurance company. This was and continues to be a major concern.

Based on the issues captured on the current state, the next step was to simply illustrate a target state that would drive the national health portal to success. The result is depicted in Figure 83, and showed the client groups, stakeholders responsible to provide the information and the technology capabilities required.

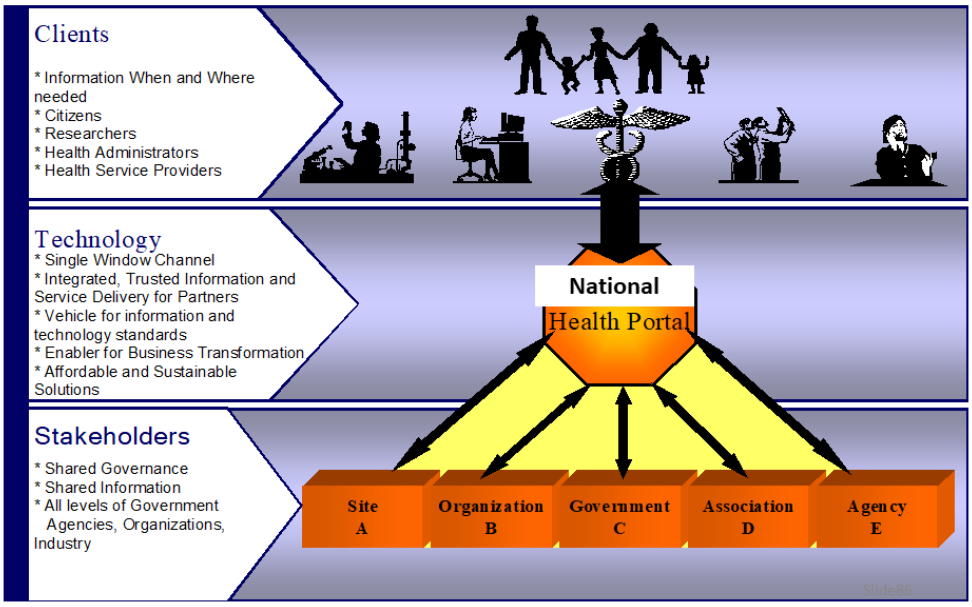


Figure 83 – The National Health Portal – An Enabling Channel for Integrated Health Information and Services

The simple architecture at the conceptual and contextual level (defining what was covered) worked well, with the challenge being that participation was not compulsory and it was known who wanted to share what when. To address this, the problem space was divided into building blocks to chunk out the implementation and lay the basis for re-use to accelerate adoption.

The enrolment of organizations to participate was handled by a business team (no CIO staff or consultants) who understood what had to be done. The first group to be recruited were the states/provinces with the initial goal to share web-based information. However, there were grave concerns about the centralization of data under a federal initiative as well as ensuring that the federal government not get the credit by showing the real provenance of the data. A gifted information systems architect understood the concerns and devised an information virtualization scheme where data would be collected from all participants in response to a query and displayed on one or more webpages dynamically with the provenance acknowledged through the display of a provincial/state crest. The project kick-off, recruitment of participants, developing the architecture (ABB and SBB) into a capability-based building block, establishment of the infrastructure and an initial operational capability (production) occurred within six-months of project inception. In fact, this was the first transition architecture.

Concurrently the environment was divided up into building blocks, using the functionality grid, with high-level ABBs created to act as a basis for a business case and incremental and opportunistic implementation as shown in Figure 84.

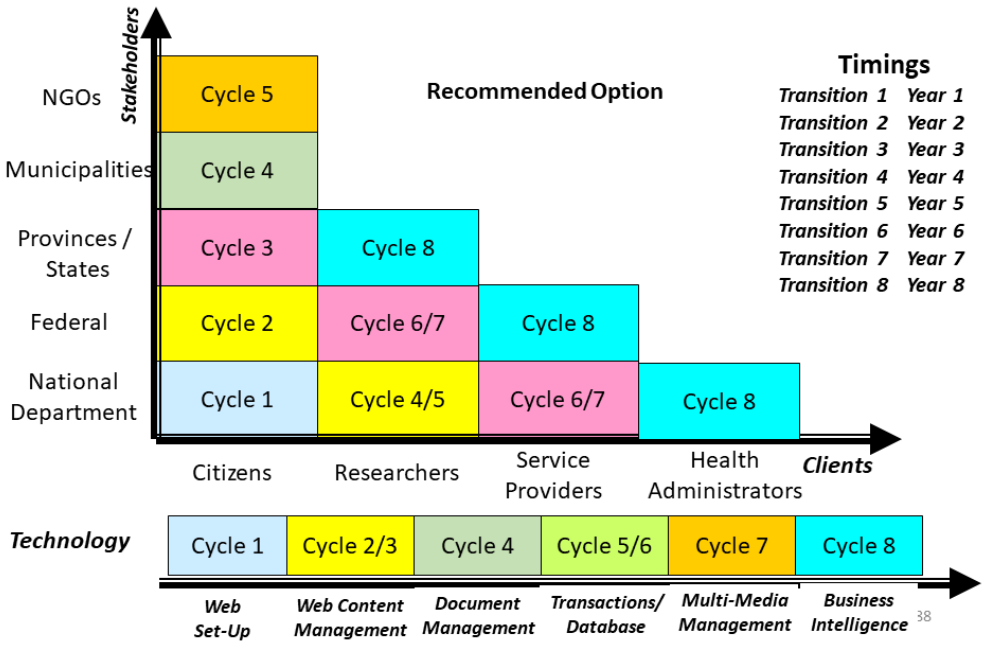


Figure 84 – Option 3 of the Health Portal Business Case for Continued Funding Using Building Blocks

Stakeholder participation and client satisfaction were major critical success factors; the intent was not to drive away participants with "you are in Transition Architecture 3, so come back in two years," but to bring them in as soon as possible. Each new class of participant was the basis for a new, and potentially re-useable, building block. This "chunking out" of the problem space allowed for rapid progression, especially when stakeholders wanted the same capability (e.g. in addition to provincial/state governments, municipalities wanted to communicate to citizens using web technologies). There was a great deal of concurrent activity as portal staff worked on multiple transition architecture capabilities, such as outreach to legal with respect to items such the sharing of royalties coming from data mining on shared research data.

The case study illustrates the importance of creating a "just in time" architecture environment enabling a new portal-based enterprise to incrementally expand its business value. Conceptual architectures were rapidly transitioned to logical and physical implementations in

a coherent but flexible manner to rapidly, effectively and efficiently maximize stakeholder participation and client satisfaction.

9.6. EADM Assessment

The EADM is not a panacea, but it does address many of the issues associated with DT including its ability to be used flexibly. With respect to the main issues raised in Chapters 5-8 the EADM:

a. Can accommodate business design constructs, specifically the integrative thinking and artistic inquiry and method;
b. Is accessible to the business community and can act to bridge the business-technology divide;
c. Is capable of being integrated with SE to mutual benefit; and
d. Provides coherence between the management frameworks.

The successful implementation of the EADM is contingent of whether it is employed as part of overall enterprise strategic planning or buried in the CIO organization, as is all too often the case.

The assessment of the EADM as a DT methodology is described in Table 33. This uses the same scoring scheme as Table 14, with the rating scale described in Section 4.1.3 and the colour scheme described in Section 4.1.4.

Table 33 - Assessment of the EADM

#	*Coverage / Feature*	*Score 0-5*	*Comments*
1	Governance	**5**	The use of the levels of abstraction as the basis for the architecture method will ensure that high level understanding, direction and resourcing is articulated
2	Management	**4**	For project completion, EA models are useful for management, especially the use of architecture contracts to ensure that project deliverables fit into a higher context.
3	Planning	**4**	Architecture-based planning integrates business and IT planning functions to a large degree. EA in many cases (e.g. DODAF Joint Capability) is used as a rigorous planning tool to ensure complex defense endeavours are integrated and succeed.
4	Building	**4**	The use of levels of abstraction and stakeholder management will ensure that projects are coherent, capability-based and resourced. Projects will be protected from scope creep and any project raised will be part of a sponsored enterprise plan.
5	Operations	**3**	The EADM levels of abstraction and the potential integration of the EA repository with the operations (e.g. service knowledge management systems) will allow the operations personnel to forecast their future needs as well as when to cease the continuous service improvement costs for systems scheduled to be replaced.
6	Audit, Verification, Monitoring	**4**	The harmonization of the repository with other management repositories will allow for the ability of continuous audit and a single source of truth to verify the enterprise control processes.
	FACTORS		
1	Transition to a Knowledge-Based Economy	4	The EADM is based on a combined EA/SE approach that incorporates elements of business design and coordination of the management frameworks. EA as an enterprise rather than an IT tool, is capable of providing a common baseline and well-articulated vision for DT.
2	The Relevance of Knowledge	3	The EADM has the ability to handle knowledge, information and data discretely at the various levels of abstraction. It still needs work but it can accommodate the knowledge architecture necessary in DT.
3	The Relevance of IT	5	The foundation of EA is IT, but the EADM places IT in its proper context so that it can be fit for purpose/integrated in an enterprise context.
4	Continuous Innovation and Business Transformation	4	The concepts of strategic and transition architectures and their integration with enterprise strategic and business plans provides a flexibility to transform more rapidly with a much better understanding of the implications of change.
5	Leadership Versus Management	3	The use of the EADM, that is focused on levels of abstraction, is useful from a leadership as well as a management perspective, as often leaders will focus on conceptual and contextual, leaving managers to handle the logical and physical. The EADM facilitates the communication of leadership intent so that it can be coherently executed.
6	Scientific Versus Creativity Approaches	3	The increased emphasis on conceptual visioning and the acceptance of integrative thinking and the additional acceptance of artistic method and inquiry needs to be enhanced but is at least present in the EADM structure.

9.7. EADM Concluding Material

As described, the EADM is not revolutionary and is intended to be easily accessible to both those new to EA and familiar with architectures. The main feature is that it is based on

levels of abstraction and not bound by specific domains, leaving their use to the enterprise implementing the EADM. It is also intended to be a Change Request for the TOGAF 9.2 (The Open Group 2019) modifications to the architecture development method, as well as a white paper/guide.

Another major feature for the EADM is the inclusion of a cross-domain view at all the levels of abstraction. These are called All-Views (AV) in the US DOD Architecture Framework (DODAF 2009) but are absent in TOGAF 9.2 (TOGAF 2009). They are very useful for governance to verify that all the domains are coherent and to provide an overall view of the architecture.

The EADM fits the new TOGAF structure and the various domains can have specialized guides offering practitioner advice. The challenge will be coherence between the guides now provided through an EA Content Framework and Meta-Model (The Open Group 2019). The TOGAF meta-model is tightly coupled and discretely segmented into the BDAT, as is the Unified Architecture Framework (OMG 2017) with more domains, so it is challenging to focus the EA on fewer or additional domains. Many of the EA tools reflect this tight coupling. Adopting the EADM will necessitate a re-think of the underlying meta-model to make it more flexible and loosely coupled to accommodate more or fewer domains as well as different architecture styles.

Chapter 10. Conclusion and Future Work

10.1. Summary

The thesis was initiated by several research questions premised on the high failure rate of digital transformation initiatives (50% Forrester 2019 p. 4) and software projects (55% Guillaume-Joseph & Wasek 2015 p. 40 Table 1). Globally trillions of dollars are being lost annually.

In discovery we found that the digital transformation failure rates have not changed since 1986 and the failure mechanisms are virtually identical. This is despite the creation of numerous methodologies and bodies of knowledge that apparently that cannot manage the complex enterprise technology environments required to achieve competitive advantage.

One of the major findings was the incoherence of the management frameworks embedded within these bodies of knowledge, both business and engineering. When the professional associations and standards groups created these methodologies, it was realized that they could not deliver in isolation, so they expanded into knowledge areas that were in fact addressed by other associations. Few have collaborated and they have managed in silos, with the overlap between the methodologies causing friction within enterprises.

This thesis examined the methodology overlaps and how the most successful aspects could be combined to improve enterprise coherence. Various chapters were addressed to communities of practice involved in these methodological overlaps or intersection sets. The thesis addressed several discrete components as follows:

a. The literature search examined the problem space through the creation of a subjective and useful analytical framework assessing the various management areas and how they contribute to digital transformation. Chapter 4, in particular analysed many different methodologies.
b. Chapter 5 addressed the engineering management stakeholders. It looked at how business design concepts both mirrored and deviated from engineering / enterprise architecture concepts and how both could be enhanced by incorporating elements from one another.

c. Chapter 6 targeted the business community by discussing how to bridge the technology-business divide using techniques such as enterprise architecture.
d. Chapter 7 addressed the enterprise architecture community and specified, in detail, how enterprise architecture addressed the systems engineering needs specified in a Vision 2025 document (INCOSE 2014);
e. Chapter 8 addressed digital government technology professionals and described first the disconnects between management frameworks and then proposed enterprise architecture stewardship to mitigate the issues; and
f. Chapter 9 presented a high-level description of a simpler enterprise architecture development method, consumable by all stakeholders and addressing many of the issues raised in the previous chapters and illustrated by an action research case study.

Each one of these areas will be summarized in more detail in the following sections.

10.1.1 Literature Review

The research was iterative and focuses on "macro" issues rather than the more traditional dissertations that focus on a narrow and well-defined problem space.

10.1.1.1 Research Questions

To guide the research several research questions were created and gradually refined. In this literature review the following two main and three ancillary research questions have been raised:

The main discovery questions and answers are:

a. Question 1:" Is there a holistic management structure that allows enterprises to innovate and evolve over time?"
    - Answer Q1: No. The search determined that references are scoped to address specific dimensions of the management challenge, but none that looks at the enterprise in a holistic manner. The dimension specific methodologies focus on one business function or another while superficially treating the others in a disjoint manner; and

b. Question 2: “Is there a recognition that there is a need for a holistic management structure?”
    - Answer Q2: Yes. References (i.e. industry best practices in business, planning, marketing, building, operations, IT and so on) indicate the need for a holistic approach but they all want to do it their way to respond to their specific needs. The net result is a collision of best practices that are often incompatible and complicate rather than facilitate the creation or transition of organizations to e-Business enterprises.

Several ancillary questions are:

a. Question 3: Why are IT related endeavours subject to such a high rate of failure?
    - Answer Q3: IT is volatile and constantly evolving, even though the underlying policies and principles (e.g. meta-data) are stable. Generally, IT exhausts itself focusing on the volatility and does not dedicate enough effort to ensure both business understanding of innovative technology and IT understanding of what constitutes value to the business.
b. Question 4: Are the different professional communities using distinct methodologies to achieve the same goals, but in conflict rather than in harmony with one another?
    - Answer Q4: To extend, the answer to question 2, the professional associations and their methodologies cannot be applied coherently. They have each evolved certification in the same areas (e.g. risk management) and become dependent on the revenue associated with training and both individual and corporate certification. Essentially, they in competition with one another and cooperation is not in their best interest.
c. Question 5: Why is IT (CIOs) misaligned with business?
    - Answer 5: As previously noted, there is a lack of understanding with respect to the business and a focus on keeping up with a volatile and evolving technology environment. There is also an inability to communicate, impassion and “sell” the potential of leveraging new technology as well as an inability to appreciate the enterprise impact.

10.1.1.2 Literature Search Results

Due to the broad scope of the literature review, more than 1,000 sources were reviewed from a wide array of disciplines across business, government and technology areas, of which some 300 were entered into the references. Government sources were valuable as they were more candid with respect to what did not work and why.

The literature search was focused by concentrating on key business functions and important factors impacting the creation of a digital enterprise. The methodology details can be found at Section 3.3. The literature search analysis was created incrementally and then consolidated into Table 34, which was the basis for the response to the research questions and combines Table 14 with Table 33.

Overall each type of methodology addressed specific business functions well and it could be said that to create a fully effective methodology (i.e. Green vertical) it would be useful to integrate their best practices. Upon analytical reflection, enterprise architecture offers a framework upon which this integration of methodologies could occur.

Table 34 - Summary of Literature Search and Methodology Assessment Results

#	*Methodology Area →*	*Digital Leader-ship*	*Planning Business (Balanced Score-card Family)*	*Business Design*	*Infor-mation Mgt / Ar-chitecture*	*Enterprise Architec-ture*	*Building Portfolio/ Project Management (PMI)*	*Running Operations Management ITIL*	*Audit COBIT 5*	*NEW Pro-posed EADM*
	FOCUS AREAS									
1	Governance	4	4	3	2	3	3	3	5	5
2	Management	3	3	3	3	4	3	4	5	4
3	Planning	3	3	3	3	4	2	3	5	4
4	Building	2	2	2	3	3	5	3	3	4
5	Operations	1	3	2	3	1	1	4	3	3
6	Audit, Verifica-tion, Monitoring	1	4	2	2	3	4	3	5	4
	FACTORS									
1	Transition to a Knowledge-Based Economy	5	3	5	2	2	3	2	2	4
2	The Relevance of Knowledge	2	3	3	3	2	2	2	2	3
3	The Relevance of IT	3	4	3	4	4	3	4	5	5
4	Continuous In-novation and Business Trans-formation	5	1	4	3	3	3	3	3	4
5	Leadership Ver-sus Management	4	3	5	2	2	2	2	5	3
6	Scientific Ver-sus Creativity Approaches	4	1	5	1	1	3	1	2	3

10.1.2 Business Design Summary

Business design involves a new set of business and general architecture skills that should be understood by all enterprise and system architects. Intuitive thinking complements standard analytical thinking to help solve both hard and wicked problems. Having both reliability and validity mindsets in the enterprise generates a healthy tension that ensures that decisions are well-thought out and risks managed in a consistent manner.

Ideally members of the emerging knowledge-based enterprises will have a bit of both mindsets. Unfortunately, this is difficult. With the increasing specialization in education and the demise of the "generalist", there are few, if any, institutions that promote both types of thinking.

The article summarized the concepts from numerous sources on business design and innovation. The author grouped them as shown in Figure 85, to contrast the key mindsets prevalent in most enterprises based on action research. Notably these issues have to be understood and addressed to successfully conduct digital transformation.

RELIABILITY MINDSET		*VALIDITY MINDSET*
Management		Leadership
Exploitation		Exploration
Red Ocean		Blue Ocean
Risk Averse		Risk Managed
Analytical Insights Data Rich	*Versus*	Intuitive Insights Data Poor
Stable Prescriptive		Agile Descriptive
Scientific Logical		Artistic Empathic

Figure 85 - Organizational Tensions in Addressing Wicked Problems

10.1.3 Enterprise Architecture: Bridging the Business-Technology Divide

Chapter 6 defined what constitutes the business-technology divide, the business complexities of adopting new technology and the use of Enterprise Architecture to leverage new technologies has addressed many issues associated with creating a business value-driven digital enterprise.

Indeed, the injection of Enterprise Architecture into business planning was deemed to be a sorely needed management innovation (as per Hamel 2007). It asserted that digital transformation required strategic leadership, awareness and understanding of technology and rigorous planning in the form of architecture. It highlighted enterprise architecture as a means of enhancing collaboration across the enterprise. In Table 18, the various existing viewpoints across EA frameworks were assessed and many directly addressed business concerns. It concluded with the formulation of a set of heuristic goals with which to create a digital enterprise as shown in Figure 86 - Heuristic Goals to Help Create the Digital Enterprise

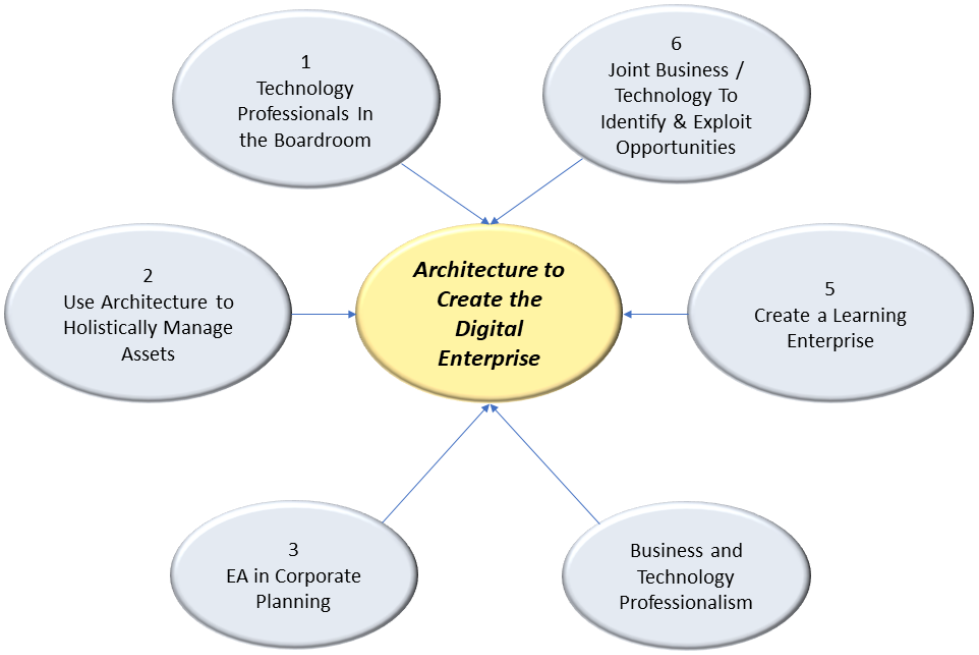


Figure 86 - Heuristic Goals to Help Create the Digital Enterprise

10.1.4 Integrating Systems Engineering and Enterprise Architecture for Better Outcomes

Chapter 6 exhaustively assessed the INCOSE Vision 2025 (INCOSE 2014) and demonstrated that enterprise architecture (EA) can address the majority of issues associated with the vision. EA is a methodology that can help manage the design and management of complex enterprise environments and the systems within them. Generally, systems engineering is found at the individual system or project level whereas EA deals with the enterprise at the portfolio level. However with the increasing complexity associated with SCADA systems evolving from mechanical to

electronic to software intensive to connected could benefit from the use of an EA enabled system of systems as in DODAF (US DOD 2009). The advantages of having a common technology platform and enabling architecture-based decision-making are highlighted as well as in indication of how EA has been used to handle complexity in US defense where EA is integrated into business and technology planning.

One issue that created considerable friction was raised, specifically the barriers to entry to become a system engineer versus an enterprise architect. The need to professionalize enterprise architects was discussed.

10.1.5 Managing the Management Frameworks: Enterprise Digital Transformation Using Enterprise Architecture Stewardship

Chapter 7 gave an overview of the various management frameworks within an enterprise and showed how they often worked at cross-purposes, creating friction and disabling the enterprise digital transformation efforts. It highlighted the previously mentioned high project failure rate and high digital transformation failure rate and assessed the factors leading to IT project failure (Guillaume and Wasek 2015) from 2015 to those from 1986 (PRISM 1986) and found them to be almost the same. At the top of the list were issues relating to unclear requirements and unrealistic project goals and expectations. This directly implicated business planning and project management frameworks. It illustrated, using EA, five case studies where the key management frameworks collaborated and worked in a coherent way. It culminated with the unveiling of an EA Stewardship Method composed of eight key steps as shown in Section 7.9. EA Stewardship inferred that the EA function would enable the enterprise to use EA throughout as a business technique with the chief architect controlling the repository and maintain coherence. Also, to be successful, EA needs to be outside the CIO organization.

10.1.6 New Enterprise Architecture Development Method (EADM)

The new EADM is not revolutionary and is intended to be easily accessible to both those new to EA and familiar with architectures. The main feature is that it is based on levels of abstraction and not bound by specific domains, leaving their specification to the enterprise implementing the EADM.

Selecting TOGAF as the basis for the EADM is pragmatic as it first meets many of the necessary criteria (Table 34) and it is already used in 80% of Fortune 50 companies and 60% of Fortune 500 companies (Perez-Castillo 2019). So rather than invent something new, it is best to modify something that already exists and is used extensively (especially as the author received an outstanding contribution award from The Open Group for his work on TOGAF 9).

Another major feature for the EADM is the inclusion of a cross-domain view at all the levels of abstraction. These are called All-Views (AV) in the US DOD Architecture Framework (DODAF 2009) but are absent in TOGAF 9.2 (TOGAF 2009). They are very useful for governance to verify that all the domains are coherent and to provide an overall view of the architecture.

The EADM fits the new TOGAF structure and the various domains can have specialized guides offering practitioner advice. The challenge will be coherence between the guides now provided through an EA Content Framework and Meta-Model (The Open Group 2019). The TOGAF meta-model is tightly coupled and discretely segmented into the BDAT, as is the Unified Architecture Framework (OMG 2017) with more domains, so it is challenging to focus the EA on fewer or additional domains. Many of the EA tools reflect this tight coupling. Adopting the EADM will necessitate a re-think of the underlying meta-model to make it more flexible and loosely coupled to accommodate more or fewer domains as well as different architecture styles.

The new EADM assessment has been included in last column in Table 34 - Summary of Literature Search and Methodology Assessment Results.

This EADM is meant to be a Change Request for the TOGAF standard (The Open Group 2019) specifically the architecture development method but will have wide-ranging implications in many parts of the standard. It may also become the basis of a white paper/guide to help socialize the change.

10.2. Summary of Contributions

In summary, the core contributions of this thesis are:

a. Raising awareness of the issues surrounding digital transformation and promoting collaboration, by publishing articles addressing different communities of practice involved in digital transformation;
b. Recognition and recommendations as to how Business Design concepts into Enterprise Architecture and System Engineering. Specifically, the concepts of
    [1] wicked problems,
    [2] abductive reasoning,
    [3] integrative thinking,
    [4] artistic method and inquiry techniques,
    [5] abstraction,
    [6] reliability and validity mindsets,
    [7] exploration versus exploitation, and
    [8] management versus leadership
c. Identification of the organizational tensions as per Figure 52 - Organizational Tensions in Addressing Wicked Problems that must be addressed.
d. A conceptual method of combining Business Design with EA Figure 54 and targeting an acceleration to business value as illustrated in Figure 55
e. Determining that EA is a key digital enabler and should be a business function within the strategic and investment planning segment within an organization (including an assessment that determined EA is still buried in the CIO organizations and not being leveraged)
f. A Set of Goals to help CEOs create a digital enterprise (Figure 57) and have the CEO not the CIO drive digital transformation.
g. Clearly demonstrating that EA addresses most of the issues surrounding the realization of the Systems Engineering vision 2025 and the need for collaboration.
h. Highlighting the need to coordinate the management frameworks, providing case studies and proposing an EA Stewardship program.

10.3. Future Work

Enterprise architecture provides a common basis for decision-making with a consistent view of all assets available to the enterprise, their relationships and their evolution over time.

The following points should be considered for future work:

a. Business design concepts should be integrated into EA and system engineering methodologies.
b. EA and systems engineering concepts should be integrated into business school curricula
c. Restrict the exclusiveness of communities of expertise and encourage "cross-pollination" collaboration.
d. There is a need for a unifying framework that incorporates business design, EA and systems engineering
e. Ideally there should also be an overall framework for loosely unifying all concepts within the govern-plan-build- run cycle and reduces the time to market.
f. Use of "generalists" rather than just "specialists" in the CIO organization to ensure that all dimensions of so-called "wicked problems" can be taken into consideration.
g. It is recommended that INCOSE and The Open Group work together to share work products and create a set of common terms.
h. The defense-specialized MITRE Systems Engineering Guide (MITRE 2014) has already integrated SE and EA for the defense environment. We recommend that it be generalized and used as a basis for generic SE/EA collaboration.
i. In SE, more emphasis should be placed on the exploitation and management of the key assets of the "Digital Enterprise" namely its data, information, knowledge and metadata.
j. Both EA and SE should leverage the Business Design (e.g. (Martin 2009a), (Martin 2009b)),
k. The skillsets for both EA and SE are similar, and it would be beneficial if the two academic curricula be coordinated and refer to one another.
l. Create a viable EA Stewardship Methodology, possibly added to TOGAF, that could be taught at business schools as a way executives can manage digital transformation.

m. Create a coherent knowledge architecture and planning methodology that addresses the key enterprise stakeholders and the various communities of practice in KM/IM/DM.
n. Moreover, it would be beneficial to coordinate and harmonize the lexicon and concepts of the various management frameworks (i.e. Govern, Plan, Build, Run) as well as key techniques such as agile.
o. Create one or more forums to allow professionals from all associations involved with digital transformation to share their experiences.

Acronyms

Acronym	Explanation
CEO	Chief Executive Officer
CIO	Chief Information Officer
DM	Data Management
DODAF	Department of Defense Architecture Framework (US)
EA	Enterprise Architecture
ICT	Information and Communications Technology (used in Europe and Asia)
IM	Information Management
IT	Information Technology
KM	Knowledge Management
MODAF	Ministry of Defence (UK) Architecture Framework
NAF	North Atlantic Architecture Organization (NATO) Architecture Framework
SE	Systems Engineering
OMG	Object Management Group
TOGAF	Formerly The Open Group Architecture Framework but now just TOGAF is used.
UAF	Unified Architecture Framework – From the Object Management Group (OMG)

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Appendix: Literature Review Process

Summary

This appendix summarizes the process, based on the original research questions, that was used to search for literature relevant to this thesis. We used the *Guidelines for performing Systematic Literature Reviews in Software Engineering* (EBSE-2007-1) produced by Keele University as guidance. Analysis of the literature can be found in Chapter 3.

It is recognized that this is not a software engineering thesis and much of the work is qualitative in nature, however the rigor associated with following a systematic literature retrieval process is useful in decreasing the amount of literature to be reviewed. Furthermore, there is not much in the way of published process associated with reviews in the business domain.

An overall finding has been that much of the material required to answer the research questions is not new, ergo much of the research has focused on existing material especially books and standards. Although the material is well-known its holistic use within an enterprise is not well documented or explained. Academic literature addresses fragments of the overall research question and will bring up to date the concepts espoused in books.

This is the second iteration of the literature search and the third iteration of the research questions. Since starting in September 2014 hundreds of books, standards and articles (both professional and academic) have been skimmed, read, and/or studied to assess their relevance to the evolving research question. Simultaneously several world-class experts have been consulted with respect to the current research question. The author is also participating in several international working groups [notably The Open Group, IIBA, ISACA and Business Architecture Guild] where they are discussing aspects related to the research question.

The planning process for the review

Identification of the need for review

At present there are numerous management methodologies that conflict rather than complement each other making it difficult for management to create a holistic view of innovative enterprises.

The key area of research is management innovation with respect to transforming enterprises and economies from industrially based to knowledge-based in accordance with corporate business needs. A focus has been on e-government.

Commissioning a Review - The Research Questions

This was subject to several iterations. Initially questions such "Has Enterprise Architecture succeeded? "were refined and the following two questions best encapsulate the thrust of the literature search.

1. Is there a holistic management structure that allows enterprises to innovate and evolve over time?
2. Is there a recognition that there is a need for a holistic management structure?

Review protocol

The review protocol has been revised continuously to accommodate new sources. At this point the following study selection criteria were used to conduct the review.

Primary Sources

The following sources (in order of priority) were used to direct the research:

a. academic literature (e.g. IEEE family of documents, Harvard Business Review, Rotman Management Review);
b. professional journals and books (e.g. Information Systems Audit and Control Association (ISACA) Journal);

c. international standards (e.g. Project Management Institute standards, The Open Group Architecture Framework (TOGAF) V9.2, IT Governance Institute, Axelos UK Government, Data Management Association, CMMI, NIST and so on);
d. conference proceedings (e.g. Open Group local and global conferences and member working group meetings, IEEE Conferences);
e. organization specific documents (e.g. Australian Government Architecture);
f. Professional association journals (e.g. ISACA Journal);
g. interviews with subject matter experts in the various domains.

Secondary Sources

The following secondary sources were used to direct the research:

a. reviews by academic or professional institutions (e.g. Sloan School of Management Center for Information Systems Research (CISR), Harvard Business Review, Financial Times /Economists Business Review);
b. published best practices
    (1) Studies that are open and in not-for-profit organizations;
    (2) Include peer-reviewed White Papers (e.g. Open Group White Papers issued by the Forums);
c. aggregation surveys of communities of practice (e.g. National Association of State CIOs [NASCIO] assessments); and
d. Findings of Research and Management Consulting Firms such as Forrestor, Gartner and PwC.

Tertiary Sources

The main technique was the use of "citation chaining" which was used extensively to discover new primary and secondary sources

Study Selection Procedures

The following criteria and procedures were used to select the materiel within the review

Peer Review

Documents had to have gone through a peer review (not necessarily academic) to be considered. Blogs, and company-issued white papers though interesting were carefully consulted to ensure that the contents were objective.

Impartiality

Documents were to be free of any conflict of interest, in terms of the solutions proposed, and were to be either non-proprietary or not-for-profit.

Disagreements amongst Assessments.

If there were disagreements between the assessments, the following criteria were used as "tie-breakers" (if necessary, as disagreement is to be embraced):

a. most recent assessment;
b. preference to not-for-profit;
c. priority to business assessment; and
d. application in the real world.

Study Quality Assessment Checklists and Procedures

For the purposes of this study, quality was construed to be from sources whereby data was only from peer-reviewed academic and professional institutions, which included white papers and standards from international standards bodies (e.g. The Open Group) where the papers were reviewed and approved for release of professional peers. For the most part this literature review does not deal in quantitative measures rather focuses on on qualitative work to describe new methodologies.

Data Extraction Service Strategy

Extraction

Data is extracted, aggregated, synthesized and presented to determine what is required and sources are aggregated using RefWorks and manual insertion of the bibliographic references, mainly from the professional literature.

The keywords used for extraction are Enterprise, Government, Corporation, Governance, Management, Framework, Methodology, Business, Business Value, Planning, Strategy, Portfolio, Project, PMBOK, PRINCE2, Operations, ITIL, "Business Transformation", "Organizational Change", "Enterprise Architecture", and "Business Design".

These Keywords are combined using the following query that extracted 56 useable documents (listed below) that will have to be analyzed.

(Enterprise OR Government OR Corporation) AND (Governance OR Management)

AND (Framework OR Methodology) AND (Business OR Business Value)

AND (Planning OR Strategy) AND (Portfolio OR Project OR PMBOK OR PRINCE2)

AND (Operations OR ITIL) AND ("Business Transformation" OR "Organizational Change") AND ("Enterprise Architecture" OR "Business Design")

The documents discovered using this query are described in Table 35.

Table 35 - Literature Search Documents Found

#	Literature Search Document
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2.	Twum-Darko, Michael, 2014 "Sustainable Local Economic Development: The Role of Informatics in Determining Municipal Revenue Management", Journal of Economics and Behavioral Studies Vol 6, Issue 6;
3.	Quaadgras, Anne; Weill, Peter; Ross, Jeanne W "Management Commitments That Maximize Business Impact from IT" 2014, Journal of Information Technology Vol 29
4.	Simon, Daniel; Fischbach, Kai; Schoder, Detlef "Enterprise Architecture Management and Its Role in Corporate Strategic Management" Information Systems and eBusiness Management - Vol: 12 Issue 1
5.	Maclennan, Elzavita; Van Belle, Jean-paul "Factors Affecting The Organizational Adoption Of Service-Oriented Architecture (SOA)" Information Systems and eBusiness Management Vol 12: Issue 1
6.	Löhe, Jan; Legner, Christine, "Overcoming Implementation Challenges In Enterprise Architecture Management: A Design Theory For Architecture-Driven IT Management (ADRIMA)" 2014, Information Systems and eBusiness Management Vol 12, Issue 1

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7.	Jafari, Seyed Mohammad Bagher, “Strategic Cost-Cutting in Information Technology: toward a Framework for Enhancing the Business Value of IT” 2014, Iranian Journal of Management Studies, Vol 7 Issue 1;
8.	Clegg, Ben; Wan, Yi, “Managing Enterprises and ERP systems: A Contingency Model for the Enterprization of Operations”, 2014, International Journal of Operations & Production Management, Vol 33, Issue 11/12
9.	Basias, Nikolaos; Themistocleous, Marinos; Morabito, Vicenzo “SOA Adoption In E-Banking” 2013, Journal of Enterprise Information Management, Vol: 26, Issue 6
10.	Svärd, Proscovia, “Enterprise Content Management and the Records Continuum Model as strategies for long-term preservation of digital information” 2013, Records Management Journal, Vol:23, Issue: 3;
11.	Parker, David; Charlton, Joshua; Ribeiro, Ana; Pathak, Raghuvar D “Integration Of Project-Based Management And Change Management” 2013, International Journal of Productivity and Performance Management, Vol: 62, Issue: 5
12.	Martin Hubert Ofner; Straub, Kevin; Otto, Boris; Oesterle, Hubert, “Management Of The Master Data Lifecycle: A Framework For Analysis” 2013, Journal of Enterprise Information Management, Vol: 26, Issue: 4;
13.	Alaeddini, Morteza; Salekfard, Sepideh “Investigating The Role Of An Enterprise Architecture Project In The Business-IT Alignment In Iran”, 2013, Information Systems Frontiers, Vol: 15, Issue: 1;
14.	Renaud, Paul E; Bot, Sonia D, “Enabling Process Alignment for IT Entrepreneurship”, 2012, Technology Innovation Management Review, Vol: 2, Issue: 11;
15.	Watson, Richard B, “Suggestions for New Application Areas for Soft Systems Methodology in the Information Age” 2012, Systemic Practice and Action Research, Vol: 25, Issue: 5;
16.	de Biazzi, Fabio “Intellectual Capital and Organizational Renewal: Building Dynamic Capabilities through People” 2013, Business And Economics—Management, http://search.proquest.com/docview/1448432041?accountid=14701 ;
17.	Bytheway, Andy, “Assessing Information Management Competencies in Organisations” 2011, Electronic Journal of Information Systems Evaluation, Vol: 14, Issue: 2;
18.	Ray, Dibakar; Gulla, Umesh; Dash, Shefali S; Gupta, M P, “A Critical Survey Of Selected Government Interoperability Frameworks” 2011, Transforming Government: People, Process and Policy, Vol: 5, Issue: 2;

#	Literature Search Document
19.	Nabiollahi, Akbar; Alias, Rose Alinda; Sahibuddin, Shamsul, "Involvement of Service Knowledge Management System in Integration of ITIL V3 and Enterprise Architecture" 2011 American Journal of Economics and Business Administration, Vol: 3, Issue: 1;
20.	Yang, Jungho; Tanner, Kerry; Kuzic, Joze, "Enablers and Inhibitors of SISP: A Case Study of a Korean Large Corporation" 2011, Computers--Computer Systems; URL: http://search.proquest.com/docview/1437172989?accountid=14701 ;
21.	Jan vom Brocke; Recker, Jan; Mendling, Jan, "Value-Oriented Process Modeling: Integrating Financial Perspectives Into Business Process Re-Design" 2010, Business Process Management Journal, Vol: 16, Issue: 2;
22.	Sharma, Mohan; Sharma, Rajneesh, "Process Integration in it Portfolio Management", 2010, Journal of American Academy of Business, Cambridge, Vol: 15, Issue: 2;
23.	Caldeira, Mário; Dhillon, Gurpreet, "Are We Really Competent?", 2010, Business Process Management Journal, Vol: 16, Issue: 1;
24.	Gendron, Michael S; Banks, David A; Miller, Daniel J "Effective Strategic Alignment of IT: Implications for the CIO as a Member of the C-Suite", 2009, Asia Pacific Management Review, Vol: 14, Issue: 4;
25.	Chen, Yu-Che; Hsieh, Jun-Yi "Advancing E-Governance: Comparing Taiwan and the United States", 2009, Public Administration Review, Vol: 69, Issue: S1;
26.	Mahmoodzadeh, E; Sh. Jalalinia; F. Nekui Yazdi, "A Business Process Outsourcing Framework Based On Business Process Management And Knowledge Management" 2009, Business Process Management Journal, Vol: 15, Issue: 6;
27.	Jafari, Mostafa; Akhavan, Peyman; Nouranipour, Elham, "Developing An Architecture Model For Enterprise Knowledge" 2009, Management Decision, Vol: 47, Issue: 5;
28.	Pawar, Kulwant S; Beltagui, Ahmad; Johann C.K.H. Riedel, "The PSO Triangle: Designing Product, Service And Organisation To Create Value", 2009, International Journal of Operations & Production Management, Vol: 29, Issue: 5;
29.	Butler, Charles W, "The Role of Architecture in Enterprise Processes", 2008, The Journal of Applied Business and Economics, Vol: 8, Issue: 4;
30.	Varadan, R; Channabasavaiah, K; Simpson, S; Holley, K; Allam, A, "Increasing Business Flexibility And SOA Adoption Through Effective SOA Governance" 2008, IBM Systems Journal, Vol: 47, Issue: 3;

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32.	Camarinha-Matos, Luis M; Afsarmanesh, Hamideh, “A Comprehensive Modeling Framework For Collaborative Networked Organizations” 2007, Journal of Intelligent Manufacturing, Vol: 18, Issue: 5;
33.	Gammelgård, Magnus; Simonsson, Mårten; Lindström, Åsa, “An IT Management Assessment Framework: Evaluating Enterprise Architecture Scenarios”, 2007, Information Systems and eBusiness Management, Vol: 5, Issue: 4;
34.	Shah, Hanifa; El Kourdi, Mohamed, “Frameworks for Enterprise Architecture” 2007, IT Professional Magazine, Vol: 9, Issue: 5;
35.	Brittenham, P; Cutlip, R R; Draper, C; Miller, B A; et al, “IT Service Management Architecture And Autonomic Computing” 2007, IBM Systems Journal, Vol: 46, Issue: 3;
36.	Gregor, Shirley; Hart, Dennis; Martin, Nigel, “Enterprise Architectures: Enablers Of Business Strategy And IS/IT Alignment In Government”, 2007, Information Technology & People, Vol: 20, Issue: 2
37.	Hamlett, Neil, “IT Outsourcing Impacts on Enterprise Architecture” 2007, IT Professional Magazine, Vol: 9, Issue: 2
38.	Augier, Mie; Teece, David J, “Dynamic Capabilities and Multinational Enterprise: Penrosean Insights and Omissions” 2007, Management International Review, Vol: 47 Issue: 2
39.	O. ChiraC. ChiraT. RocheD. TormeyA. Brennan, “An Agent-Based Approach To Knowledge Management In Distributed Design” 2006, Journal of Intelligent Manufacturing, Vol: 17, Issue: 6
40.	Brane Kalpic; Bernus, Peter, “Business Process Modeling Through The Knowledge Management Perspective” 2006, Journal of Knowledge Management, Vol: 10, Issue: 3
41.	Vandergriff, Linda J, “Unified Approach To Agile Knowledge-Based Enterprise Decision Support”, 2006, VINE, Vol: 36, Issue: 2
42.	Lindström, Åsa; Johnson, Pontus; Johansson, Erik; Ekstedt, Mathias; Simonsson, Mårten, “A Survey On CIO Concerns-Do Enterprise Architecture Frameworks Support Them?” 2006, Information Systems Frontiers, Vol: 8, Issue: 2

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43.	Iyer, Bala; Shankaranarayanan, G; Wyner, George "Process Coordination Requirements: Implications For The Design Of Knowledge Management Systems" 2006, The Journal of Computer Information Systems, Vol: 46, Issue: 5
44.	Burn, Janice; Ash, Colin, "A Dynamic Model Of E-Business Strategies For ERP Enabled Organisations", 2005, Industrial Management + Data Systems, Vol: 105, Issue: 8
45.	Carlson, Brent; Himler, Alan, "Turning Application Security Inside Out: Security for Service-Oriented Architectures (SOAs)", 2005, Information Systems Security, Vol: 14, Issue: 4
46.	Brown, William; Nasuti, Frank, "What ERP Systems Can Tell Us About Sarbanes-Oxley", 2005, Information Management & Computer Security, Vol: 13, Issue: 4
47.	Kapoor, S; Bhattacharya, K; Buckley, S; Chowdhary, P; et al "A Technical Framework For Sense-And-Respond Business Management", 2005, IBM Systems Journal, Vol: 44, Issue: 1
48.	Malhotra, Yogesh, "Integrating Knowledge Management Technologies In Organizational Business Processes: Getting Real Time Enterprises To Deliver Real Business Performance", 2005, Journal of Knowledge Management, Vol: 9, Issue: 1
49.	Viedma Marti, Jose Maria, "Strategic Knowledge Benchmarking System (SKBS): A Knowledge-Based Strategic Management Information System For Firms", 2004, Journal of Knowledge Management, Vol: 8, Issue: 6
50.	Zhu, J; Tian, Z; T Li; Sun, W; et al, "Model-Driven Business Process Integration And Management: A Case Study With The Bank Sinopac Regional Service Platform", 2004, IBM Journal of Research and Development, Vol: 48, Issue: 5/6
51.	Patel, Nandish V, "Emergent Forms Of IT Governance To Support Global E-Business Models", 2002, JITTA : Journal of Information Technology Theory and Application, Vol: 4, Issue: 2
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53.	Meyer, Marc H; DeTore, Arthur, "Product Development For Services", 1999, The Academy of Management Executive, Vol: 13, Issue: 3
54.	Guha, Subo; Grover, Varun; Kettinger, William J; Teng, James T C, "Business Process Change And Organizational Performance: Exploring An Antecedent Model", 1997, Journal of Management Information Systems, Vol: 14, Issue: 1

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