Université Paris-Dauphine
Ecole Doctorale de Dauphine
Programme en Sciences de Gestion

Proposing Architecture and Process Governance for Risk Mitigation in Organizational Change:

A Case Study of the Flight Test and Development Centre (FTC),

A Division of the UAE Armed Forces

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TABLE OF CONTENTS

LIST OF FIGURES 8

LIST OF TABLES 10

SUMMARY OF THE THESIS 12

CERTIFICATE OF AUTHORSHIP / ORIGINALITY 15

ACKNOWLEDGMENTS 16

1 INTRODUCTION 17

1.1 Background Context 17

1.3 Thesis Overview 18

1.4 Benefits of Early Risk Mitigation 20

1.5 Multi-Dimensional Framework 21

2 DEFINITIONS / BASIC DESCRIPTIONS 24

3 QUESTIONS FOR THE THESIS 28

4 OUTSOURCING OF MILITARY ACTIVITIES 31

4.1 Motivation for Outsourcing 31

4.2 Advantages of Outsourcing 33

4.3 Disadvantages of Outsourcing 34

4.4 General Risks in the Context of Outsourcing 36

4.4.1 Risk Definition 36

4.4.2 Common Risks 37

4.5 Conclusion 39

5 OUTSOURCING OF TWO MILITARY PROGRAMS AND RISKS ENCOUNTERED – AUTHOR'S EXPERIENCE 40

5.1 Outsourcing a Depot Level Repair Service for Aircraft Components 40

5.1.1 Objectives 40

5.1.2 Commercial Agreement 40

5.1.3 Civilian Entity 41

5.1.4 GCO 41

5.1.5 Problems Encountered 41

5.1.6 Conclusion 44

5.2 Upgrade and Major Overhaul of the UAE AF&AD M2000 Aircraft 44

5.2.1 Description of Project and Contract Frames 47

5.2.2 Risks Encountered 58

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5.2.3 Constraints Easily Transferable to Risks 59
5.3 Conclusion 60

6 UAE AF&AD FLIGHT TEST CENTRE (FTC) 63
6.1 FTC "As-Is" 63
6.1.1 Organizational Structure 63
6.1.2 Functions 64
6.1.3 Capabilities, Activities and Processes 66
6.2 Transition to FTC "To-Be" 67
6.3 FTC "To-Be" 70
6.3.1 Organizational Structure "To-Be" 71
6.3.2 FTC Capabilities, Activities and Processes - Towards "To-Be" 72
6.3.3 FTC Basic Skills and Means – "To-Be" 82
6.4 Mapping of FTC Evolution to Meta Model 84
6.5 Conclusion 86

7 A COMPARATIVE STUDY OF FLIGHT TEST CENTRES 88
7.1 SAAB AB Flight Test Centre 88
7.1.1 Background 88
7.1.2 Mission 88
7.1.3 Strategy 88
7.1.4 Organization 89
7.1.5 Interface with government 94
7.1.6 Challenges 94
7.1.7 Risk and Lessons Learnt 94
7.2 The Operational Test and Evaluation Centre (CEAM) in France 95
7.3 Dassault Aviation Flight test Centre Organization 96
7.3.1 Overview 96
7.3.2 Challenges - Recommendations 99
7.4 A General Comparison between Military and Civil Flight Test Centres 100
7.5 Conclusion 104

8 GOVERNANCE 106
8.1 Challenges and Risks for the FTC 106
8.2 Risk in Governance 108
8.3 Conclusion 109

9 RISK MANAGEMENT 111
9.1 Introduction 111
9.2 Managing the Risks 113
9.3 Multi-disciplinary Approach to Risk Management – Safety & Security 115
9.3.1 Background 115
9.3.2 Safety & Security 117

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9.3.3 Risk Analysis Theory Applied to the FTC Case 119
9.3.4 Tools 121
9.3.5 FTC Use Cases 125
9.3.6 Detailed Analysis of the Functional Safety Use Case 127
9.4 Author's Findings and Conclusion 131

10 COMPATIBILITY MATURITY MODE INTEGRATED (CMMi) 133
10.1 Introduction to CMMi 133
10.2 Process Improvement Life Cycle 135
10.3 Conclusion 137

11 ENTERPRISE ARCHITECTURE (EA) 138
11.1 Introduction 138
11.1.1 General Description of Enterprise Architecture 138
11.1.2 Integrating Technologies with Enterprise Architecture 140
11.1.3 Zachman's Definition of Enterprise Architecture 140
11.1.4 The Importance of Modelling Enterprises 141
11.1.5 EA Framework Model 142
11.1.6 Enterprise Architecture Framework 142
11.1.7 Conclusion 144
11.2 A Comparison of the Top Four EA Methodologies 144
11.2.1 Zachman Enterprise Architecture Framework 145
11.2.2 The Open Group Architecture Framework (TOGAF) 147
11.2.3 Federal Enterprise Architecture (FEA) 149
11.2.4 Gartner 152
11.2.5 Selection criteria for an FTC framework 153
11.3 Author's findings and conclusions 156

12 THE ZACHMAN ENTERPRISE ARCHITECTURE 159
12.1 Detailed Description 159
12.2 Focus and Perspective 160
12.2.1 Building Enterprise Architecture: the Perspective View 161
12.2.2 Building Enterprise Architecture: the Focus View 162
12.3 Constraints and Requirements 162
12.4 Conclusion 163

13 DEVELOP A CAPABILITY AND GOVERNANCE FRAMEWORK (CaGF): KEY ELEMENTS TO RISK MANAGEMENT 164
13.1 Mission and Objectives: FTC (To-Be) 164
13.2 Solution Framework 165
13.2.1 CaGF and Initial EA Consideration in FTC 166
13.2.2 CaGF Overview 167
13.2.3 CaGF Goals 169
13.2.4 CaGF Objectives, Vision, and Mission 170

13.2.5 CaGF: The Planning 171
13.2.6 Impact on Risk Analysis 177
13.2.7 Assessment overview 178
13.3 CaGF Benefits to FTC 182
13.4 Risk Management in CaGF 185
13.5 CaGF Deliverables 187
13.5.1 Project Artifact 187

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13.6 CaGF Functions & Capabilities 193

14 HYPOTHESES 196

14.1 Hypothesis 1 196

14.2 Hypothesis 2 199

14.3 Hypothesis 3 201

14.4 Meta Model Element Mapping 202

15 METHODOLOGICAL ISSUES 203

15.1 Overview of the research study 203

15.1.1 Premise for the study 203

15.1.2 Objectives of the research study 203

15.1.3 Methodology 204

15.2 Research Philosophy 204

15.2.1 Abductive Reasoning 204

15.2.2 Qualitative Research Method 205

15.3 Case Study Research 205

15.3.1 Critical Instance Case Study 206

15.3.2 Group Interviewing 206

15.3.3 Case study FTC - As is 207

16 LIMITATIONS & RECOMMENDATIONS 208

16.1 Limitations 208

16.2 Recommendations 208

17 BUSINESS RISK MITIGATION PLAN 210

17.1 Introduction 210

17.2 Risk Assessment 210

17.2.1 FTC Outsourcing 210

17.2.2 Government level 211

17.2.3 Governance level 212

17.2.4 Management level: 212

17.2.5 Transition towards a civilian organization: 212

17.3 Risk Mitigation Action Plan 213

17.3.1 Government/governance level 213

17.3.2 Management Level 214

18 HOW TO ATTRACT GROWTH CAPITAL 216

18.1 Introduction and Background 216

18.2 The Writing of the Business Plan 217

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18.3 Conclusion 222

19 MAIN CONCLUSION 225

19.1 Major Findings 225

19.2 Benefits to the Organization 226

19.3 Implications 227

19.4 Limitations & Further Research 227

REFERENCES 229

GLOSSARY 242

APPENDICES 245

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LIST OF FIGURES

FIGURE 1: THESIS OVERVIEW: TRANSFORMATION OF THE MILITARY FTC INTO A CIVILIAN ENTITY 19
FIGURE 2: BENEFITS OF RISK MANAGEMENT INTEGRATED WITH AN ENTERPRISE ARCHITECTURE FRAMEWORK 21
FIGURE 3: A STRUCTURED APPROACH TO BUILDING A DEDICATED ENTERPRISE ARCHITECTURE FRAMEWORK 22
FIGURE 4: COSO ENTERPRISE RISK MANAGEMENT FRAMEWORK 26
FIGURE 5: PERCEIVED OBSTACLES TO EFFICIENCY IN A MILITARY ORGANIZATION 31
FIGURE 6: UAE MILITARY FORCES STRUCTURE 63
FIGURE 7: FTC ORGANIZATION STRUCTURE – "AS IS" 64
FIGURE 8: TRANSITION PATH FROM MILITARY STRUCTURE TO CIVILIAN ORGANIZATION 68
FIGURE 9: THE DRIVERS OF EVOLUTION 71
FIGURE 10: FTC ORGANIZATION STRUCTURE – "TO-BE" 72
FIGURE 11 : FTC BASIC PROCESSES – "TO-BE" 73
FIGURE 12 : STEPS OF THE DEVELOPMENT AND FLIGHT TEST PROCESS – "TO-BE" 74
FIGURE 13: FTC DEVELOPMENT CYCLE – "TO BE" 75
FIGURE 14: OVERALL FTC "TO-BE" PROCESS DETAILS 77
FIGURE 15 : FLOW CHART OF THE AUTHORIZATION PROCESS 78
FIGURE 16: THE FEEDBACK PROCESS 79
FIGURE 17: ODILE SYSTEM ENGINEERING 80
FIGURE 18: MAIN ISSUES OF THE OVERALL FTC PROCESS 81
FIGURE 19: FTC PROCESS INTERACTIONS 82
FIGURE 20: FTC BASIC SKILLS – "TO-BE" 83
FIGURE 21: FTC BASIC MEANS – "TO-BE" 84
FIGURE 22: OVERLAYING META MODEL ELEMENTS ON THE EVOLUTION CONCEPT COMPONENTS 85
FIGURE 23: ORGANIZATION CHART OF FLIGHT TEST AND VERIFICATION DEPARTMENT 89
FIGURE 24: FLIGHT TEST ACTIVITIES 97
FIGURE 25: TRADE DEPARTMENTS 98
FIGURE 26: GOVERNANCE - CHALLENGES AND RISKS FOR ENTERPRISES 107
FIGURE 27: VARIOUS COMPONENTS OF RISK 115
FIGURE 28: ITERATIVE RISK ANALYSIS WORKFLOW 118
FIGURE 29: RISK ANALYSIS WORKFLOW 119
FIGURE 30: COMMON INTEGRATED WORKFLOWS 121
FIGURE 31: RISK ANALYSIS SERVICES LAYER REPRESENTATION 124
FIGURE 32: ASSETS QUOTING MATRIX 131
FIGURE 33: THE 5 LEVELS OF MATURITY IN THE STAGED MODEL 134
FIGURE 34: IDEAL MODEL 135
FIGURE 35: ENTERPRISE-ARCHITECTURE TIMELINE 143
FIGURE 36: ZACHMAN GRID 146
FIGURE 37: TOGAF'S ENTERPRISE ARCHITECTURE 147
FIGURE 38: THE TOGAF ENTERPRISE CONTINUUM 149
FIGURE 39: SEGMENT MAP OF THE FEDERAL GOVERNMENT 151
FIGURE 40: POSITIONING ENTERPRISE ARCHITECTURE FRAMEWORKS 157
FIGURE 41: JOHN ZACKMAN FRAMEWORK (SOURCE: WIKIPEDIA) 159
FIGURE 42: VIEW OF THE ENTERPRISE FROM ONE PERSPECTIVE 161
FIGURE 43: VIEW OF THE ENTERPRISE FROM ONE FOCUS 162
FIGURE 44: CONSTRAINT FLOW OF THE FRAMEWORK 163
FIGURE 45: CAGF FRONT INTERFACE 168
FIGURE 46: LAYER TWO OF CAGF FRAMEWORK 168
FIGURE 47: - SECOND LAYER DECOMPOSITION 169
FIGURE 48: THE POSITIONING THE EA FRAMEWORK 170
FIGURE 49: FRAMEWORK REFINEMENT LIFECYCLE PROCESS CAGF 171
FIGURE 50: SPAN OF ORGANIZATION 174
FIGURE 51: BREADTH OF EA 175

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FIGURE 52: THE 4 POINTS ANALYSIS PERSPECTIVES 179
FIGURE 53: THE MATURITY MEASUREMENT SCALE 180
FIGURE 54: CAGF COMMAND CAPABILITIES SUMMARY (FRONT INTERFACE) 185
FIGURE 55: CAGF COMMAND CAPABILITIES DETAIL VIEW INCLUDING RISK MANAGEMENT 185
FIGURE 56: CAGF THE RISK META MODEL - AN EXTRACT FROM CAGF 186
FIGURE 57: CAGF V1 PROJECT ARTIFACTS 187
FIGURE 58: CAGF PROJECT DEFINITION 188
FIGURE 59: CAGF V1 PROJECT TIMELINE 191
FIGURE 60: BUSINESS PROCESS SUBJECT AREA META-MODEL DIAGRAM 197
FIGURE 61: BUSINESS PROCESS DIAGRAM: DEVELOP NEW SYSTEM OR SYSTEM FUNCTION 197
FIGURE 62: BUSINESS PROCESS DIAGRAM: DEPLOYMENT OF NEW SYSTEM OR SYSTEM FUNCTIONS 198
FIGURE 63: RISK SUBJECT AREA META-MODEL DIAGRAM. 199
FIGURE 64: CAPABILITY SUBJECT AREA META-MODEL DIAGRAM 200
FIGURE 65: BUSINESS PROCESS ATTRIBUTES, WITH A FOCUS ON PERFORMANCE MEASUREMENT 201
FIGURE 66: BOSTON CONSULTING GROUP MATRIX 219
FIGURE 67: SWOT REPRESENTATION MATRIX 221

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LIST OF TABLES

TABLE 1: WORKSHOPS 44
TABLE 2: A COMPARATIVE APPROACHES BETWEEN MILITARIES AND CIVILIAN FLIGHT TEST CENTRE 103
TABLE 3: CROSS-REFERENCE BETWEEN KEY CONCEPTS OF COSO AND D'APPLONIA METHODOLOGY 118
TABLE 4: MAPPING MATRIX AMONG SECURITY, SAFETY AND PROGRAM RISK MANAGEMENT 120
TABLE 5: THE MAIN RISK ASSESSMENT TOOLS ON THE MARKET 123
TABLE 6: ASSETS - THREATS ASSOCIATION MATRIX 130
TABLE 7: IDEAL MODEL ACTIVITIES 136
TABLE 8: CRITERIA AND RATINGS FOR EACH METHODOLOGY 154
TABLE 9: THE GOAL OF THE CAGF FRAMEWORK 169
TABLE 10: BCG ANALYSIS OF THE FTC POSITION 220

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SUMMARY OF THE THESIS

A number of Defence organizations worldwide are moving towards outsourcing. The United Arab Emirates Air Force & Air Defence (UAE AF&AD) is also transforming some of its activities from military entities into civilian organizations. This paper studies the risks associated with the transformation of the UAE AF&AD Flight Test Centre (FTC) into a civilian organization to become a competitive, independent and autonomous outsourcing agency able to undertake additional, complex and specialized aeronautical projects.

The UAE AF&AD has in the past outsourced some of its activities and encountered specific risks; this study takes into account the risks experienced and lessons learnt.

The flight test centre (FTC) is operating a state of the art tools and expensive assets in support of the United Arab Emirates Air force and Air Defence (UAEAF&AD). These assets, comprising of flight instrumented aircraft, test range, integration benches, infrastructure, software development facilities, etc., cost hundreds of millions of USD, and an aeronautical project may take between 5 to 10 years (or more) and cost from tens to hundreds of millions USD.

In the last couple of years the FTC was short of activities and their experts were slowly departing or seconded in other military and non-military organizations, undermining its continuity and even its existence. The author who was the commander of the FTC, considered the necessity of transforming the FTC in to a civilian organization, allowing it to secure activities beyond just the UAE AF&AD and allowing it to be an outsourcing organization. However, the author asked: does this transformation come without challenges or risk? Will the FTC, as civilian organization be capable to sustain its activities and meet customer expectations, in this world of competition? What solution do we need to ensure that risks are continuously studied and managed prior to and after the transformation? At present, the FTC operates without a certified or cohesive process, and does not have any risk management function. Given the present status and the market conditions as well as competition, what are the potential risks likely to affect the FTC?

In this paper, the author has studied various paths in his endeavour to develop an innovative approach to managing risk in the FTC (TO BE civilian). The author believes that Enterprise Architecture Framework (EAF) combined with Capability Maturity Model integrated (CMMi) shall provide an innovative approach and a leverage to Risk Management (RM). Thus, the author's subject in this thesis is: "Leveraging Architecture and Process Governance for Risk Mitigation: A Case Study of the Flight Test and Development Centre (FTC), a Division of the UAE Armed Forces".

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Before heading the FTC, the author was involved in 2 major programs where the UAEAF&AD outsourced services to civil organizations. Based on his personal experience, he will describe here the findings of the said two real cases and the lessons learnt that he will take into consideration in this paper. The analysis and the findings indicated that numerous surprises and problems were mainly due to a lack of risk management culture. These major programs and the encountered risks are described in this paper, for academic purposes only and to the extent they do not divulge proprietary issues.

Additionally, the author has reviewed numerous literatures, associated with the advantages and disadvantages of outsourcing. Among the points of interest is the fact that men under uniform are subject to obligations under oath, while the civilians are contract-based personnel who can refuse to extend a contract or go on strike.

In this paper, the author describes the FTC "AS IS" organization, mission and function while focusing on the future "TO BE". He underlines the existing challenges and develops the future needs of the FTC. In his mind, it is clear that the future of the FTC has to be sustainable, competitive, process oriented, cohesive and dynamic in response to changes. The need of an enterprise framework is, in the authors view, a critical matter. And it is not just a framework: the greatest challenge is to identify or develop the right framework with a risk dimension and governance for a specific FTC application: a framework that will assist the FTC to identify, determine and assess at an earlier stage various risks.

In support of his research, the author compares three worldly reputed flight test centres to understand their functions, role, challenges and risks. Two of these flight test centres combine both civilian and military, while the third is dedicated only to military.

For the readers' understanding, the author summarizes the general description of enterprise architecture and frameworks. He addresses the comparison of four well-known frameworks - the Zachman Framework for Enterprise Architecture, The Open Group Architectural Framework (TOGAF), the Federal Enterprise Architecture (FEA) and the Gartner Methodology - in his endeavor to identify the most suitable framework. His conclusion indicates that a blended approach, one that combines more than a framework, would be ideal to the FTC. It was not until later in his research that the author decided to develop a new, innovative and dedicated framework for the FTC, as none responded precisely to the need of FTC's unique and high technology activities.

Process improvement in FTC is imperative to ensure that success or failure is measurable; failures can then be easily identified, thus facilitating improvements. The author has selected CMMi as the suitable methodology to be integrated into the FTC framework. This paper summarizes the twenty-two CMMi process areas from Ad-Hoc (level 0) to Continuous Improvement (level 5).

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As for risk, the author evaluated various risk management tools, including COSO (Committee of Sponsoring Organization of the Tread Way Commission) and ARES, a tool developed by D'Appolonia of Italy. Tailoring COSO to specific FTC application and integrating it in to the FTC Framework is part of this research paper.

The specific FTC framework is referred to as CaGF (Capability and Governance Framework). The CaGF definition and requirements are extremely important for the FTC "TO BE" at a time where the world is changing rapidly and global competition provides a constant threat to the enterprise and business; survival remains a critical risk parameter requiring important attention and consideration. FTC's ultimate goal is to strengthen its internal operation in order to be of higher contribution to the UAE Air force capability development effort.

The author, as part of his research project and as the head of the FTC, undertook the initiative to define an appropriate approach to Enterprise Architecture Framework adoption by initiating a qualitative assessment (based on open ended interviews and organizational planning insight and benchmarks) of FTC's operation. He identified various opportunities and needs for improvement in the Governance, Organization Planning, Operation Setup and Risk management. The assessment provided evidence that the very obvious risk at FTC was the lack of visibility into Governance and Capabilities.

Finally, the author addresses the limitation of CaGF and his recommendations for future research.

His findings and conclusion indicate that this research adds knowledge to important management disciplines with profound relevance for organization managers. The cumulative impact of EA in conjunction with CMMI, Risk Management (RM) and Change Management (CM) has yielded a number of observable benefits and implications for the FTC.

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CERTIFICATE OF AUTHORSHIP / ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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1 INTRODUCTION

1.1 Background Context

A number of Defence organizations worldwide are moving towards outsourcing. The United Arab Emirates Air Force and Air Defence (UAE AF&AD) is also transforming some of its activities from military entities into civilian organizations.

This paper describes the risks associated with the transformation of the UAE AF&AD Flight Test and Development Centre (FTC) into a civilian organization.

The UAE AF&AD has in the past outsourced some of its activities and encountered specific risks. This study takes into account the risks experienced and lessons learnt.

The flight test centre (FTC) is operating a state of the art tools and expensive assets in support of the United Arab Emirates Air force and Air Defence (UAEAF&AD). These assets, comprising of flight instrumented aircraft, test range, integration benches, infrastructure, software development facilities, etc., cost hundreds of millions of USD, and an aeronautical project may take between 5 to 10 years (or more) and cost from tens to hundreds of millions USD.

In the last couple of years the FTC was short of activities and their experts were slowly departing or seconded in other military and non-military organizations, undermining its continuity and even its existence.

As a consequent of the above potential threat facing the existence and continuity of the FTC, the author who was the commander of the FTC, considered the necessity of transforming the FTC in to a civilian organization, allowing it to secure activities beyond just the UAE AF&AD and allowing it to be an outsourcing organization.

However, prior to such a decision to outsource, the author asked:

- Does this transformation come without challenges or risk?
- Will the FTC, as civilian organization be capable to sustain its activities and meet customer expectations, in this world of competition?
- What are the risks and what are the pro-active actions or solution does the FTC need to ensure a smooth transition and a sustainable future?
- How does the FTC ensure that risks have been evaluated prior to this transformation?
- What actions the FTC needs to under take to ensure that risks are continuously studied and managed prior to and after the transformation?

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1.2 Present Challenges at FTC

The following are present challenges facing the FTC:

- The FTC operates without a certified or cohesive process,
- The FTC lacked a clear and shared vision
- (The FTC) does not have any risk management function
- Weak governance, and inability to exploit the existing FTC capability.

All the above points undermine the credibility and viability of the FTC to function credibly and professionally in this world of completion. It is obvious in the author's view that if the FTC remains under the present state, it'll continue to function as an Ad Hoc organization, with a higher risk of loosing its reputation, increased cost and delays in delivery.

1.3 Thesis Overview

Survivability, sustainability and management of a flight test centre within a military structure is becoming a real challenge due to a number of factors. To counter such a challenge, the military is now moving towards converting certain military sectors/organizations into private/civilian entities or outsourcing the activities to the civilian sectors. Although this transformation may appear to be an ideal approach, such transformation does present new and complex challenges entailing the need for a number of changes, mainly organizational and governance processes. It is therefore necessary to study and analyze the potential risks which may arise from such changes and transformations.

This thesis proposes an integrated approach to managing the risks associated with both outsourcing and the transformation of the FTC into a civilian entity mainly in terms of change management, organizational and governance process, using Enterprise Architecture (EA) as leverage, supported by other disciplines and methodologies.

The figure below portrays the author's vision of the transformation path from the present military organization "As Is" to the future organization "To Be". There are two (2) paths: the upper path takes to you again towards a military organization, while the lower path takes you to a civil autonomous organization. The figure defines the obstacles preventing the expansion and growth in terms of competencies, activities, skills and means (infra-structure, tools …) while pursuing the military path. However, the civilian path provides challenges such as: ability to confront "resistance to change", competencies build-up and retention, maintaining and expanding the means, effective management structure and risk management culture. In response, the author has described the potential solutions such as: CMMI for process improvement, a dedicated enterprise architecture framework, risk management structure, the development of a business plan and a strategy to attract capital. During the transformation, a continuous risk management process is necessary to continuously analyse, identify and act rapidly.

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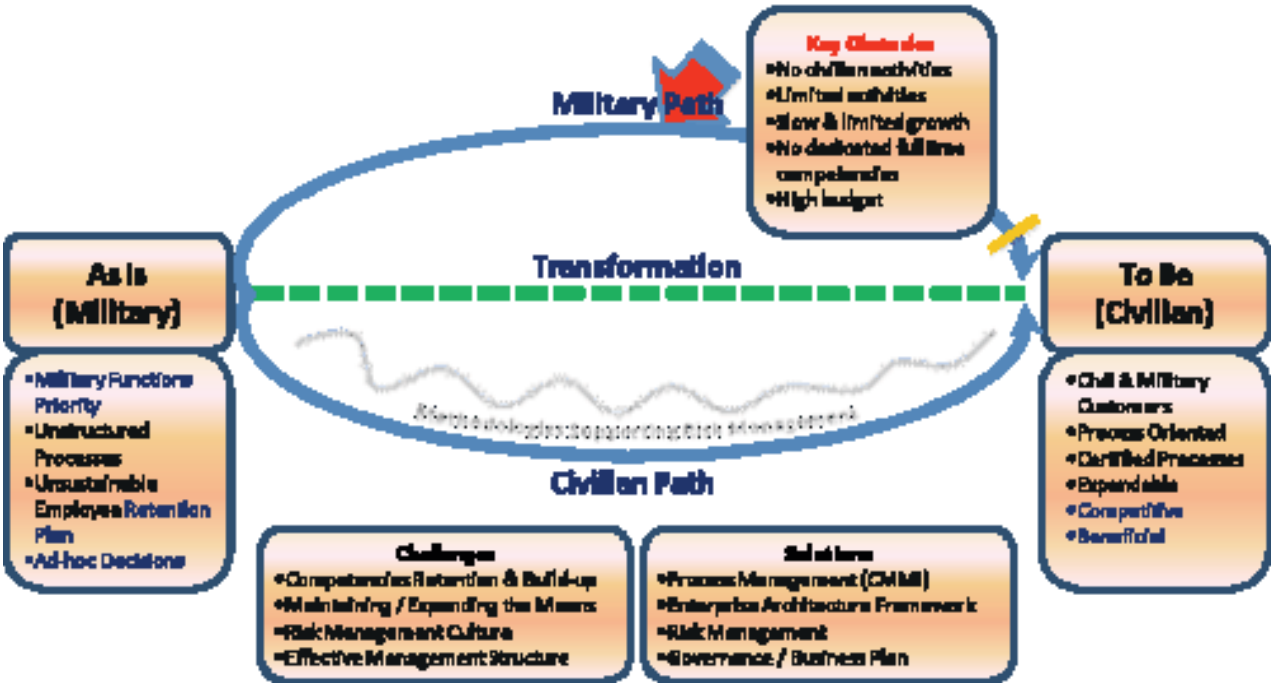

Figure 1: Thesis Overview: Transformation of the Military FTC into a Civilian Entity

The outsourcing of military functions is not a new concept for the military. Indeed the first recorded case of outsourcing of military functions occurred in 2094 BC when King Shulgi of Ur hired mercenaries to augment his army. “Singer, Corporate Warriors (12)”

Outsourcing has steadily expanded away from traditional support duties, for e.g. basic logistic support, to those that more directly affect the success or failure of critical military mission objectives. This expansion has begun to expose the forces to new risks which impact a number of areas including policies, procedures and organizational functions. With many experts predicting that outsourcing and its associated risks will only continue to increase, it is essential that the Air Force develops and integrated risk management approach to ensure that the service’s ability to perform efficiently and effectively is not jeopardized.

A well-developed Enterprise Architecture framework, integrated with a risk management function, and then implementation of such a framework, provides a delivery platform for effectively managing and governing risks within an outsourced business function.

Outsourcing of selected parts of a business process or function within the military organizations has increased significantly over the last decade, often aimed at increasing efficiency while reducing costs and human resources workload, more focused on military core-competencies.

When outsourcing a business or a function, the outsourcing organization also outsources the risks inherent in these activities but is still responsible and accountable for the potential consequences of such risks.

As a case study, we shall study and analyze the risks associated with the outsourcing, or transformation and running, of a military flight test centre in a civilian entity, while providing simultaneously, services to both the military and the civilian sectors (((COSO, 2004), (Parent and Reich, 2009), (Iacovou and Nakatsu, 2008))).

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The outsourcing of a flight test centre deriving from a military organization into a civilian entity combines essentially two complexities/complications in the Risk Management process: the first is linked to intrinsic activities of a flight test centre, and the other to "outsourcing".

This combination is to be placed obviously in a local and regional geopolitical context. It is therefore necessary to establish the initial cartography of risk in a flight test centre within the outsourcing and define the inter-actions; this approach allows to obtain the initial start/launch status of the project, and define and establish the first strategy of risk management ((Noor et al, 2001), (Aron and Singh 2005)).

Later, the author shall focus in the dynamism of the project taking into account the progress and changes pursuant to each specific cartography - the rate of possible exchanges and inter-actions, and the consequential modifications resulting thereof.

Accordingly, it is necessary to create and establish reliable, effective and rapid methods, which will allow acquiring these cartographies and defining the rate of exchanges and inter-actions. The author intends to analyze the possibilities of modelling certain dynamisms in order to pre-define the “Strategies” of management.

1.4 Benefits of Early Risk Mitigation

UK Strategic Defence review white paper 2002 –
“We spend some £9Bn a year on equipment, spares and stores…….. The 1997 National Audit Office report on major programs reported an average delay of 37 months, unchanged from 1996.” “A particular weakness has been a failure to strike the right balance between cost, time, and performance in the very early stages of a project. Insufficient investment in risk reduction at this stage has cost us dear later on”.

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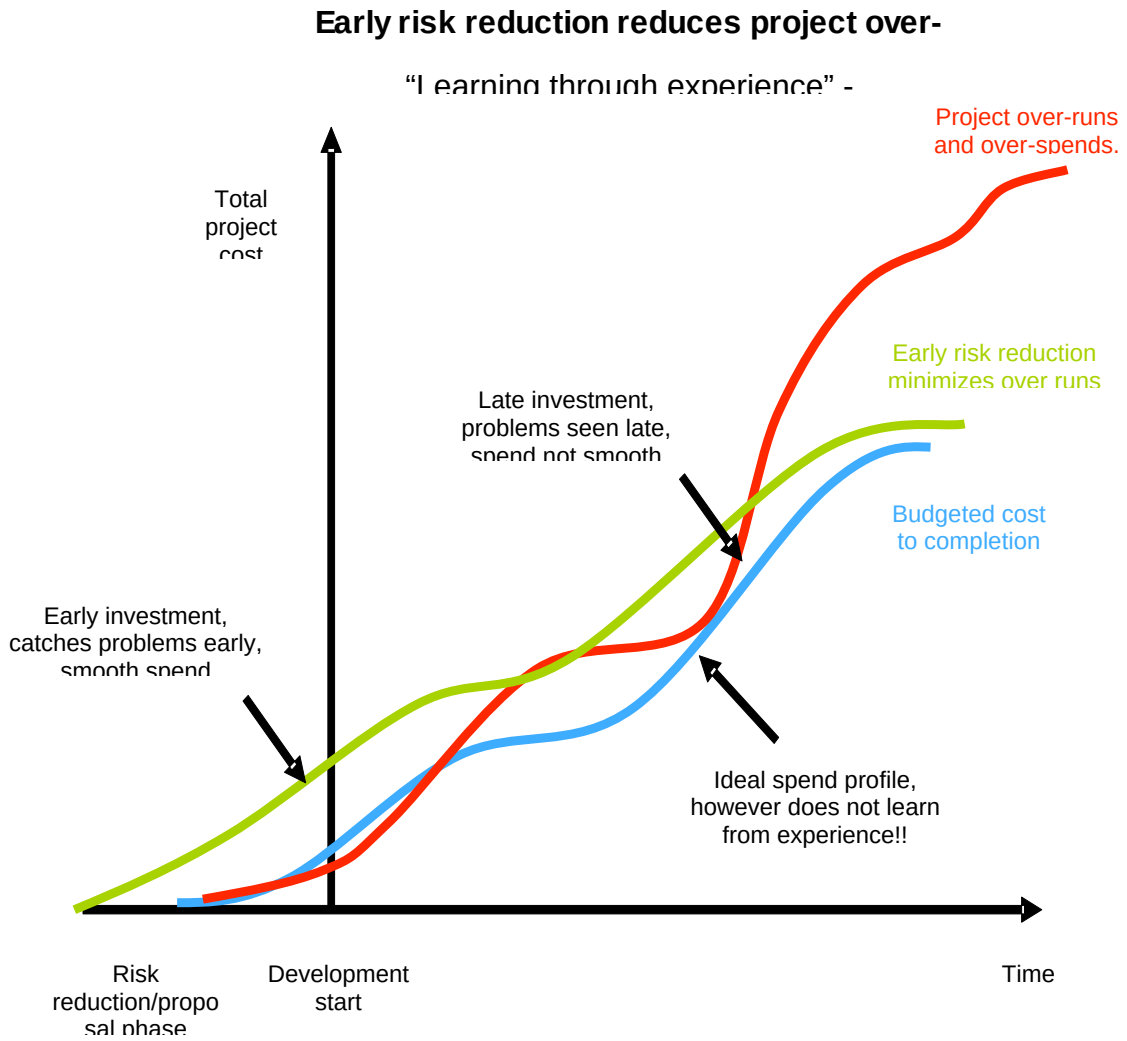

Figure 2: Benefits of risk management integrated with an enterprise architecture framework

1.5 Multi-Dimensional Framework

The diagram below elaborates the author's vision towards a Multi-Dimensional Framework as an approach and a path to an Integrated Risk Management for the "To Be" FTC.

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From the author's perspective, an ideal FTC organization, as an outsourcing entity, must be capable to function with governance, built around policies and certified processes, with shared vision in the FTC at all levels. The author in this research, however, will follow the above figure as a path towards the definition and the development of the FTC governance processes capable to adapt to frequent and complex organizational changes, and provide a holistic in the change management and organizational built-up, as the EA will provide a practical vehicle and a global tool able to raise awareness, early warnings and thus support to managing risks.

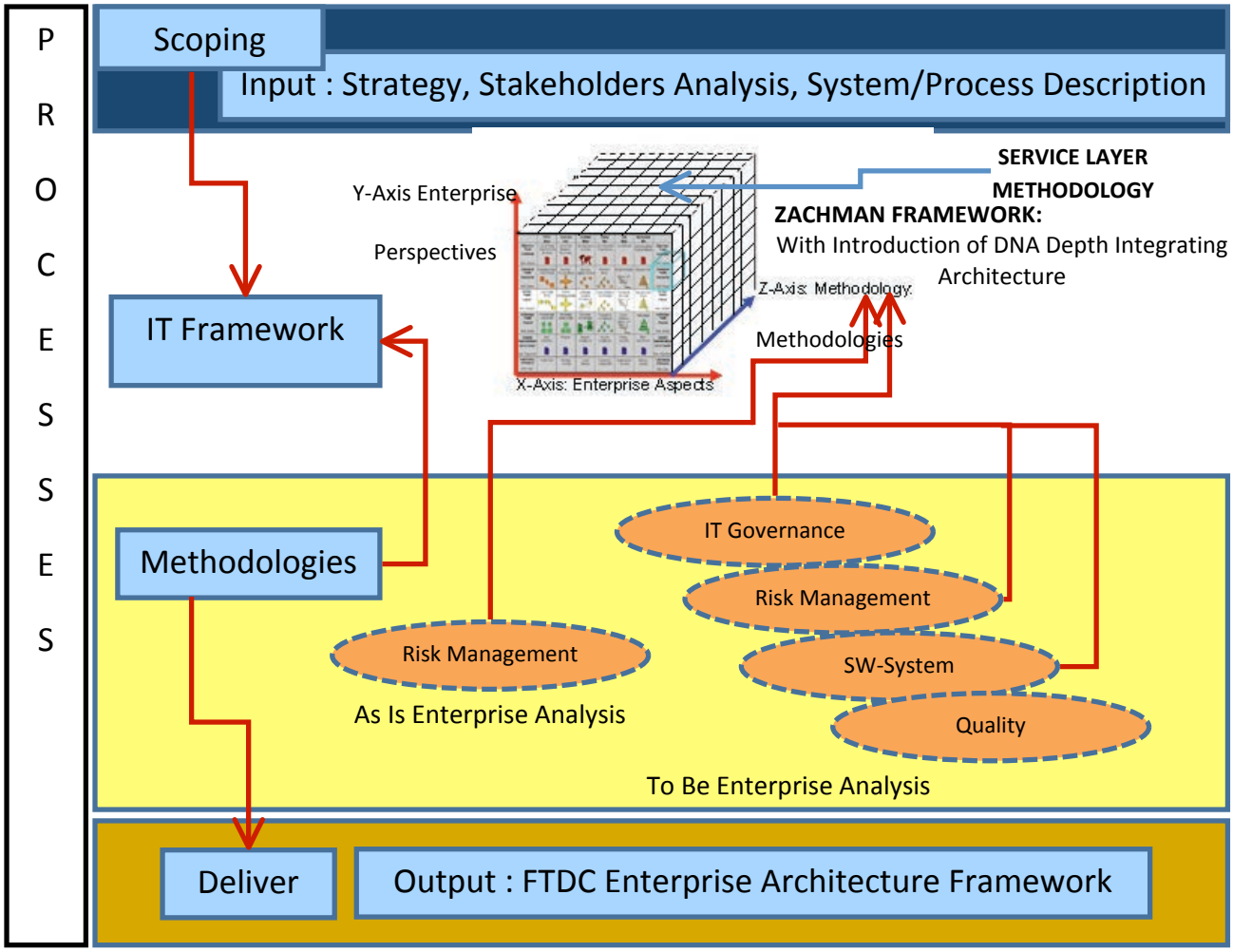

Figure 3: A Structured Approach to Building a Dedicated Enterprise Architecture Framework

The above figure demonstrates four (4) frame layers:

- The first layer defines the Scope which includes the input (stakeholder analysis, strategies etc…)
- The second layer defines the selected Framework: at the early stage, the author selected the John Zackman Enterprise Framework; the framework contains two (2) axis: the "Y" (Perspective) axis and the "Z"(Aspect) axis. The author introduced the "Z" axis as a 3rd new axis. This 3rd axis contains the "RISK" dimension as well as other potential methodologies. Such as CMMi.

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- The third layer defines the various specified methodologies which the author intends to link to the FTC framework
- The fourth layer defines the final intended output of the enterprise architecture framework to be delivered - dedicated and appropriate for FTC specific needs.

The transformation of the military flight test centre will undergo a major change during its transformation, mainly change management in governance processes as well organizational changes. Organizational changes in medium enterprises and higher, are always a very complex matter.

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2 DEFINITIONS / BASIC DESCRIPTIONS

Enterprise Architecture

Enterprise architecture (EA) is a rigorous description of the structure of an enterprise, which comprise enterprise components (business entities), the externally visible properties of those components, and the relationships (e.g. the behavior) between them.

EA describes the terminology, the composition of enterprise components, and their relationships with the external environment, and the guiding principles for the requirement, design, and evolution of an enterprise.

This description is comprehensive, including enterprise goals, business process, roles, organizational structures, organizational behaviors, business information, software applications and computer systems.

EA will be further described later in this paper.

Framework

The Enterprise Architecture Framework is derived from similar or parallel structures that are found in disciplines associated with Architecture/Construction and Engineering/Manufacturing that classifies and organizes the design relics, established over the process of designing and producing complex physical products (Sandhu et al, 1996). The Enterprise Architecture Framework as it applies to Industries is simply a logical structure, which assists in classifying and organizing the descriptive representations of Industries that are significant to their management as well as to the development of their systems ((Togaf, 2009), (Assimakopoulos and Riggas, 2006)).

Frameworks will be further described later in this paper.

Governance

The word "governance" describes a concept - that people in any position of power or authority should apply that authority to control events wisely, and for the benefit of others. Governance in its widest sense refers to how any organization, including enterprises or industries are run. Governance describes the overall management approach through which senior executives direct and control the entire organization, using a combination of management information and hierarchical management control structures. Governance activities ensure that critical management information reaching the executive team is sufficiently complete, accurate and timely to enable appropriate management decision making, and provide the control mechanisms to ensure that strategies, directions and instructions from management are carried out systematically and effectively in order to achieve corporate goals.

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Governance, Risk and Compliance (GRC)

Governance, Risk and Compliance or "GRC" is an increasingly recognized term that reflects a new way in which organizations are adopting an integrated approach to these aspects of their business. "GRC is an integrated, holistic approach to organization-wide governance, risk and compliance ensuring that an organization acts ethically correct and in accordance with its risk appetite, internal policies and external regulations through the alignment of strategy, processes, technology and people, thereby improving efficiency and effectiveness."

Capability Maturity model integration (CMMI)

Capability Maturity Model Integration (CMMI) is a process improvement approach that helps organizations improves their performance. CMMI can be used to guide process improvement across a project, a division, or an entire organization.

CMMI will be further described later in this paper.

Risk

There are many different definitions of ‘Risk’.

- In a business context, Risk is defined as an event that affects a company's or organization’s ability to reach its objectives.
- Risks occur and are managed in different contexts (personal/individual, business, project/venture, nation etc.)

Enterprise Risk Management

Enterprise Risk Management is a process performed by the board of directors, executive management team and other personnel, in a strategic and organizational-wide context, designed to identify potential events which can affect the organization and manage these risks in accordance to predefined risk apatite and provide adequate assurance that the organization’s objectives will be achieved.

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COSO Enterprise Risk Management Framework

COSO is a widely used enterprise risk management framework.

The COSO framework emphasizes the need and importance of having a sound and functioning internal environment in an organization.

When defining and concretizing an organization's internal environment one should start with defining its overall risk philosophy. The COSO definition of risk philosophy is:

"An entity's risk management philosophy is the set of shared beliefs and attitudes characterizing how the entity considers risk in everything it does, from strategy development and implementation to its day-to-day activities."



Figure 4: COSO ENTERPRISE RISK MANAGEMENT FRAMEWORK

From the definitions given above and the discussion in the preceding paragraph of the COSO ERM framework it is natural to argue that an Enterprise Architecture shall include an implemented ERM.

The definition of EA states "This description is comprehensive, including enterprise goals, business process, roles, organizational structures, organizational behaviors, business information". These are evidently areas of importance in an ERM. Of course it might be argued that these areas can be addressed by other means but as will be elaborated in later sections, the ERM is an efficient part of the governance system of an organization and the way to realize a number of components in the enterprise architecture.

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3 QUESTIONS FOR THE THESIS

Organization of the Research Study

Rationale, significance and expected contributions of the study

For the purpose of the research, the author has identified key questions on which this paper shall study. These questions are addressed below.

Research Questions

The primary question for this research is:

Q1: Does Risk Management facilitate Change Management?
Organizations operating in developed and developing economies are subject to change, from both external forces and internal factors, that can be attributed to drivers from economic, political, market-driven, business contexts and environmental factors, to name a few. Change therefore, is inevitable.
One of the questions that we would like to explore is if by effectively managing the risks associated with a change, we are able to provide any benefits and value to the change management effort, and how would we manage the risks associated with change from an organizational perspective.

Q2: Does Enterprise Architecture modelling improve Risk Management?
Enterprise Architecture modelling allows one to map the living genome of an organization, as well as track and manage its evolution with time in response to external and internal change.
One of the fundamental questions that we would like to explore is if by using Enterprise Architecture modelling and integrating risk management into an Enterprise Architecture Framework, we are able to achieve an improvement for the overall risk management effort.

Q3: Can Enterprise Architecture modelling allow one to effectively manage the initial and dynamic risks associated with organizational change?
Each potential change in an organization carries with it, a set of initial risks. These risks would need to be assessed and weighed, to determine if the organization goes forward with implementing the change, or adapting the extent of the change to minimize risk exposure to the organization, while implementing the change.
Dynamic risks, on the other hand, result from external and internal forces acting on the organization that manifest or raise a new set of risks that need to be continually managed, while implementing changes in the organization.
Does Enterprise Architecture integrated with risk management allow one to effectively manage the initial and dynamic risks associated with organizational change?

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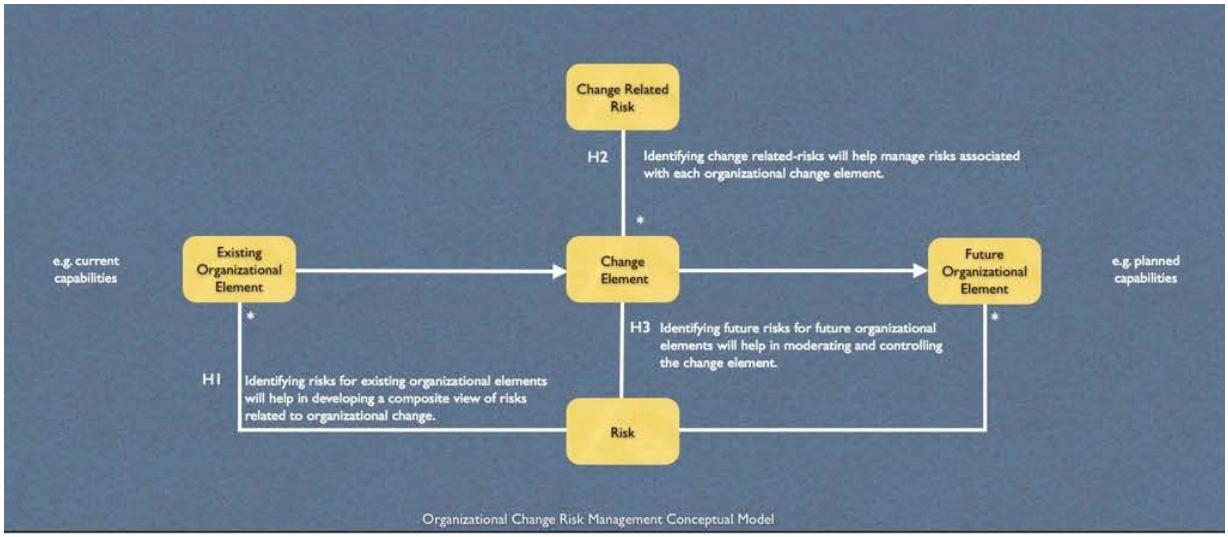
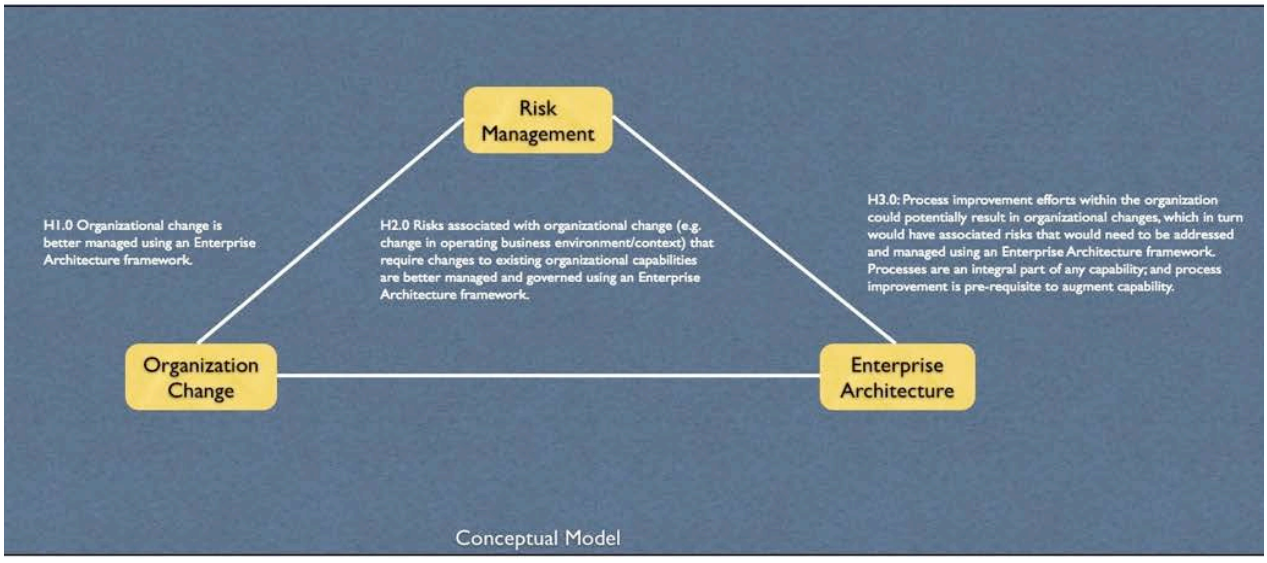


Q4: Can Enterprise Architecture modelling allow an organization to better manage and govern its capabilities?

Every organization has unique needs and goals that influence its approach to governance. For example, a larger organization will probably require more detailed governance than a smaller organization [5].



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4 OUTSOURCING OF MILITARY ACTIVITIES

In support of what the author has indicated earlier, he studied and analyzed the motivation, advantages, disadvantages and risks of outsourcing military activities and functions, having in mind the FTC case. Additionally, he has taken in to consideration the lessons learnt and the experience he acquired during his involvement in two major UAEAF&AD projects in the past.

4.1 Motivation for Outsourcing

To perform the setting-up of a flight test centre in a military structure request, in first, to solve some issues:

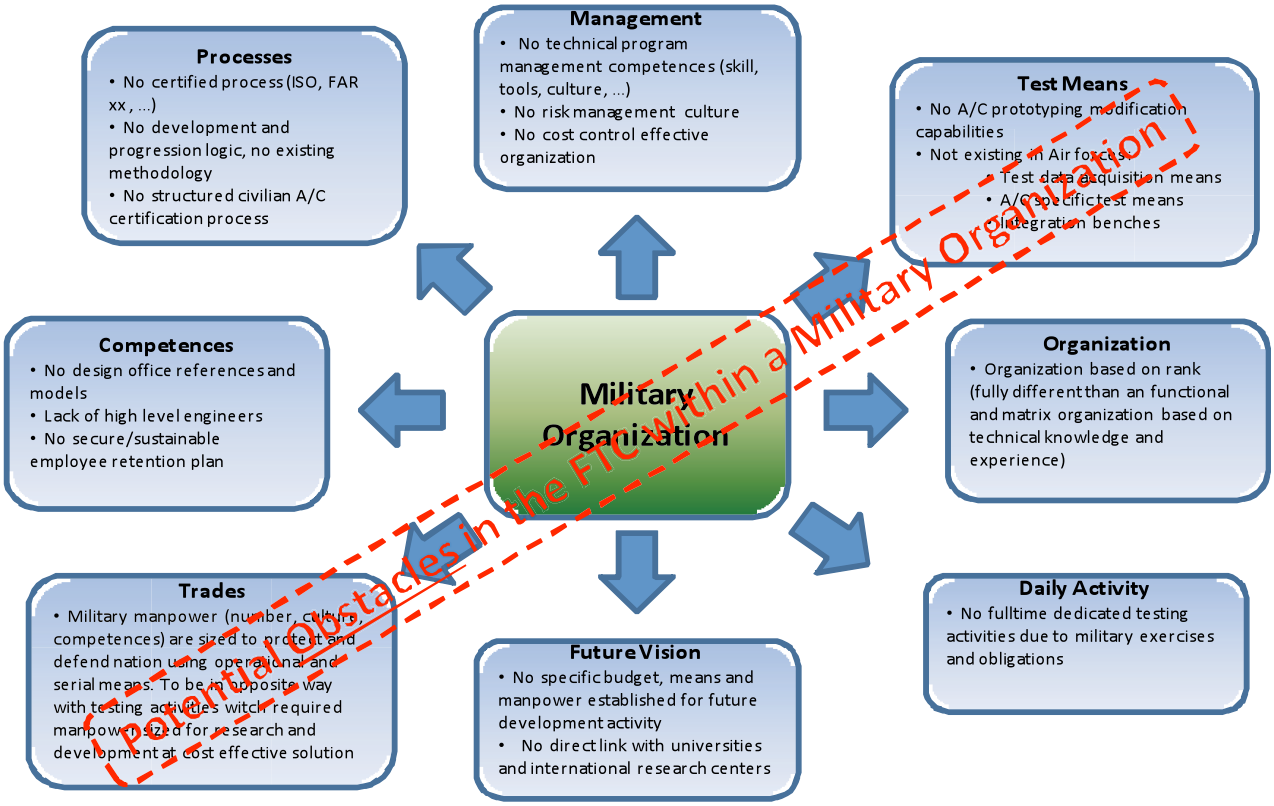

Figure 5: Perceived Obstacles to Efficiency in a Military Organization

- **Management / Organization:** More focused on operational and immediate issues, there is no in a military organization a real technical spirit in industrial matters. Generally speaking, the military management based on clear orders supported by ranks seniority doesn't match with the Return of Investment (ROI) spirit, the innovation culture and the cost effective organization. The risk management based on a predictive situation study, thoroughly analyzed, and permanently updated is a long way task with is not in accordance with military decisions more oriented in immediate or short term actions.

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- **Processes:** Mandatory for customer's recognition, the management process allows establishing a clear methodology, fully documented in the main working sectors. Certified processes (ISOXX, FARXX, PARTXX) are mainly based on international criteria, followed by permanent audits witch penetrate deeply in the industrial structure. Military organization is not appropriate to be audited by external entities.
- **Competencies / Trades:** Military organization is basically a "means user" of proved serial materials. All the military structures and associated trades are adapted to this process (tasks are repetitive, if possible plug and play oriented and fully documented). In opposite way, based on appropriate methodology and safety, flight test tasks have for goals to open new domain and to explore new fields. Consequently, trades, skills, competencies and also work spirit are fully different in the two structures. To establish in a military organization the culture and trades needed for a flight test centre will be very long and costly.
- **Test means:** The flight test centre efficiency is directly linked to its ability to record, analyze and dispatch test data. This issue is probably one of the most important one. Regarding the data reduction, i.e., the transformation from a recorded field of byte to a number having a physical sense (what it is the probably the most difficult task) require experienced manpower non available in a military organization. Among the main test means there are: integration benches, laboratories, stress rigs, telemetry antennae, acquisition and analysis software packages, instrumented development aircraft. These means (design, use, maintenance…) required specifics trades and consequently trained manpower that is not basically available in Air Forces.
- **Future vision:** to prepare the future request appropriate budget and means. To believe that future vision is limited to ideas is not enough. To prospect new domain requests specific laboratories, models and theoretical studies. This is not the first task of a military organization to maintain a costly department without direct operational link on the side of its main activity. The infrastructure of the Air Force including weapon systems, communications, information networks, flight test facilities etc. continues to evolve in order for the Air Force to maintain a capability that is technologically advanced and aligned to cope with the continuous geo-political evolutions in the region.

In addition to the above obstacles or huge challenges, there are consequently numerous other factors that motivate the Air Force to consider outsourcing many of its highly technical and operational tasks. In alignment with its strategy to remain at the edge of technology comes the requirement to possess core personnel, competent and experienced with the advanced and often unique technological skills necessary to maintain and operate these systems.

As mentioned previously many forces around the world are increasingly outsourcing advanced system maintenance, development and operational activities in addition to menial tasks. For example:

- *The United States Air Force's Predator and Global Hawk unmanned aerial vehicles (UAV) depend on contractor support for maintenance and limited predator flight operations during deployment.*
- *The United States Air Force temporarily relies on contractor support until it can train an initial cadre of its personnel to conduct new missions. For example, the presence of contractor personnel aboard operational flights of Joint Surveillance Target Attack Radar System aircraft. (Reference)*
- *The UAEAF&AD had outsourced its depot level capability to Gamco for the 4th Line repair and overhaul of Mirage 2000 equipment*

In line with its motivation to outsource, the USAF has defined and established guidelines for reasons of law, command and control of crisis situations, combat readiness, etc. when unusual working conditions are not suitable to civilian employment; or when military unique knowledge and skills are required for the successful performance of the duties.

"*Manpower shall be designated as civilian except when military incumbency is required for reasons of law, command and control of crisis situations, combat readiness, or esprit* de corps; when unusual working conditions are not con*ducive to civilian employment; or when military unique knowledge and skills are required for the successful performance of the duties.*"

—DODD 1100.4, *Guidance for Manpower Management*, 12 February 2005

The perceived advantages and disadvantages of outsourcing by forces around the world are remarkably similar. An interesting publication by Colonel USAF William G. PALMBY outlines these. These have been adopted and tailored by this author in the context of the FTC.

Although the following list is far from complete, it should provide the reader with a better understanding of the most common advantages and disadvantages that outsourcing has to offer.

4.2 Advantages of Outsourcing

a. Improved Continuity

It is a given that military personnel move constantly. Along with movement comes turbulence in the position recently vacated. Although outsourcing itself does not guarantee continuity in a particular role, experience demonstrates that both contract and civil service employees tend to remain in one position much longer than do their military counterparts. Although one commonly finds civil service or contractor personnel with 15 to 20 years in a particular position, the same situation with enlisted personnel is known as 'home-steading' and can have negative career implications. Stability has a twofold advantage: (1) retention of valuable experience gained over a longer period of time and (2) more employee productivity because of less time spent on training or duties related to making a permanent change of station. Even if some of these employees move to a different position, it is often to another within the same unit, so one still has access to their expertise.

b. Cost Savings

The two most recognized sources of savings include manpower reductions and lower labor costs.

Regarding the former, a GAO study of 1995 observed that only 800 civilians replaced approximately 2,000 military personnel. Additionally, the US Air Force estimates that the averaged manpower savings obtained in outsourcing conversions during the past decade equates to 38 percent of the original workforce. As for lower labor costs, the study offered an example of the military's saving $46,000 per year when it replaced two captains with two civil service GS-9 personnel, adding that "DoD officials said civilian employees can be paid at grades lower than their military counterparts because civilians either enter government service with specific expertise or they develop more expertise at an earlier stage in their careers since they do not rotate as frequently ".

One should note however that not all conversions will result in cost savings.

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c. Greater Flexibility

Outsourcing provides an Air Force with the flexibility it needs to resource changing and/or short term mission requirements. When a new short term or indefinite service requirements arises, outsourcing to a private industry contractor provides a significant advantage. The service can quickly address the new requirement without training military members in a new skill or, even more difficult, creating a new career field. Furthermore, an Air Force gains additional flexibility when one considers that it may not maintain the required expertise within it ranks

This problem is becoming more prevalent as the size of an Air Force decreases and as advances in technology require greater specialization within the military workforce. Since the commercial market boasts a much wider spectrum of capabilities than does an Air Force, it is often much easier to accommodate changes to missions with a simple contract modification, Contractors may be having more than one client, thus providing time sharing or maximum human resources utilization.

d. Focus on Core Functions.

When an Air Force's end strength is capped or reduced, outsourcing provides an excellent opportunity either to do more with the same number of military personnel or to maintain the current admission load.(1)

e. Fresh Perspective

New personnel coming to an old job often bring with them a fresh perspective (2) No thawing gone through traditional blue suit training programs and coming from a culture that differs from the military's could allow contract personnel to make improvements to existing processes that the previous military workforce would not have recognized. This effect stands to become more pronounced in performance based contracts – those in which the contractor examines new possibilities for mission execution and tailors an innovative process.

4.3 Disadvantages of Outsourcing

a. Military versus Non-Military

The distinction between military versus non-military will become more blurred as the number of contractors' increases and as the scope of their duties infringes further into the traditional roles and duties of military personnel. Numerous issues arise as contractors cross into the military arena to influence procurement decisions for their commercial interest.

b. Security of Contractors

When a significant number of nonmilitary personnel are located in a military zone it exposes them to adverse action in the case of an attack to the base. This is indeed the case at the FTC today. Civilians at FTC do not possess the weapons and knowledge. Moreover the civilians are not

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authorized to carry weapons even for self-Defence. The UAE AF&AD must now reallocate a greater portion of its combatant resources to attend to their security.

Althoughtheservicewouldhaveusedsomeresourcesevenifmilitarypersonneloccupiedthesepositions,th e allocation would not have been as extensive because the military personnel are authorized to carry weapons and have all received a basic level of combat arms training and could contribute to the defence of the facility.

c. Control over Military Forces

According to a GAO study, military leaders prefer to use military personnel instead of contract personnel because "they believe they can exercise greater control over such personnel."(2) Steeped in the traditions of discipline and order, military organizations benefit from embedded chains of command that ensure the swift execution of orders. One cannot say the same of contractor personnel, who are bound not by an oath of office or the Code of Military Justice but by the terms of their contract.

This fact has produced and probably will continue to produce less than optimum operational results. For example, during contingency operations in the Gulf War, the UAE AF&AD encountered a problem with contractors assigned to maintain its systems. Another control relatedconcerninvolvesthefactthatciviliancontractorpersonnelcanquit, strike, refuse to deploy for family reasons, or perform other actions that capability. Certainly, contractors' employees can also quit their jobs.

d. Budget Issues

It is often perceived that outsourcing has the potential to provide cost savings for the UAE AF&AD; however in this authors experience while this is generally true for short term contracts, or in an unplanned event requiring certain expertise on emergency bases, for a long term contract, it tends to be more costly and more dependent on the mercy of the contractors. Secondly, the process of obtaining budget approval is quite long's a result contractors are withdrawn by their employees if their contract is not signed in a timely fashion. This jeopardizes the program by exposing it to additional risks, and in addition may negate previous program investment by the Air Force.

e. Reduced Flexibility

Although outsourcing can enhance flexibility, as mentioned above, it can also degrade it under certain conditions. Specifically, the same strong efforts the Air Force makes to precisely define the scope of contractor responsibilities and expectations can actually result in reductions to flexibility when changes to mission requirements occur. For example, under normal UAE AF&AD rules, civilians are not authorized to enter the base during the weekends. Furthermore they are not allowed to take work outside the base. Special authorizations required to overcome these restrictions require long approval processes. Civilians need to go through stringent security clearances processes. In some cases clearance is not granted. These factors contribute to reducing the flexibility when using these resources to achieve mission objectives.

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f. Reduced Innovation

Outsourcing can limit military innovation and knowledge if it removes military personnel active engagement from programs. In my experience, it is extremely important to maintain and develop technical expertise in order to have the in-house capability to develop innovative solutions to meet mission objectives. Such military personnel shall have the ability to effectively guide sub-contractors or suppliers in ensuring that the procured systems meet the needs of the Air Force. The major concern here involves avoiding development of an Air Force culture that hinders the development of military personnel expertise and innovation and minimizes their involvement in problem resolution.

g. Reduced Productivity

Military personnel are underpaid in comparison to their counterparts in the civil sector. Therefore, in my experience there is an impact on their productivity as they may lack a strong initiative due to insufficient financial motivation. This in general tends to perform with a high productivity rate.

In order for the UAE AF&AD to realize the advantages listed above and overcome the challenges presented by the disadvantages, it will also have to consider new pros and cons when deciding whether or not to outsource. An effective risk management scheme/strategy would need to be devised as the UAE AF&ADcontinuestoincrease the number and scope of outsourced functions.

The next sections describe the importance of risk management in the context of outsourcing.

4.4 General Risks in the Context of Outsourcing

Understanding and managing outsourcing risk is an essential requirement for achieving outsourcing readiness. Unfortunately, poor risk management is often more common than good risk management in this context. Far too many organizations begin outsourcing without a comprehensive assessment and understanding of total risk, even fewer have an efficient plan to manage it.

The following section defines risk definition and describes the most commonly identified risks in the context of outsourcing.

4.4.1 Risk Definition

Risk is defined as a possible event or circumstance that can have negative influences on the Enterprise in question. Its impact can be on the very existence, the resources (human and capital), the products and services, or the customers of the enterprise, as well as external impacts on society, markets, or the environment. In a financial institution, enterprise risk management is normally thought of as the combination of credit risk, interest rate risk or asset liability management, market risk, and operational risk. In the more general case, every probable risk can have a pre-formulated plan to deal with its possible consequences (to ensure contingency if the risk becomes a liability). (Ref: Wikipedia).

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4.4.2 Common Risks

Many studies have been conducted by various organizations to attempt to identify and understand the risks involved in IT outsourcing. The section below is taken from a study by META group (36), (37) on the most commonly known risks to outsourcing. The next section describes particular risks associated with outsourcing of the UAE AF&AD entity.

a. Cost-Reduction Expectations

The biggest risk to outsourcing involves the expectations the internal organization has regarding the level of savings which can be gained. Unfortunately, many executives assume that labor arbitrage will yield savings comparable to person-to-person comparison (e.g., a full-time equivalent in India will cost 40% less) without regard for the hidden costs and differences in operating models. In reality, most IT organizations save less than expected value.

b. Data Security/Protection

IT organizations evaluating any kind of outsourcing question whether vendors have sufficiently robust security practices and if vendors can meet the security requirements they have internally. While most IT organizations find outsourcing vendor security practices impressive (often exceeding internal practices), the risk of security breaks or intellectual property protection is inherently raised when working in international business.

c. Process Discipline (CMM)

The Capability Maturity Model (CMM) becomes an important measure of a company's readiness to adopt an outsourcing model. Outsourcing vendors require a standardized and repeatable model, which is why CMM Level 5 is a common characteristic. META Group observes that approximately

70% of IT outsourcing organizations are at CMM Level 1 - creating a gap that is compensated for by additional vendor resources on-site and hence additional cost that are passed on to the entity outsourcing the job (36),(37).

d. Loss of Business Knowledge

Most IT organizations have business knowledge that resides with the developers of its applications. In some cases, this expertise may be a proprietary or competitive advantage. Companies must carefully assess business knowledge and determine if moving it either outside the company or to an offshore location will compromise company practices.

e. Vendor Failure to Deliver

A common oversight for IT organizations is a contingency plan - what happens if the vendor, all best intentions and contracts aside, simply fails to deliver. Although such failures are exceptions, they do occur, even with the superb quality methodologies of vendors.

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f. Scope Creep

There is no such thing as a fixed-price contract. All outsourcing contracts contain baselines and assumptions. If the actual work varies from estimates, the client will pay the difference. This simple fact has become a major obstacle for IT organizations that are surprised that the price was not "fixed" or that the vendor expects to be paid for incremental scope changes. Most projects change by 10%-15% during the development cycle.

g. Government oversight/regulation

Utilities, financial services institutions, and healthcare organizations, among others, face various degrees of government oversight. These IT organizations must ensure that the vendor is sensitive to industry-specific requirements and the vendor's ability to: 1) comply with government regulations; and 2) provide sufficient "transparency" showing that it does comply and is thus accountable during audits. The issue of transparency is becoming more significant as requirements such as the Sarbanes-Oxley Act place greater burdens of accountability on corporations.

h. Culture

Executives often assume that cultural alignment will be insignificant or trivial. Cultural differences include religions, modes of dress, social activities, and work ethics.

i. Turnover of key personnel

Rapid growth among outsourcing vendors has created a dynamic labour market. Key personnel are usually in demand for new, high-profile projects, or even at risk of being recruited by other vendors. While vendors will often quote overall turnover statistics that appear relatively low, the more important statistic to manage is the turnover of key personnel on an account.

j. Knowledge transfer

The time and effort to transfer knowledge to the vendor is a cost rarely accounted for by organizations. Indeed, META observe that most IT organizations experience a 20% decline in productivity during the first year of an agreement, largely due to time spent transferring both technical and business knowledge to the vendor (7). In addition, employee turnover often places a burden on the organization to provide additional information for new team members.

In this author’s experience these common outsourcing risks described above are also applicable in varying degrees to the outsourcing of a defence entity. However, there are particular risks that are associated with defence industry that are not widely understood.

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4.5 Conclusion

According to the author, outsourcing or otherwise, both have their pros and cons. The most ideal situation for the FTC is to understand earlier on the possible causes and consequences of your decision and path towards outsourcing. The UAEAF needs to address the risks associated with their decision to outsource the FTC activities. With risk management a continuous effort in any organization, the creation and implementation of a risk management function within the FTC, once the FTC is established, is essential to assess and evaluate the decisions and minimize surprises and their consequent risks on a continuous basis.

Below, the author describes his experience in 2 case studies of military programs where risks were encountered: both the causes and consequences are elaborated.

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5 OUTSOURCING OF TWO MILITARY PROGRAMS AND RISKS ENCOUNTERED – AUTHOR'S EXPERIENCE

The author shall describe here the findings of two real cases (projects) for which there was no risk management strategy. The lack of a risk management strategy resulted in missing schedules, degraded operational performance, and financial impacts amongst others as described below.

It is important to analyze in detail risks encountered in these projects since one of the objectives of this research is to develop a risk management strategy that will help mitigate these risks and others when transforming and running the FTC as a civilian entity.

5.1 Outsourcing a Depot Level Repair Service for Aircraft Components

5.1.1 Objectives

The AF has defined a strategy to support the expansion of local industries. As part of this strategy the AF decided to support the set-up of a depot level capability. The objective of this capability was to later enable the outsourcing of overhaul and repair of aircraft components for military aircraft. The main objectives for the outsourcing by the AF were:

- Initiate and encourage the creation and expansion of small industries by establishing a capability in a civilian organization already in existence in UAE
- Avoid the military complex bureaucracy with the aim of reducing decision making process
- Exploit the maximum potential of this capability by offering and commercializing it's services to the growing civilian airliner the both the UAE and wider Gulf region
- Expand core capability to provide additional expertise both for civilian and military platforms
- Reduce operational cost
- Increase return in investment

To achieve the above objectives, the following action was undertaken.

5.1.2 Commercial Agreement

The AF funded the setup of the facility. It was agreed with the civil entity that all of the artifacts including documents and tools will be the property of the AF. A MOU was signed between the AF

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and the Civil Entity. A date for the launch of the first item to be overhauled was identified to be 15 months from the date the MOU was signed by both parties. This was due to the lead time required by the original equipment manufacturers (OEM) to deliver the tools and documentation, the preparations for training of personnel and the set-up of the workshops.

The responsibility of the civilian entity was to:

- Run and maintain the facility
- Commercialize the activities
- Pay royalties to the AF for any business generated by the facility
- Provide priority to the works of the AF
- Provide the AF with preferential rates for the service provided compare to civilian customers.

5.1.3 Civilian Entity

The real name of the civilian entity chosen is not mentioned in these studies due to customer confidentiality. For the purpose of this study, the name given to this civil entity is GCO. GCO was selected for the reasons listed below:

It was a functional organization with profit and loss centre

Had an established infra-structure and was already engaged with military and civil organizations

GCO was certified by the ICAO, Bureau VERITAS and FAA among others

Had a human resources pool of required trades

Had good potential to grow and benefit the AF

5.1.4 GCO

GCO organization structure and functions are described briefly hereunder:

Manpower: 1400 personnel

Areas of specialization &capabilities: Large airframe and engines, components, logistic support, administration, human resources, contract/finance/marketing and legal

Location: Abu Dhabi, UAE.

Potential Business: Workshop available for maintenance of wide body civil aircraft, medium body military cargo/passenger aircraft, civil and military aircraft engines, component repair and overhaul.

In the eyes of the AF, this was only the beginning of a huge expansion to come. The potential business, within the frame of the program, was secured to cover maintenance and overhaul of components over 7 years. A positive outcome was anticipated, as the AF appeared confident. Although only basic studies were performed, the sentiments were such that the positives greatly outweighed the negatives.

5.1.5 Problems Encountered

From the early stages the program faced a number of problems which originated in the Civilian Entity. These were due to the absence of a risk management strategy and function:

a. Lack of sufficient work

As the facility was activated and jobs started to come into the workshops, the company started to realize that the activities coming in were not generating sufficient income to self-sustain the workshop financially. Being a profitable organization, such a situation would result in an over expenditure and consequently lead to a negative balance sheet. For the AF, this meant that the AF entered into a risk of compensating the loss. The AF had the option of paying higher prices or risk closure of the workshop. As this risk was not anticipated before, and therefore no risk management was considered, the AF found them in a situation where the only solution available was paying higher costs to support the workshop. Otherwise they would have lost their investment and hindered the delivery of repaired equipment.

b. Weak Company Asset

The Company had no financial strength or capital. They failed to establish the necessary contacts with financial institutions to obtain loans or financial support. Their lack of a reasonable capital rendered them weak in negotiations with equipment manufacturers. For the AF, this meant that the terms negotiated were weak, the prices high and the risk of non-timely delivery was extremely high. These factors hindered or interrupted aircraft maintenance programs affecting the training programs of the AF, as spares were not delivered concurrently with the AF programs. Reduced training affected the AF operational activities. In order to reduce these impacts the AF was obliged to engage into negotiations with the manufacturers jointly with the Company. This again involved a lot of effort by the AF personnel affecting their focus on their other military functions, and reduces the AF performance in certain organizations. The expected benefits of outsourcing turned to the contrary as the AF got involved continuously.

c. GCO Management Changes impacting Marketing/Business Priorities

The depot project was negotiated and agreed with the Company. But at the early stage of the program, there was a change of management. It soon appeared that the new management had higher priorities than the depot program. This was confirmed by their lack of total commitment for a better performance. They were no quick solutions to the problems. This resulted in delays to equipment delivery, affecting the AF training, maintenance activities and performance.

d. Lack of, or poor Business Development, Marketing Strategy and Policy

As the AF supported the establishment of the depot, it was clear from the outset that for the AF that this was only the beginning. Marketing and business development strategies needed to be developed to expand and sustain the facility. However, it was later evident that this was not the case for the civilian entity. Poor business development and lack of strategy had a direct impact on the AF. The AF had to shoulder the cost burden for lack of business from other customers to ensure the facility was sustained. This increased Air Force costs by thirty to fifty percent.

e. Lack of Policy and Strategy in Logistic Support/Procurement

During the program execution, equipment was regularly delayed at the company because GCO lacked the spares required. GCO did not have any stock. Ordering time varied between six months and eighteen months. The lack of policy and strategy to maintain reasonable stock affected the repair cycle and hindered AF training and operational readiness.

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f. Lack of a long term strategic alliances with OEMs

GCO did not establish a long term alliance and relation with the manufacturers. These manufacturers who supply the small components for the repair of equipment play an integral role in ensuring repairs are performed and completed The lack of a good strategic alliance between GCO and these manufactures affected the AF on many occasions. The manufacturers never considered GCO among their alliances, resulting in low priority being assigned to orders from GCO..This resulted in high or fluctuating costs and delays.

g. Departing of Trained/Specialized Personnel & Weak GCO Policy for Quick Replacement

As part of its early support to GCO, the AF paid for the training of the company's personnel. However, during the execution of the program, some of the trained personnel left the company, leaving a gap (of a trained expert). The concerned workshop was affected by GCO's lack of a quick and effective policy to replace the expert. This affected the output and delivery of the AF equipment. At one time, this departure of trained personnel led to the grounding of five aircraft; a high risk and disaster in times of crises.

h. Lack of GCO Initiative to Capture Investments for Growth and Expansion

The depot facility set-up by the AF provided the complete repairs for the mirage2000 aircraft and had the potential to growth to provide equipment for repairs to other types of aircraft. This growth potential required a minimum investment but would allow the company to expand business opportunity and therefore increase the workload in the workshops. However, GCO did not exploit this potential and had no strategy for expansion. The lack of such policy meant that the workshops were not utilized at their maximum capacity under used, resulting in a higher running cost to be borne by the AF.

i. Increased AF work load in support of GCO

All the above problems resulted in:

- A higher expenditures and a cost burden (to the AF) to sustain the capability.
- A delay to deliver in a timely manner to the AF, affecting both training and operational needs
- Increased AF work load in support of the Company
- Discourage the AF to outsource

j. Delays in Delivery of Contracted Services

All of the above problems contributed to numerous delays in the delivery of contracted services to the Air Force

As described above, multiple and almost simultaneous/parallel cases emerged, where risks were multiplying and a combination of multiple risks were soon to be real problems, which resulted in delays, reduced performance, loss of credibility, and higher expenditures.to the AF. The risk of continuing to pay high cost was imminent to sustain the facility.

The following table demonstrates the load factor on the various GCO workshops. It clearly demonstrates how the workshops were underworked and under-utilized and only serves to highlight the risks described above.

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	No of Units/Year	Average Repair Time (days)/Unit (Man hours)	PRODUCTIVITY/Year	REMARKS
Workshop 1	20	90 man hours	60%	Reasonably used
Workshop 2	10	50 man hours	30%	Under used
Workshop 3	15	45 man hours	25%	Under used
Workshop 4	45	65 man hours	35%	Under used
Workshop 5	65	60 man hours	65%	Reasonably used

Table 1: Workshops

5.1.6 Conclusion

The causes and consequences of the problems encountered were typical examples when an organization acts on an "adhoc" practices with a lack of risk management policies. The author shall explore the lessons learnt in these projects, by introducing structured governance in FTC "To Be", supporting a risk management function to manage risks in FTC, in a professional manner and minimize risks.

5.2 Upgrade and Major Overhaul of the UAE AF&AD M2000 Aircraft

The AF had decided to upgrade and overhaul its fleet of M2000 aircraft. The upgrade requirements were identified. The AF had studied a number of alternatives to perform the upgrade and overhaul. This included either undertaking this activity in-house or outsourcing the work

A. Perform upgrade within the Air Force

There were a number of compelling reasons to establish this facility in-house. These included the ability:

- To control the program in-house
- To acquire technology know-how
- To ensure the confidentiality

However, to establish this activity in-house, the AF would have required large financial resources and technical expertise. Furthermore the time required to establish such a facility was considered to be prohibitively very long. The additional constraints that influenced the decisions to outsource this activity included the following:

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- Time required to secure the budget
- Time required to develop and commission the facility
- Time required to acquire and sustain the competencies

B. Outsourcing the Upgrade and Major Overhaul

The AF had studied two possible alternatives to outsourcing of the upgrade and major overhaul. These were:

a. Outsource to a Single Organization

There were a number of benefits to the single source approach, mainly the reduced bureaucracy/administrative processes, and consequently a reduced workload for the AF. Furthermore it was perceived that it would reduce the risk of project failure due to disputes/conflicts amongst multiple organizations.

Outsourcing to a single supplier would also introduce risks. The main risks analyzed were as follows

Higher Cost: A single source would have been more expensive due to overhead costs such as risk cost (insurance, procurement of third part equipment and administrative overheads.

Compromised Solution: The choices and comprises would solely be under the control of the said single source. This would have introduced the risk of receiving a system or function more inclined for the benefit of the single source rather than for the benefit of the Air Force.

Lack of Knowledge Transfer: The Air Force would have no direct communication to the other suppliers involved, as such would not take part in a new problem serving exercises. This is a key factor in knowledge transfer and experience i.e. in other words, “technology transfer through project development/participation”. The risk on not acquiring knowledge, will ultimately lead to not having the right capability to ensure that your contractual product has been delivered according to your requirements and specifications.

b. Outsource to Multiple-Organizations

The study conducted by the Air Force suggested the following advantages in outsourcing the project to multiple organizations. Some of the main advantages which influenced the Air Force decision to select this approach were as follows :

Reduced purchase prices as the contracts were signed directly with the suppliers, who were direct sellers

Communications were easier and quicker, and problems and issues were discussed directly. This allowed us to improve our knowledge base and experience

Buyer had direct access to new products and innovations associated with the suppliers. This ensured that the Air Force would continue to be equipped with state of the art products

The organizations to which work was outsourced included the following companies.

DASSAULT AVIATION

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Company Profile:

- Structured to adapt its production to military and civil aircraft market cycles, DASSAULT AVIATION gives business to a rich industrial network of high tech companies in France, Europe, the US and many countries worldwide. Through its engineering design departments, production facilities, the skills of its employees and its product lines, DASSAULT AVIATION offers its customers in-depth know-how, ranging from design to operations, based on strong entrepreneurial values.
- DASSAULT AVIATION is a French group, held 50,02% by Groupe Industriel Marcel DASSAULT, in turn privately owned by the DASSAULT family. The other shareholders are EADS France and private investors.
  The Workforce:
- Total employees in Dassault (2005):12 082
  Revenue &Investment:
- Net income in 2005: 305 million Euros

THALES (THALES CORPORATE)

Company Profile:

- Thales is one of the world's largest professional electronics groups, serving the Defence, aerospace and security markets. The group has consolidated revenues of €10.3 billion in 2004 and employs 61,500 people in almost 50 countries. Thales is recognized worldwide as a leader in high security solutions.
- THALES plays a pivotal role in many of today's most ambitious aviation programs: A380, Boeing 787, Rafale, Mirage, A400M, Lynx, Tigre, NH90, Meltem, Watchkeeper (UAV), etc.
  The Workforce:
- 60,000 employees
- 27,000 outside France UK: 10,000; Australia: 3,200; Germany: 3,500; North America: 2,500
- 20,000 researchers
  Revenue &Investment:
- R&D at Thales totals €1.9bn (18% of revenues), including €400m company-funded
- 20,000 researchers on cutting-edge technologies
- Typically 250 inventions per year
- Over 12,000 patents
- 30 cooperation agreements with universities and public research laboratories in Europe, the United States and Asia.

SAFRAN

Company Profile:

- Safran is an international Group controlled by SAFRAN France. Its headquarters and directorate are based in Paris. France.
- The activity of the SAFRAN Group, which specializes in sophisticated technological solutions, is divided into four branches. These branches are Aeronautical and Space Propulsion, Aeronautical Equipment, Defence Safety and Communications.

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The Workforce:

- The Safran Group employs 62,000 employees and manages workshop and factory constructions, studies and commercial activities in more than 30 countries.

Revenue &Investment:

- Sales 2006: 11,329 millions of euros
- Operating income: 465 millions of euros
- Net income, Group share: 177 millions of euros

MBDA

Company Profile:

- MBDA is a world leading guided missiles and missile Systems Company. MBDA currently has 45 missile system and countermeasure programs in operational service around the world and has proven its ability as prime contractor to head major multi-national projects.
- MBDA was created in 2001 following the merger of Europe's major businesses in the sector: Matra BAe Dynamics in the UK and France, Aerospatiale Missiles in France, the missiles activities of Alenia Marconi Systems in the UK and Italy and EADS/LFK in Germany. MBDA is jointly owned by BAE Systems (37.5%), EADS (37.5%) and Finmeccanica (25%).
- Though recognized for its remarkable provenance MBDA has its sights most definitely on the future. The Company has a strong culture of innovation and technical excellence and has gained wide-ranging recognition in the field with many combat-proven products (such as Storm Shadow, which was used by the RAF during Operation Iraqi Freedom).
- Thanks to the high quality of its products and its optimized organization, MBDA has become a global leader within a period of only five years. Since 2001, MBDA has doubled its turnover and consolidated its order book which will provide the equivalent of five years of workload. The Company has also launched a number of programs based on the most advanced and innovative technologies.
- This success can be attributed not only to the Company's ability to bring together and retain the best engineers in their field in Europe – an ability supported and enhanced by the creation of engineering centres of excellence - but also to the development of a true spirit of cooperation amongst more than 10,000 employees of the group across all four countries.

The Workforce:

- Employees : 10,400

Revenue &Investment:

- Turnover: 3.3 billion Euros
- Order Book: 13.5 billion Euros
- Customers: >70
- Products in Service: >45
- Products in Development: > 30

5.2.1Description of Project and Contract Frames

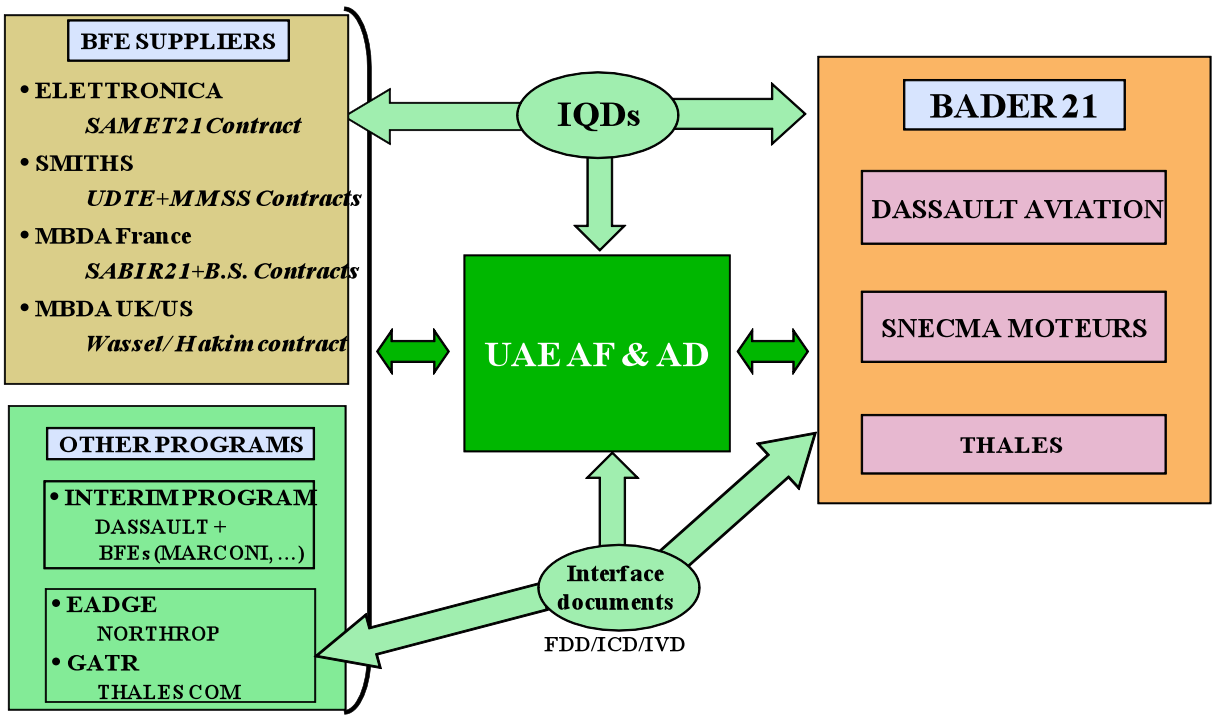
The project included several companies, from various countries, each of which is of a different dimension. The term dimension here means that not only do the company sizes vary, but more

importantly, the dimension of the project or the contract awarded to each such company varied. The contracts as formulated are described here in later in this chapter.

The overall Mirage 2000-9 contract was a aggregation of five different specific contracts dealing respectively with :

- The aircraft and some elements of its Logistic Support
- The Electronic Warfare suite and its associated Logistic Support
- Armament for some Air to Air and Air to Ground Missiles and their associated Logistic Support,
- Armament for some already existing Air to Ground Missiles,
- One Electronic Unit to be installed into the aircraft (for Mass Memory functions, …) and some elements of the associated Logistic Support

The basic principle to manage these contracts was to have a common Go-Ahead for all these contracts with shared interfaces and consistent scheduling. This required a large initial effort to ensure this consistency. Specific documents, called Interface Qualification Documents (IQD) dealing with technical and programmatic information were issued whenever an interaction between two contracts was foreseen. These documents included the main tasks and assets to be shared between these contracts and the associated responsibilities for the tasks in interface.



So, at the Go-ahead, a Master schedule was established to monitor for the overall project.

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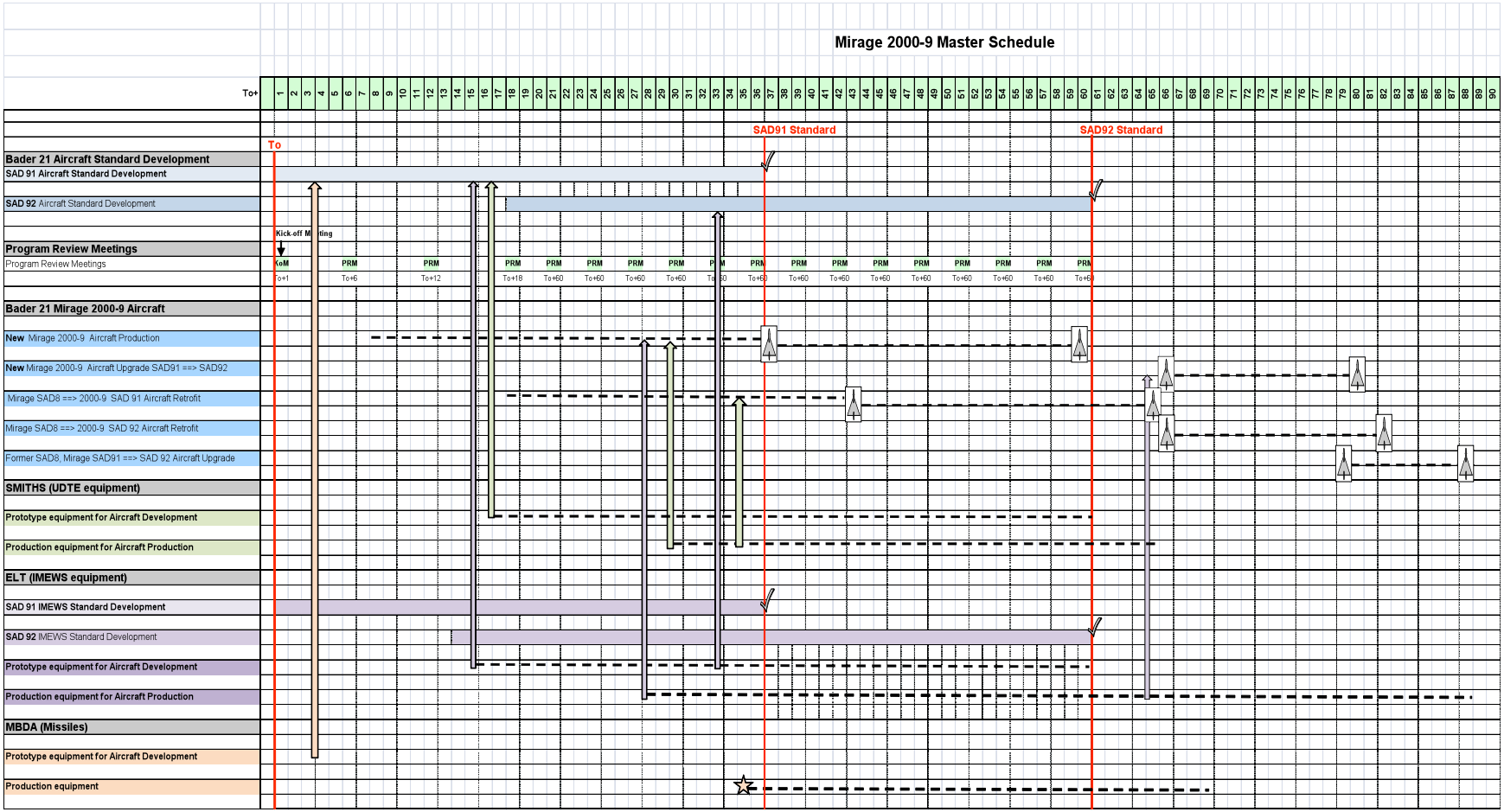
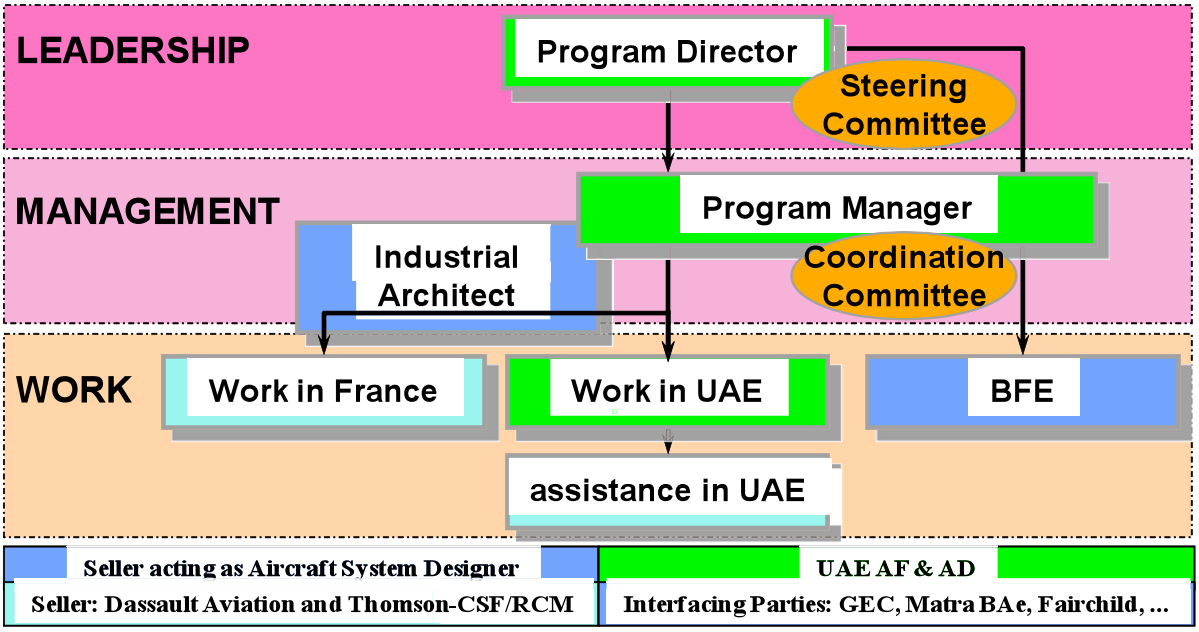


Most of the contracts had a development phase to adapt the existing product to the new specifications and capabilities that were required by the UAE AF&AD. The two contracts which had the most important and challenging development were the Electronic Suite and the aircraft contracts. This development phase was followed by a production phase.

In order to comply with the requirement of having some capabilities as early as possible, two "Standards" were defined in order to phase the arrival of these capabilities. The consequence was a retrofit of already delivered items into the final standard, adding an activity to an already complex project.

In order to manage these contracts, Program management teams were set in the UAE AF&AD and in all the companies. An example of such organization is provided hereafter for the specific case of the second standard development for which joint work was performed between UAE and France.



Specific Progress Meetings were organized for each contract and common sessions for contract interactions were planned together with the aircraft Progress Meetings to address specifically all the interactions between the contracts.

However, and despite all the efforts to maintain the programs on track, and as most often for such an ambitious program, some difficulties arose during the development of these new capabilities (either for new Hardware or new software elements). They can be sorted into different types:

a) Difficulties internal to a given contract, with no impact on other parts of the contracts. In this case, a classical "Risk Management" process with contingency plans to mitigate the risk was set in place. Potentially, an amendment to the contract was made to deal with the induced changes. This Risk management was discussed on a bilateral relation between the UAE AF&AD and the contractor.

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b) Difficulties impacting other contracts, but without any changes neither in the overall schedule nor in the technical specifications. In several occasions, deviations from the initial definition or from the original planning were encountered. In this case, under the supervision of the UAE AF&AD, the industrials involved were solving the issue, using the initial IQD's to sort out the responsibilities. This was generally resulting in a modification of the detailed schedule to adapt to the situation, and a temporary solution was defined. For example, when the prototype for the Mass Memory encountered some delays, the flights were done with flight plans directly entered in the Aircraft Mission System with a Flight Tests Instrumentation instead of being loaded by the Mass Memory. Adjustments were made possible by the fact that some functions involving mainly software were launched early in the program and could be validated on a standalone basis in lieu of a function requiring hardware that was not available. In this case however, dummy equipment was sometimes necessary and they had to be planned in advance, depending on the associated foreseen level of risk. The number changes of this type were quite numerous since the objective of the contract was very ambitious and that these adjustments were inevitable.

c) Difficulties impacting other contracts, but with impacts on the overall schedule or on the technical specifications. This was obviously the most complicated cases to be solved. In the life of the program, two main adjustments had to be made due to the delay in the development of some equipment. The solution that was found to minimize the impact on the aircraft deliveries and therefore on the operational capability of the UAE AF&AD, was to have an initial capability of the aircraft standard with a minimum delay and then to have a complementary capability delivery to meet the full expected standard capabilities. This type of adjustment was made for the two standards.

This can be summarized by the schedule provided below.

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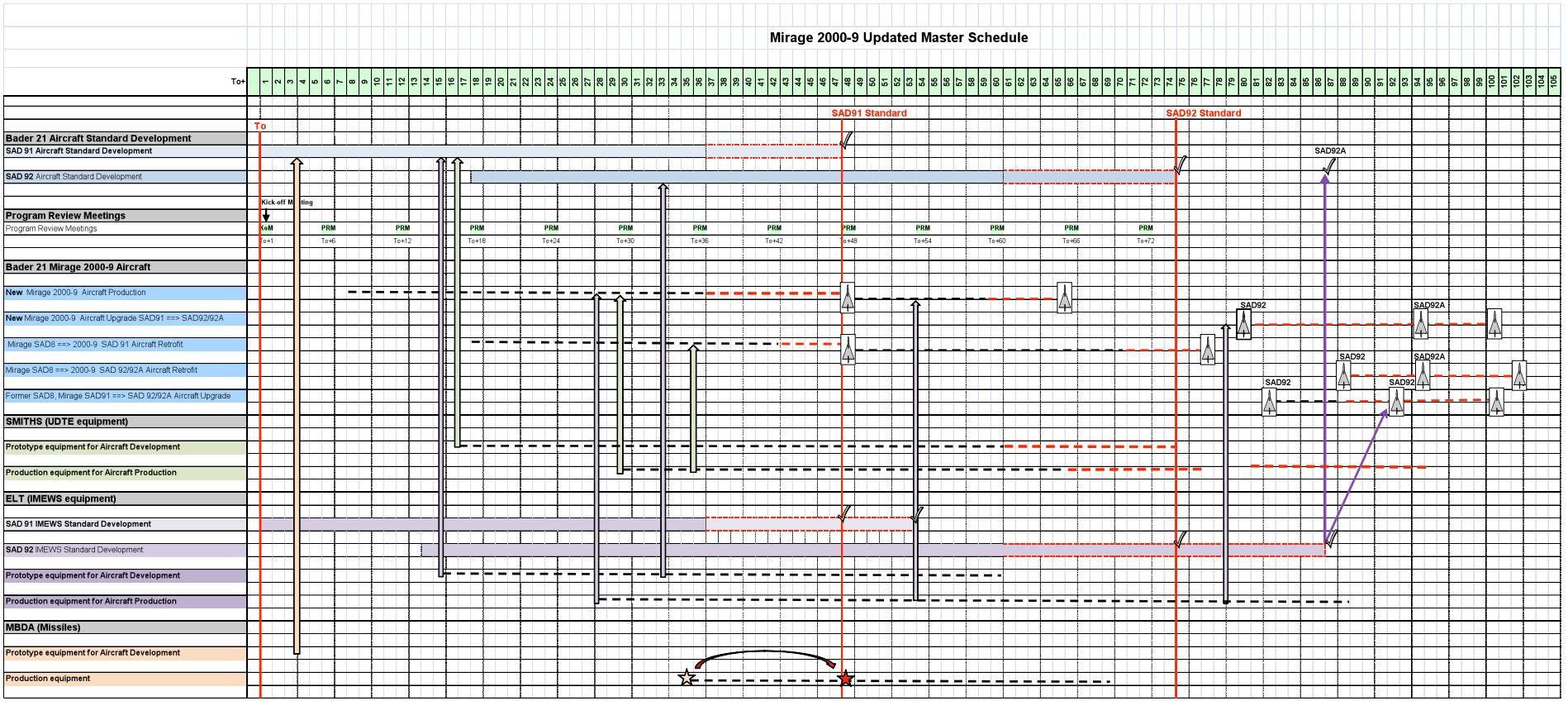
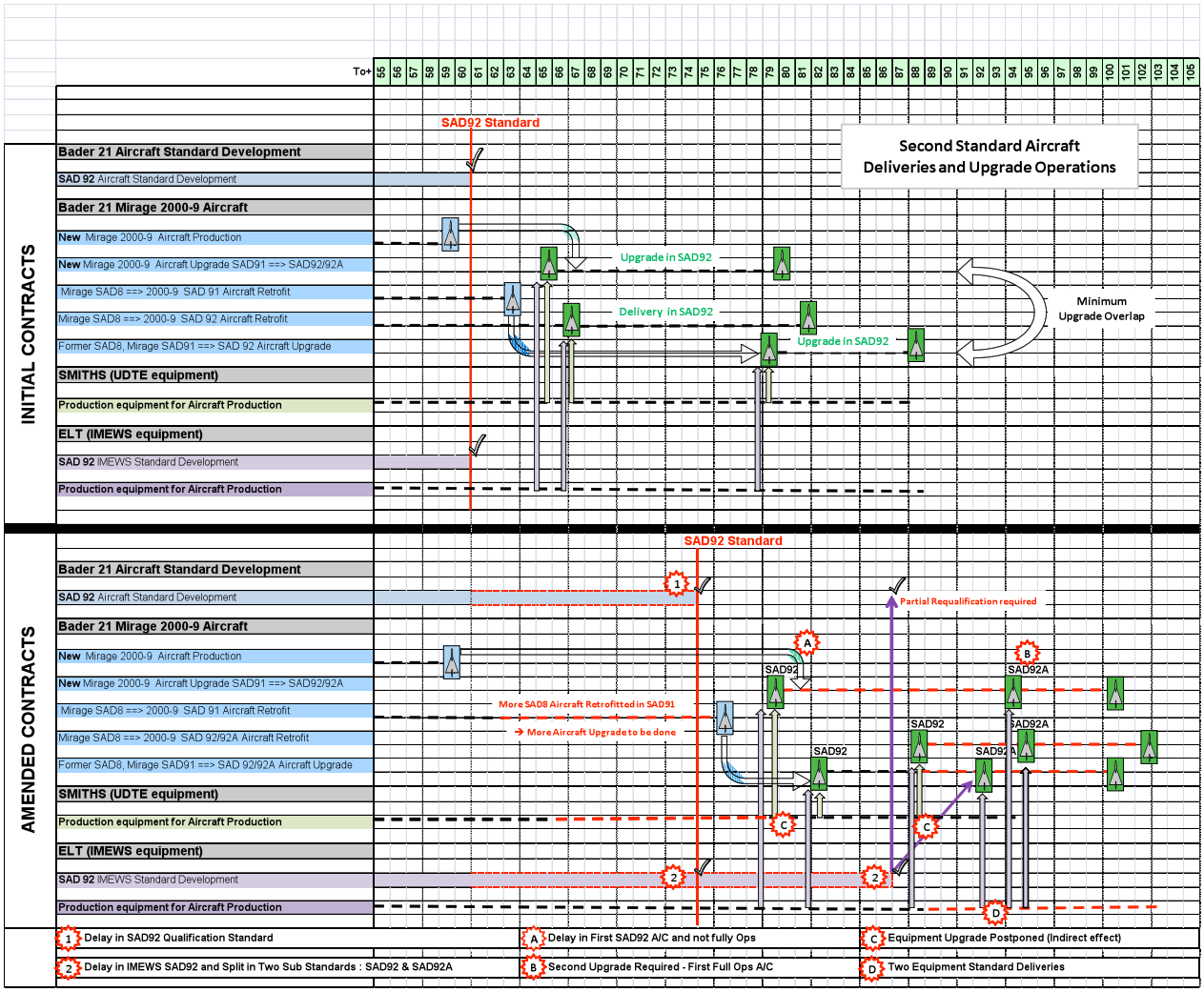


The direct impact was much more complex upgrade operations since instead of one upgrade from the first to the second Standard, up to three had to be performed on some aircraft to get first standard full capability and then the two steps for the second standard. The following graph focuses on the First to Second Standard Upgrade operations.



As a whole, the duration extension of the program and all the changes that occurred induced a much larger management work with contractual amendments to be performed.

Decision making and management process can be summarized by the drawing below in which the link between different contracts is illustrated.

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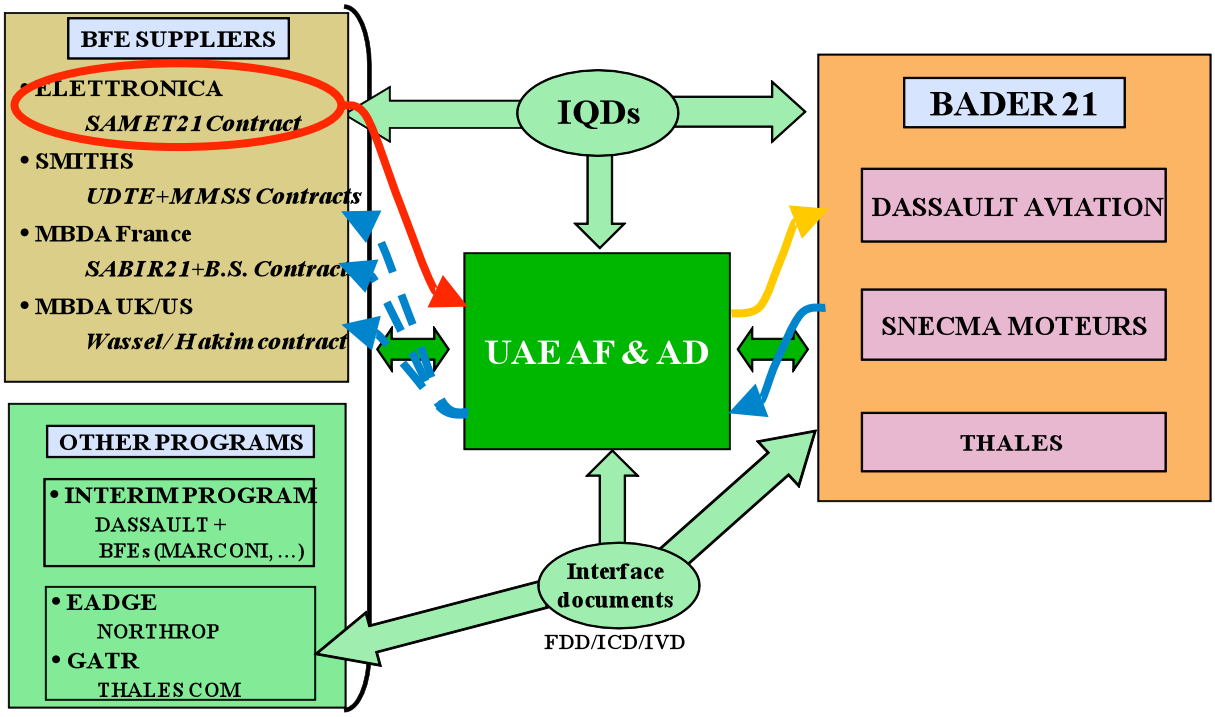

The case study is the following: One issue that occurs at one of the Equipment Manufacturer level may impact not only its own contract but all the others as well. For example, an issue on the Electronic Warfare suite may have an impact in the Mass memory of the aircraft. In this case, the issue is reported to the UAE AF&AD. The impact on the integration is studied with Bader 21 Sellers. Consequences are reported back to the UAE AF&AD. If these consequences also impact other suppliers, the UAE AF & AD will have to amend these supplier's contracts in order to take them into account.

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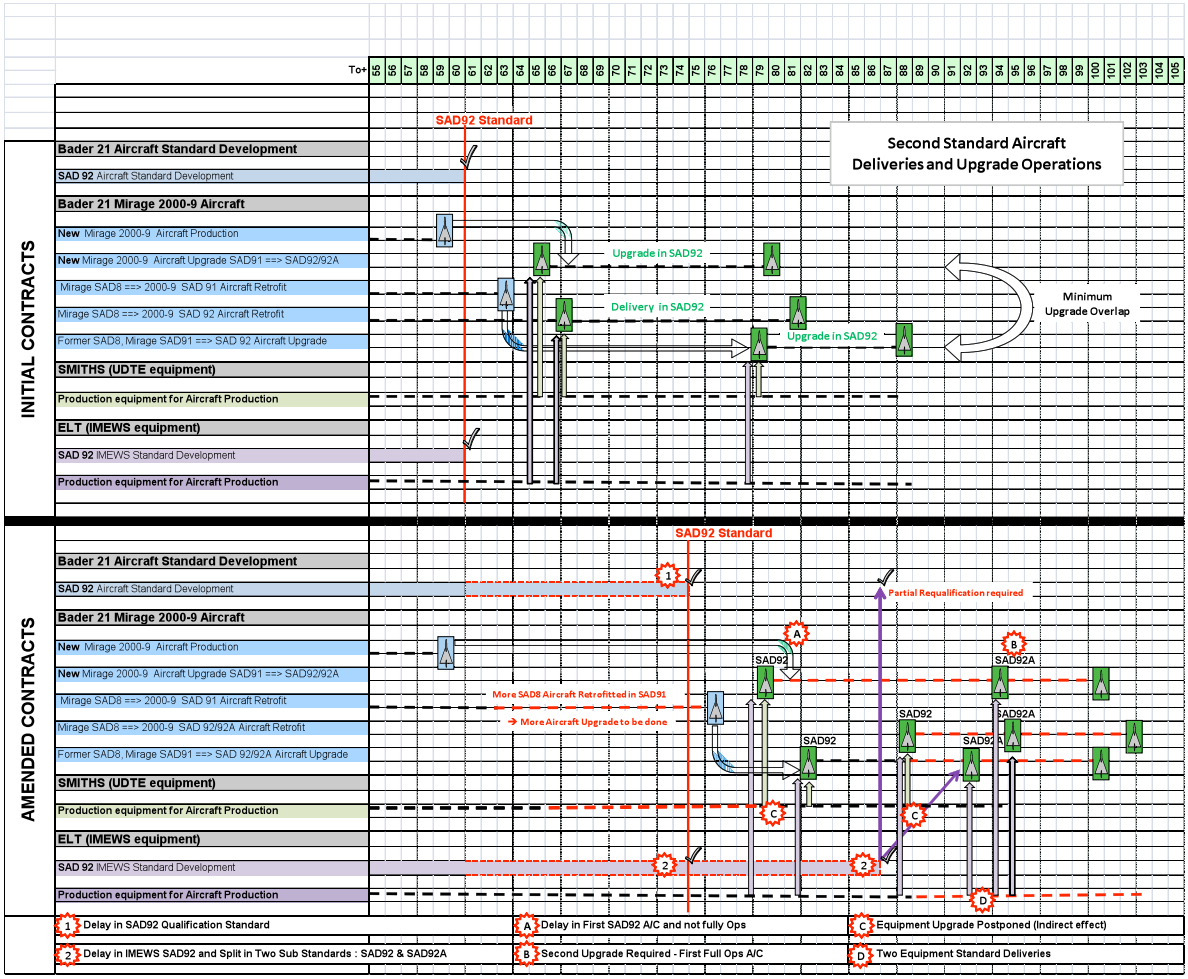

CONTRACT: This was a financial agreement, in which each SELLER would sign a contract, which would include the terms and conditions to deliver the Product and/or Services defined in the technical specifications and Integration and Qualification Document (IQD) and agreed by the Buyer and the Seller. As seen above, in this program, there are five Sellers. It is to be noted that Dassault Aviation, THALES and SAFRAN are one Seller.

Integration& Qualification Document (IQD): Defines the interfaces requirements between the Units provided by the Supplier and the aircraft. This obviously defines the functional requirement, volume, power needs, schedules etc.

Technical Specification: The Buyer and each Seller need to agree on the specification of the Product/Unit to be delivered by the Seller

Pre-Studied Risks – Author's Implication

For this program, a study was carried out with the participation of the author that considered a number of potential risks to the project. Risk mitigation for each of the risks identified was also put in place and it is outlined below.

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Risk: It was perceived that program could delay due to one of the companies in the consortium, providing an important system or sub-system, is late in delivery. The concern of the AF was that a probability to a program delay is higher due to a small company in a consortium. This would result in exposing a large company in the consortium to higher financial and legal liabilities. The AF also considered that these liabilities to a bigger company would result in a risk where AF is exposed to higher liabilities

Mitigation: A study was conducted, prior to contract, to evaluate the financial strength and stability (liability, turn-over and contracts in force) of the companies.

Risk: Another risk considered by the Air Force was the ability to find an alternative company to undertake and deliver the project within the already fixed price and budget, should one of the small companies change ownership or be declared bankrupt.

Mitigation: In order to mitigate this risk substitute companies, systems and sub-systems were evaluated. However it was identified that if such a risk were to occur introduction of an alternative company or system would still result in program delays. This was regarded as an acceptable risk by the Air Force.

Risk: Confidentiality rules and processes, in exchanging technical and proprietary data between several companies, of different countries. The risk in this scenario would be a failure by a party to transfer data to another party, particularly data unforeseen previously

Mitigation: In order to mitigate this risk a study was conducted prior to contract. Some clauses were incorporated in the contracts to allow speedy response times in exchanging sensitive data, and called for each company to include in their export license request the flexibility to exchange/provide such data.

Risk: Changes in the export laws from any of the countries: this risk could either delay the program, and/or deliver a degraded product performance, or in the worst case, lead to cancellation of a program. Moreover, the other key risk, in this case, is the method into which we would recover our advance payments/investments. This as well, carries with it the risk of losing time.

Mitigation: In order to mitigate this risk a study was conducted prior to contract. A statement in the contract indicating that a change in export laws was not to be considered as a “force majeure”; as such, the liability will fall under the supplier.

Risk: Competition within the Parties, as some may be producing similar Products; this may cause strains and disturb the smooth running of the development or production

Mitigation: To mitigate the risk of disputes arising between the parties involved in the program, a “lion clause” was introduced in favor of the Air Force. This clause allowed the Air Force to make a decision by which the suppliers must abide.

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Risk: The larger the number of companies involved, the higher the risk of disputes and the higher the risk of an abnormal scenario occurring i.e. obsolescence, price increases, delays etc.

Mitigation: This point was addressed by enforcing a contract based on "firm and fixed price"

Risk: The failure or inability by one or more of the companies involved to meet the specifications, and as such have an impact on the overall performance of the Product. This is an even greater risk if the project involves a development process

Mitigation: We addressed this point by enforcing a contract based on "firm and fixed price and a common master schedule, supported by the IQD (Integration & Qualification document)"

Risk: Management and Control of the Project by the Air Force, the risk of not having competent program managers and staff, with efficient tools and processes

Mitigation: To mitigate this risk it was agreed that a team/organization to manage the program and associated risks would be developed.

5.2.2 Risks Encountered

In this program the Air Force encountered two types of risks namely, foreseen risks and unforeseen risks. The impacts of these risks and the effectiveness of mitigation in place for the program are described below.

5.2.2.1 Foreseen Risks

During the project the AF encountered a situation where ownership of the companies changed hands. Although, provisions were set in the contract to counter against risks that resulted from change of ownership, this author discovered that there was no mechanism, contractual or otherwise, to enforce such provisions. For example one of the companies in the consortium was taken over by another company. Although in the contract it was stated that in the case of a merger, the new ownership fulfilled all the contractual obligations, it was discovered that there was no process to enforce the terms with the new company. Therefore, it is important that in addition to identifying the risks which may arise as a result of mergers, mechanisms to enforce the mitigation must also be studied and applied.

The author would also like to point out that military programs are often very lengthy. In this subject program, the project duration was eight (8) years. The dynamic economic situation means occurrence of mergers between companies is very likely during such lengthy programs. Therefore a greater focus has to be given to these types of risks and their possible consequences.

Risk: Changes in the export laws from any of the countries: this risk could either delay the program, and/or deliver a degraded product performance, or in the worst case, lead to cancellation of a program. Moreover, the other key risk, in this case, is the method into which we would recover our advance payments/investments. This as well, carries with it the risk of loosing

Although the contract in place had a provision covering against such a scenario, unfortunately, the enforcement of such provisions did not ensure the delivery of the product.

Risk: The failure or inability by one or more of the companies involved to meet the specifications, and as such have an impact on the overall performance of the Product. This is an even greater risk if the project involves a development process

Contractual provisions failed in avoiding the occurrence of such a risk i.e. ensure the delivery of the contractual product.

Risk: One company providing an important system or sub-system, is late in delivery, causing a program delay, thus entailing a huge financial impact on the other companies; the worst case is, if such a case was caused by a small company. In the latter case, the liability to the bigger companies could be enormous. This would have a risk of the suppliers claiming liability from the Air Force.

In fact, contrary to our belief, it was a big company which failed to meet its contractual obligations, resulting in a critical impact to the AF and particularly the small suppliers

5.2.2.2 Unforeseen Risks

During the program, two additional cases appeared:

The test aircraft crashed: this interrupted the schedule. This prohibited us in performing some tests under certain conditions, within a given schedule. The risks associated were not anticipated

An aircraft to be upgraded crashed, and the ordered upgrade kit was on production/delivery; this remained a liability to the AF. Such a risk was not anticipated.

5.2.3 Constraints Easily Transferable to Risks

Considering the above two experiences, a number of potential risks may reappear in outsourcing the FTC. These include the following:

5.2.3.1 Financial: Expenditures/Budgets

The UAE Armed Forces are seen to be the main customer, and consequently the main source of income. The challenge is to be able to secure contracts; the risk is to be able to secure such contracts and receive payments in a timely and continuous manner. The other risk associated with this, is the failure by the FTC to deliver the product accordingly, given the fact that the FTC will be relying on a major single customer.

5.2.3.2 Obtaining, Maintaining and Augmenting Skills

As the UAE is a small non-industrialized country with a small population and limited skilled/experienced citizens, employing foreign citizens is essential to be able to perform and deliver, as well as to share their experience. However, this entails a number of complications and risks such as:

Some countries do not accept certain nationalities for political reasons; so you have limited choices, which may be either low skilled people or high cost experts. In the first case, you need to train while the other case will demand a high pay: in all the two cases, you'll require a higher budget, with the risk of not securing a long term return for your investment

Security issue for such activities; when employees leave, they take with them knowledge, experience but mainly your ideas and objectives

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The people (of foreign nationalities) leave to either return to their countries or change jobs for a better living: training may be a solution

5.2.3.3 Export Authorizations

As the UAE is not a manufacturing country, all systems will be purchased and imported from outside the UAE. And as exports from those countries are subject to export authorization, a delay by a country to authorize exports, shall delay our activities, and as such have a consequential effect to the FTC in terms of cost and calendar. Although the calendar can be negotiated with the customer, the bigger risk is to be able to justify and particularly convince the customer of your financial losses as a result of this export authorization, where the FTC personnel were still on company's payroll despite the break in activities.

5.2.3.4 Profit Making

Profit is a key element in the survivability, sustainability and more importantly the reputation and the confidence build-up of the company. Given the fact that a government entity is the main customer, a minimum but reasonable profit has to be established and agreed with the customer. We foresee a profit of 10-15% as reasonable. The business plan has to consider this profit margin. However, the risk in this "minimum profit rule" lies in the fact that the FTC will have numerous unknowns in the programs. These unknowns include delays or failures by other FTC suppliers or sub-contractors to meet their obligations to the FTC, or delay in payment by the customer due to bureaucracy (delays in responses) or disputes, or increase in prices of products, raw materials or extra training.

5.2.3.5 Management

The management must ensure a good working environment, and establish, execute, and enhance the rules of the FTC. The management must ensure qualitative production environment. A good management is an essential input for a good output, and obviously a good profit. It is important that clear, manageable and measurable processes are established (DDU) to reduce bureaucracy. These processes shall be able to identify as maximum as possible, the default party in case of a dispute. Moreover, for issues which could be difficult to identify the party in fault, a mechanism allowing a quick response and resolution needs to be established; this includes the need to allow a quick meeting by the parties. The parties in the meetings must be delegated with a power to take a decision or at least have direct and quick access to decision makers.

5.3 Conclusion

Based on his experience, but more specifically due to knowledge gained during this thesis and research, the author believes that the causes and consequences of the problems encountered were typical examples when an organization acts on an "ad-hoc" practices with a lack of risk management policies, processes and dedicated resources for risk management. The author combined with his professional experience, shall explore the lessons learnt in these projects, by introducing structured governance in FTC, supporting a risk management function to manage risks in FTC, in a professional manner and minimize risks.

The author describes below, the FTC organization "AS IS" and later identifies the delta functions, in particular, the Risk Management function which needs to be embedded within the transformation

towards “TO BE” functions as well as during the operation of FTC. The transition from “AS IS” to “TO BE” shall mark the transformation phase from a military FTC to a civil FTC.

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6 UAE AF&AD FLIGHT TEST CENTRE (FTC)

The main focus of this study is to define a path and process towards the transformation of the FTC in to a civilian entity and later become sustainable and competent to undertake outsourcing functions of the FTC. This undertaking comes with numerous risks, which the author with his professional experience, undertakes to manage. For this purpose it is important that the reader has a good insight into the present FTC organizational structure and various functions performed. The information below provides the required insight.

The author herein shall describe the FTC "As Is" and later elaborate the various work, activities, progress and path towards FTC "To Be".

6.1 FTC "As-Is"

6.1.1 Organizational Structure

The United Arab Emirates (UAE) Military Structure is a hierarchical Organization:

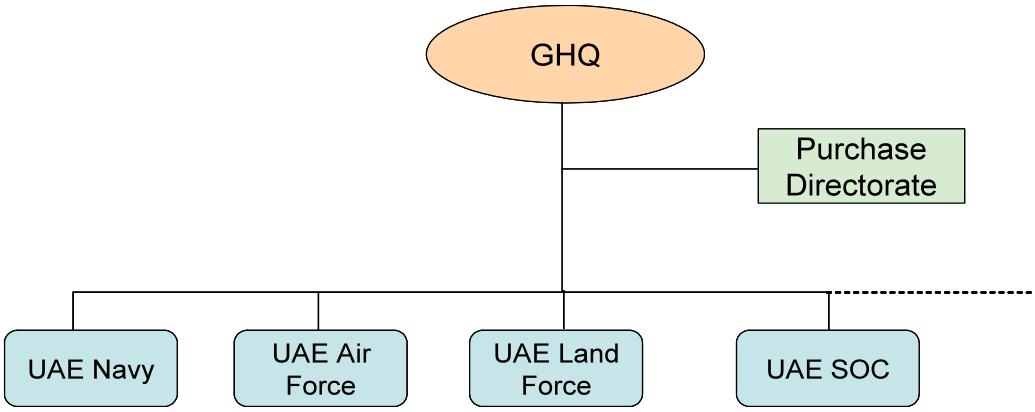

Figure 6: UAE Military Forces Structure

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The following figure represents the internal organization of the present FTC:

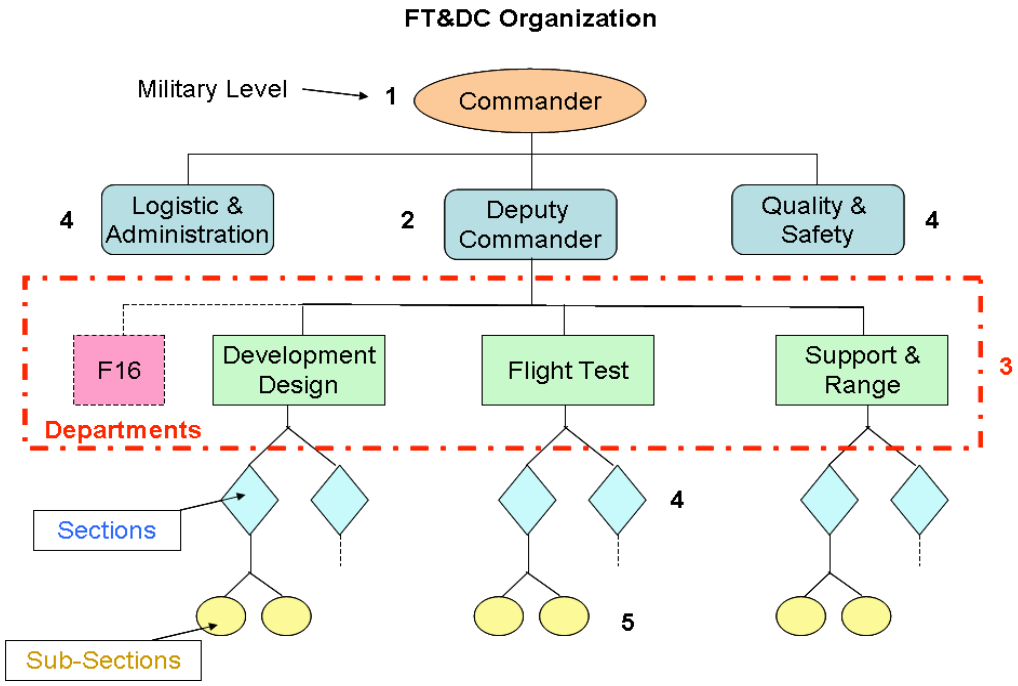

Figure 7: FTC Organization Structure – "As Is"

6.1.2 Functions

The paragraphs below describe in brief function of each entity shown in the chart above.

a. Commander

The function of the Commander of the FTC is to

- Establish overall vision and strategy
- Establish the functional strategy
- Communication with hierarchy of AF(HQ)

b. Deputy Commander

The function of the Deputy Commander is

- Support the Commander
- Assume the roles and responsibilities of the Commander during his absence

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c. Range and Logistics Department

This department is responsible for:

- Participating in the development of Technical Development Plans (TDP) and implementing assigned aspects of TDP. Assigned TDP tasks include verifying required aircraft stores and armament personnel are available in a timely manner.
- Maintaining, developing and administering information technology systems (ITS) including development tools and intranet/networks.
- Operating and maintaining the instrumented training range (ITR) and range control facilities (RCF) for squadrons' operational training as well as for FTC testing.

d. Test & Operational Department

This Department is responsible for:

- Participating in the development of Technical Development Plans(TDP) and implementing assigned aspects of TDP. Assigned TDP tasks include verifying required aircraft stores and armament personnel are available in a timely manner
- Defining and conducting ground and flight tests.
- Analyzing and reporting the test results to the users or customers
- Performing and assessing all operational studies with the aim of validating the users requirements

e. Design & Development Department

This department is responsible for:

- Participating in the development of Technical Development Plans (TDP) and implementing assigned aspects of TDP.
- The management, design and development of new software capabilities for aircraft and aircraft simulator operated by the UAE AF&AD
- Conducting all required aeromechanical studies related to any weapon system program initiated by UAE AF&AD

f. Safety & Quality Assurance

This section is responsible for:

- Developing, implementing and monitoring guidelines for safety and quality assurance across FTC
- Translating FTC specific requirements related to the safety & quality assurance matters into appropriate procedures compliant with the UAE AF&AD regulations and ensuring implementation of the same within the FTC

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g. Logistics & Administration

This section is responsible for:

- Set-up of administration and general logistics rules and procedures for FTC.
- Procurement of furniture, stationary and clothing
- Building maintenance

6.1.3 Capabilities, Activities and Processes

a. Product Lines

Inside the Mirage line of Product FTC affords various projects of:

- Units Integration
- MMI interface modification
- Development
- Testing

b. Processes

The FTC centre mainly involves two basic processes:

- Development process
- Flight Test process

The nature and complexity of these two processes are subjected to technical and financial risks. The Development Process and Flight Tests is organized in the following steps:

i. Requirement Analysis and modelling;
ii. Design;
iii. Software Implementation;
iv. Core Avionics Bench Tests;
v. Integration Bench Tests;
vi. Ground Tests;
vii. Flight Test.

c. Software Tools

The following software tools are used for requirements handling and traceability:

- TELELOGIC DOORS: is a requirements management tool Failure to appropriately managing, controlling and tracing requirements is a big risk for an enterprise

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- IBM RATIONAL ROSE: Rational Rose is an object-oriented Unified Modelling Language (UML) software design tool intended for visual modelling and component construction of enterprise-level software applications.
  Again, consistency is a very important culture in any organization, to avoid the risk of repetitions, redundancy and thus spiral cost in the FTC.
  Other following tools have been identified:
- MSDF, which includes:
- ODILE: used for software development
  - Administration System (AS) Workshop, used by System Team
  - Mission Software Workshop (MSW), used by SWT
  - Visualization Software Workshop (VSW), used by SWT
  - Benchmarking software tools:
  - Core Avionics Bench (CAB);
  - OASIS
  - FTS-MA (Mission Application);
  - FTS-VA (Visualization Application);

The above tools raise the complexity of the technologies contributing to the good operation of the FTC.
To the extent however, these technologies, their use, training, dependency to vendors, costs and their evolving nature bring with them various risks.

d. Hardware Tools

As far as the Development Centre is concerned, during the visits at the FTC premises the following Hardware Tools were identified:

- PC's (Windows);
- Printers;
- A flight simulator: Functional
- 2 other flight simulators: a dedicated space where there is a complete and operative aircraft pilot environment unit, with all the real instruments and commands.

6.2 Transition to FTC "To-Be"

The passage to a private sector is a complex transition. Resistance to change is a factual human character and the need of change is hardly ever perceived. Transition of an FTC to a private entity is not just a simple change of name and status; it is a complex process requiring changes in culture, organization, processes and habits. Successfully managing change requires convincing the personnel of the long term added value of the change.

The transition from a military structure to a private entity will be difficult but possible. Main difficulties to be solved will be:

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- Spirit: To be based on Return of Investment Concept and Risk Management process
- Organization: To be based on matrix structure
- Management: To be based on technical competencies

This transition will require an important human investment, specifically for the first managers (recently coming from a military organization) and which will be first to be transferred in a civilian and private organization. Their initial accompaniment must be carefully followed; probably the best way is to organize a partnership with OEM to facilitate the transition.

Transition path is divided in 5 main steps:

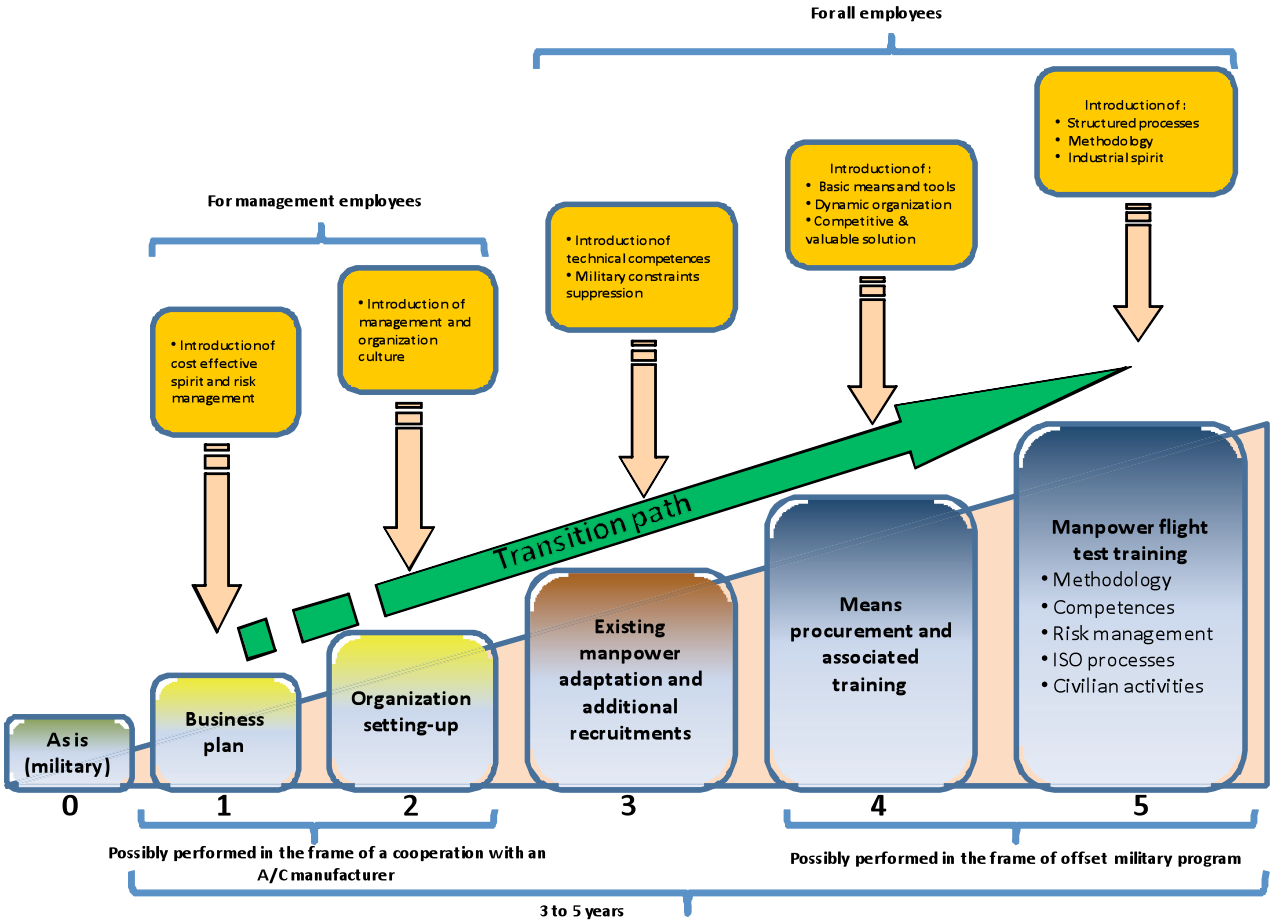

Figure 8: Transition Path from Military Structure to Civilian Organization

Step 1: Business plan

With the assumption that the future head of the flight test centre and his deputy are detached from the Air Force and are working in a civilian environment, the first task will be dedicated to build the business plan of the project:

- Market study
- Potential customer identification
- Manpower evaluation (number & quality)
- Search of partners and financing

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- Flight test centre setting-up logic and progression
- Project cost, phase by phase
- Project viability

Step 2: Organization setting-up

Performed by a small management team (including head an deputy), this step will be dedicated to organize in details the flight test centre setting-up:

- Financing means (and associated cost control) setting-up
- Overall schedule publication
- Infrastructure works study
- Logistic issues, communication, electrical power, water, tools, security
- Agreement with air-base or airport to use their installation (hangars, A/C parking, runway)
- Test means: studies launching, equipments ordering

Note: These two first steps will be highly valuable for the future flight test centre management by introducing a cost effective spirit and risk project management. In order to secure the process these two first tasks could be performed in cooperation with industrials partners or A/C manufacturers.

Step 3: Manpower adaptation and additional recruitment

With the assumption that the involved Air Force (and future centre's customer) will put at the flight test centre disposal a technical manpower, these trained resources, detached from the Air force to the Flight Test Centre, will be mainly assigned to do the aircraft servicing, maintenance and A/C modification works. The flight test centre will start a manpower recruitment process based on :

- Experienced flight test manpower (mainly coming from A/C or weapons manufacturers) and acting as a trainers
- Not experienced manpower but coming from high engineer's school, just finishing schooling and ready to be trained on flight test centre trades
- Manpower number and quality has to be defined according to potential market and envisaged contracts.

Note: This step will introduce technical competencies to the centre in civilian organization.

Step 4: Means procurement and associated training

Essential to the Flight Test Centre, this step is mainly dedicated to the test means installation. This is also the occasion to introduce a dynamic human resources organization based on individual and collective manpower performance and competence (compared to a military organization principally based on seniority and rank).

To take advantage of the means installation, this step is also the occasion to start the Flight Test Centre quality process and to show to the future customers the competitive and valuable solutions adopter by the centre.

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Step 5 : Manpower flight test training

The best way to succeed the manpower training is to organize a real activity based on "On the Job" methodology. This initial activity, specifically chosen at low technical risk, will be the opportunity to:

- Perform the knowledge transfer between experienced and non experienced manpower
- Structure and validate the processes
- Acquire the basic methodology of test (logic, progression …)
- Develop the industrial spirit
- Qualify the personnel (ISO, FAR; PART ...)

This step is also the best way to tune the flight test centre organization, confirm head of departments and to detect talents of the centre manpower.
Obviously, to perform an "On the Job" activity needs a first contract, preferably carried out in the frame of military offset program.

In order to measure and assess the transition path progress, some indicators should be established:

- End of steps 1 and 2 (business plan & organization setting-up): Organization of an audit carried out by an independent external entity in order to validate the FTC concept. This audit will be highly valuable for the future flight test centre managers by checking the project's cost effective efficiency.
- End of step 3 (manpower adaptation and recruitments): A recruitment roadmap (taking into account needed manpower number and competencies) has to be initially established. During the step 3, the real recruitment progress has to be compared with the reference roadmap in order to fulfil all requirements.
- Step 4: To respect the planned expenditure.
- Step 5: During the On The Job Training, a special attention must be given to the following indicators:
    - Activity
    - Customer satisfaction
    - Management of product or process discrepancies

6.3 FTC "To-Be"

Flight Test Centre models are built around 4 basic pillars that are going to be described in the following paragraphs: Organization, Processes, Manpower (skills) and Means. As illustrated by the figure below, the Vision Objectives and Management, together with these basic pillars, are the core drivers of evolution.

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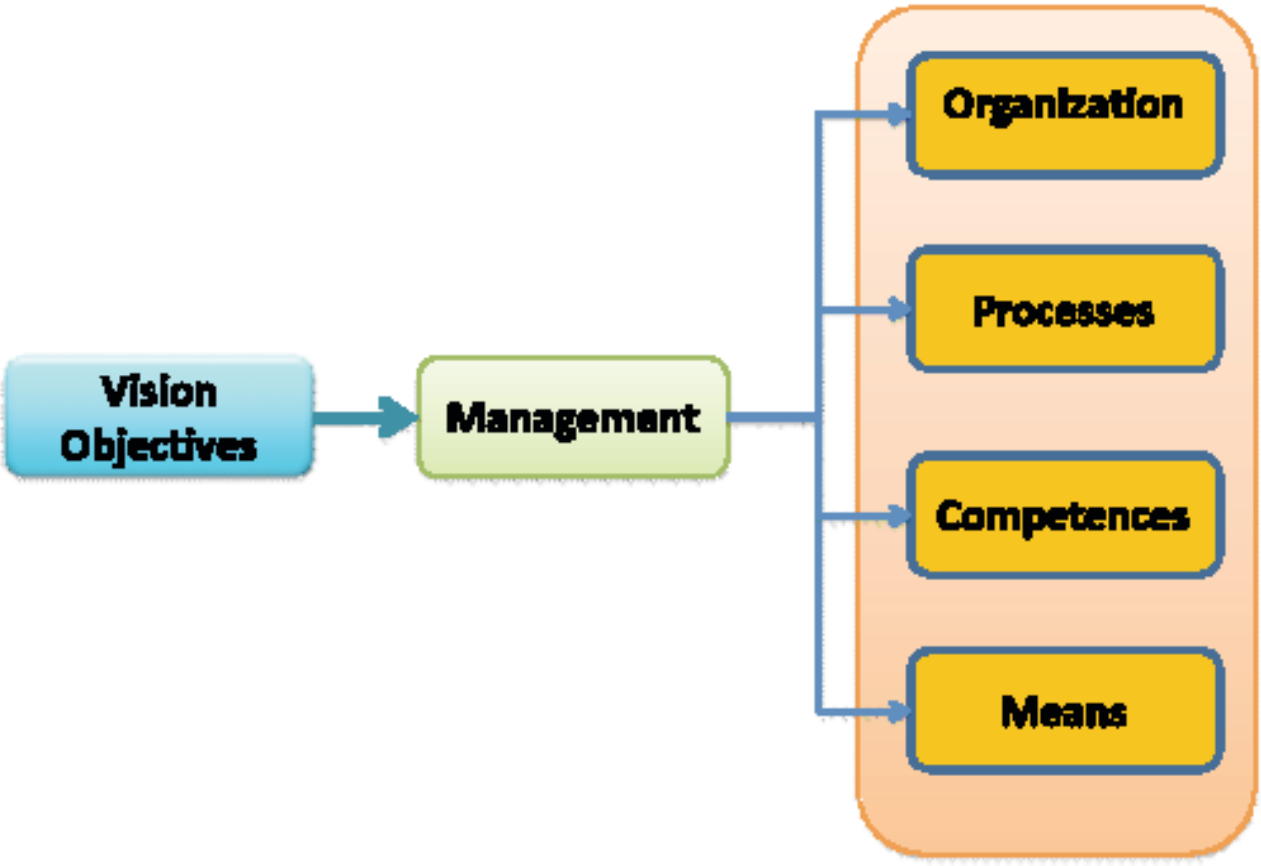

Figure 9: The Drivers of Evolution

6.3.1 Organizational Structure “To-Be”

The following figure represents the projected internal organization of the present FTC:

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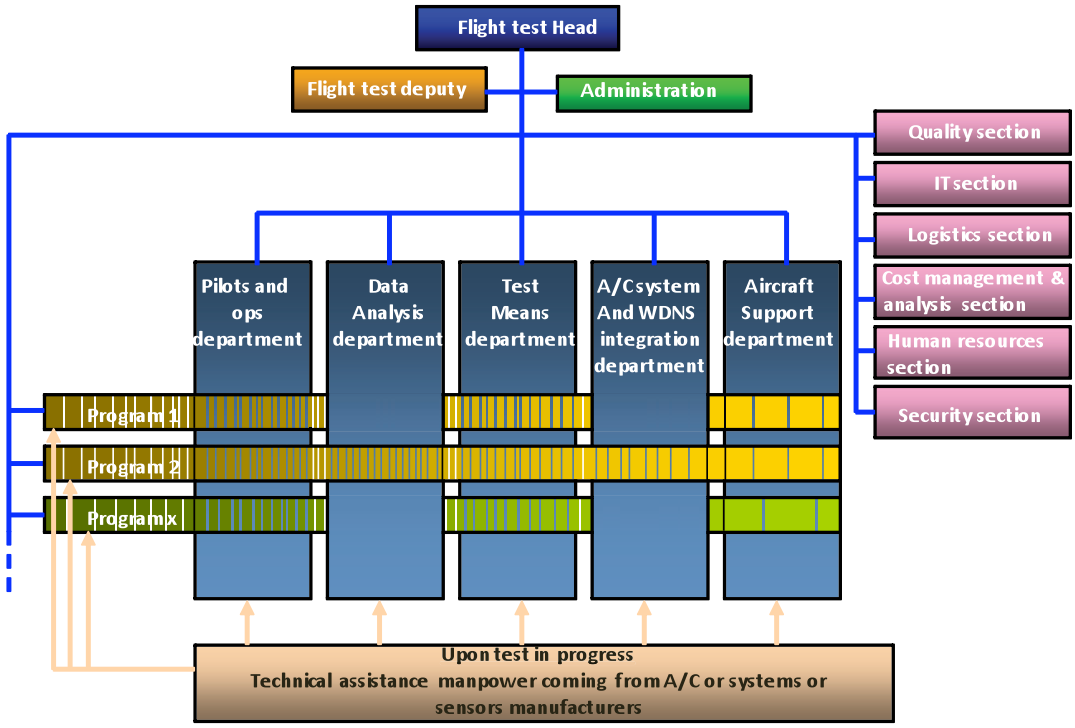

Figure 10: FTC Organization Structure – "To-Be"

Such a matrix organization mixing program departments and trade activities is generally considered as the most suitable one for a test centre. This structure allows minimizing the personnel number by taking benefit of specialized transverse functions putting their knowledge at the disposal of all programs. This organization provides a coherent flight test development and avoids remaking tasks between different programs.

6.3.2 FTC Capabilities, Activities and Processes - Towards "To-Be"

As a minimum, four distinct processes have progressively to be established:

- **Flight test management, organization and methodology:** This process describes the full centre's organization, job descriptions and what links between all entities. This process also describes the OPS manual (test flight classification, safety procedure, pilots qualification…), the management review meetings (aim, participants, schedules…) and the methodology for customer satisfaction indicators establishment.
- **Aircraft preparation and configuration:** This process describes the aircraft works methodology and provides the configuration management process of all changes occurring during works on aircraft.
- **Test means design and realization:** Gives the details of the test means development plan including calibration, inventory and test means maintenance.
- **Program management:** Provides flight test centre programs organization including
    - Risk management (at program level, measured with tangible indicators)
    - Product / anomaly management

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- Program activity indicators
- Program activity monthly cost (to be compared to the expected)

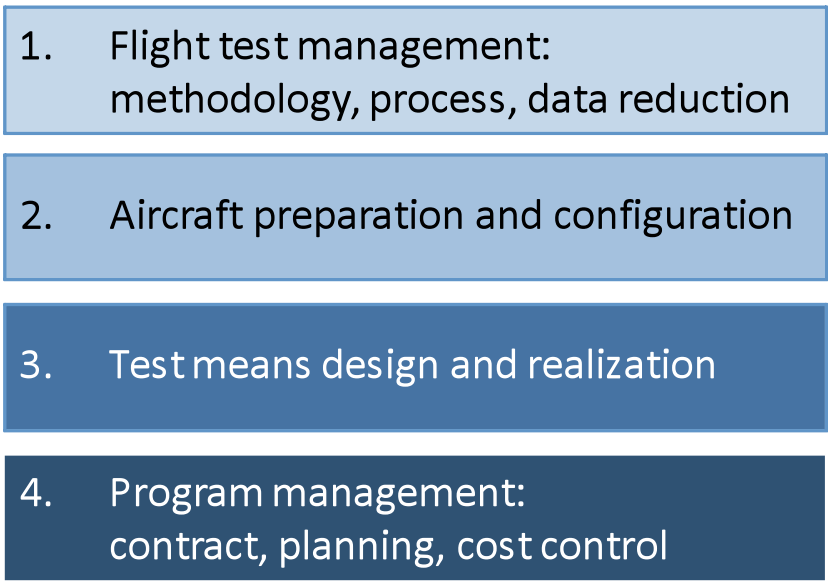

Figure 11 : FTC Basic Processes – "To-Be"

During the thesis' research, the author simultaneously continued to conduct improvements in the FTC. Firstly, he noticed that there is no mission statement in the FTC and, therefore, the personnel could not have a clear understanding of FTC's real mission. Consequently, and having in mind the "To-Be" FTC, he defined and documented the following mission statement that summarizes its goals and objectives:

'The mission of the Flight Test Centre is to respond to the UAE AF&AD technical and operational requirements in order to enhance the operational capabilities of the UAEAF&AD fighter aircraft.'

Secondly, in line with his goals for the "To-Be" FTC, the author worked to improve and document FTC functions and processes, as indicated in the figures below.

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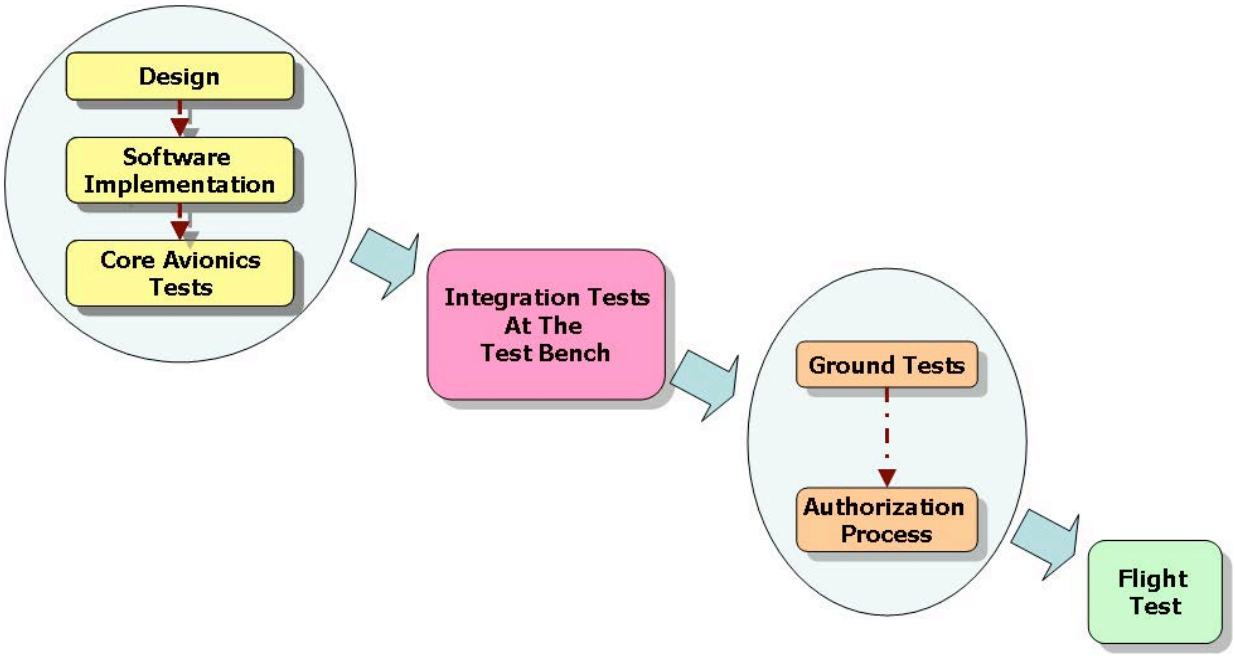

Figure 12 : Steps of the development and flight test process – "To-Be"

Recognized methodologies and processes provide better governance, key performance indicators (KPI), common language and suppository. The non-availability of such processes and methodologies are factors contributing to risks thus the need to implement CMMI and a EA framework.

FTC Development Cycle

The development cycle followed by the FTC is structured with a "V-Shape" organization diagram:

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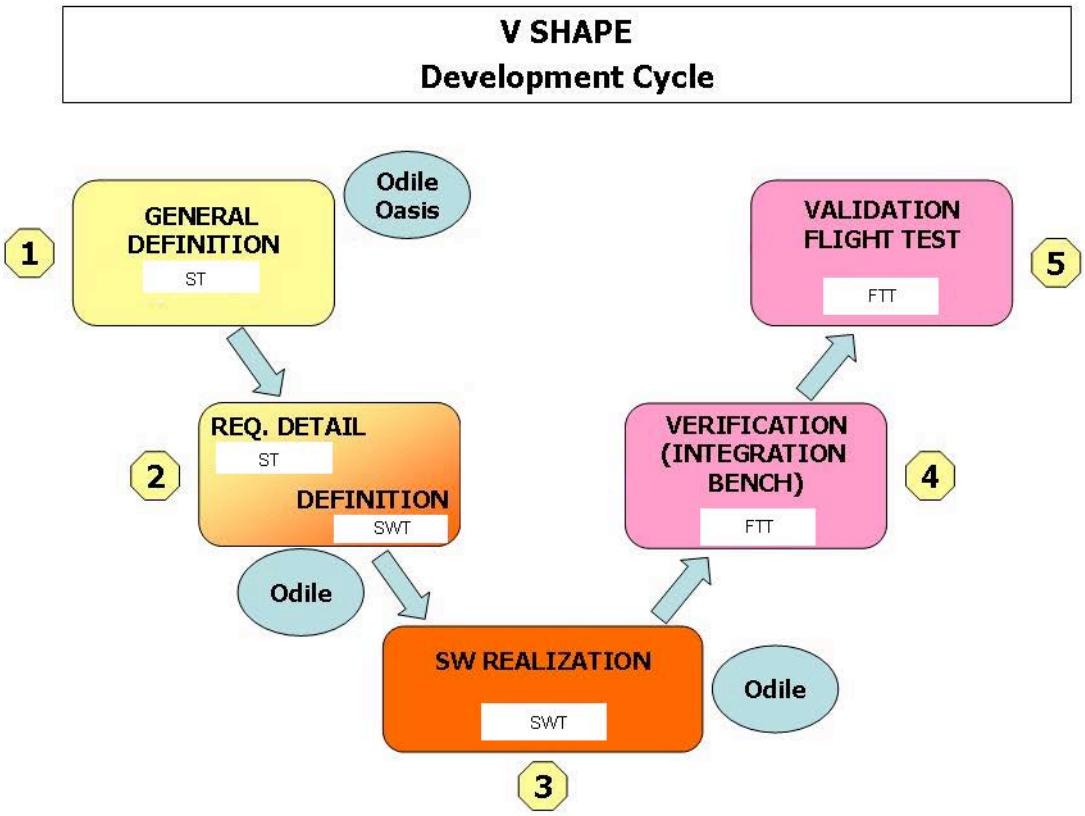

Figure 13: FTC development cycle – "To Be"

The following is a description of the process breakdown.

STEP 1: GENERAL DEFINITION

- SGS (System General Specification): developed by DOORS tool.
- MFD (Map Functional Diagram): preliminary description of the interfaces.
- ICD (Interface Control Document).
- IVD (Interface Validation Document)

In this phase a rapid MMI prototyping tool is used.

STEP 2: DETAILED DEFINITION

This step may be divided into sub-steps, which happen consequently:

The following tasks are performed by ST:

- Production of the Digital Interface Sheet (using Morgane), in order to verify the order and the exchange of messages.
- generation of the Core System Technical Specification (CSTS), using DOORS tool;

The following tasks are performed by the Software Team (SWT):

- mission application (building the Analysis Model using Rational Rose),
- visualization application (using ALG Studio)

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STEP 3: SOFTWARE REALIZATION

- for Mission Application
- for Visualization Application
- Once the software is completed, it is directly tested at the Core Avionics Bench (CAB). At this level SW is treated as a “white box”. After validation the SW is delivered as a “black box”.
- Practically the Core Avionics Bench is a facility to support SW integration. At the CAB the scenario and all the sensors are simulated.

STEP 4: VERIFICATION AT INTEGRATION BENCH

Integration Bench Team (IBT) tests the implemented SW first at the Integration Test Bench then on the aircraft itself.

In this step, therefore, IBT mainly performs the following tasks:

- reception of the software developed in the previous tasks along with the delivery note;
- verification of the new functions on the Integration Test Bench;
- verification of the new functions on the aircraft;
- messages analysis and tests, in order to find and identify errors;
- test implementation, scheduling, running and result analysis.

STEP 5: VALIDATION AT FLIGHT TEST

Flight Test Team (FTT) also evaluates and analyses post flight data coming from:

- pilots debriefing;
- data acquired during the Flight Test (telemetry) at the RCF;
- Data recorded on board.

To summarize, the detailed FTC “To-Be” process is presented in the figure below:

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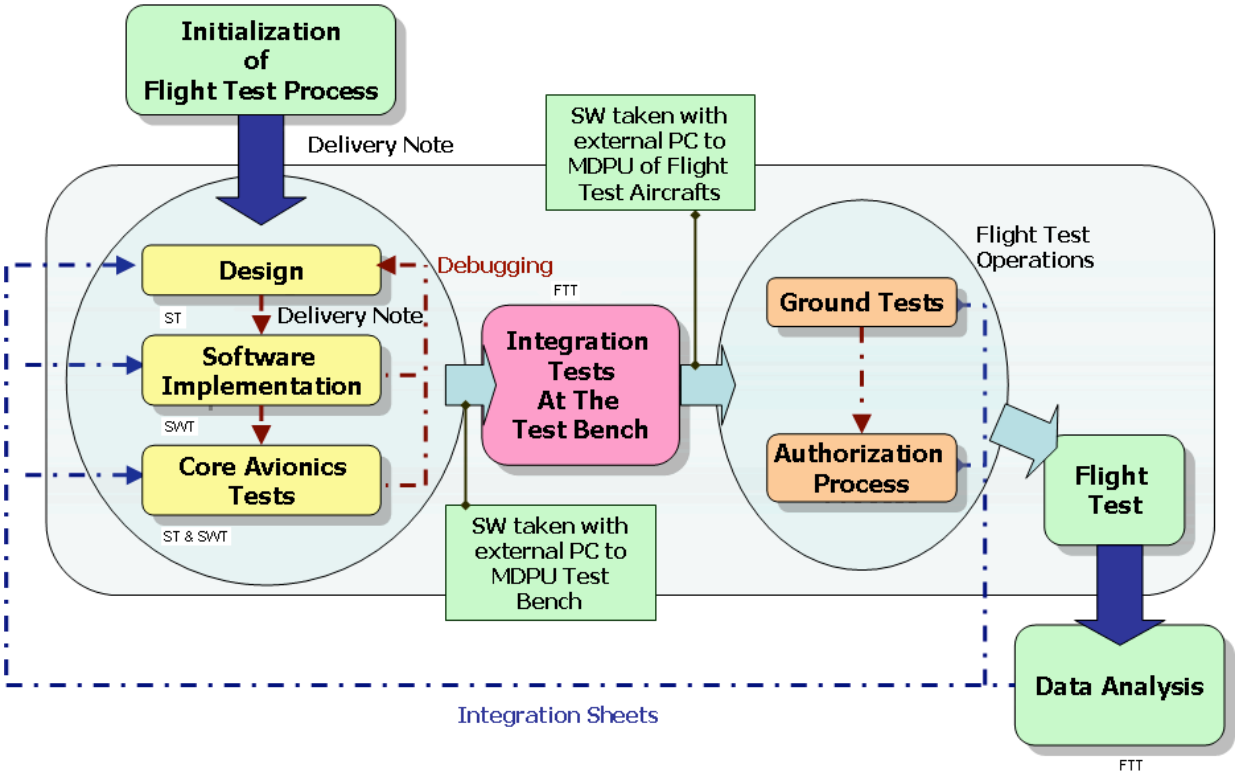

Figure 14: Overall FTC "To-Be" process details

For the flight Authorization Process, once the new SW is integrated at the Integration Test Bench, it is uploaded on the Main Processor Unit and Ground Tests are performed on the aircraft, both to verify that:

- the SW is correctly integrated on the system;
- the SW integrated is not affecting other functions of the aircraft;

More generally the aircraft is working in all its functions (e.g. engine, thrusters, etc.).

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A graphical representation of the process is provided in the flow chart below:

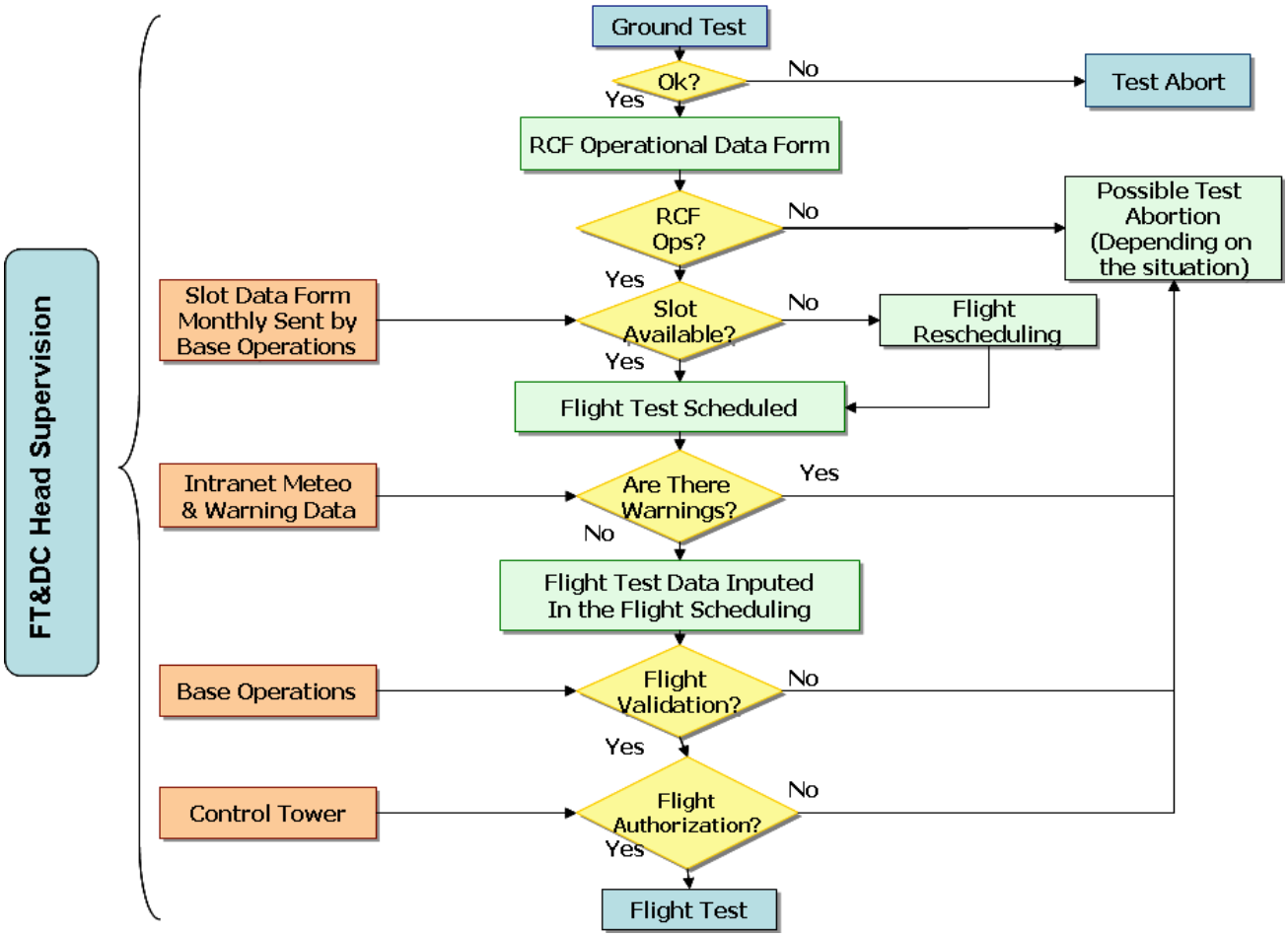

Figure 15 : Flow chart of the authorization process

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The feedback process is presented in the diagram below:

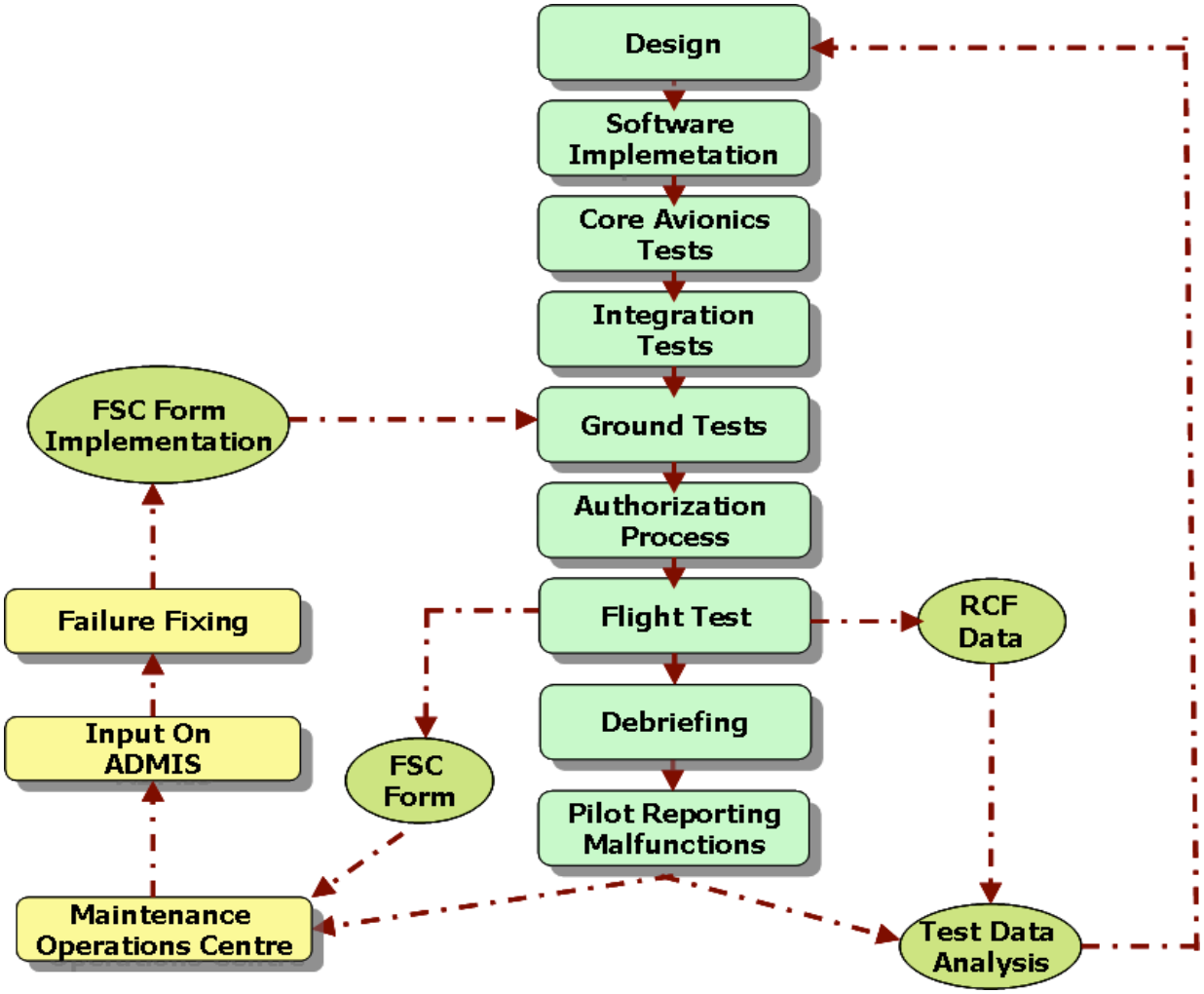

Figure 16: The Feedback process

Inside the V-Shape Development Cycle, the UAE FTC defined two sub-processes:

- OASIS sub process;
- ODILE sub process.

The ODILE sub process defines the development specifications. It is practically a sort of coding of the development process previously described.

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In particular, the ODILE sub process is organized as shown hereafter:

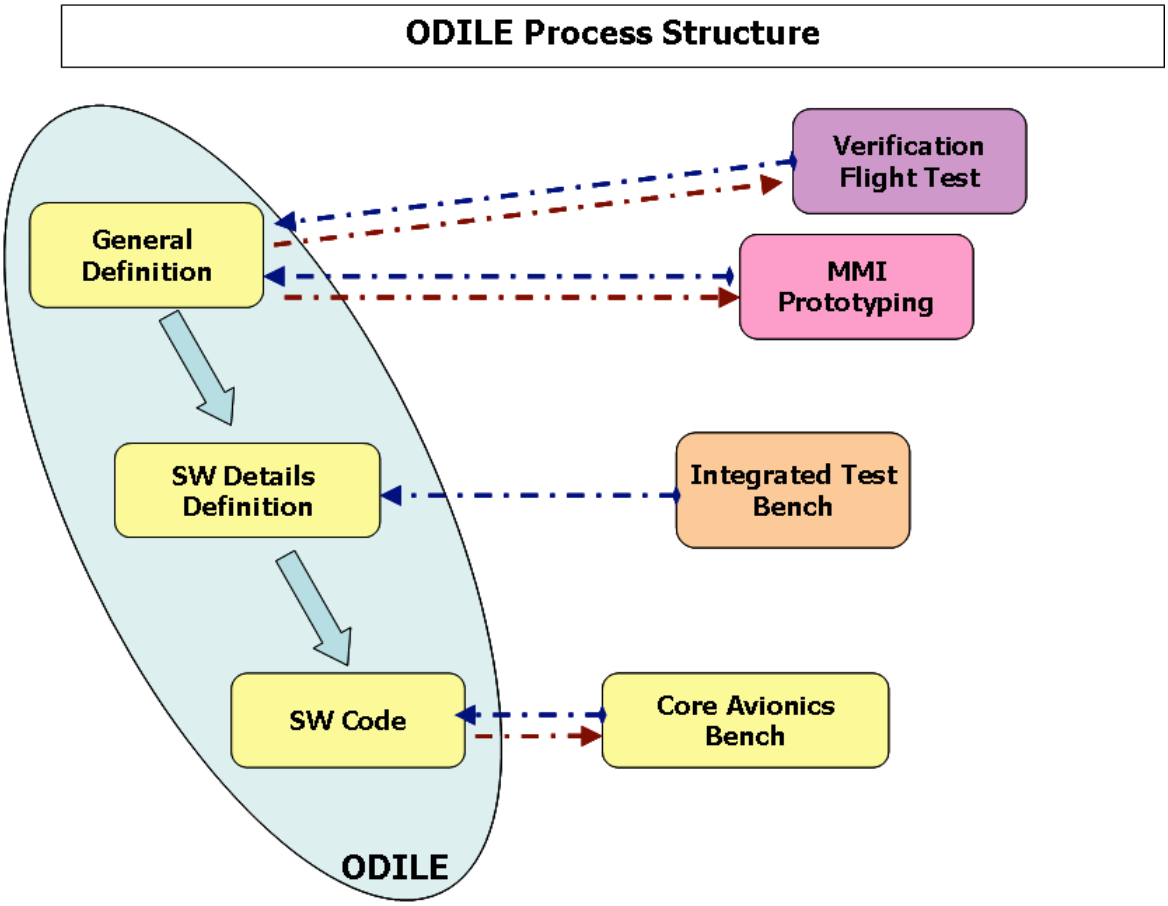

Figure 17: ODILE System Engineering

The OASIS sub process is used in order to enhance understanding of general specification and for fast prototyping of the SW to be developed by the Development Centre.

External interactions

To summarize the description of the processes provided in the previous sections, the following diagram is reported, showing the main steps of the FTC process and the actions and interactions they involve.

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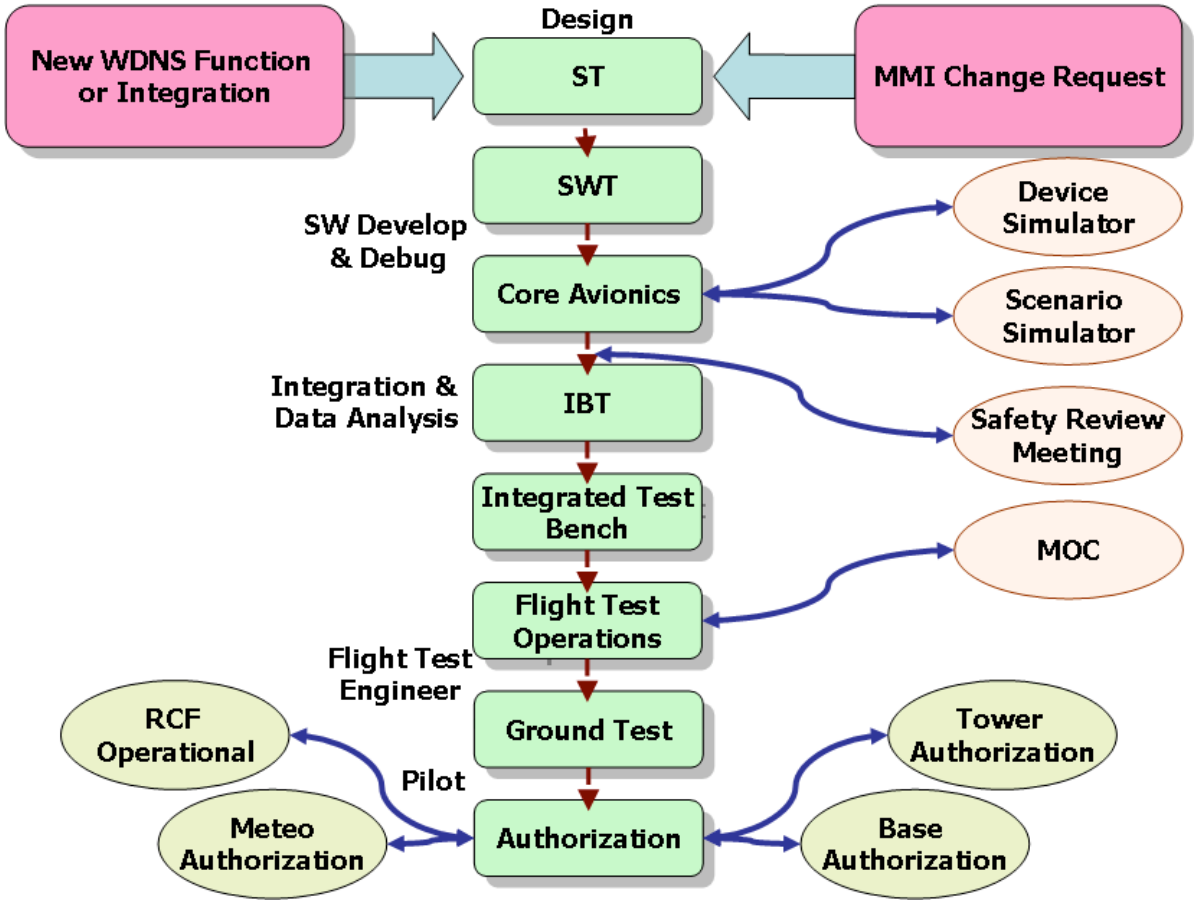

Figure 18: Main issues of the overall FTC process

The main external interactions of the FTC process have been therefore identified. These relations are shown in the following diagram

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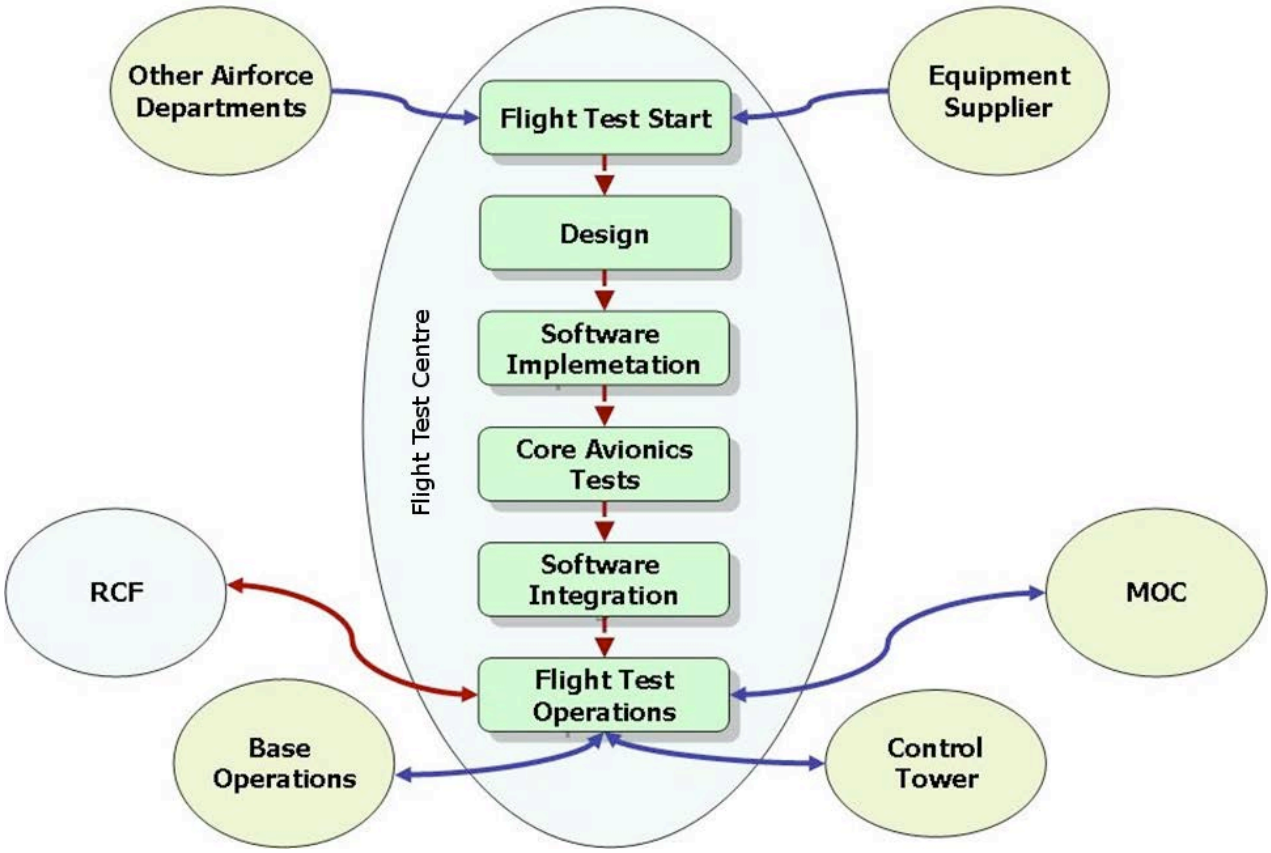

Figure 19: FTC process interactions

6.3.3 FTC Basic Skills and Means – "To-Be"

Having continuous activities at the FTC is instrumental to its very existence. Minimum needs must be provided from the start, in terms of tools, competencies, organization, methodologies and processes, while assessing cost and workload as a function of projects. Certain aerospace and aviation competencies such as a test pilot, test engineer… are rare and costly, and need to be addressed at an early stage.

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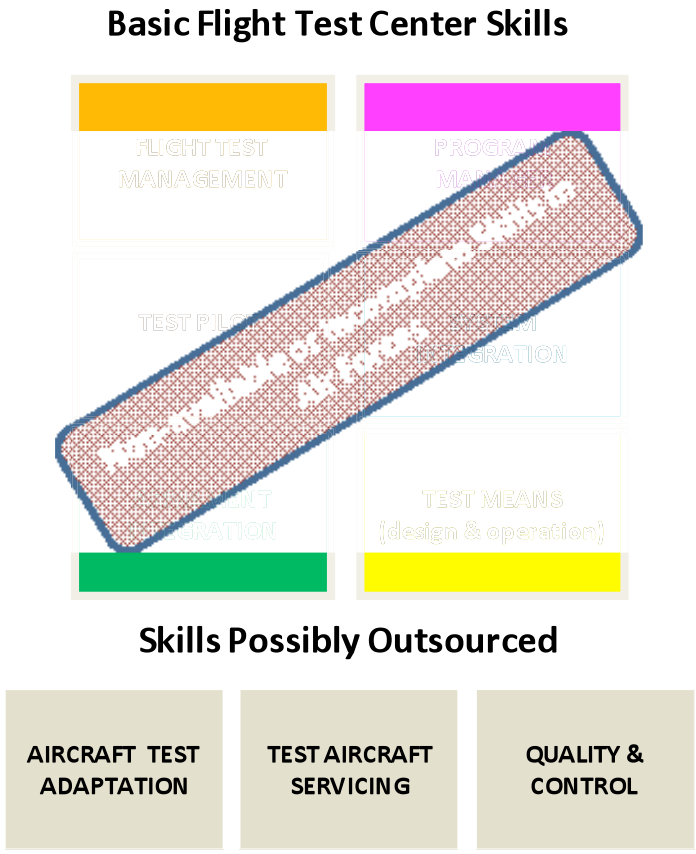

Figure 20: FTC Basic Skills – "To-Be"

As seen in the figure above and the one below, we should focus on core skills and basic means. For a progressive and secure strategy, consider at the earliest stage creating partnerships with manufacturers / original equipment manufacturers (OEMs) and universities.

- OEMs, in order to transfer to the centre:
  - Industrials spirit
  - Proven processes and organization
  - Experienced manpower, acting as trainers
  - Test means design knowledge, for the centre setting-up
  - Design office competencies
  - Software packages (data reduction, data acquisition, …)
- Universities, in order to prepare the FTC setting-up by:
  - Detecting young talents
  - Mastering advanced technologies
  - Taking existing laboratories benefits

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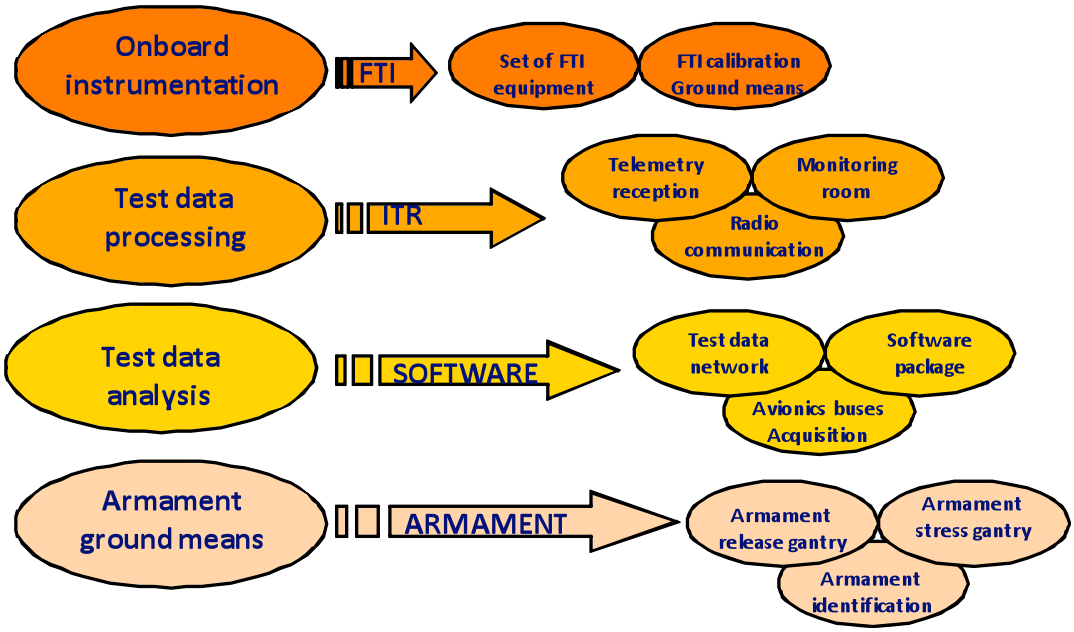

Figure 21: FTC Basic Means – "To-Be"

The "On the Job" Training methodology seems the most appropriate to start the flight test activities. Select, prioritize the creation of competencies from start, and expand as you progress. Vacuum shall be filled as a function of needs, capitalizing through on-going projects and partnership with OEMs and universities. The means will provide a pragmatic local vehicle towards continuous "on the job" training for specialized and advanced skills.

6.4 Mapping of FTC Evolution to Meta Model

To manage every aspect of the evolution, the FTC needs to use a standardized way to capture and communicate information. Ultimately, combinations of Meta Model components give stakeholders different views that help them manage their domains, concerns and risks.

For example, the vocabulary below could be defined as follows:

- Capability = Role + Competency + Process + System
- Competency cannot be defined without role: every role requires a set of competencies
- Competency is not for an organization position but per role
- You cannot define a process without defining the role associated with it

Although the above sounds simple and logical, our experience shows that a majority of companies do not follow such structure. This affects the enterprise capability to manage and plan basing on insights from standardized and integrated management information; this information is coming from various business and technological domains.

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How does it work?

Every Meta Model component becomes an agreed and standardized way to capture planning information across every department. Information is captured in a centralized repository. Each Meta Model object is related to other Meta Model objects according to strict relationships where cardinalities are important.

For example:

- One Organization Unit has Many Roles; conversely, one Role can belong to Many Organization Unit
- Cannot define a capability before defining the related Roles, Competencies, Processes and Systems

Once data and relationships are captured, incredible management insights can be obtained for planning and Risk mitigation.

For instance, a matrix in the EA tool showing gaps between Organization Units that have no defined Role, or Roles with no associated competencies; this is absolutely imperative to avoid the Risk of non-realistic planning and poor management.



Figure 22: Overlaying Meta Model Elements on the Evolution Concept Components

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6.5 Conclusion

The FTC, as a military entity, is dependent both internally and externally. Internally, it depends on certain function such as finance, budget, legal, rules / regulations etc… Externally, it depends on technical support, logistics, competencies, international regulations, etc. … these entire dependencies expose the FTC in a number of risks. Although a reader would see a number of processes in some departments, these processes were initially limited to a single department but later continue to expand to the other departments of the FTC towards the whole organization. Here, the introduction and implementation of level 3 of CMMI shall play a vital role because (level 3 of CMMI) specifically addresses the process improvement as and within a complete organization. The on-going governance improvement in parallel to the CMMi is showing signs of positive results in communication, task distribution and responsibilities. Otherwise, without documented processes and methodologies, FTC would have remained weak, almost ineffective and decisions in many occasions would remain on "adhoc" basis.

The point once again, is that the FTC "As Is" organization lacked a cohesive approach; underlining in it the potential risk the FTC is subjected to. The author believes a risk management function introduced in the FTC would develop a new culture which will assist the FTC identify, determine and assess various issues, which would otherwise lead to major risks.

In the authors view, and based on his professional experience, believes a study and / or an understanding of the functioning of a flight test centre elsewhere in the world would provide an additional insight and knowledge of how FTCs' function elsewhere. Some potential lessons will be learnt - adding value to this paper.

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7 A COMPARATIVE STUDY OF FLIGHT TEST CENTRES

The author conducted a comparative study to compare the differences between civilian flight test centre and a militaries flight test centre. The descriptions below reflect a description and summary of the results.

7.1 SAAB AB Flight Test Centre

7.1.1 Background

This is a short description of the Flight Test and Verification organization at SAAB AB.
The text here is compiled based on a request that is stated in a cover to this document.
The information is intended to be used as background data and only gives a brief overview of the selected topics.
Flight Test involves many disciplines and nearly all of the technical areas that are needed to develop, verify and validate aerial vehicles and systems.

7.1.2 Mission

The Flight Test and Verification organization is responsible for test and evaluation of prototypes, modified and production aircraft through ground-, simulator and flight testing.
The organization is also responsible for support of marketing activities such as demonstrations, customer evaluations, ground and flight displays in connection with marketing activities and aerospace exhibitions.

7.1.3 Strategy

Flight Test and Verification satisfies customer needs for professional testing which includes development testing, verification and validation and delivers quality assured test results to competitive prices
Flight Test and Verification has world class competence and cost efficiency and performs testing and related activities in Sweden and abroad
In addition to testing and verification, Flight Test and Verification is responsible for and performs Saab AB requirements for military air operations and participates in marketing campaigns and customer support.

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7.1.4 Organization

The Saab Flight Test and Verification organization has around 200 employees and performs all tasks necessary to perform flight testing.
The main areas are test engineering, flight operations, aviation maintenance and flight test instrumentation. Test Management is also a vital part of running a successful flight test organization.

Below is an organization chart of the flight test and verification department

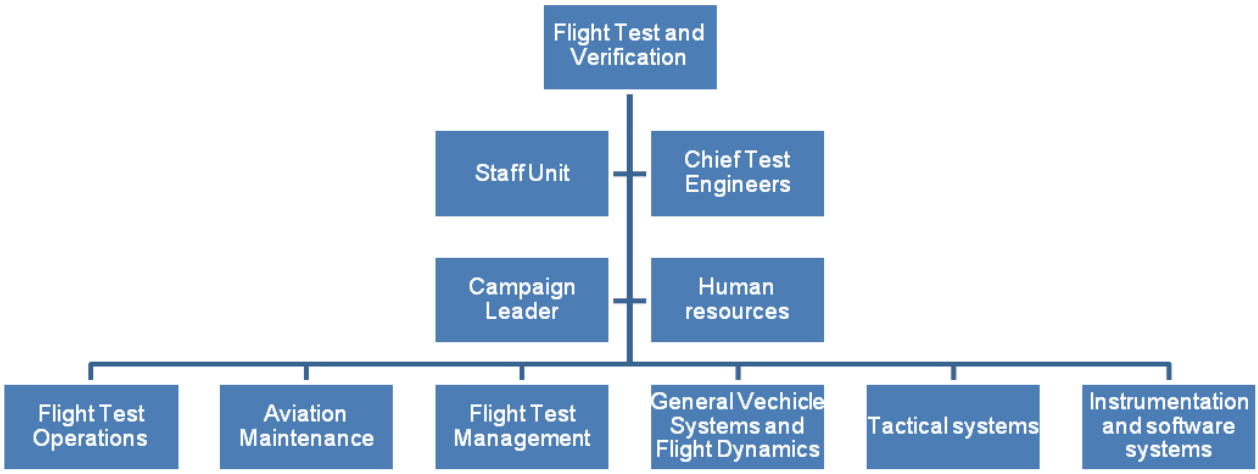

Figure 23: Organization chart of Flight Test and Verification Department

Test Engineers

Test engineering tasks are to perform development tests, verification- and validation in rigs and ground test stations as well as in aircraft.
The test engineering departments provides testing within all needed areas such as:

- Aerodynamics, Flying qualities & flight control systems, Performance
- Primary data and navigation, Landing systems
- Target acquisition systems, Identification systems, Electronic warfare systems
- Reconnaissance systems
- Weapon systems, Armament installation, External stores
- Human-machine interface, Communication systems, Decision and mission support
- System computer and adapter units, S/W-edition check-outs
- Functional monitoring and built in test, Maintenance data recording
- Complete aircraft
- Fuel systems, Environmental control systems /AEA, Propulsion
- Secondary power systems, Electrical power and lighting systems
- Hydraulic systems, Landing gear and brake systems, Escape systems
- Structure, Environmental testing, (thermal & mechanical), Ground vibration testing

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The work is organized in test task where the test teams have members that together have all the needed competences. Members are not necessarily only from the test organization but the test task manager is always from the flight test organization and has been trained accordingly.

Flight Test Operations

The department is responsible for flying the flight tests, perform simulation of subsystems, systems and complete aircraft and review system and operating documentation.
All test pilots have a solid Swedish Air Force background to ensure the highest flying proficiency and up-to-date knowledge of all different aspects of operational requirements.
The area manager is Flight Operations Manager according to military rules and in certain respects under the command of the Inspectorate of Military Flight Safety, FLYGI according to Rules for Military Aviation - RML.

Aviation Maintenance

The department is responsible for aircraft maintenance regarding test aircraft, in-service aircraft on loan and ground support equipment (GSE).
The area manager is Technical Manager according to military rules and in certain respects under the command of the Inspectorate of Military Flight Safety, FLYGI according to Rules for Military Aviation - RML.

Flight Test Instrumentation

Activities within this area include development and administration of measuring equipment, analysis software, operation and maintenance the telemetry centre and operation and maintenance of the test data computer centre.

Flight Test Management

Flight Test Management is responsible for planning, management and control of the entire flight test work. Flight Test Management is also responsible for ensuring that test assignments specified are carried out according to commitment regarding time, technique and costs

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More information

Versatility – Services include static, fatigue and damage-tolerance testing, and subjects may range from small components to full-scale structures. Our experience includes the certification process of commercial and military aircraft, including test request, test plan and certification documentation



Not all testing is done in the air; much of the work is done in laboratories and rigs on the ground where our specialists
can investigate anything from the smallest component to full-scale structures.

STRUCTURAL TESTING - STATIC EFFECT
Saab engineers can design and manufacture tailor-made stress test rigs so we are able to take full responsibility for your entire evaluation requirements, from draft stage to final report.

EXPERTISE:
Our experienced test managers and well-equipped facilities can readily meet the requirements of the modern aerospace industry, taking care of your complete testing process. From small components to complete airframes, we can quickly construct tests from a wide range of standardised equipment, as well as designing and manufacturing tailor-made test rigs. Operations are certified to ISO 9001 and AS/EN 9100.

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FACILITIES:

Mobility – Test rigs are designed and manufactured using CATIA 3D modelling software and our own workshops. Our load control facilities are equipped with leading-edge computer systems. We can conduct stress and strain measurement at Saab laboratories, or at the customer's site using mobile, high-capacity data acquisition systems. We also perform test article inspections using the latest NDT methods.

EXPERTISE:

In developing the Gripen NG fighter, we will make extensive use of our wide range of state of-the-art environmental test equipment. Our ground-breaking facilities are as equally suited to commercial uses as military development, and we now have the capacity to undertake test programmes for commercial vehicles, electronic systems, or even a component for a domestic appliance.

FACILITIES:

Climatic testing – Our climatic chambers, including the largest facility in Sweden, enable the recreation of multiple environmental conditions, including humidity, pressure and temperature.

Mechanical testing – Vibration rigs simulate operating, handling and transportation conditions, allowing weaknesses to be discovered and corrected before the product is launched. Measurements by accelerometer or strain gauges are controlled by a sophisticated computer system. Mechanical tests can also be combined with different climatic conditions.

Modal testing – Our state-of-the art experimental test equipment can accommodate several hundred transducers, picking up the response of a structure subjected to a vibration input. Through advanced software the modal characteristics of the structure are then determined. This equipment can be used for small, simple items up to large and complex structures such as complete aircraft.

Rain erosion testing – Our rain erosion rig, the only one of its kind in Europe, tests the ability of any material, including advanced composites, to withstand being struck by water droplets at high speed. Whether it's an aircraft wing, part of a missile, or the blade of a wind-power installation, rain erosion could cause damage to the top coating of a structure, leading to more serious, costly problems. The test rig can prevent potential problems in prototypes, enabling solutions to be found before a product is launched. It comprises a horizontal, rotating asymmetrical arm in a cylindrical bay, while water droplets are spread through oscillating nozzles.

Thermal flow – Thermal flow chambers combine high-capacity air compressors, heaters and vacuum pumps to perform a wide range of thermal flow tests not commonly available elsewhere.
Fire resistance and acoustic noise tests are also available.

Process and certification

Saab has RML and EASA certificates allowing the organization to develop, flight test (flight operations and aviation maintenance) and produce aircrafts.

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Flight Test Permits are generally given on a yearly basis, and allows the organization to perform flight test without direct involvement from the authorities.
The flight test process is a generic process that is used for all testing. The test process stipulates requirements on planning, configuration, permits, flight safety, performing tests, data reduction and reporting.
Part of the authority's certification is requirement on competences. Saab has an in-house test engineer authorization program. The program grants different levels of authorizations where the higher ones permit the test engineer to lead more complex and high risk flight testing.

7.1.5 Interface with government

Saab has a close cooperation with the Swedish Defence Material Administration (FMV) and the operational development wing of the Swedish Air Force.
The Swedish Air Force provides the operational requirements and FMV translates this to top level aircraft system specifications.
Generally a contract is signed between FMV and the industry (Saab) that stipulates a close cooperation between all parties for the total development and operational clearance phases.
Within the contract Saab Flight Test and Verification has a focus on development test, verification and validation, FMV focus on acceptance testing and air force focus on tactical development and service introduction. The work is performed as combined tests whenever possible.
The work share is naturally high for flight testing coupled to the development work and therefore the industry performs most of the test activities and usage of test facilities.

7.1.6 Challenges

Demand is constantly growing for more efficient development of aircraft systems to create systems in the forefront of technology and at the same time keep costs down to a minimum. This also means pressure on the flight test organization to develop more efficient test methods, test tools and ways of working.
The trend is to use model based system development approaches. The challenge for the flight test organization is to constantly develop more efficient testing while maintaining high focus on flight safety.
Saab is in the forefront of this and is able to introduce the use of the new test methods based on new technology combined with long experience of flight testing and development work.

7.1.7 Risk and Lessons Learnt

Flight safety is always a big and important issue for flight testing. Based on decades of experience the flight safety is built into the generic flight test process and is both efficient and safe.
Based on experience the key components are clear responsibilities in the organization, flight safety build into the processes and the mind of people involved, close cooperation with the development organization and external parties, and also mechanisms to develop more efficient ways of working.

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7.2 The Operational Test and Evaluation Centre (CEAM) in France

« L'expertise au service des forces » / Le Centre d'Expériences Aériennes Militaires

The Operational Test and Evaluation Centre (CEAM in French) was created in 1933 in Reims by the Air Force first chief of staff to define the employment rules of equipments before their delivery in the units.

Then it was transferred in Orleans-Bricy in 39 to take it away from the German threat.

At the liberation, the CEAM settles down in Mont de Marsan on the infrastructure left by the Germans under the orders of the colonel K.W.Rozannoff.

Until then, the experiments become more extensive. Today, the activities of this decentralized Air Force General Staff extend from operational medicine to information and communication systems, from safety sets on fire to systems of the most complex weapons, so becoming a pole of operational validation and development follow-up.

The integration of new equipments is accompanied from their conception to the operational launch.

The CEAM also follows the evolution of equipments already used in the forces so as to propose and validate adaptations answering to an urgent operational need.

Because of its double skill, technical and operational, the centre insures the connection between manufacturers and operational, inter-service and combined requirements.

With a so named long program, the CEAM enters into a development follow-up process. As soon as there is a need, it intervenes to advise the Air Force Staff (EMAA in French), participate in the criticism of the contracts technical clauses as well as in the developments and trials made by the manufacturer or the armament head office.

The CEAM receives the material.

Then its teams test the equipment to check the operational capacities.

This work of tactical analysis, sampling of operations, this fundamental phase of "grinding" allows to clarify the best possible outline of use of a new product.

At this stage, the CEAM is in charge of proposing a first use manual and teaching the first users.

In support of forces in operation, the CEAM has to work on programs called «Urgent ops» whose process is shorter.

It realizes by itself or in support of the products manufacturer answering to an urgent operational need.

According to a quality process that responds to the standard ISO 9001 v2000, these products, realized under the form of prototypes, are proposed for industrialization within the state or the manufacture.

To be as closed as possible to users, an experience feedback office was organized in 2006. Its role is to get information for a permanent questioning and an evolution of the experiments methods.

The CEAM brings a coherent global vision of a mini future Air Force.

The staff of 1000 persons from the forces gives it this legitimacy because it relies on their operational experience to lead the annual 500 works relative to the programs. Within the CEAM

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they have the opportunity to work at filling the lacks that they perceived when they were in operational units.
Through all the representative specialities of the Air Force, this critical glance establishes the advantage of such a centre.
Without breaking the operational capacities, the CEAM joins in a concern to satisfy at best and as quickly as possible the need of the forces.
Below is an example of the French Air Force flow chart from preparation, concept realization and service life. It emphasises the whole procurement cycle and the implementation steps. Given the French air force needs and specific process, the author learnt that DGA has developed its own EA Framework. The need for a specific and dedicated framework for an enterprise or an organization has its pros and cons. Each organization needs to find the best balance (mainly cost and time or both) in their decision to developing and introducing a cost effective framework.

7.3 Dassault Aviation Flight test Centre Organization

7.3.1 Overview

The proposed Flight test centre organization is based on the matrix principle. Vertically, there are the trade departments (aircraft support, data analysis engineers, test means…) and horizontally, the program department.

This organization allows performing different flight test activities including military and civilian program.

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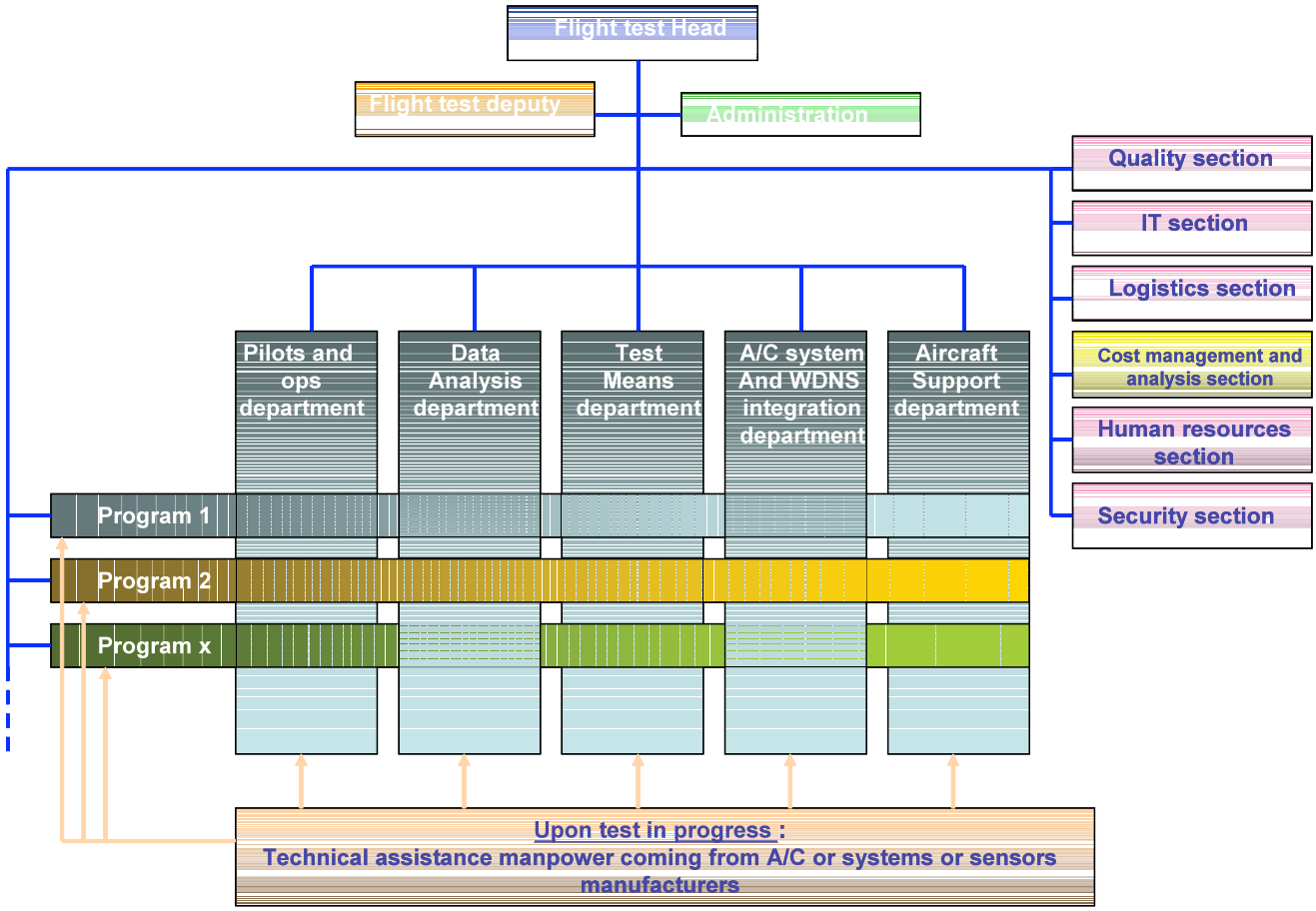

Figure 24: Flight test activities

As an example, program 1 is in charge to enhance existing armament on fighter aircraft and program 2 to perform the certification of new winglet on civilian aircraft. The corresponding organization of the trade departments has to be compliant with these requirements. The solution used in some existing manufacturer flight test centre is to divide trade departments in two, or more, sections (see the figure below).

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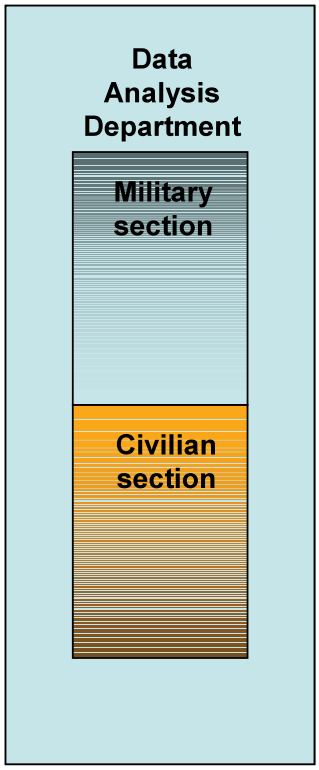

Figure 25: Trade Departments

As a synthesis, military and civilian activities are organized at trade department level and not at management level.
This organization allows reducing technical hazards because:

- There is an only one management (and manager) at all level (head of centre, heads of departments, …) and consequently all actions are coordinate in the same direction :
- Management process and reviews
- Ground and flight test safety matters
- Test means
- Budget and procurement and program sharing
- On each department the personnel is :
- Assigned to one section during the program duration
- capable to move from one section to another one section given to the management the full manpower program adaptability
- able to transfer knowledge and experience for the flight test centre benefit
  This general process allows reducing the general manpower cost of the flight test centre due to the non-duplicate manpower organization

Technical manpower

The flight test centre technical manpower is usually divided in two categories:

- Technical manpower (engineers, technicians…) directly appointed by the centre. These personnel received the basic and generic aeronautical knowledge. Obviously these people are trained specifically on limited aircraft or system or weapon types.

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- Technical assistance: specialized manpower contracted upon needs by the centre to other entities (aircraft / weapon / System manufacturers, Air Forces…). These personnel are fully specialized and provide to the centre the specific knowledge and habilitation requested by the current activities on such or such aircraft or equipment or weapon.
  As a result, the association of the two personnel categories (the first one represent 90% of the total number of employee) will allow to the centre to work on different aircraft program

Budget

A powerful "Cost Management and Analysis Section" is mandatory in order to master expenses and procurement. Cost control process has to be permanent during a test campaign and the flight test centre manager must know month by month the gap between effective and expected cost in order to take the necessaries action. This process request to have belonged to the centre:

- Specialized manpower in charge to compute :
  - the final cost of a program (taking into account test means, charges, manpower involved, …)
  - the expected cost repartition during the campaign
  - the real expenses month by month and the comparison with the expected expenses

Partnerships

A flight test centre has to be open on the "external world" in order to:

- acquire knowledge from other entities
- dispatch his know-how to other entities *(this topic is fundamental to get an international recognition)*

  Main entities are:
- R&D networks European and worldwide
- Aerospace industry
- Universities (education and training)

7.3.2 Challenges - Recommendations

To perform flight test activities in civilian and military field is a real challenge. Around the world, only a few existing test centres are able to do this. The key of the success is certainly the flight test centre manpower taking into account :

- For the engineers, the mandatory initial technical knowledge and in consequence the necessary recruitment in the very high aeronautical schools (France, UK, US, India …)
- For technician, a recruitment strategy in specialized school (instrumentation, measures, …)
- For aircraft crew, a recruitment process in Air Forces given a high technical knowledge and experience.
- For all trades an onsite initial On The Job training with experimented trainers (coming from existing flight test centre)

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- A permanent training process given to all trades the international qualification, especially for civilian aircraft works and aircraft servicing
- A full quality process recognized by international standard (EN9100…).

The author observed at the early stage of this thesis, that Dassault Aviation has not embarked in to CMMi; I understood it was mainly due to cost. I personally think that the added value of CMMi was not seen as such. However, it became apparent now that Dassault Aviation is, at least in some departments, undergoing CMMi certification.

7.4 A General Comparison between Military and Civil Flight Test Centres

The author has conducted a brief comparison between a civilian and a military FTC. The table below describes the differences in, not only in functions but also rules and regulations governing the flight-testing within the aerospace industry as well as the challenges and limitations.

FLIGHT TEST CENTRE			
MILITARY		CIVIL	**RISKS IN CIVIL**
1/ AVIATION RULES		1/ AVAILABILITY OF PERSONNEL	**1/ Availability of the PERSONNEL** **A Motivated Population: The need to employ young graduates, aware of new techniques, bringing in, new innovative spirit**
Reduced Traffic		Long working hours	
Flexibility in flight (time) slot		Reduced Turn over of the Teams	
		More availability and flexibility of Personnel	
		Perennity/continuity of informations	
2/ SAFETY and AVAILABILITY OF MEANS			
Longer and reliable runway		2/ BUDGET/FINANCING	**2/ BUDGET/FINANCING** **To well evaluate:** **- the capacity of the company to auto-finance and the reliability of the industrial partners and banks-emergency/ back-up solutions in case of unforeseen risks**
Base Infrastructure (Control Tower, Fire fighters,…) Far from big cities >>> reduced collateral damages in case of accident/crash		Autofinancing … possible Highly active/dynamic for investment or launching of conceptual studies thruself/auto-funding	
Reduced Traffic			**Ex : CATIA (Dassault Aviation internal development, and the creation of "Dassault Systeme" for marketting), FALCON aircraft which is purely a Dassault Aviation funded project**
3 / CONFIDENTIALITY OF TESTING & TESTS			**3/ MARCHE EXPORT**

Protection of information		**Easily accessible and open to civil**
Industrial "espinnage" more difficult		**A commercial and marketting approach simpler and easier** **Highly competent business oriented specialists**
4/ MILITARY MARKET : PROTECTED	4/ CIVILIAN CERTIFICATION	**4/ CERTIFICATION** **Protection policies in Organizations : Risk of delay in the certification process, (in a given area/zone) caused by the relevant local authorities, (tactically) to favour a competitor**
Local Market ensured	**Certification FAA (USA), JAA(EU) for civilian aircraft**	
	5/ PILOT QUALIFICATION	**5/ PILOTS** **The selection of pilots having a wide experience in military domains, are normally considered efficient in tuning civilian products**
		Qualification of pilots for civilian aircraft has to be financed by the flight test centre
	6/ INDUSTRIAL CERTIFICATION	**6/ CERTIFICATION** **The need to well evaluate the cost for maintaining the skills as well as the industrial means, and consequently leading to retaining/maintaining the "certification"**
Certification of the test centre >>> ISO 9001 (Working Methodologies), ISO14001 (Respecting/abiding by/to the environnement) by Bureau Veritas		
Audit regulier pour conserver les certifications		

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7/ A NEED FOR A TREASURY or Finance department	**7/ TREASURY/FINANCE** **The need to evaluate:** **- the reliability of the industrial partners so as to allow the bonding of the budget provisions required for the development** **"**
Necessitates a Cycle of "Concept definition, Production, delivery" short to ensure a higher rate of cash turn-over/quick return; this is necessary for the survival of a civilian company (Payment of Salaires, Charges, Taxes)	

Table 2: A comparative approaches between militaries and civilian flight test centre

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Given the table above, the author with his professional experience, considers the synergy between civil and military flight testing is extremely important for the FTC, given the complexity associated with competencies, infra-structure, operation cost … However, combining civil and military functions, with 2 clients of different culture, is in itself a challenge which comes up with its own risk. The rules and regulations are different and so are the risks, priorities and safety requirements as well as budget and authority. The thesis will address, in the author's opinion, the best approach for FTC path towards a civilian entity.

7.5 Conclusion

In reviewing the above test centres, the author with his professional experience, has come up with the following comments:

- SAAB and Dassault Aviation combines both civil and military activities/projects, while the French air force has still maintained CEAM and the Swedish air force has maintained FMV.
- CEAM is deeply supported by the DGA while maintaining a coordination and cooperation with the industries. Additionally, CEAM acts as a watch dog to ensure that products and services for DGA customers are well performed, while providing an in-house capability for operational evaluations.
- Flight testing remains a key function in the aerospace industry and a key platform in the air forces. DGA continues to maintain CEAM although Dassault Aviation and EADS are running their FTC.

As a professional, having worked in fight testing, I consider the United Arab Emirates need to define a synergy between a civilian and a military FTC mainly because:

- the UAE is a small country – more than FTC would be more expensive
- a synergy between civil and military is necessarily important, to combine both activities – rules and process/firewall to be defined
- a combined (civil and military) FTC is more likely to be commercially viable as human resources, expertise and competencies, infra-structure, vision/strategy, etc. will be commonly shared, thus providing huge cost savings.
- Neither SAAB, Dassault Aviation nor CEAM seem to have any local competition in flight testing in their own countries. This, in my opinion, confirms the fact that government support to FTC is critical to its survival, sustainability and innovation. As a professional, this lack of competition contradicts the theory of competition as necessary for innovation, because both Dassault Aviation and SAAB are among the world successful aerospace companies.

As having worked in numerous aviation projects, I believe innovation does not necessarily have to come within an enterprise or competition. External forces can influence progress and innovation:

again I believe that this is the case for both the above companies. The needs, requirements and "exigencies" of the client has largely contributed to their success – leadership with vision and a culture for innovation, combined with governance and structured processes, I believe, are all contributors to their success.

The FTC has a lot to learn from the above test centres. They have passed through lots of challenges over time to reach the level of knowledge, competence and governance. Each one has different views and strategies, but at the core of their activities, they all share the need for safety, qualified processes, skills and resources. Risk management is a component in their organizations and embedded in their processes. This provides a better governance and efficient risk management function.

As the author has concluded above, the importance and necessity for proper governance, the later becomes ad-hoc without a structured process in the FTC; and as a professional, the need for a structured and certified processes are key for a better governance. As a professional I decided to evaluate the CMMi as a potential candidate to introduce and continuously improve the FTC processes.

In this regard, the author presents an introduction and a brief study on CMMI, as a process improvement tool for the FTC for the reader have a better understanding; the author shall describe the added value CMMi shall provide when implemented in the FTC. The author intends to merge process improvement with enterprise architecture framework for FTC, for a better governance and consequently better risk management.

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8 GOVERNANCE

8.1 Challenges and Risks for the FTC

The word "governance" describes a concept - that people in any position of power or authority should apply that authority to control events wisely, and for the benefit of others. Governance in its widest sense refers to how any organization, including a nation, is run. Governance describes the overall management approach through which senior executives direct and control the entire organization, using a combination of management information and hierarchical management control structures. Governance activities ensure that critical management information reaching the executive team is sufficiently complete, accurate and timely to enable appropriate management decision making, and provide the control mechanisms to ensure that strategies, directions and instructions from management are carried out systematically and effectively in order to achieve corporate goals. [212]

Every organization has unique needs and goals that influence its approach to governance. For example, larger organization will probably require more detailed governance than smaller organization. Within the context of the FTC, the authors considers introducing a comprehensive governance function. Such a comprehensive governance shall benefit all FTC organization to streamline the deployment of their capability and services, to protect FTC from security threat or non-compliance liability and to earn best return on investment for their investors, by developing best practice for continuous improvement framework. [214]. The introduction of both EA and CMMi processes supported “governance principles, As CMMi and EA were progressing, governance became gradually evident and apparent with the FTC as slowly the FTC was heading towards a process oriented-governed organization. Templates were being developed, processes starting to take a lead, and a new culture was being born.

If there is a wider spread understanding of what governance is, why is there also examples of poor governance? The main reason in the FTC, seems to be a lack of knowledge and education at the higher management, of what to do about poor governance; in fact we did not realize it . Before the author’s endeavour to introduce governance, the FTC higher management as well as the staff, felt powerless to change the situation, and just accepted it.

Since the beginning of the author’s initiative, Governance, Risk and Compliance or "GRC" has become an increasingly recognized term among the FTC staff, reflecting a new way in which FTC adopts an integrated approach to these aspects of their business [213]. "GRC is an integrated, holistic approach to organization-wide governance, risk and compliance ensuring that an organization acts ethically correct and in accordance with its risk appetite, internal policies and external regulations through the alignment of strategy, processes, technology and people, thereby improving efficiency and effectiveness": this is exactly the author’s objective towards the FTC “To-Be”.

GRC can be represented schematically as shown in diagram below.

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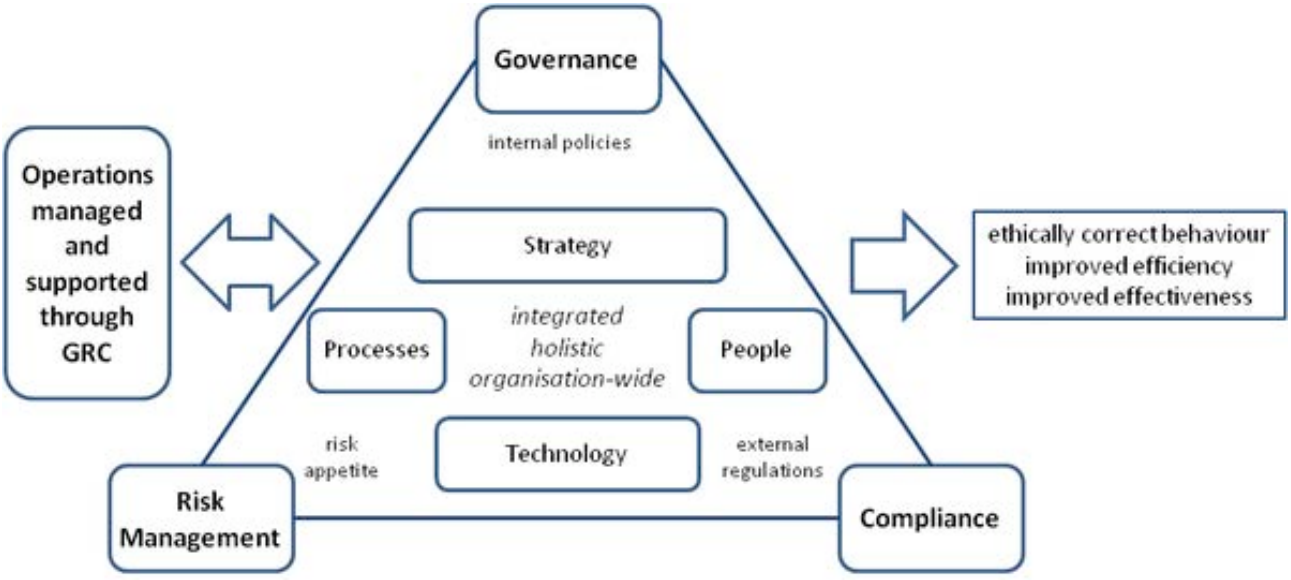

Figure 26: GOVERNANCE - Challenges and Risks for Enterprises

In applying this approach, FTC will help to achieve the objectives of GRC: ethically correct behaviour, and improve efficiency and effectiveness of any of the elements involved.
The FTC has a unique challenges to implement a governance plan that is tailor to it environment;

- Misgovernance in finance and corruption are the key challenges where these issues were not acknowledged. Red tape is the set of rules and regulations that FTC are obliged to comply in order to engage in entrepreneurial activity. Xxx…..
- Managing business risk and achieving regulatory compliance are among the greatest challenges that FTC shall continue to face.
- Corporate responsibility to enhance mutually dependent relationship between business and societies. Shareholders, in fact, expect their corporations to meet society's demands, consistent with maximizing the value of the firm. Indeed, the author shares what experience has shown that companies that do so are generally the best performers in the long run.
- Multinational enterprises sometimes are perceived as taking the money and running, not doing enough to build up local economies, and so on. They are accused of being party – in many cases, inadvertently – to serious problems such as corruption of public officials, and labor rights abuses and environmental damage. According to the world bank report 2011, the UAE ranks among the best in the region – just behind Qatar.
- The challenge for FTC businesses activities to engage in voluntary initiatives to improve their performance in various areas of business ethics as well as legal compliance.
  The author agrees that successful governance is an iterative process. As progress takes place in the FTC, a governance committee should be established under the leadership of the author, and shall meet regularly to consider incorporating new requirements in the FTC governance plan, re-evaluate and adjust governance principles, or resolve conflicts. The FTC committee shall provide regular reports to its executive sponsors to promote accountability and to help enforce compliance across the FTC. Consider that, although this process seems complicated, its goals are to increase the return on investment in the FTC, take full advantage of the usefulness and improve the productivity of the enterprise. Among the biggest challenges the author has faced in

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this endeavour to introduce governance and establishment of a committee to raise reports and promote accountability, was a fear (psychological effect in humans) and the normal human trend: “resistance to change”. This factor was evident as the author was introducing improvements in various areas (CMMi, EAF, Governance), in parallel.

In his research, and within the context of governance, the author learnt that in 2011 and the 3rd quarter of 2012, both world bank reports and International Monetary fund Reports)IMF), indicate that poor governance or lack of governance in developing countries, is often more visible in the form of corruption , the impact of corruption in developing countries is considerable more damaging given the poverty of the citizens and the lack of adequate infrastructure. The World Bank estimates that US $ 1.5 trillion is lost to bribery per annum in which a large sector of loss is related to infrastructure. Where this happens, other aspects of governance may only receive limited attention. Such aspects might lead to badly chosen technical solutions, inefficient use of resources, inappropriate staffing levels and inadequate staff skills for the jobs that need to be done. Poor governance can also lead to non-existent use of an organization’s strategies and processes that slow down FTC values. In-effective processes, integrated with automated workflows will result in continuous product delays and poor productivity. However, as the FTC is a military organization; corruption is controlled through a number of security measures and authority, within the military. But the biggest challenge facing the FTC in its process of introducing governance, is the timely recruitment of competent resources and the external agencies to which the FTC depends.

8.2 Risk in Governance

The governance function in the FTC, is carried out by the higher management or equivalent, and is linked to both demand and supply management activities. It is focussing on risk situations that might compromise the realization of expected benefits in the FTC, and it is developing risk minimization strategies -- activities that will negate the risk or reduce its potential impact.
This focus will include existing business systems, business systems under development, and business systems being considered for approval.
From a functional perspective, the various FTC management layers report frequently to their higher management and alert them of any major risk events, their consequences, and actions to eliminate, avoid or reduce them. Monthly meetings at FTC, sets the table for reporting and discussions by all required layers of the organizational structure. It is the author’s endeavour that the human resources manager and risk manager, in coordination with other departments, will be initially responsible for approving processes for risk categorization, business impact assessment weightings, risk probability determination guidelines, and finally, the probability/impact index threshold, i.e., when the probability is high and potential impact is so serious that it must be reported to the executive.
The author continues to work towards the risk governance practices, and is following closely the activities by the designated staff, to include in the FTC guidelines for the following:
- Discontinuing the funding for a project if the likelihood of realizing expected benefits is low (e.g., the differentiated services being developed are no longer in demand by the end-user, who is until now, the UAEAF&AD; such is the case for the integration of helmet mounted display which the customer initially expressed its desire to get it evaluated and later integrated and tested, but later backed away or delayed the need.
- As the FTC is on its path for improvement in parallel areas (EA, CMMi, Governance …), the author proposed to postpone a new program/project until progress is stable and the risks are lower
- Postponing the program/project (e.g., until dependent software has been proven by the vendor or other clients, or critical technical resources have been secured);

As the FTC progresses towards the future – To Be scenario –
- the FTC will have to be dynamic and responsive to potential changes, which will reduce the scope and funding of the program/project because the expected market or opportunity has shrunk slightly; and,
- Continuing development as per schedule while regularly monitoring risks in the knowledge that the cost of doing nothing is itself too high to contemplate.

The FTC staffs continue to have considerable grasp of the impact of implementing aspects of the guidelines above when, for example, discontinuing a program/project and having to determine the breakage costs. The FTC leadership is responding to questions such as: Have the risks been objectively assessed? Are the risks overstated? Has management tried to implement all risk minimization options? Who will be adversely impacted if the program/project has to be cancelled or postponed? At this early stage of transition, the author and the FTC are facing a number of challenges in the implementation process due mainly to resistance, lack of competency and external factors to the FTC. This includes recruitment of experts, delays in signing contracts or delays in implementing changes to the contract and limited management authority.
The author has observed that much organizational learning takes place at FTC meetings when all aspects of the risk event are canvassed, business impact assessed, scenarios presented and a course of action determined.

8.3 Conclusion

In summary for many institutions the business case for GRC is clearer than ever. Companies are faced with a wave of regulatory initiatives. Their Boards and Regulators are demanding more detailed and timelier information. Turnover of staff introduces a risk that key knowledge is lost to the organization. There is a need to do more for less and to be more efficient in the use of resources. GRC ensures that all the local regulations and policies are captured and managed whilst also ensuring that group best practice is adopted in each locality, with consistent processes and business controls being observed. The ability to see consistent and consolidated reporting across all entities is also key. Today, the FTC is not subjected to such shareholders constraints and pressure. But as a civilian entity, the situation will be different. And thus effective Governance is essential to control and manage internal bureaucracy and externally, to respond to shareholders and customers expectations.

The FTC represents a unique capability in the UAE and the region, providing a base for core aviation technologies. The UAEAF&AD has seen a tremendous expansion and growth over the last twenty years. These include the introduction of a new fleet of aircraft and upgrading of existing aircraft. As described in the previous chapters, four major French companies and two other major companies from Europe and the United States were involved. The M2000 aircraft had to undergo various standards (at least seven standards) of upgrades in the last twenty years. In each standard upgrade, flight-testing was a major milestone of the program. Using this unique program the author

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experienced, the author believes that aerospace and aviation shall remain extremely dynamic, progressive with continuous technology innovation: the need for such innovations in the UAEAF&AD is real, to maintain the technology edge: thus the need for a sustainable and effective FTC.

A non-consistent use of processes or at the worst, the non-existence of processes, would entail the FTC towards poor governance that would slow down organization values and successes. Effective processes integrated with automated workflows provide work efficiency and common awareness through information sharing, avoid redundancies and thus lowers the risk of poor performance and low productivity. The author believes that introducing EA shall effectively improve the FTC governance and lower the risk. For the reader, the author provides here below, the EA definitions, and describes the value EA shall provide to the FTC.

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9 RISK MANAGEMENT

9.1 Introduction

The desirability of developing risk management (RM) in organizations is clear (((Boehm,1991),(Jones,1998), Higuera, and Haimes,1996))). Recent large company failures, uncertainties in global markets, and concerns about the effectiveness of corporate governance merely serve to underline the central importance of RM ((((Kapuria, 2006), (Makedonov, 2006),(Reifer,1993),(Van Scoy, 1992)))). Uncertainty and risk is inherent in all organizational activity ((Young, 1997), Department of the Air Force, (2003). Every member of an organization needs to make decisions, plan, and manage uncertainty to a greater or lesser extent, so RM should find natural application in all organizational activity. Indeed, much existing good management practice could be regarded as RM. For example, effective planning, coordination, setting objectives, and control procedures are all responses to pervasive sources of risk such as human error, omissions, communications and so on (Integrated IT Risk Management, Symantec Corporation, (2007). Nevertheless, the extent and quality of RM carried out in an organization can be very variable, ranging from sophisticated, formal processes in some areas to a reluctance to contemplate uncertainty in any form ((Fischer, 2008), (Dickinson,2003)). A common intermediate approach involves informal processes, often involving little more than an intuitive perception of risk, followed by ad hoc approaches to the management of risks. In the absence of formal processes, RM is often implicit within existing business processes, so that it is less effective than it could be. The challenge is how to develop RM practice in ways which increase the extent and effectiveness of RM in the organization (((Deloach, 2000),(Taylor, 2006 and 2005),(Baccarini et al,2004))). Such development could be the subject of a corporate-wide initiative, or expansion of existing areas of RM activity within particular organization units. Taking a strategic management approach to such development involves three main elements (Johnson and Scholes, 2002): *

1. understanding the strategic position;
2. understanding strategic choices;
3. And * turning strategy into action.

In RM terms, understanding the strategic position would be concerned with understanding the nature and extent of current RM practice, in respect of the external environment, internal resources and competences, and the expectations and influences of stakeholders (((Barki et al 1993 and 2001), Boehm, B. W. (1991), (Christopher et al, 2002))). This includes understanding and questioning assumptions or constraints which might have a fundamental influence on selected RM development strategies. Understanding strategic choices involves understanding the options for developing RM in terms both of the directions in which development might proceed and of the methods of development. Selection of approaches involves evaluation of the suitability, feasibility and acceptability of possible strategy choices (Johnson and Scholes, 2002). Turning strategy into action is concerned with successfully implementing the chosen strategy via appropriate administrative structures, resourcing, exploiting existing competences, and the effective management of change. Note that while any strategy implementation or organizational change involves risk and uncertainty (and therefore warrants the use of RM), the introduction of changes in RM practice itself also carries associated risk and uncertainty (Chapman and Ward, 2003). Each of these three elements is important and potentially non-trivial, even if the focus is the development of RM within a single

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organizational unit. The aim of this paper is to identify the nature of RM development choices available to provide a basis for RM development strategy. The rationale for this is that unless the possibilities for developing RM are clarified it is not possible to make the most effective choices about how to develop RM capability ((Bornman and Labuschagne, 2004), (Innerhofer-Oberperfler, and Breu, 2006)).

Discussion is structured around a framework of six separable directions or dimensions in which an organization's RM practice could be developed. This framework could be used, by either corporate or unit management, not only to identify options for RM development but also to structure analysis of an organization's 'strategic position' in respect of RM practice. Integrated RM and related concepts The desirability for corporate-wide capability in RM has motivated the introduction of terms such as 'integrated', 'enterprise-wide', 'holistic', 'total' and 'organization' RM. Such terms attempt to capture key features of the envisaged RM activity, but can mean different things to different people. For example, the term 'integrated' RM is frequently used by corporate risk managers to refer to the joint management of all risk management functions in the organization. However, the term is well established in the financial risk management literature, where integration relates to the combined treatment of the various sources of financial risk, recognizing inter-dependencies between both sources risk and management responses. Integrated RM in the financial sense is concerned with employing insurance, debt, equity and financial derivatives in a coordinated manner to manage the organization's overall financial position (see for example Doherty, 2000). The term 'integrated' has also been used to describe the combined treatment of two or more areas of management concern. For example, CFO Research Services (2002) introduce the term 'strategic risk management' in discussing the 'integration' of risk management and strategic planning. Similarly, Miller and Waller use the term 'integrated RM' in discussing 'how scenario planning and real option analysis contribute to an integrated approach to managing risk' (2003:99). A somewhat different definition of integrated RM uses the term 'integrated' to mean the embedding of RM processes into all aspects of decision-making. For example, the Integrated RM Special Interest Group of the Association of Insurance and Risk Managers defines the achievement of integrated RM as 'when RM is integrated (or embedded) into all of the functions and processes within the organization' (Association of Insurance and Risk Managers in Commerce, 1999:4).

Enterprise-wide RM is described by Mottershead and Godfrey in terms of the extent of application of RM as an approach 'that looks at risk across the whole organization rather than through the traditional functions [and] aligns RM activities to shareholder value levers' (2001:11). However, Hodgkinson gives a wider, more detailed definition of enterprise-wide RM: ... a RM philosophy that is: positive and proactive; value based and broadly focused; embedded in processes; integrated into strategy and total operations; and continuous. (2001:27) The term 'holistic' RM is sometimes used in the simple sense of the management of all sources of risk (Hopkin, 2002). Miller and Waller clearly regard this as a necessary part of their view of integrated RM: 'The essence of integrated risk management is consideration of the full range of uncertain contingencies affecting business performance' (2003:99). However, in its proper sense, 'holistic' implies a systemic perspective, which recognizes system properties which are distinct from those of system components. In this sense holistic RM would imply recognition and management of interactive effects between organization activities and associated risks. Linking the concepts of enterprise-wide, holistic and integrated approaches, DeLoach defines enterprise-wide RM as meaning that: a truly holistic, integrated, forward looking and process orientated approach is taken to manage all key business risks and opportunities - not just financial ones- with the intent of maximizing shareholders value for the enterprise as a whole. (2000:5) The foregoing definitions illustrate the potential for ambiguity, and even confusion, between the terms 'integrated', 'enterprise-wide' and 'holistic' RM. Terms such as 'total' and 'organization' RM are even more ambiguous. At best these terms and associated definitions may be useful in conveying a vision of corporate capability, but they offer

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little guidance about the directions in which appropriate RM practice might be developed. A number of recent publications aimed at managers have attempted to set out the concepts of integrated, enterprise-wide and holistic RM (Association of Insurance and Risk Managers in Commerce, 1999; DeLoach, 2000; Hopkin, 2002; Hunt, 2001). Table 1 summarizes the scope of some of this guidance. As the table indicates, the focus is on describing basic process frameworks, with some reference to related organizing principles. While this may be useful in explaining what a generic process of RM involves, such guidance offers limited advice on how organizations might deploy and develop RM. One consequence of this can be that organizations attempt to adopt particular RM processes as an 'add-on' to existing administrative processes, and in a simplified form to facilitate implementation. This can make it difficult subsequently to embed RM more closely into decision-making, or to increase its sophistication in useful directions. External pressures to implement measures by a certain date can exacerbate this tendency. For example, in the UK an important development was the publication of the Combined Code on Corporate Governance (Committee on Corporate Governance, London Stock Exchange, 1998), and of subsequent guidance on compliance for company directors developed by an ICAEW working party chaired by Nigel Turbull. This 'Turnbull guidance' was based on the adoption by a company's board of 'a risk based approach to establishing a sound system of internal control, and reviewing its effectiveness'(Institute of Chartered Accountants in England and Wales, 1999: para 9).

Understandably for a document addressed to board directors, the Tumbull guidance was confined to broad principles and provided little detailed guidance on the form that RM processes might take. The need for companies listed on the London Stock Exchange to become 'Turnbull- compliant' by the end of 2001 obliged many to augment their existing control systems, in a relatively short period of time, with risk-based review processes. For many firms this has resulted in a new risk-reporting structure which operates in parallel with, and somewhat separately from, other reporting and control systems. While such arrangements may be considered as complying with the requirements of the Combined Code on Corporate Governance, they fall well short of the possibilities for developing effective RM ((Thompson and Frost,1997),(Horrigan,1967)).

9.2 Managing the Risks

Risk management includes activities concerned with identifying, quantifying and responding to program risks. It includes maximizing the results of positive events and minimizing the consequences of adverse events. It is an iterative process initiated at start of the program and continues throughout the life cycle see Blacker (2000).

The Project Management Institute (PMI) has created a Guide to the Project Management Body of Knowledge (PMBOK).

- Risk Description

  The following is a summary of some of the currently identified categories of risks in FTC:

  - Political

    The risk that parts of the implementation are rejected on non-technical or non-operational grounds, mainly political decisions. Missile Treaty Control Regulation (MTCR)
  - Safety & Security: FTC today is in a operational military base; testing has a number of risks and require a more safer and dedicated environment, with sufficient safety considerations.

Risks associated with the safety of persons and property., as just around the base are civilians and properties which put constrains to certain testing and also a risk of something going wrong during the testing and effecting the civilians and their properties.

- Organisational
  Risks concerning the interactions of the Programme with other Programmes deliverables. In the FTC, the resources were limited and staff had military obligations other than just the FTC tasks. This had constraints on the activities, with higher risk of delays.

- Contractor specific
  All risks concerning possible lapses by the contractor, including late delivery. Any or all the above points remained potential risk for the FTC, as contractor is late due to to his sub-contractor. This matter happened twice and the risk remains until the program is completely and totally delivered.

- Effect of Risks
  Risks can have an effect an entity on the following aspects of a Programme/Project:
    - Schedule
    - Cost
    - Quality
    - Performance

  In his professional career, the author has encountered the above risks which in some cases, turned in to real problems. In his personal experience, the author believes that "risk" was not an existing culture; in the FTC: for example, more complex systems and shorter schedules were demanded from the suppliers, resulting in delays in delivery with consequently delaying the introduction in to service of the new systems and training.

In the FTC "To Be", the Risk Management department is building up its capability; the following functions are to be implemented:

- Measures to Estimate Severity of Risks
  Where possible, a quantitative measure will be used to estimate the severity of Risk Impact, Risk Probability, Risk Ranking, etc. … Accordingly, my objective, once again, is to identify, and create innovative ideas to respond and appropriately manage such risks. In principle, the mostly known principles of Risk Response, lies today in:

- Avoidance: eliminating the threat, usually by eliminating the cause (…);

- Mitigation: reducing the expected monetary value of a risk event by reducing the probability of occurrence, or reducing the risk event impact value, or both;

- Acceptance: accepting the consequences. Acceptance can be active (e.g. by developing a contingency plan…) or passive (e.g. by accepting a lower profit)
  Although there may be more than one potential strategy/tactic to deal with a risk, industries still strive to improve towards a better understanding and consequently achieve a better result.

I conclude this introduction by emphasizing that Risk Management needs to be achieved in an integrated process which includes, but not limited to, Risk Monitoring, Risk Control and Risk Response. It is necessary to consider both the immediate, pragmatic and flexible, short and long term risks and responses.

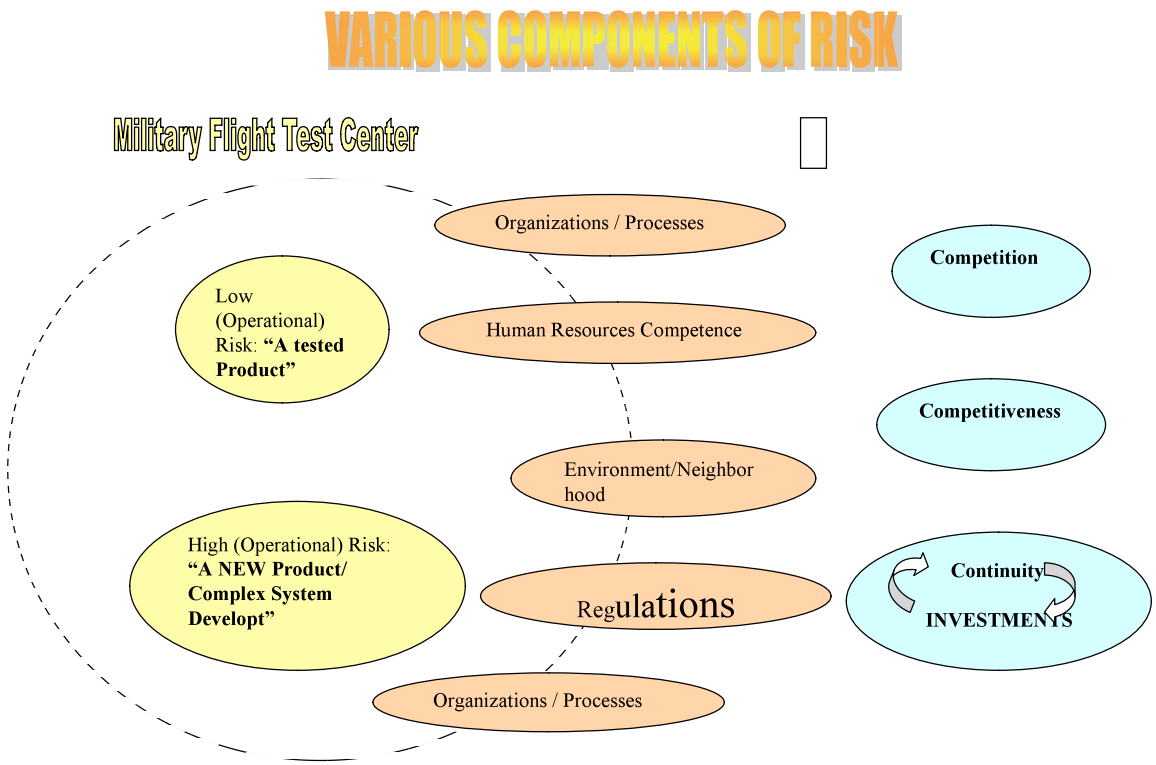

Figure 27: Various Components of Risk

9.3 Multi-disciplinary Approach to Risk Management – Safety & Security

9.3.1 Background

FTC has been running a project named "CMMI, Quality and Safety" where a company in the name of Abu Dhabi Systems Integration (ADSI) was the prime contractor. For FTC, the objective of this project concerns safety issues, measures and processes, specifically in relation to Safety Management System, in accordance with the guidelines of MIL-STD-882C, while taking into consideration the + SAFE V1.2 extension model to CMMI for Development .

The CMMIQS Program activities aim to improve the organizational processes and in this particular case, to reduce the safety risks involved with the conduction of FTC projects and operations, with risk analysis as a very relevant discipline within this domain.

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The Safety part of the project is piloted by D'Appolonia team, supported by a combined FTC and ADSI teams, and led by the author, to provide an integrated engineering and management service, during the whole project life cycle.

In consideration of the interest of FTC, a workshop on Risk Analysis for safety, was organized to identify and analyze the potential safety risks within the FTC.

V1.2 is an extension to the continuous representation of CMMI ® for Development, Version 1.2 (CMMI-DEV, V1.2). This extension consists of two process areas added to CMMI-DEV to provide an explicit and focused basis for appraising or improving an organization's capabilities for providing safety critical products.

+SAFE was designed to reduce the dependence of CMMI appraisers on safety domain expertise. Initially, this extension was developed for standalone use, but was later to be further developed and tailored to FTC specific applications. It is not intended to be embedded in a CMMI model document, nor is it integrated in the official CMMI certification of any level. However, there are intentional overlaps with CMMI model content and some safety standards.

During a two-day's workshop, Risk Analysis approach and methodology were discussed and introduced using D'Appolonia proprietary tool named ARES ,which was developed by D'Appolonia based on their extensive experience on Risk Analysis acquired during the many years in this sector .

Some preliminary findings relevant to the possibility of integration of the Risk Analysis service within the Enterprise FTC framework being implemented (in FTC) were presented. ARES represented the current implementation state, approach and methodology to Risk Analysis, and moving towards the evolution and customization of this tool: a valuable instrument that need to be developed, tailored and integrated in the existing FTC Framework.

The aims of the workshop were:

- Sharing of experiences, awareness and know-how on Risk Analysis
- Presentation of the methodology used by D'Appolonia in large programs
- Evaluation of tools devoted to support risk management practices associated mainly with safety Presentation through use of the tool and methods to perform studies and consultancies
- Discussion about the certain of a framework (including methodologies, tools and services) of Risk Management for FTC to be integrated in the Overall FTC framework

Events in the FTC can have negative impact, positive impact, or both. In implementing their relevant projects, FTC needs to understand that events with a negative impact represent risks, which can prevent value creation or erode existing value. Events with positive impact may offset negative impacts or represent opportunities.

Opportunities are the possibility that an event will occur and positively affect the achievement of objectives, supporting value or preservation. Management channels opportunities back to its strategy or objective -setting processes and formulating plans to seize the opportunities.

Committee of Sponsoring Organization of the Tread Way commission (COSO) defines the Risk management as "a process, effected by an entity's board of directors, management and other personal, applied in strategy setting and across the organization, designed to identify potential events that may affect the entity, and manage risk to be within an acceptable level (risk tolerance), to provide reasonable assurance regarding the achievement of entity objectives ".

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As can be easily noticed, the above definitions are purposefully broad. They can successfully apply to every project or operation where results and objectives are expected; additionally they can be relevant to several sectors that the enterprise it is dealing with (e.g. program Risk Management, Information Security, Safety, etc.).

An effective Risk Management process is therefore a key issue for the FTC organization. The principle goal of the risk management process for FTC is to protect FTC itself and its ability to perform its mission. Risk management has to be treated as an essential management function within FTC.

Standard and best practices in risk analysis in different sectors gather for these key concepts. The main state –of-art standards and best practices that have to be considered are the following:

- Project Risk Management:

- ISO/IEC Guide 73 Risk Management –Vocabulary – Guidelines for use in standards;

- Committee of sponsoring Organizations of the Tread way commission (COSO) ENTERPRISE Risk Management Integrated Framework;

- COBIT 4.1 –control Objectives for Information and Related Technology.

9.3.2 Safety & Security

The following standards were considered in the case study:

- DEF STAN 00-56-Saftey Management Requirements for Defence Systems;

- MIL STD 882 (Rev C and Rev D) Military Standard, System Safety Program Requirements .

Whereas an Organization has multiple involvements from several applications areas, a multidisciplinary approach and shared commonalities (but in parallel catering for sector-specific issues), would represent the best response for the need to harmonically fit into an organic enterprise framework.

In the authors view, this would fit the FTC operations, where the application of a structured-multidisciplinary methodology seems to be the best response to the FTC needs. The methodology should be:

-Based on NATO standard information security or similar standards;

-Based on best practices engineering approach;

-Based on quantitative approach;

- Assessed by external bodies (e.g. National Security Agencies) with

Operative Programs → best practice;

- Compliant with other standards and best practices (e.g. COSO, COBIT,

ISO/IEC 27001, MIL STD 882, CMMI);

- Able to exploit multidisciplinary combined approach;

- Train risk experts and utilize their experience on risk analyses (e.g. libraries of threats and vulnerabilities).

Compliance with standards and best practices that are worldwide recognized is an important factor to be taken into account when building viable enterprise processes. The methodology under evaluation has been verified against these standards by the team.

As a result of the author's analysis, the following table shows the cross-reference between key concepts and terminology of COSO and the D'Appolonia methodologies.

D'APPLONIA	COSO
Organization /System Characterization	Internal Environmental
Objectives Definition and Quoting	Objectives Setting
Threats definition	Event identification
Impact/ occurrence Matrix	Risk Assessment
Risk Mitigation	Risk Response
Countermeasures definition	Control Activities
Output Dissemination	Information and Communication
Iteration Of the analysis	Monitoring

Table 3: Cross-reference between key concepts of COSO and D'APPLONIA methodology

The FTC adopted the approach depicted here below to determine an integrative workflow.

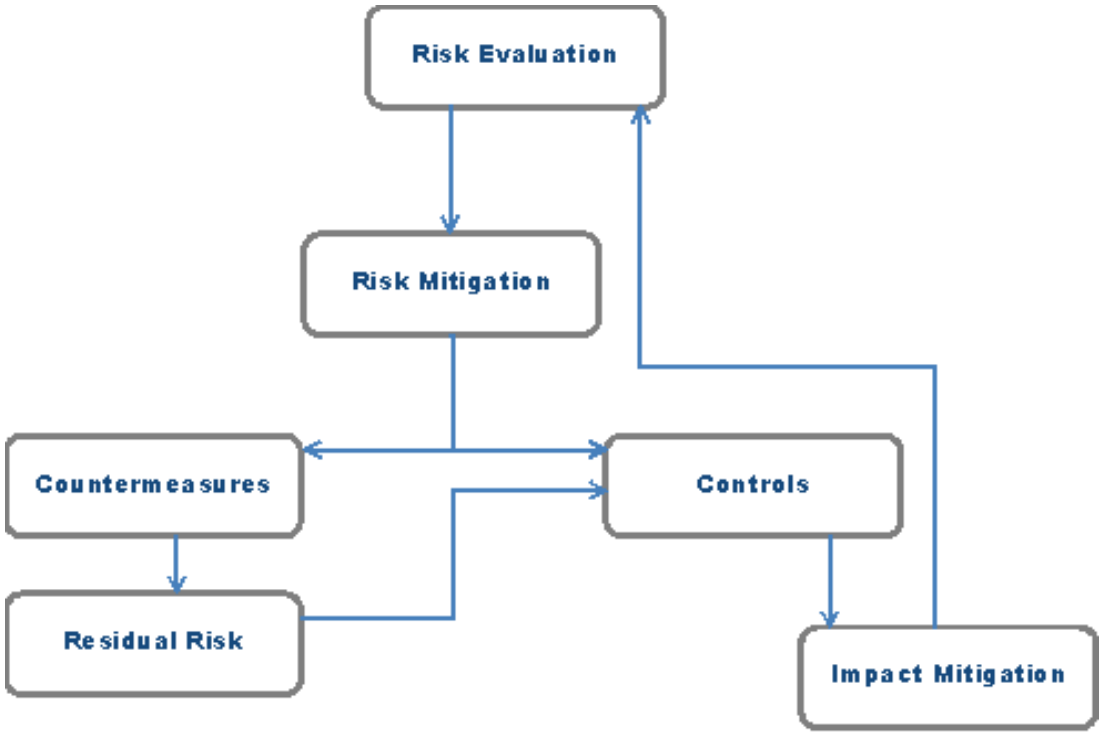

Figure 28: Iterative Risk Analysis Workflow

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9.3.3 Risk Analysis Theory Applied to the FTC Case

In referring to different open sources literature, the author is hereafter describing the theory behind Risk Analysis as the process of identifying vulnerabilities and threats to recourses/assets used by the FTC organization in achieving objectives, and decide what countermeasures and necessary to reduce risk to an acceptable level.

The Risk is defined depending on the estimation of threats occurrence probability and on their impact on the system assets.

A Vulnerability is a flaw or weakness in system procedures, design, implementation, or internal controls that could be exercised (accidentally triggered or intentionally exploited) and result in a violation of the objectives.

A threat contains the potential for an opportunity source to exercise (comparative analysis) as well as the improvements related to the countermeasure choice.

The outcome of the risk evaluation defines:

-The critical systems and subsystems having an “acceptable” level of risk and don’t require the risk reduction;

-The critical systems and subsystems having a level of risk “greater than acceptable” level:

In this case, the level of risk of each single subsystem shall be reduced through the adoption of specific physical, procedural or technical countermeasure.

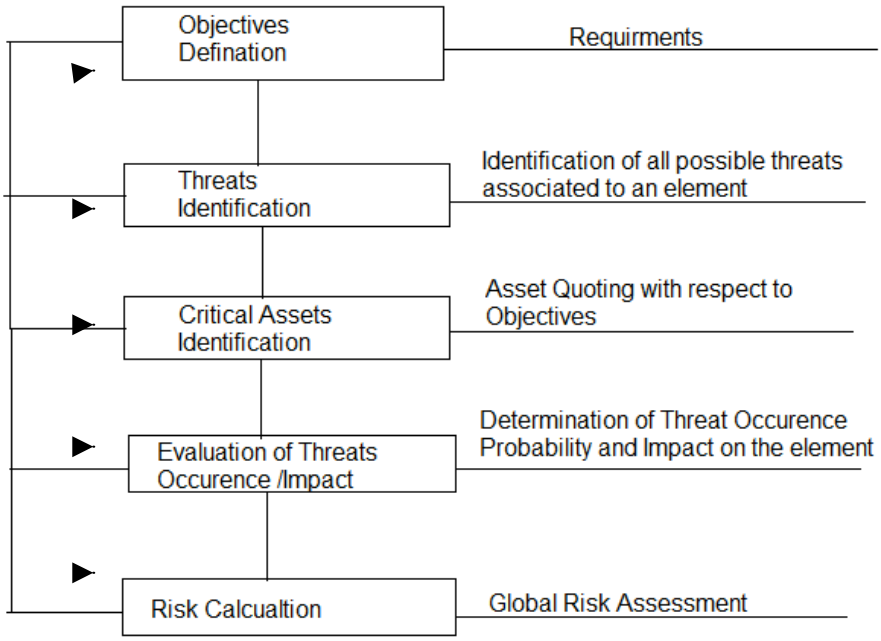

Figure 29: Risk Analysis workflow

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In quantitative analysis, the assets are quoted by associating numerical weight values respect to the relevant objectives. Averaging these values define the system quote.

Risk associated to each threat applicable to an asset is evaluated according to its impact versus occurrence parameters, thus allowing to determine the overall risk associated to an asset. The system's risk is then calculated averaging the contribution of asset's risks that are above a predetermined threshold and a determined weighting the asset's risk threshold with the system quote.

The evaluation of the risk determines its acceptability or not, therefore indicates whether there is the need to implement a risk reduction by adopting proper or specific, physical procedural or technical countermeasures.

This generic theoretical approach can be applied to field-specific instances. As an example, the mapping matrix among Security, Safety and program Risk Management provided hereafter is being used in the FTC and has identified a number of flows in the various departments, mainly, the non-availability within the FTC of structured functions, processes, competences and dedicated resources for Security, Safety and program Risk Management.

PROGRAM RISK MANAGEMENT	SAFETY	SECURITY
Program Objectives (Time Scale , Cost plan , Performances)	Safety Objectives (personal safety , Equipment integrity , Environmental Safety)	Security Objectives (Availability , Integrity , Confidentiality)
Risk	Hazards	Threats
Causes of the Risk	Weak points	Vulnerabilities
Contingencies /Actions	Safety Processes / Physical Countermeasures	Countermeasures
Program/Tasks /Resources	Facilities /system/subsystem	Subsystem /Asset
Probability (p)	Hazard occurrence (Risk)	Threat Occurrence
Risk factor (p * 1)	Severity Occurrence Matrix -→Hazard class	Threat Occurrence Matrix
Impact (I)	Hazard Severity (Based on consequences)	Threat Impact
Risk Exposure Evaluation	Fault tree + Analysis	Risk Evaluation
Risk Reduction (Risk Action Plan)	Risk Reduction (FT+)	Risk Reduction

Table 4: Mapping Matrix among Security, Safety and Program Risk Management

The steps of Risk Evaluation and Risk Reduction are Domain dependent, while other steps are common to each application.

Accomplishing to the general philosophy of the FTC intended framework, the common integrated workflow on different domains of Risk Analysis are of main importance.

In an effort of unifying the approach, this would result in common workflow for most of the Risk Analysis.

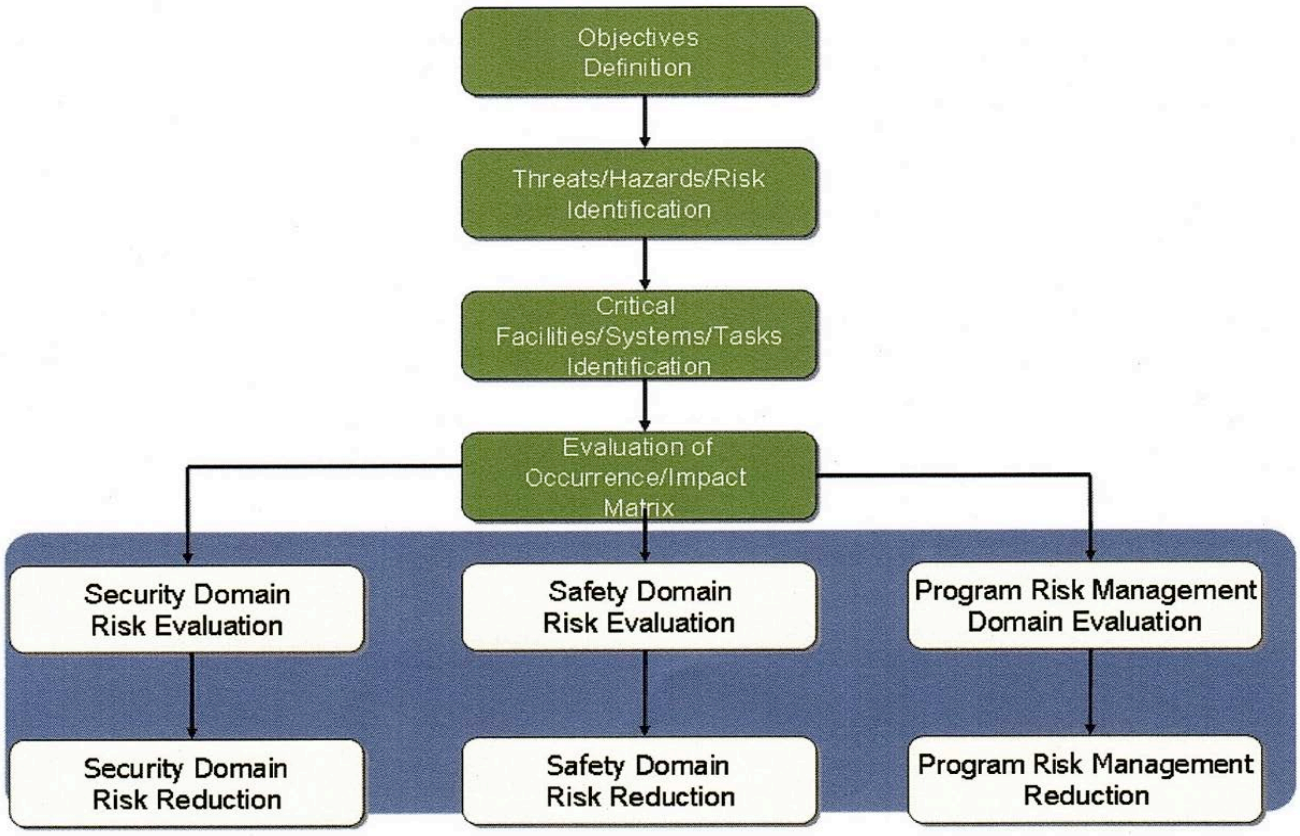

Figure 30: Common Integrated Workflows

The application of this concept in FTC puts the Risk Analysis as the lever on which to act to obtain significant improvements in terms of recourses, time, procedure, processes, data and costs in several disciplines contemporarily.

9.3.4 Tools

The practical application of the Standard Methodologies raised the need of using tools to supporting the Risks Analysis methodology.

In considering that any organization has its own specific needs, and that an actual added value is brought by tools particularly integrated in the overall framework of the FTC organization, thus becoming a unique tool covering homogenously all the relevant domains of the FTC organization and not several tools, implementing a different methodology for each domain.

The FTC has followed a harmonized approach, allowing exploiting the synergies derived from multidisciplinary approach. Tools must be used not only for analysis but also for monitoring; as such a proper integration of the tools in the organization framework is an important requirement.

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Additionally, tools generate outputs and reporting, which should be tailored according to standard and guidelines (e.g. program templates) as well as to the organization's needs.

To summarize, the key elements in the evaluation of a tool for the FTC are:

- Integration

- Customization

- Adoptable to the entire domain, using common baselines

- Unique high-level methodology

- Multidisciplinary approach

The Risk Assessment tools market is relativity small. The most commonly used tools are COBRA, CRAMM, Risk Check, Risk PAK, Counter Measure, and iQRAS. A high level evaluation of each of them has been performed, and the following table reports the main features.

FEATURES	TOOL NAME
Knowledge base Questionnaires Reports What If Testing Information Security oriented	COBRA
Asset evaluation : Cost, Impact What-if analysis Qualitative Approach Information Security Oriented	CRAMM
Health & Safety Oriented Environmental Configurable Reports	Risk Check
Business continuity Customized able Questionnaires What –if modelling and progress comparison	Risk PAC
Physical and Information Security oriented critical infrastructures Possibility to integrate documents Cost analysis of countermeasures Reports Cost-Benefits analysis	Countermeasures
Safety & Security oriented Event sequence Diagrams Reports	iQRAS

Table 5: The main Risk Assessment tools on the market

As a general consideration on this tools' (ARES) survey and on the commercial tools scenario, the author has reached the following conclusion: the existing tools are;

- Qualitative based;

- Questionnaire based;

- Stand-alone tools (not easily enterable in the overall FTC organization frame work);

- Software programmers instead of risk experts have developed many of these products, and their quality of recommendation in safeguards, threats and vulnerabilities sometimes does not reflect the real world experience in this domain;

- Each one is designed for specific selected domains;

- Not necessarily fitting with all specific FTC needs and not easily customizable.

To conclude, a custom solution would probably best fit the needs of FTC, having the primary characteristic of:

- Multidisciplinary approach;

- Integration with the enterprise EA framework;

- Collection of the organizational knowledge base.

Additionally, when assessing the best way to support their projects dealing with Risk Analysis, and among other risks, appeared the need to supporting projects in the fields of Information Security, and ARES became. a viable candidate for a possible solution or a part of FTC wider integrated EA solution.

Basically ARES is a tool suite, which supports the entire Risk Analysis Process by providing the following main functionalities:

- Knowledge base Management which provides the facilities to collect in a library all the information necessary to carry our Risk Analysis and to share experience and Knowledge ;

- Risk Analysis Scenario Management which provides support in the composition , versioning and duplication of scenario , object of the risk analysis ;

- Risk Analysis Calculation and Evaluation, which provides instruments and algorithms to calculate, quantify, evaluate and mitigate risk.

The ARES tool suite is a development product, which is already in use. In the authors view, any future tool for FTC needs to cater for continuous and on-going upgrades of features to fit at best the needs of engineers and analysts that use in their daily work.

The flexibility of a custom solution, along with the extension of its use to a multi-disciplinary domain based on a common methodology makes it a viable solution to be further studied in the effort of coping with FTC needs.

In this process, D'Appolonia and FTC intended to evolve and customize the tool in their endeavor to re-align with FTC needs in the operations domain.

The most challenging factor, as mentioned earlier, is to maximize the added value that a tool can bring by integrating it in the overall EA framework of the organization. FTC is currently

implementing the enterprise framework, which was jointly undergoing development by FTC and Telelogic. The scope is to create a structure of decision making process that take advantages of some tools like Enterprise Architect , Rhapsody , Focal point, Synergy, Doors as well as tools from other vendors that will support the operation and elaboration of the FTC data .

Capabilities, interfaces and integration of the various tools within the framework are an essential element in creating the framework itself.

Within this scenario, an initial feasibility evaluation of the D'Appolonia Risk Analysis tool as well as an integration assessment within the FTC intended Framework has been performed, to consider if FTC and Telelogic approach in the representation of the systems to be developed for FTC are compatible with D'Appolonia tool .

The Enterprise descriptions are done by decomposing the main systems into subsystems. The FTC framework is based on System Architect, and it is a derivative of DoDAF 1.5. The DoDAF model defines system that implements Services Oriented Architect (SOA); therefore all the members of the framework will have to be integrated like services consuming and supplying information managed inside the system. In this perspective, the inclusion of Risk Management can be seen as the addition of a Services Layer interfacing with the other components of the Framework through events and methods, as shown in the following picture.

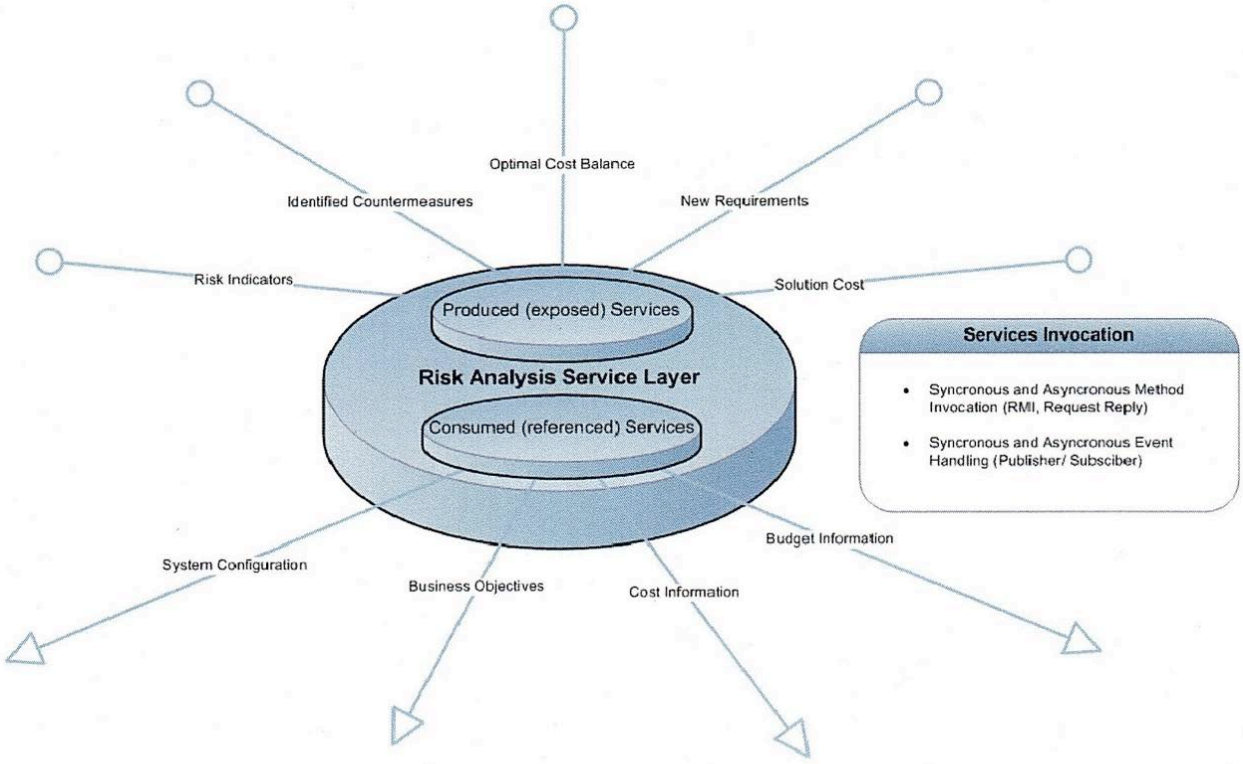

Figure 31: Risk Analysis Services Layer Representation

Just as an example, the risk analysis tools will take as input the description of the system and provides as output the risk values and the evaluation of the countermeasures.

As a general hypothesis of integration of Risk Analysis layer in the design for FTC framework, the above figure helps to understand the logical and holistic view proposed by the author.

Risk Management is generally one of the most interesting methodologies that can be included as third dimension, solving the intrinsic weakness of the FTC framework in this field.
Quality is a general methodology processes.
On the other hand, FTC core business is system Development and Test , therefore it may require another possible methodology to be evaluated, proposed and possibly integrated . Moreover, System /software development is tightly dependent on the IT infrastructure and process within the FTC. A methodology to build and run our IT infrastructure will complement the picture within the FTC.
In the authors opinion, other integration are possible, necessary, useful and envisaged, however would need a more detailed study and discussion.

9.3.5 FTC Use Cases

The methodology and the validity of the multidisciplinary approach have been reviewed by presenting some User Cases coming from the experience of the FTC situation.
Five use cases have been prepared for the Workshop:

- Safety
- Functional Safety
- OSHA Safety
- Program Risk Management
- Security
- Information Security
- Physical Security.

However, only the first use case was discussed in detail during the workshop due to the in-depth level of detail and to the constructive intervention of the audience.

The general approach to the use case definition was in sequence:

- Knowledge Base Analysis
- Risk Analysis Creation
- Scenario Composition
- First Risk Evaluation (Continue If Risk is not acceptable)
- New Risk Analysis Version Creation
- New Countermeasure Definition
- Scenario Update
- Second Risk Evaluation (Lower Risk but continue if the risk is not acceptable yet)
- New Risk Analysis Version Creation
- New Countermeasure Definition
- Scenario Update
- Third Risk Evaluation (Loop until the Risk is considered acceptable or if further countermeasures are not considerably cost –effective)

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Studies performed in the frame of the CMMIQS safety program were taken as reference for the definition of the threats and the system breakdowns.

In the following, the use cases are introduced as they were presented during the Workshop.

9.3.5.1 Functional Safety Use Case

Functional Safety addresses all operational aspects of FTC artifacts such as flight test and data analysis.
It mainly relates to equipment's and data integrity. Functional Safety Analysis is carried out to identify hazards associated with the activates of the system under analysis while in operative mode: in the specific FTC case, main devices involved in the operations are aircrafts, navigation systems, weapons and communication systems, while data are collected by on-board and ground instruments for offline analyses on the results of the flight test.
Along the CMMIQ program, this hazard analysis and the related risk evaluation was carried out at the lowest reasonable level reaching the detail of a numerical quantification of the system breakdown and related risk. Anyway, it can be approached as well according to a higher –level (functional oriented) point of view. This approach is being presented throughout this user case since it is the ARES approach to systems description.

9.3.5.2 OSHA Safety Use Case

"Occupational Health Hazard Analysis "and "Operating and support Hazard Analysis "are both applicable to FTC and they have many common aspects and principles. In the context of the CMMIQS program, they are considered as only one analysis named Occupational Safety Hazard Analysis (OSHA) that covers both maintenance and operational aspects.
In this user case, the OSHA analysis is approached according to ARES Risk Analysis Tool Philosophy as performed for the Functional Safety User Case.
As well as for the Functional Safety User Case, the different level of system breakdown definition and threats identification, represented an interesting alternative approach compared to the one followed in the CMMIQS program; the opportunity of carrying out this second hazard analysis was taken in great consideration also as an added value for the validation of results obtained in the CMMIQS program.

9.3.5.3 Program Risk Management Use Case

Program Risk Management involves all the artifacts within FTC, aiming at identifying and measuring the risks in projects development and implementation in the attempt to create effective risk response strategies and to deliver projects that meet stakeholder expectations.
Applying the same methodology used for other Use Case, a hypothetical project on the enhancement of the physical security of the Mirage 2000-9 Hangar had been broken down in its composing parts (Work carried out in the FTC Scenario allowed to analyze a specific situation without interfering with restricted information such FTC projects details.

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9.3.5.4 Information Security Use Case

Information security means protecting information and information systems within FTC, from unauthorized access, use, disclosure, disruption, modification, or destruction. Its goal is to protect the availability, confidentiality and integrity of information. This is achieved through the identification of vulnerabilities and associated threats of the system and then, by the identification of the possible countermeasure. Vulnerabilities, threat and countermeasures are strictly linked to the system used and to the security objectives.
All details specified in this use case have been produced according to FTC and D'Appolonia team joint experience and knowledge about FTC facilities but not necessarily on the specific network configuration (save in the case of restricted areas for D'Appolonia)

9.3.5.5 Physical Security Use Case

Physical security describes countermeasures preventing or deterring attackers from accessing the FTC facility, recourses, or information kept in a physical place. It deals with prevention from unauthorized intrusion, terroristic attacks, thefts intrusion and anything else concerning the protection of borders and private property. It can be as simple as a locked door or as elaborate as multiple layers of armed guard posts or technological products such as biometric detection systems.
The system and sub-system have been detailed according to the FTC current situation, while threats, vulnerabilities and countermeasures have been listed according to general assessments and previous experience.
Specific critical situation have been analyzed. For example, the most critics are the ITR, installations being far from the Al Dhafra Base limits and being usually unmanned, representing a weakness in the FTC equipment's safety and protection.

9.3.6 Detailed Analysis of the Functional Safety Use Case

As already explained at the beginning of this paragraph, only the functional safety use cases were discussed during the FTC workshop. The discussion brought to several clarifications and details adjustment on technical and practical specifications. Thus, to be sure to provide verified and validated information, only details about the discussed use case are being provided in the following paragraphs:
The first step presented was the definition of the system, its breakdown structure, objectives, threats, vulnerabilities and countermeasures.
Being a preliminary study performed only for the sake of an example of how the D'Appolonia methodology can be applied to the specific subject, only a small part of the system FTC had been considered.

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9.3.6.1 System Characterization

FTC is composed of several facilities, only two over all had been analyzed, and only some of the equipment /operations concerning them had been considered as assets:

- FTC
- Flight Test
- Aircraft Sensors data acquisition
- Aircraft Sensors data elaboration
- Actuators control data quality
- Radio Data acquisition
- Radio Data Transmission
- RCF
- Telemetry Data Acquisition
- Data from aircrafts acquisition
- Data elaboration

9.3.6.2 Analysis Objectives Identification

As in literature, the following step consisted in identifying Objectives, they embody the organization aims, and they have to be defended against threats that might exploit vulnerabilities of the system to harm the organization itself.

Typical objectives of the Functional Safety Risk Analysis are:

- Data Reliability
- Equipment's Integrity

9.3.6.3 Threat Identification

As previously discussed, Threats are the potential for a threat-source to exercise (accidently trigger or intentionally exploit) a specific vulnerability.

As Threats for the specific Use Case, some of the Functional Hazards identified along the CMMIQS Program were listed:

- Autopilot Malfunction
- Navigation Data System Failure
- Actuators Malfunction
- Telemetry Transmission Failure/Data Corruption
- Radio Subsystem malfunction

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9.3.6.4 Vulnerabilities Identification

As previously discussed, a Vulnerability is a flaw or weakness in system procedures, design, implementation, or internal controls that could be exercised (accidently triggered or intentionally exploited) and result in a violation of the objectives.

In this case, generic system vulnerabilities were listed:

- Hardware degradation
- Software bug/failure
- Shortage of Personnel
- Lack of Safety Signs
- Lack of training on Safety Procedures

9.3.6.5 Countermeasures Identification

Countermeasures are the procedural, managerial or physical modifications of the system intended to limit the vulnerability critically reducing the risk. Thus, reduced the probability of a vulnerability to be exploited by a threat, the related assets are protected.

A list of countermeasures applied as hypothesis in the Use Case Risk Analysis is reported in the following:

- Software Quality Assurance (CMMI aspects)
- Maintenance/Audit Plan definition
- Training for Personnel
- Safety Procedures Customization
- Responsible Figures Designation

9.3.6.6 Knowledge Base Relational Details

The table below has been used to categorize and evaluate the different systems

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Association Assets → Threats

In x-axis are reported identified Assets and in y-axes are reported identified Threats.

Circles represent the crossing where the association is consistent.

	Flight Test					RCF		
	Aircraft Sensors data acquisition	Aircraft Sensors data elaboration	Actuators control data quality	Radio Data acquisition (from RCF, Control Tower, other aircrafts)	Radio Data Transmission (from the aircraft to RCF, Control Tower, other aircrafts)	Telemetry Data Acquisition	Data from aircrafts acquisition	Data elaboration
Autopilot Malfunction	O	O						
Navigation Data System Failure	O			O				O
Actuators Malfunction	O	O	O					
Telemetry Transmission Failure\Data Corruption					O	O	O	O
Radio Subsystem Malfunction	O			O	O			

Table 6-1: Assets-Threats association matrix

Table 6: Assets - Threats Association Matrix

The matrix below has been used to document the results of the assets.

Asset / Objective	Availability	Integrity
Aircraft Sensors Data Acquisition	M - Maximum	H - High
Aircraft Sensors Data Elaboration	M - Maximum	M - Maximum
Actuators Control Data Quality	H - High	H - High
Radio Data Acquisition	N - Normal	N - Normal
Radio Data Transmission	N - Normal	N - Normal

Figure 32: Assets Quoting Matrix

9.4 Author's Findings and Conclusion

The findings of the author, resulting from an initial study, have found that each framework is suited to solving particular aspects of a problem or oriented towards a given objective. Each framework has its limitations and none of them addresses fully the integrated approach. None of the framework possesses a complete solution to address the problems faced through a complete integrated approach. However, the author has initially selected the Zachman Framework to implement Enterprise Architecture in this project. He considered the framework as having the most generic framework from which other frameworks can be derived and one which the author believes provides the flexibility to adopt it to an integrated approach to risk management. It has been identified that the Zachman Framework has limitations. Therefore for the purposes of this project we will expand the capabilities of the Zachman Framework by adding an additional axis to deal with risk management.

An integral Risk Analysis tool is needed in the FTC organization since there are no logical and realistic reasons to consider the FTC as not vulnerable to any risk.

The availability of an integrated tool allows:

- Constant and structured monitoring
- To make available post experiences and lessons learned
- Save time and resources while using an automatic interfaced instrument
- Avoid human errors in reporting data into tool
- Limit the need for specialized personnel to a team of well-trained Risk Analyst expert in the tool usage

Choosing the right tool is a key point for the future satisfaction of the FTC needs for risk analysis, performance and effectiveness. Thus, generally speaking and not referring to the specific solution

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proposed by D'Appolonia, a customized solution is suggested as to be the best way ahead for the requirements:

- Any organization has its own specific needs
- Tools gain considerable added value when integrated in the overall IT framework of an organization

A unique tool covering homogenously all the domains should be adopted by the organization and not several tools, avoiding the implementation a different methodology for each domain;

- An harmonized approach has to be followed
- Synergies derived from multi-disciplinary approach should be exploited
- Tools must be used not only for analysis but also for monitoring (integration in organization framework is a must)
- Output and reporting must be tailored according to standard and guidelines (e.g. program templates)

Once the tool has been chosen, it has to be integrated not only in the IT framework, but in the organization itself thought its personnel. Specific needs necessitate addressing:

- Establishing a specific team for Risk Management
- Identifying a responsible figure for the organization Risk Management
- Training people to use the tool and processes
- Getting into contact with the consultant (risk analyst) to build the functional and data integration in the complete framework
- Establishing and regularly update a knowledge base at organizational level

The case study in this paper, therefore proposes the development of a dedicated Framework specifically tailored to the FTC, in order to help understand thoroughly the risks a unit or an organization faces when outsourcing. Furthermore, we will study, evaluate and assess as to how the framework and its associated models can be utilized to manage the possible risks. It is hoped that visualization of an enterprise in terms of governance and capability will help to provide better understanding of the risks various units are exposed to, and to see new best practices methodology using models can be developed.

The prototype of the tool will be evaluated with industrial partners to provide input for improvements and to determine if the related effort of employing our approach is effective from a cost-benefit view. Future plans include the extension of the approach to provide a quantitative measurement method for calculating the risks and atomizing the causes, consequences and impacts of potential risks.

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10 COMPATIBILITY MATURITY MODE INTEGRATED (CMMi)

As part of the author's efforts in developing the path towards the "FTC To-Be", he introduced the Capability Maturity Model Integrated CMMi process improvement methodology in the FTC. For the reader of this paper, I am introducing below the description of the CMMi, as well as the steps undertaken to implement it.

10.1 Introduction to CMMi

CMMi (Capability Maturity Model Integrated) methodology, developed by Software Engineering Institute (SEI), was chosen firstly in the USA and then in many other countries, as a reference for evaluation and improvement of processes ((Deepa et al, 2010),(Agarwal and Lucas, 2005)). It is composed of sets of process descriptions adapted to various companies (Model) and focuses two complementary aspects:

- Capability, level of adequacy of a process with respect to the scope for which it has been defined;
- Maturity, level of reusability (consolidation) of a process within an organization.

CMMI (Capability Maturity Model for Integration) is the result of a long integration process of different models in the ambit of CMM (((Anand and Khanna, 2000),(Anderson and Narus 1990), (Argyres, 1999))). The current version of CMMI includes two basic disciplines that are Software Engineering (SW) and System Engineering (SE), incorporating product and service acquisition, Supplier Sourcing, (SS) and for the broad applicability of Integrated Product and Process Development, the IPPD. Moreover, it has been structured in order to constitute the infrastructure for future processes related to new disciplines ((Argyres and Liebeskind, 1999), (Armstrong and Overton, 1977)).

CMMI is also coherent to Total Quality Management (TQM) as it continuously stimulates process improvement (((Aron and Singh, 2003), (Aundhe,2003), (Bagozzi and Phillips, 1991))). In authors perspective, it'll support and assist the FTC when implemented mainly in:

- Identification of strengths and weaknesses of processes;
- Measurement of corrective actions effectiveness;
- Evaluation of necessary process improvement investments;

SEI developed CMMI model with the support of USA DoD, which included the contribution of world leading companies in SW Development, System Development and highly-software-embedded development((Baker, 1990), (Bensaou and Venkatraman1995)).

As for the FTC, the author's principal reasons for introducing and implementing CMMI, are the followings:

- Support the objectives in terms of time, cost and quality;
- Apply and manage frameworks using learned lessons and guidelines;
- Increase the objectives predictability;
- Increase the objectives quality;
- Reduce time and cost of projects;
- Identify evolution stages in process improvement, creating standard benchmarks;
- Standardize management of products and services (((Borman, 2006),(Chung and Charoenwong 1998),(Daft and Lengel,1986))).

In their endeavour to introduce CMMI in to the FTC, the author undertook the initiative to establish a team within FTC, under his leadership, to conduct the following in support of the FTC:

- Analyze, define and evolve Organization processes in accordance to the objectives of FTC business;
- Establish common language and metrics due Knowledge management between FTC, companies and organizations;
- Verify, by means of objectively self-evaluation standard processes (conforming to the requirements defined in the Appraisal requirements for CMMI) the progress of a program (as-is) with its objectives (to-be).

The following figure depicts the 5 maturity levels of the Staged Model. (Nota: repetition …to select one diagram)

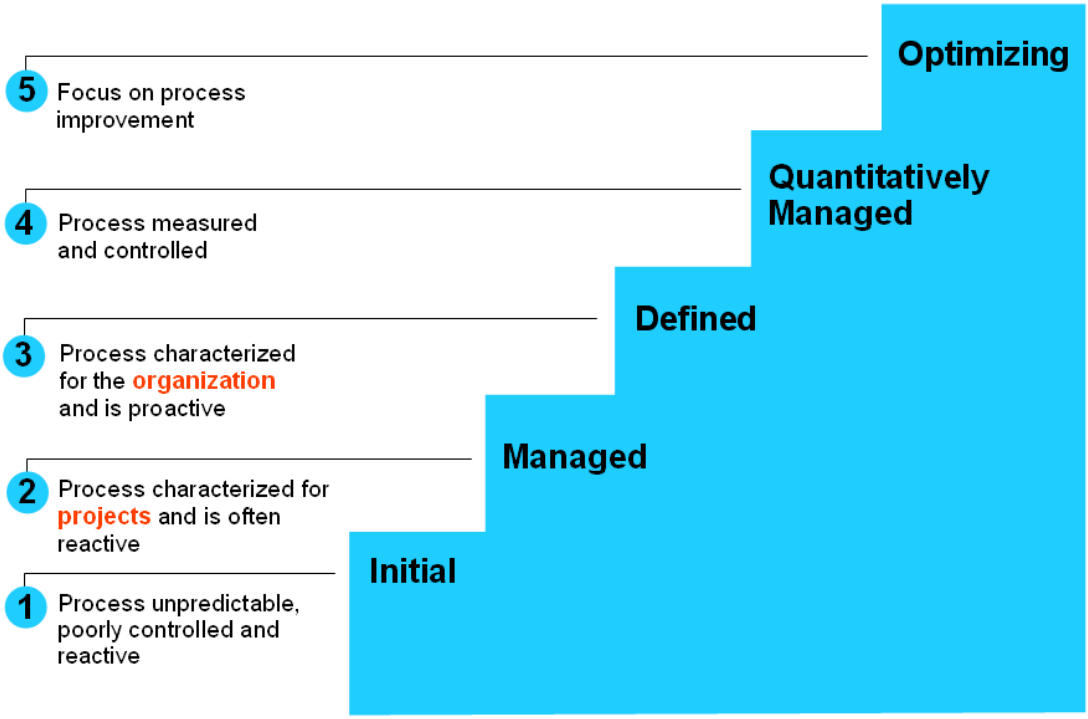

Figure 33: The 5 levels of maturity in the staged model

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10.2 Process Improvement Life Cycle

In the implementation process in the FTC, the author considered that the suitable way to apply the CMMI model practices for Process Improvement life cycle is by using the IDEAL model with its five phases (Initiating, Diagnosing, Establishing, Acting and Learning)
For the author, the IDEAL model, with its recursive 5 phases, provides a usable, understandable approach to continuous improvement by outlining the steps necessary to establish a successful improvement program and establishes the foundation for a long-term improvement strategy. Following the phases and principles of the IDEAL model with a program based on the implementation of the practices as they are described in each CMMI key process area has proven beneficial in many improvement efforts in FTC and enables an FTC to reach the maturity level proper for its needs (Paulk et al,1995), (U.S.EPA. EPA, 2001), (Zubrow, 2001),(Mills,2001))))
The following figure describes the activities of the IDEAL model.

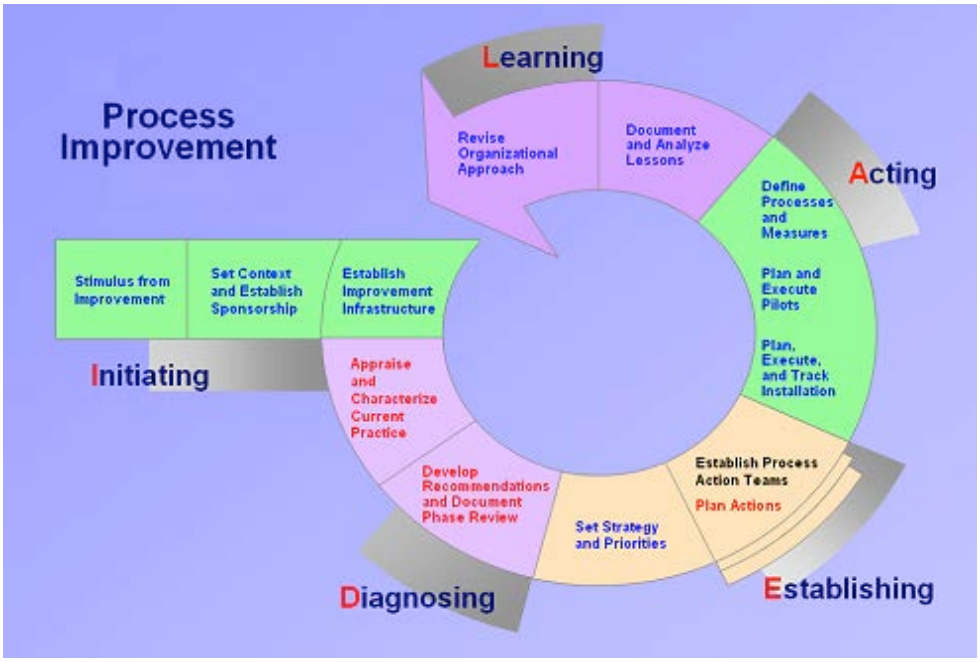

Figure 34: IDEAL Model

IDEAL Phases			CMMI Support at FTC
I	**Initiating**	Laying the groundwork for a successful improvement effort	CMMI models assisted FTC in understanding how to build sponsorship and in developing the infrastructure for improvement

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D	**Diagnosing**	Determining where you are relative to where you want to be	The "Standard CMMI Appraisal Methodology for Process Improvement" (SCAMPI)" has provided in the FTC, a yardstick for appraising processes based on CMMI.
E	**Establishing**	Planning the specifics of how you will reach your destination	CMMI process areas focus the FTC process improvement teams
A	**Acting**	Doing the work according to the plan	CMMI models provide guidance for defining or improving processes in FTC.
L	**Learning**	Learning from the experience and improving your ability to adopt new technologies in the future	Lessons learned in all FTC activities, are documented and are the basis for revision of an organizational approach within FTC.

Table 7: IDEAL Model activities

The author considers the above stages, are critical to the FTC, both in terms of identifying and managing risks, and its consequent success. Initially, the FTC is in the "Ad-Hoc" stage. This in itself, contains numerous risks as everything is adhoc and unstructured. The second stage, in my opinion, is the learning stage, with a lot of human resistance – "a resistance to change" - bringing awareness to the FTC engineers and technicians. This is an important stage, as it demonstrates value, even though it is only limited to a project base. Stage 3 combines the whole organization, at a larger scale. Hierarchy support, in this case the HQ UAEAF&AD, is essential, as a project is necessary to pass this level.

Under the author's guidance and authority, the FTC were engaged in the following activities:

Scampi appraisal methods

CMMI provides also methods for doing the appraisal process.

Regarding the Appraisal, SEI has defined in the ambit of CMMI, 3 "classes" of self-evaluation (Appraisal):

Class A

It lasts from 7 to 15 days, depending on the number of PA, projects, disciplines involved and dimension of the Organization;

The Appraisal team composition is 50% of the Organization;

It is conducted by an authorized SEI Lead Appraiser;

It assigns Maturity levels (or a Capability profile) and produces a report to be notified to SEI, which can be published at discretion of the Organization.

Class B

It uses the structure defined for Class A but is less formal;

It lasts from 5 to 10 days;

The Appraisal team can be supported by the Organization;
It produces a report that constitutes the base for the improvement plan.

Class C
It is addressed to a quick analysis over a single project;
It lasts typically 1 or 2 days;
It can be based upon a unique interview by the appraiser or project manager.
The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) provides precise indications on objective evidence judgment due practices: it is required to have evidenced and documented at least a single *Direct Artifact* and single *Indirect Artifact* and that these be confirmed by an *affirmation* during the interview.

CMMI provides also training support. In particular the following courses were conducted at the FTC:
"Introduction to CMMI®, Ver. 1.2", Carnegie Mellon, Software Engineering Institute
"Standard CMMI Appraisal Method for Process Improvement (SCAMPI)", Training of the Appraisal Team, Carnegie Mellon, Software Engineering Institute.

10.3 Conclusion

As a result of the above write-up and evaluation, the author concludes that process improvement is the driving force in determining the quality level and competency of FTC. It shall provide a continuous guidance for process improvement while focusing on its own business objectives and vision. With stage 4 – "Measurement and control" – followed by stage 5 – "continuous improvement" – CMMi provides the guidelines to identify where problems or process weaknesses are and, based on these, assists in determining the path towards improving processes. When looked at business objectives and known as to what the model content is, it is possible then to start thinking about what to do to address business and operational matters.

By combining CMMi and EA, the author considers that the FTC will be better governed and lays the foundation for a wider integrated risk management function.

In the authors view, governance is an important element in the FTC organization. The paragraph below describes governance; both its causes and consequences in general. The author will than study the introduction of Governance function and its added value to managing risks in the FTC operations.

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11 ENTERPRISE ARCHITECTURE (EA)

The world is changing rapidly. New technologies promise to save us time and money. Global competition provides a constant threat to the enterprise and business survival ((Tang, 2004), (Tapscott and Caston, 1993)). Although risk management has taken an important step in averting a number of potential issues, risks remains a critical parameter requiring an important attention (Tapscott and Caston, 1993).
This underlines an increasing need for people to understand their enterprises in a more integrated manner ((Boh and Yellin, 2007), (Duncan , 1995)). The answers to: “How? When? Where? Why? Who does what? What tools do they need to do it?” … These questions form the basis of an Enterprise Architecture.
First, we will show the risks of modelling enterprises on local aspects and why it is necessary to consider enterprise modelling as a global process. Then we will focus on the Zachman Enterprise Architecture Framework as a basis of our demonstration. Finally, the chapter concludes with a description of the tools needed to take advantage of Enterprise Architecture concepts in your organization.

11.1 Introduction

11.1.1 General Description of Enterprise Architecture

The term enterprise refers to a complex, socio-technical system that comprises interdependent resources of people, information, and technology that must interact with each other and their environment in support of a common mission. (Giachetti, 2010) (Whittle and Myrick, 2005), (Yimlaki and Halttunen, 2004), (Steen et al, 2004)). The term "enterprise" is used because it is generally applicable in many circumstances (Ross, 2003), Hamel and Prahalad (1996), (Quinn, 1999) , including;

- Public or Private Sector organizations
- An entire business or corporation
- A part of a larger enterprise (such as a business unit)
- A conglomerate of several organizations, such as a joint venture or partnership
- A multiply-outsourced business operation

Defining the boundary or scope of the enterprise to be described is an important first step in creating the enterprise architecture (Erol *et al*, 2009), (Smith2002),((Quinn and Hilmer, 1994))) . It should also be noted that the term "enterprise" as used in enterprise architecture generally means more than the information systems employed by an organization (Strnadl, 2006).

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An enterprise, generally, is comprised of (Siishil, 2006), (Swurz and Derosa, 2006)):

- Process domain
- Organization domain
- Location domain
- Data domain
- Application domain
- Technology domain

In the authors view, the above domains are not necessarily comprehensive, but provide a sufficient basis in defining the “initial” important steps towards the buildup of an enterprise needs: the introduction of risk and the governance aspect remain to be further considered in the later stage of this paper.

Systems design is often overlooked as one of the most important aspects for ensuring that everyone in the organization understands how they can contribute to its success and thereby improve their own performance and job satisfaction see Venkatachalam (2006) and Weske (2007). Simple system structures enable people to see how the systems work to achieve company goals ((Jonkers et al (2006), (Zachman (1987)). Enterprise Architecture can be structured in a simple set of process hierarchies and with appropriate software packages can be shown in the way that everyone can understand (((Cummins (2002), ErI T. (2007), Gold-Bernstein and Ruh (2004), IBM (2005))).

In the authors view, the fact that everyone in the organization does not share the same understanding of the enterprise goals, the contribution of each employee in FTC has become “Ad Hoc”, and performance were in most cases, an individual rather than a collective effort. As described above, the author’s goal to introduce EA in the FTC is to transform the FTC environment in to a collective effort, shared understanding and common awareness. Being aware of EA, is in itself a change in mindset.

An Enterprise Architecture (EA) is a rigorous description of the structure of an enterprise ((Nightaiigale and Rhodes (2004), Minglun and Lyytinen (2008)), its decomposition into subsystems, the relationships between the subsystems, the relationships with the external environment, the terminology to use, and the guiding principles for the design and evolution of an enterprise. (Giachetti, R.E., Design of Enterprise Systems, Theory, Architecture, and Methods, CRC Press, Boca Raton, FL, 2010. 2) Enterprise Architecture Research Forum, http://earf.meraka.org.za/earfhome/defining-ea. 3) MIT Centre for Information Systems Research, Peter Weill, Director, as presented at the Sixth e-Business Conference, Barcelona Spain, 27 March 2007). This description is comprehensive, including enterprise goals, business functions, business process, roles, organizational structures, business information, software applications and computer systems ((Riempp and Gieffers-Ankel (2007), Frank (2002)). Enterprise architecture provides a tool for identifying opportunities to improve the enterprise, in a manner that more effectively and efficiently pursues its purpose (Grembergen, 2000).

Enterprise architects use various business methods, analytical techniques and conceptual tools to understand and document the structure and dynamics of an enterprise (Ferstl and Sinz, 2006), (IEEE, 2000),(Johansson et al, 2006), Jonkers et al, 2004)))). In doing so, they produce lists, drawings, documents and models, together called "artifacts" (((Lankhorst, 2005), Laudon and Laudon, 2002), Gammelgård et al, 2007))) . These artifacts describe the logical organization of

business functions, business capabilities, business processes, people organization, information resources, business systems, software applications, computing capabilities, information exchange and communications infrastructure within the enterprise see Armour and Kaisler (2001), Bannister and Remenyi (2000), Barbacci et al (1995). A collection of these artifacts, sufficiently complete to describe the enterprise in useful ways, is considered by EA practitioners an 'enterprise' level architectural description, or enterprise architecture, for short ((Bass et al, 1999), (Brackett,1994)). (Jarvis, R, Enterprise Architecture: Understanding the Bigger Picture - A Best Practice Guide for Decision Makers in IT, the UK National Computing Centre, Manchester, UK).
Normally an EA takes the form of a comprehensive set of cohesive models that describe the structure and functions of an enterprise (Brownsword, 2004), (Cassidy, 1998), (Vasconcelos et al, 2007), (Vernadat, 1996). The individual models in an EA are arranged in a logical manner that provides an ever-increasing level of detail about the enterprise (W3C, 2002), (Zijden et al, 2000), Venkatesh et al, 2007))): its objectives and goals; its processes and organisation; its systems and data; the technology used and any other relevant spheres of interest ((Tobin et al, 2007), (Sowa and Zachman, 1992)).
In author's view, success in this regard is achieved when you are able to ensure that system; data, technology and process do perform in an integrated approach, and aligned with the enterprise business goals while confronting the challenges and resistance to change (Spewak, 1992).

11.1.2 Integrating Technologies with Enterprise Architecture

A lot is written these days about tools and technologies for understanding the modern enterprise/industries and their associated risks (Fournier,1999). However, none of these individual tools or technologies adequately addresses the total risk in an industry as a whole (((Galbraith, 1994), (Gefen et al, 2000), (Gelinas et al,2005))). Each is only effective in dealing with its little piece of the Enterprise Architecture puzzle ((Goodhue et al, 1988), (Goodhue,1992)). Each of these tools or technologies, rather, addresses a discrete area of risk in the enterprise, answering a specific question from a specific perspective for a specific area, with little or no regard for understanding the whole. Integrating the disparate technologies described above into a cohesive and useful description of the enterprise is the main goal of an Enterprise Architecture ((((Guynes and Vanecek, 1996), Haenlein and Kaplan, 2004), (Hamilton, 1999), (Harman,1976)))).

11.1.3 Zachman's Definition of Enterprise Architecture

John A. Zachman defines Enterprise Architecture as:
…the set of descriptive representations (i.e., models) that are relevant for describing an Enterprise such that it can be produced to management's requirements (quality) and maintained over the period of its useful life (changed).

Identifying the limits of an enterprise is among the key challenge of Enterprise Architecture.
In general, a business is made up of many different "materials," including physical resources, financial means, location, personnel, and type of market ((Hasselbring, 2000), (Heo and Hanv, 2003)). These "materials", and their relevant risk, must be taken into account when designing the business ((Hite,2003), (Huang, 2001)).

An Enterprise Architecture, taking all of the various points of view into consideration, makes it possible to see when an enterprise is no longer capable of meeting the demands placed on it. In addition, an Enterprise Architecture allows you to make significant changes to a business without running the risk of destroying it ((Jain et al,1998), (Karimi et al, 2000)).
A well-defined Enterprise Architecture will include techniques such as: knowledge management, business (re)engineering, data warehousing, and alignment of business and IT strategy((Kayworth and Sambamurthy, 2000), (Khoumbati et al, 2006)) – all techniques crucial to risk mitigation and thus, the success of an enterprise. How do you make sense of all available information and decide how much of it to use and how? That is the role of an Enterprise Architecture Framework.
The approach of Zachman seems to be very successful to design and to analyse Enterprise functions as well as a prevention tool. Indeed, Zachman's definition of an Enterprise Architecture: "a set of descriptive representations (e.g., models) which are relevant for describing an Enterprise such that it can be produced to management's requirements (quality) and maintained over the period of its useful life (changed)." Enterprise Modelling is the act of providing that "set of descriptions."

11.1.4 The Importance of Modelling Enterprises

While modelling has been utilized in great success in many technology areas and industries (CATIA, CAD, …), industries have not invested much in modelling their enterprise: the FTC is just one of them. Historically, some concepts did exist, but real enterprise modelling started with John Zachman followed by other conceptual modelling (see TOGAF …). Modelling in industries has contributed in cost savings, expedite deliveries, gained time and reduce risk.
Modelling is meant to express concepts ((Park et al, 2001), (Roman et al, 2002)), which allows each part of an organization to understand and contribute to its own evolution. Models only become meaningful to the Enterprise when they cause action and provoke thoughts, and it only happens when all parts of an organization work together to create something rich enough for all to use. Models also promote understanding across different business groups in an organization. Modelling is (and should) be applied to all stages of business and systems development (in our case, in the FTC). Additionally, a modelling is meant to support Risk Management through better awareness at all level of the enterprise hierarchy, understand the impacts of change, and provide an ability to act pro-actively.
There are multitudes of modelling methods available. An Enterprise Model is composed of multiple modelling methods integrated in a way that is sufficient to describe the Enterprise.
According to the points previously introduced, there are limitations in enterprise modelling, analyze and validation. The ways of possible research are:

- The need for formal representation and description models for Enterprise modelling
- The need for validation framework in global approach of enterprise modelling.

Regarding those different aspects, there is a real need for a framework modelling the enterprise capabilities as a result of integrated units. In that sense, the "Integrated Approach" Zachman framework/Architecture seems to be suitable.

11.1.5 EA Framework Model

It is important to note that Models are the language of the Framework ((Kim, and Everest, 1994), (Kumar,2004)). They provide an unmistakable way of representing enterprise knowledge so that technical and non-technical people can understand and use it. The Framework provides a means for organizing the models into useful levels or categories (((Lam, 2005), (Lewis and Byrd, 2003), (Priggouris, and Hadjiefthymiades, 2006))).

Models are contained within the Framework Cells. How do we know if what we place in the cell is a model?

A model is a representation of concepts which enables :

- Process validation,
- Process robustness assessment,
- Ideas comprehension and assessment,
- Modification,
- Scenarios providing (‘what if’ and ‘where do I fit in?’), and
- syntax and semantics definition.

Conversely, a model is not:

merely a collection of drawings and documents

- anything that can’t reflect the business changes
- anything that can’t derive the impact of change
- anything that can’t be navigated

In other words, the terms *Enterprise Architecture* and *Enterprise Modelling* work together:

“Enterprise Modelling is the act of building Enterprise Architecture”.

11.1.6 Enterprise Architecture Framework

There are several frameworks developed by different companies or individuals. The author presents here below, some literatures describing these frameworks for the reader to have a larger understanding of the different thoughts and applications supported by the frameworks.

The figure below summarizes this history with an enterprise-architecture timeline. This brings us up to date in the history of enterprise architecture.

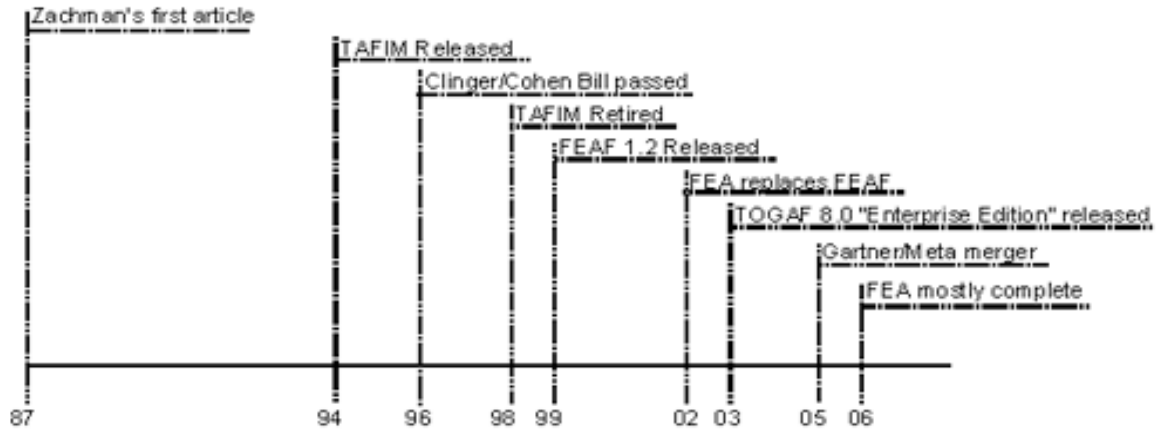

Figure 35: Enterprise-architecture timeline

In the author's opinion, the above EA evolutions provide us with a number of outcomes: EA has been on continuous evolutions, with lessons learnt e.g TAFIM, TOGAF … The most important observation by the author is the implication and introduction of new legislations such as Clinger/Cohen Bill. This bill, in the author opinion, is a clear recognition of the added-value for EA in government and its implications on non-government organizations.

The Enterprise Architecture Framework was derived from similar or parallel structures that are found in disciplines associated with Architecture/Construction and Engineering/Manufacturing that classify and organize the design relics, established over the process of designing and producing complex physical products (Sandhu et al, 1996), e.g. infra-structures/buildings or aero planes. The Enterprise Architecture Framework as it applies to Industries is simply a logical structure, which assists in classifying and organizing the descriptive representations of Industries that are significant to their management as well as to the development of their systems ((Togaf, 2009), (Assimakopoulos and Riggas, 2006)). The author's objective is capitalize and exploit enterprise architecture framework to support risk management or in another way, to integrate the risk function in enterprise architecture framework.

An Enterprise Architecture Framework is a generic classification scheme for designing relic or objects (Ramanathan, 2005). It helps to prevent the risk of isolation of a single problem area from the other areas its change or elimination might affect. Most business people can identify some event or business decision we have witnessed which served one area of the enterprise well while causing unseen disaster or havoc in another ((Hoogervorst, 2004), (Buchanan, 2002)). It most cases, decision is taken either out of context or without knowledge of how the two areas were interrelated. Enterprise Architecture Framework avoids and prevents disconnections among the various entities and processes within an enterprise allowing greater connectivity, awareness and optimized performance and governance ((Malhotra, 1996), (Stevenson, 1995)).

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The role of an Enterprise Architecture Framework, on the other hand, is to provide a logical structure for classifying and organizing the descriptive representations of an enterprise ((Sandhu, 1995), (Sandhu et al, 1999)).

11.1.7 Conclusion

In authors view, introduction of EA framework to the FTC is critical to the transformation of the FTC in to a modern state of the art organization, capable to operate competitively with efficient governance structure, manage the risks dynamically, better face the competition challenges and to be able to meet the customer expectation. The choice of the "right" framework, the higher management support and the proper implementation of a framework, all are just even more critical elements of success for the FTC. The author conducted a search for a suitable framework for the FTC and set out to compare four enterprise architecture frameworks. Below is description of such a search.

In the author's opinion, the EA evolutions provide us with a number of outcomes: EA has been on continuous evolutions, with lessons learnt e.g TAFIM, TOGAF … The most important observation by the author is the implication and introduction of new legislations such as Clinger/Cohen Bill. This bill, in the author opinion, is a clear recognition of the added-value for EA in government and its implications on non-government organizations.

11.2 A Comparison of the Top Four EA Methodologies

The author has conducted numerous research on Enterprise Architecture frameworks. Many papers and books around the subject exist (see References). The author has reflected, analyzed and came up with his findings deriving from a paper published by Roger Sessions, in May 2007 (see annex 2) which provided a brief history of Enterprise Architecture, a case study and four renowned frameworks.

More than two decades ago, enterprise architecture started appearing as a new domain, or discipline which addressed two problems:

- **System complexity**—Organizations were spending more and more money building IT systems; and
- **Poor business alignment**—Organizations were finding it more and more difficult to keep those increasingly expensive IT systems aligned with business need.

In the author's experience, the above two elements are of considerable importance and remain very challenging fort he FTC. The use of IT structure and its alignment with both engineering and business processes are fundamental to build a cohesive FTC enterprise.

Fort he FTC, the basic objective will be to counter the two main issues: more cost and less value. These two challenges are increasingly reaching crisis levels with potentially higher risks. The cost and complexity of IT systems continue to rise, while the possibilities of creating or obtaining real value from existing systems have widely decreased.

Actual/present situation show us that the costs have increased even more, yielding lesser value. Consequently, organizations are not anymore able to ignore these facts. The subject of enterprise architecture that two decades ago seemed quaintly unrealistic today seems impressively realistic.

Although numerous enterprise architecture methodologies have appeared and disappeared in the last two decades, today, it is most probable that more than 90 percent of the enterprise architecture users utilize one of these four methodologies:

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- The Zachman Framework for Enterprise Architectures—Although self-described as a *framework*, is actually more accurately defined as a *taxonomy*
- The Open Group Architectural Framework (TOGAF)—Although called a *framework*, is actually more accurately defined as a *process*
- The Federal Enterprise Architecture—Can be viewed as either an *implemented enterprise architecture* or a *proscriptive methodology* for creating an enterprise architecture
- The Gartner Methodology—Can be best described as an *enterprise architectural practice*

In this paper, the author discusses these four approaches to enterprise architecture. He does so within the context of FTC operations problems, which include:

- Software development environment that have become unmanageably complex and increasingly costly to maintain.
- FTC process, governance and methodologies that are hindering the organization's ability to respond to current, and future, market conditions in a timely and cost-effective manner.
- A gap between the various functions in the organization, specifically, business and technology.

How should the FTC choose from among these four very different approaches to enterprise architecture? The author traces and evaluates the challenges the FTC is likely to encounter in using any one of these methodologies.
When exploring each of these methodologies in depth, one discovers the fact that none of these methodologies is all encompassing or comprehensive. Every one of them has weaknesses in some areas and strengths in others.
In various organizations, none of these methodologies will hence provide a comprehensive solution. For such organizations, the white paper by Roger Sessions proposes a different approach, one that he described as a *blended methodology*. Choosing parts from each of these methodologies, modifying and merging them according to the specific needs of your organization. This white paper provides a recommendation to developing such a blended methodology that best meets your organization's needs.
However, even a blended methodology will only be as good as an enterprise commitment to bring about changes. This commitment must be driven by the higher management. With a strong willingness and commitment to change, combined with a customized methodology for supporting and guiding that change, a goal to a reduced enterprise cost with increased business value is now potentially within reach, which in turn, will improve your competitiveness in the global market.

The author disagrees with Roger Session’s view that Zackman framework, by his interpratation, “isn’t a framework”. The author considers the Zackman definition better suits the principles of EA Framework, as compared to the definition by American Heritage Dictionary. Zackman supports his definition by a “Framework’, providing a global view from both “perspective and focus”, not just a definition in generic terms.

11.2.1 Zachman Enterprise Architecture Framework

As John Zachman retrospectively described his work:

The [Enterprise Architecture] Framework as it applies to Enterprises is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise, as well as to the development of the Enterprise's systems. [13]

Many proponents of the Zachman Framework see it as cross-disciplinary, with influence extending far beyond IT. One popular book on Zachman, for example, says:

...in due course, you will discover that the Framework exists in everything you do, not only IT projects. When you thoroughly understand the Framework, you can become more effective in everything you do. This means everything. This statement is not made lightly. [14]

John Zachman indicated in an interview:

...the Framework schema has been around for thousands of years and I am sure it will be around for a few more thousands of years. What changes is our understanding of it and how to use it for Enterprise engineering and manufacturing. [15]

As I mentioned earlier, the Zachman Framework consists of six functional focus, each considered from the perspective of a major player. The Zachman Framework as it is portrayed today is shown in the figure below.

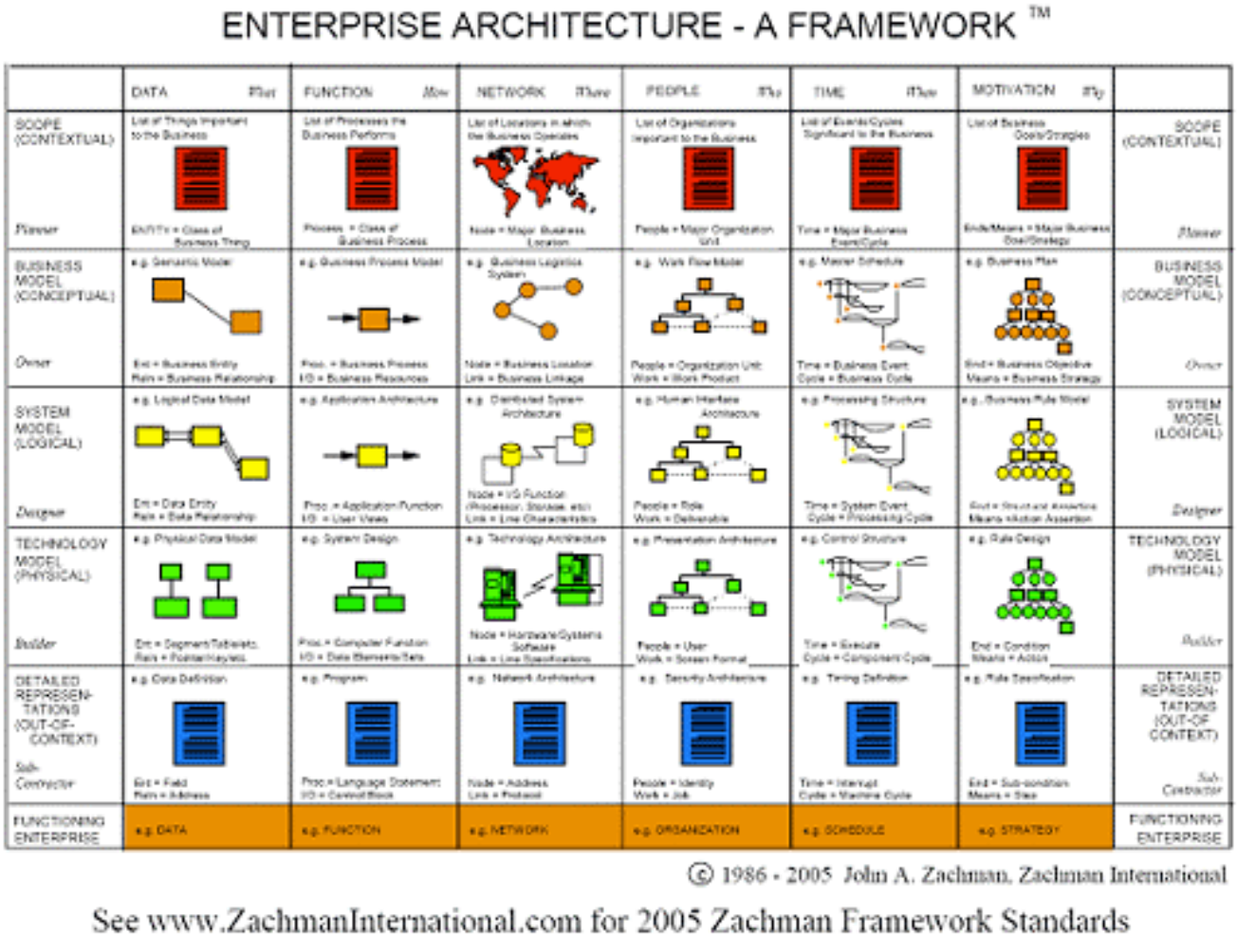

Figure 36: Zachman grid

As you can see from the figure above, there are 36 intersecting cells in a Zachman grid—one for each meeting point between a player's perspective (for example, business owner) and a descriptive focus (for example, data.). As we move horizontally (for example, left to right) in the grid, we see different descriptions of the system—all from the same player's perspective. As we move vertically

in the grid (for example, top to bottom), we see a single focus, but change the player from whose perspective we are viewing that focus.

It is a costly and lengthy process to apply all Zackman's cells. The detail evaluation of the priority cells which will trigger the starting point for FTC is an essential first step. In his approach, the author started his evaluation horizontally, with the first layer and continued randomly picking some cells from the other layers, not necessarily in a chronological approach. This method appeared complex because it required every cell to be populated with appropriate artifacts, demanding a sufficient amount of detail to fully describe the system from the perspective of every player. This complexity had a negative approach in its motivation within the FTC staff.

The author agrees in principle that Zackman framework does not provides a complete solution: a lack of defined process is a real example. The author furthermore does not share Roger Session's view that "Zachman doesn't even give us an approach to show a need for a future architecture ".In the author's view, future architectures are a result of lessons learnt from the implementation of present frameworks. The "Enterprise-architecture timeline" figure indicates the continuous evolutions of various frameworks, supporting the author's argument that it is difficult and not advisable to build a future framework within an existing framework. The only area the author agrees is from the IT perspective, to include flexible interfaces and growth potential.

Below are descriptions with which the author has studied and reviewed different enterprise architecture frameworks.

11.2.2 The Open Group Architecture Framework (TOGAF)

The Open Group Architecture Framework is best known by its acronym, TOGAF. TOGAF is owned by The Open Group [19]. TOGAF's view of enterprise architecture is shown in the figure below.

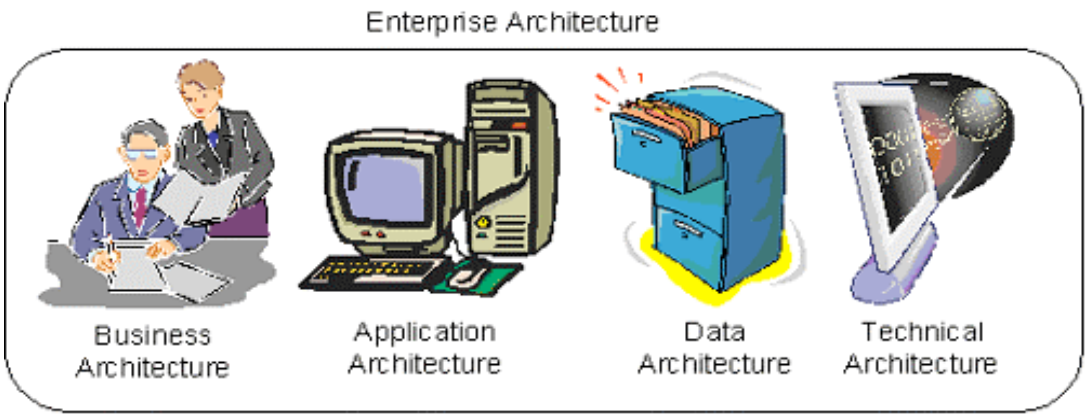

Figure 37: TOGAF's enterprise architecture

As shown in the figure, TOGAF divides enterprise architecture into four categories, as follows:
Business architecture—describes the processes the business uses to meet its goals

Application architecture—describes how specific applications are designed and how they interact with each other

Data architecture—describes how the enterprise data stores are organized and accessed

Technical architecture—describes the hardware and software infrastructure that supports applications and their interactions

TOGAF describes itself as a "framework," but the most important part of TOGAF is the Architecture Development Method, better known as ADM. ADM is a recipe for creating architecture. A recipe can be categorized as a *process*. Given that ADM is the most visible part of TOGAF. I categorize TOGAF overall as an *architectural process*, instead of either an *architectural framework* (as The Open Group describes TOGAF) or a *methodology* (as it describes ADM).

Viewed as an architectural *process*, TOGAF complements Zachman—which, recall, I categorized as an architectural *taxonomy*. Zachman tells you how to categorize your artifacts. TOGAF gives you a process for creating them.

TOGAF views the world of enterprise architecture as a continuum of architectures, ranging from highly generic to highly specific. It calls this continuum the Enterprise Continuum. It views the process of creating a specific enterprise architecture, such as MAM-EA, as moving from the generic to the specific. TOGAF's ADM provides a process for driving this movement from the generic to the specific.

TOGAF calls most generic architectures *Foundation Architectures*. These are architectural principles that can, theoretically, be used by any IT organization in the universe.

TOGAF calls the next level of specificity *Common Systems Architectures*. These are principles that one would expect to see in many—but, perhaps, not all—types of enterprises.

TOGAF calls the next level of specificity *Industry Architectures*. These are principles that are specific across many enterprises that are part of the same domain—

TOGAF calls the most specific level the *Organizational Architectures*. These are the architectures that are specific to a given enterprise.

The figure below shows the relationship between the Enterprise Continuum and the Architecture Development Method (ADM).

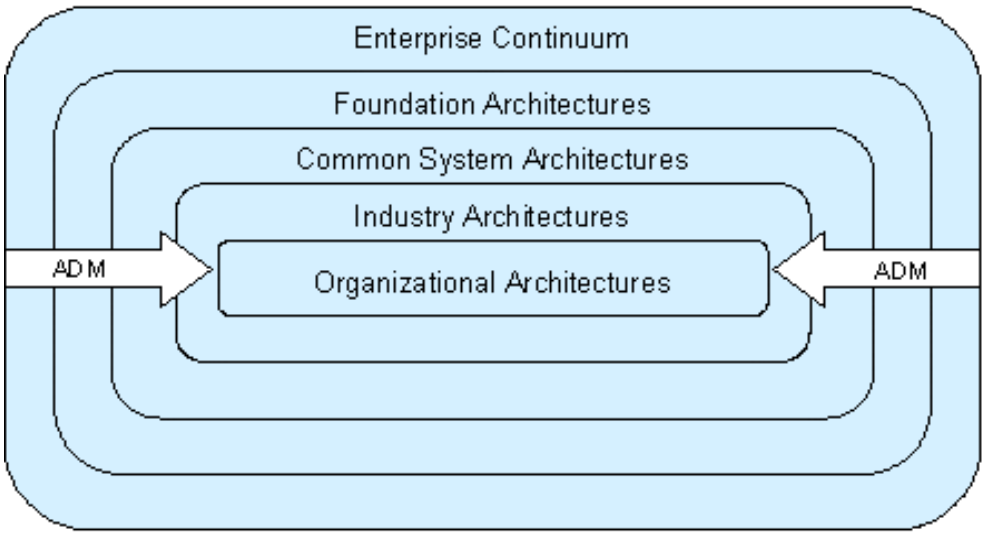

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Figure 38: The TOGAF Enterprise Continuum

The author in FTC has to face an internal challenge: similar to many organizations, achieving buy-in on the need for an enterprise architecture could be very difficult. This is especially true when the effort is driven from a middle or lower layer of the FTC organizational structure, and even more so when there is a history of discord between the different deaprtments. However, this effort is not driven at a middle or lower layer of the FTC organization; it is driven by myself – the head of the FTC. This gave the project high visibility and created a positive incentive for cooperation from all departments.

TOGAF allows phases to be done incompletely, skipped, combined, reordered, or reshaped to fit the needs of the situation. So, it should be no surprise if two different TOGAF-certified consultants end up using two very different processes—even when working with the same organization.

TOGAF is even more flexible about the actual generated architecture. In fact, TOGAF is, to a surprising degree, "architecture-agnostic". The final architecture might be good, bad, or indifferent. TOGAF merely describes *how* to generate enterprise architecture, not necessarily how to generate a *good* enterprise architecture. For this, you are dependent on the experience of your staff and/or TOGAF consultant. People adopting TOGAF in the hopes of acquiring a magic bullet will be sorely disappointed (as they will be with any of the methodologies).

In the author’s opinion, TOGAF is a more matured system. TOGAF has seen itself shifting and transforming itself from TAFIM, to FEAF and later TOGAF. This passage of transformation has earned TOGAF the benefits and added value from the lessons learnt deriving from its original status. The author further agrees with Roger Session that one could view TOGAF as a continuum of architectures, ranging from highly generic to highly specific. It calls this continuum the Enterprise Continuum, which incorporates the process of creating a specific EA, while shifting from the generics to a dedicated purpose or framework. The author shares the opinion as well that TOGAF's ADM supports a process for moving from the generic to a dedicated purpose although Roger Sessions indicated, it provides very little in the way of prescriptive document templates—merely guidelines for inputs and outputs. Excellent EA Framework itself is not sufficient: a higher management commitment, ability to demonstrate early gains and the ability to bond the business unit and the IT unit towards a common workable strategy, is critical to success.

11.2.3 Federal Enterprise Architecture (FEA)

The Federal Enterprise Architecture (FEA) is the latest attempt by the federal government to unite its myriad agencies and functions under a single common and ubiquitous enterprise architecture. FEA is still in its infancy, as most of the major pieces have been available only since 2006. However, as I discussed in the history section, it has a long tradition behind it and, if nothing else, has many failures from which it has hopefully learned some valuable lessons.

FEA is the most complete of all the methodologies discussed so far. It has both a comprehensive taxonomy, like Zachman, and an architectural process, like TOGAF. FEA can be viewed as either a methodology for creating an enterprise architecture or the result of applying that process to a

particular enterprise—namely, the U.S. Government. I will be looking at FEA from the methodology perspective. My particular interest here is how we can apply the FEA methodology to private enterprises.

Most writers describe FEA as simply consisting of five reference models, one each for performance: business, service, components, technical, and data. It is true that FEA has these five references models, but there is much more to FEA than just the reference models. A full treatment of FEA needs to include all of the following:

A perspective on how enterprise architectures should be viewed (the *segment* model, that I will describe shortly)

A set of reference models for describing different perspectives of the enterprise architecture (the five models, mentioned earlier)

A process for creating an enterprise architecture

A transitional process for migrating from a pre-EA to a post-EA paradigm

A taxonomy for cataloguing assets that fall within the purview of the enterprise architecture

An approach to measuring the success of using the enterprise architecture to drive business value

You can see that the FEA is about much more than models. It includes everything necessary to build an enterprise architecture for probably the most complex organization on earth: the U.S. Government. As the FEA-Program Management Office (FEAPMO) says, FEA, taken *in toto*, provides:

...a common language and framework to describe and analyze IT investments, enhance collaboration and ultimately transform the Federal government into a citizen-centreed, results-oriented, and market-based organization as set forth in the President's Management Agenda. [25].

While it might be a stretch to imagine that anything short of divine intervention could "transform the Federal government into a citizen-centred, results-oriented, and market-based organization," there is at least hope that some of the FEA methodology could help our beleaguered MedAMore corporation deal with its much more mundane problems. So, let's take a look at what FEA has to offer.

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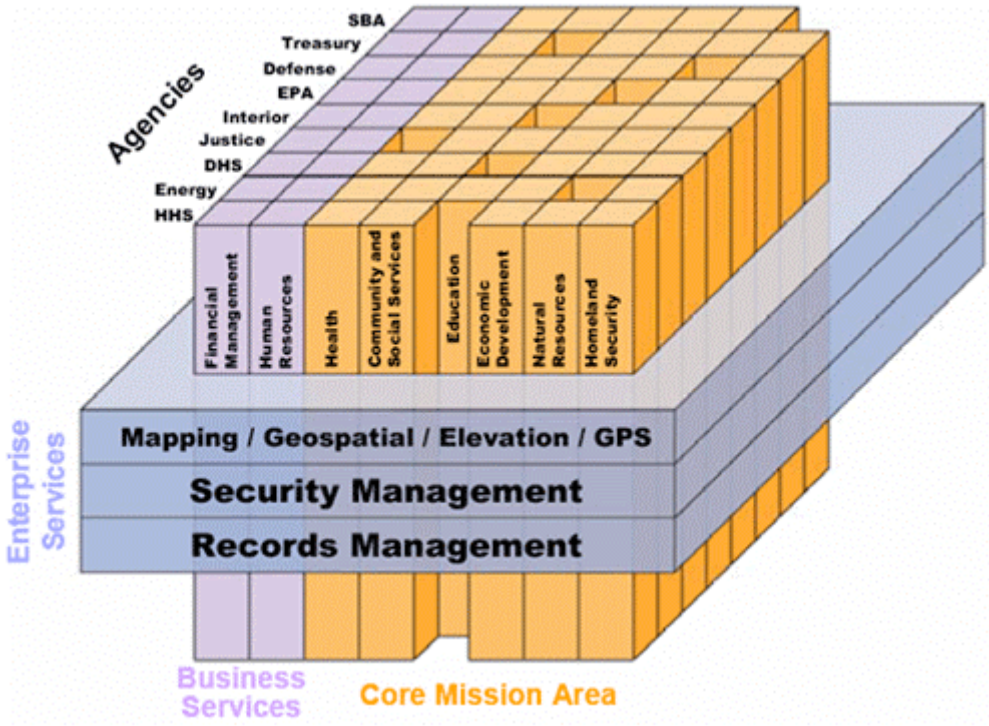

Figure 39: Segment map of the federal government

FEA Reference Models

The five FEA reference models are all about establishing common languages. The goal here is to facilitate communication, cooperation, and collaboration across political boundaries. According to the FEAPMO:

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FEA Success Measurement

The FEA framework for measuring organizational success in using enterprise architecture is defined in the Federal Enterprise Architecture Program EA Assessment Framework 2.1 [35]. Federal agencies are rated on their overall maturity levels in three main categories:

1. Architectural completion—Maturity level of the architecture itself
2. Architectural use—How effectively the agency uses its architecture to drive decision-making
3. Architectural results—The benefits being realized by the use of the architecture

OMB assigns each agency a success rating, based on its scores in each category and a cumulative.

The framework is interesting beyond the confines of the public sector. The category ratings can be fruitfully adapted by many enterprises to assess the maturity level of their own architectural efforts. The previous figure, for example, shows my own interpretation of the OMB maturity rankings for *architectural completion*, as I adapt them for the private sector. Similar adaptations can be created for *architectural usage* and *architectural results*.

11.2.4 Gartner

The author has written about three different methodologies that come together under the banner of enterprise architectures. This last methodology is a little different. It isn't a taxonomy (like Zachman), a process (like TOGAF), or a complete methodology (like FEA). Instead, it is what I define as a *practice*. It is the enterprise-architecture practice of Gartner.

In Gartner’s approach to enterprise architecture, you don't bring in Gartner because they do or don't use TOGAF. You don't go to Gartner because they do or don't follow Zachman's taxonomy.

Gartner contends that best practices are timeless, and they continue to augment them as appropriate. The current Gartner methodology was not solidified until probably April of 2006, after the Gartner/Meta merger.

Gartner believes that enterprise architecture is about bringing together three constituents: business owners, information specialists, the technology implementers. If you can bring these three groups together and unify them behind a common vision that drives business value, you have succeeded; if not, you have failed. Success is measured in pragmatic terms, such as driving profitability, not by checking off items on a process matrix.

Gartner believes that the enterprise architectures must start with where an organization is going, not with where it is. If we are going to clean house, we don't need to exhaustively document everything we are throwing out. Let's focus our energy on what we want to end up with. As soon as we know our goal, we can see how what we have relates to that goal.

Gartner recommends that an organization begin by telling the story of where its strategic direction is heading and what the business drivers are to which it is responding. Gartner will want this story in plain language, without worrying about prescribed documentation standards, acronyms, or techno-babble. The only goal is making sure that everybody understands and shares a single vision.

Most organizations are facing major changes in their business processes. The process of creating an enterprise-architecture vision is the organization's opportunity to sit down, take a collective breath, and ensure that everybody understands the nature, the scope, and the impact of those changes.

As soon as an organization has this single shared vision of the future, it can consider the implications of this vision on the business, technical, information, and solutions architectures of the enterprise. The shared vision of the future will dictate changes in all of these architectures, assign priorities to those changes, and keep those changes grounded in business value.

Enterprise architecture, in the Gartner view, is about strategy, not about engineering. It is focused on the destination. The two things that are most important to Gartner are *where an organization is going* and *how it will get there*.

11.2.5 Selection criteria for an FTC framework

The criteria to select and rate the most appropriate framework for the FTC are summarized in the figure below. The author used the table below to evaluate the frameworks in line with FTC requirement, to identify as to which framework would suit the most the FTC. Valuable results obtained supported the author in moving forward with a decision.

	Ratings				
Criteria	Zachman	TOGAF	FEA	Gartner	CaGF
Taxonomy completeness	4	2	2	1	4[1]
Process completeness	1	4	2	3	4[2]
Reference-model guidance	1	3	4	1	3[3]
Practice guidance	1	2	2	4	3[4]
Maturity Model	1	1	3	2	4+[5]
Business focus	1	2	1	4	4[6]
Governance guidance	1	2	3	3	4[7]
Partitioning guidance	1	2	4	3	4+[8]
Prescriptive catalog	1	2	4	2	3[9]
Vendor neutrality	2	4	3	1	4+[10]
Information availability	2	4	2	1	4[11]
Time to value	1	3	1	4	3[12]

Table 8: Criteria and ratings for each methodology

[1] A full Taxonomy appendix was provided in the shape of a table. It included all definitions for all meta model components for FTC, which represents all important aspects for FTC

[2] The Consulting team provided a full methodology for capturing all important aspects of the architecture lifecycle from study input to a full output which included a set of models, reports, analytics and a website for optimized communication. The process also includes a provision for maturity of the framework and contained model. All templates were provided.

[3] A Technical Reference model TRM, Service Reference Model and Business Reference Model BRM were a bi-product from our work on CaGF in accordance to FTC's actual requirements.

[4] A Website was provided to fully guide any user of CaGF and Enterprise Architecture practice, including non-technical savvy person. The objective was to explain, in business-like language, various components, perspectives and relationships of CaGF

[5] CaGF had a customized Maturity model based on CMMI. This was directly used to measure and plan maturity of various FTC capabilities

[6] CaGF had an elevated business focus. It was based on Porter value chain to give focus on business value for any service to be delivered by FTC with it's underlying operation and processes

[7] Governance meta model components and relationships were clearly identified as well as peoples roles and responsibilities on various operational activities within well defined organization structures.

[8] The Framework was very well partitioned in accordance to Capabilities, which is a major concept in managing and Military and modern competitive organizations. The use of the tool and associated website provided online guidance.

[9] CaGF high level management perspectives on Capabilities and maturity were directly decomposed to lower operational models with different perspectives for Operational and test engineers. The use of automation EA tool provided catalogues of various perspectives.

[10] CaGF was solely customized for FTDC thus was 100% vendor neutral

[11] Information was available in the shape of the EA online Tool Catalogues, Views, Published Models as well as Published reports, documents and a website describing the methodology used, relevance to Military and specific references to FTDC. This ensured ease and optimization of information sharing, dissemination, feedback and continuous update.

[12] This point is hard to qualify or quantify in FTDC context because although the adoption of CaGF provided immediate insight and Roadmap to how capabilities are to be matured at FTDC, the changes that took place at FTDC did not allow for proper quantification of the realized value through measurement.

A blended approach, in which you create your own enterprise-architectural methodology consisting of bits and pieces of each of the methodologies that provide the highest value in your specific areas of concern, seems a logical approach, although again, one has to evaluate the impacts and consequences.

You will want a different kind of consultant—one who has a broad perspective of all of these methodologies and specializes in helping enterprises create a methodology that works best, given the specific needs and political realities of that enterprise.

In his white paper, Roger Sessions has made the following conclusion:

“This paper has covered a broad introduction to the field of enterprise architecture. The history of the field goes back 20 years, but the field is still evolving—and rapidly so. Two of the four major methodologies (Gartner and FEA) have undergone major changes in the last two years alone.

As I have shown, these methodologies are quite different from each other, both in goals and in approach. This is good news and bad. It is bad news, in that it increases the difficulty for many organizations in choosing one single enterprise-architectural methodology. How do you choose between methodologies that have so little in common? Choosing between Zachman and TOGAF, for example, is like choosing between spinach and hammers.

But the good news is that these methodologies can be seen as complementing each other. For many organizations, the best choice is all of these methodologies, blended together in a way that works well within that organization's constraints. This white paper should provide a good starting place for understanding the value of each of these methodologies and how they can complement each other.

Whichever route you choose, remember that enterprise architecture is a path, not a destination. An enterprise architecture has no value unless it delivers real business value as quickly as possible. One of the most important goals of any enterprise architecture is to bring the business side and the technology sides together, so that both are working effectively toward the same goals.

In many organizations, there is a culture of distrust between the technology and business folks. No enterprise-architecture methodology can bridge this divide unless there is a genuine commitment to change. *That commitment must come from the highest level of the organization.* Methodologies cannot solve people problems; they can only provide a framework in which those problems can be solved.

But, as soon as you have that commitment to change, an enterprise-architecture methodology can be a valuable tool for guiding that change. This change can manifest itself in many ways. Some of the predicted benefits from a successfully implemented enterprise architectural include:

- Improvements in using IT to drive business adaptability.
- Closer partnership between business and IT groups.
- Improved focus on organizational goals.
- Improved morale, as more individuals see a direct correlation between their work and the organization's success.
- Reduced numbers of failed IT systems.
- Reduced complexity of existing IT systems.
- Improved agility of new IT systems.
- Closer alignment between IT deliverables and business requirements.

Naturally, an enterprise that does well in these main domains will be more effective than an organization that does not. This is evident irrespective of whether success is measurable(tangibles), such as profitability and return on investment, or unmeasurable(intangibles), such as customer satisfaction and employee turnover.

Some critical self-analysis are important as a starting point for any enterprise architecture and Roger Sessions considered the following questions just as critical:

- Does your organization spend too much money building IT systems that deliver inadequate business value?
- Is IT seen as improving or hampering business agility?
- Is there a growing divide between your business and IT folks?
- And, finally, perhaps the most important question of all: Is your organization truly committed to solving these problems, and does that commitment come from the highest levels of the organization?

If the answer to all of these questions is "yes," enterprise architecture is your path. It's up to you to take that next step."

In the author's opinion that Roger Sessions' paper was focused on a generic conceptual model rather than a dedicated concept for a specific organization, or application.

As concerns the FTC, the author considers that the military mindsets were not readily looking at the FTC from a value perspective: it was purely a military organization with the typical cultures associated with that type of organizations. Accordingly, governance was perceived purely from military stand-point.

Based on all the above, the project analysis team (led by the author) decided to develop a customized framework that would address the above constraints, dedicated to the FTC's operational requirements.

Now taking in to consideration the comparisons provided by the author's report, it is obvious that any dedicated framework for FTC, a customized EA framework, may not necessarily include some of the criteria on which the frameworks were compared because, in the author's opinion, will be tailored to a specific application.

On the other hand, our work to build a dedicated framework needs to provide an optimized operational model with strong links to services and processes that shall be driven by value, and which need to be constantly aligned and viewed in terms of Porter's value chain.

It is clearly evident that neither of the frameworks would be sufficient to respond to the goals to which this study was set. However, a combination of the strengths clearly identified here, is what will ensure a robust adoption of EA in the domains of capability, governance and risk management amongst many other benefits that can be delivered through EA.

11.3 Author's findings and conclusions

After reviewing the four enterprise architecture frameworks, and Roger Sessions' conclusions, the author has come up with the following findings, recommendations and conclusions:

a. All frameworks, irrespective of its suitability, will need to be adapted and tailored for each organization. EA frameworks provide us with a starting point, for an organization to take the framework and adapt it to an organizations unique context.

b. The taxonomy completeness also depends upon the customer/organizational operating context or domain. Zachman, TOGAF would never be able to compete, with an FTC operational context. Neither would FEA, which is geared up for federal IT systems acquisition for the US government, much like DoDAF is for defence systems acquisition.

c. The same comment applies for the rest of the comparisons:

- Process completeness

- Reference-model guidance
- Practice guidance

d. Maturity model guidance is relevant.

e. The business focus needs further in-depth analysis.

f. Governance would be specific to the operating domain.

g. The rest of the attributes seem good: Partitioning guidance, Prescriptive catalog (never have heard of this one before, but the description of the term hints at a desirable outcome), Vendor neutrality (I think all EA frameworks are vendor neutral, but its very nature), Information availability & time value.

In summary, some good attributes, but also some attributes that do not exactly match or align, due to different operating contexts or domains, to perform a fair comparison.

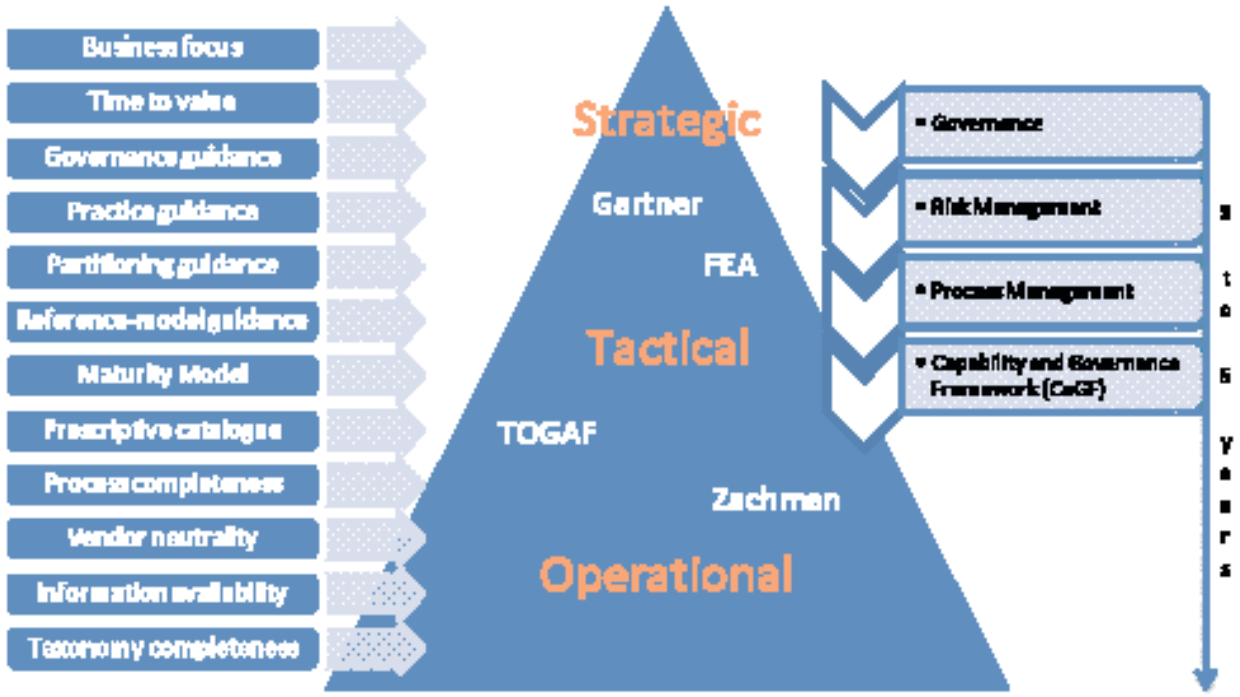

Figure 40: Positioning Enterprise Architecture Frameworks

In consideration of the above analysis and findings, the author with his professional experience, considers the blending aspect of the methodologies as being more complex although theoretically sound. In this regard, the author decided to initially take a more in-depth look at the Zachman Framework (which appeared more comprehensive and contained an integrated approach), before taking a decision on the way forward towards the selection of the best and optimized framework for FTC.

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12 THE ZACHMAN ENTERPRISE ARCHITECTURE

12.1 Detailed Description

Although John Zackman (JZ) Framework was described earlier, the author by selecting the JZ framework as a potential candidate for the FTC framework, has gone through more detailed literatures on EA and JZ framework to allow the author to expand his knowledge and provide a reader with a wider understanding

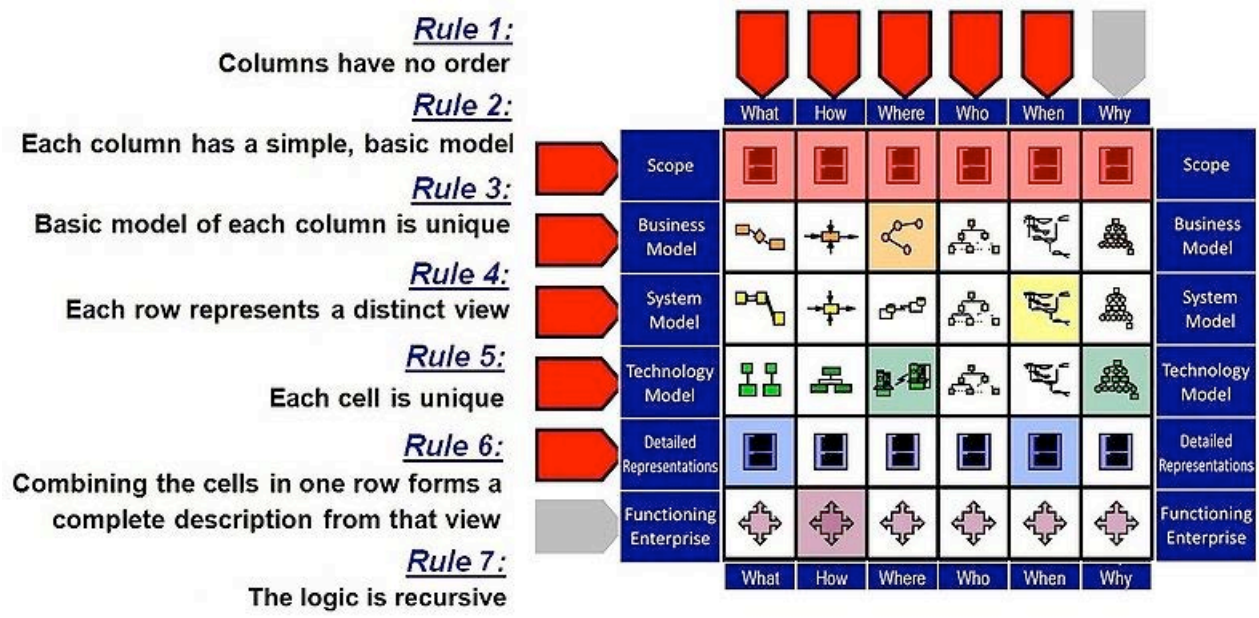

Figure 41: John Zackman Framework (source: Wikipedia)

Zachman summarizes the framework as:

a) **SIMPLE**: It is easy to understand ... not technical, purely logical.
b) **COMPREHENSIVE**: It addresses the Enterprise in its entirety: an integrated approach. Any issues can be mapped against it to understand where they fit within the context of the Enterprise as a whole.
c) **A LANGUAGE**: It helps you think about complex concepts and communicate them precisely.
d) **A PLANNING TOOL**: It improves your decision-making, as you are never making choices in a vacuum. You can position issues in the context of the Enterprise and see a total range of alternatives.
e) **A PROBLEM-SOLVING TOOL**: It enables you to work with abstractions, to simplify, and to isolate simple variables without losing sense of the complexity of the Enterprise as a whole.

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f) **NEUTRAL**: It is defined totally independently of tools or methodologies and therefore any tool or any methodology can be mapped against it to understand its implicit trade-offs ... That is, what they are doing, and what they are NOT doing.

Contrary to Zachman's statement, his framework, although comprehensive, is complex, not simple. This became obvious when trying to assess its implementation at the early stages of the project.

The Framework for Enterprise Architecture is not "the answer." It is a tool ... a tool for thinking. If it is employed with understanding, it should be of great benefit to technical and non-technical management alike in dealing with complex environments and the risks associated with them.

Therefore, coming back to our initial point; what is an Enterprise Architecture Framework? What goes into it? How do you use it? The graphic below provides a representation of the Zachman Framework, as defined by John A. Zachman

12.2 Focus and Perspective

Each cell in the Zachman Enterprise Architecture Framework represents the intersection of a particular focus and a perspective. Each focus (the question what, how, where, who, when, and why) is depicted in a column and each perspective (point of view) in a row.

When you ask or answer a question, your point of view determines the kind of information contained in the answer. It is the same with the perspectives in the Zachman Enterprise Architecture Framework. The perspective determines the kind of information that will be recorded in a row and/or cell. Without a proper perspective, information can never become knowledge. You can't describe your network in a useful way without a perspective.

12.2.1 Building Enterprise Architecture: the Perspective View

	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*	
Objective/ Scope *Contextual* *Role: Planner*	List of Things Important in the Business	List of Core Business Processes	List of Business Locations	List of Important Organizations	List of Events	List of Business Goals/Strategies	**Objective/ Scope** *Contextual* *Role: Planner*
Enterprise Model *Conceptual* *Role: Owner*	Conceptual Data/ Object Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan	**Enterprise Model** *Conceptual* *Role: Owner*
System Model *Logical* *Role: Designer*	Logical Data Model	System Architecture Model	Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rule Model	**System Model** *Logical* *Role: Designer*
Technology Model *Physical* *Role: Builder*	Physical Data/ Class Model	Technology Design Model	Technology Architecture	Presentation Architecture	Control Structure	Rule Design	**Technology Model** *Physical* *Role: Builder*
Detailed Representations *Out of Context* *Role: Programmer*	Data Definitions	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification	**Detailed Representations** *Out of Context* *Role: Programmer*
Functioning Enterprise *Role: User*	Usable Data	Working Function	Usable Network	Functioning Organization	Implemented Schedule	Working Strategy	**Functioning Enterprise** *Role: User*

Figure 42: View of the Enterprise from One Perspective

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12.2.2 Building Enterprise Architecture: the Focus View

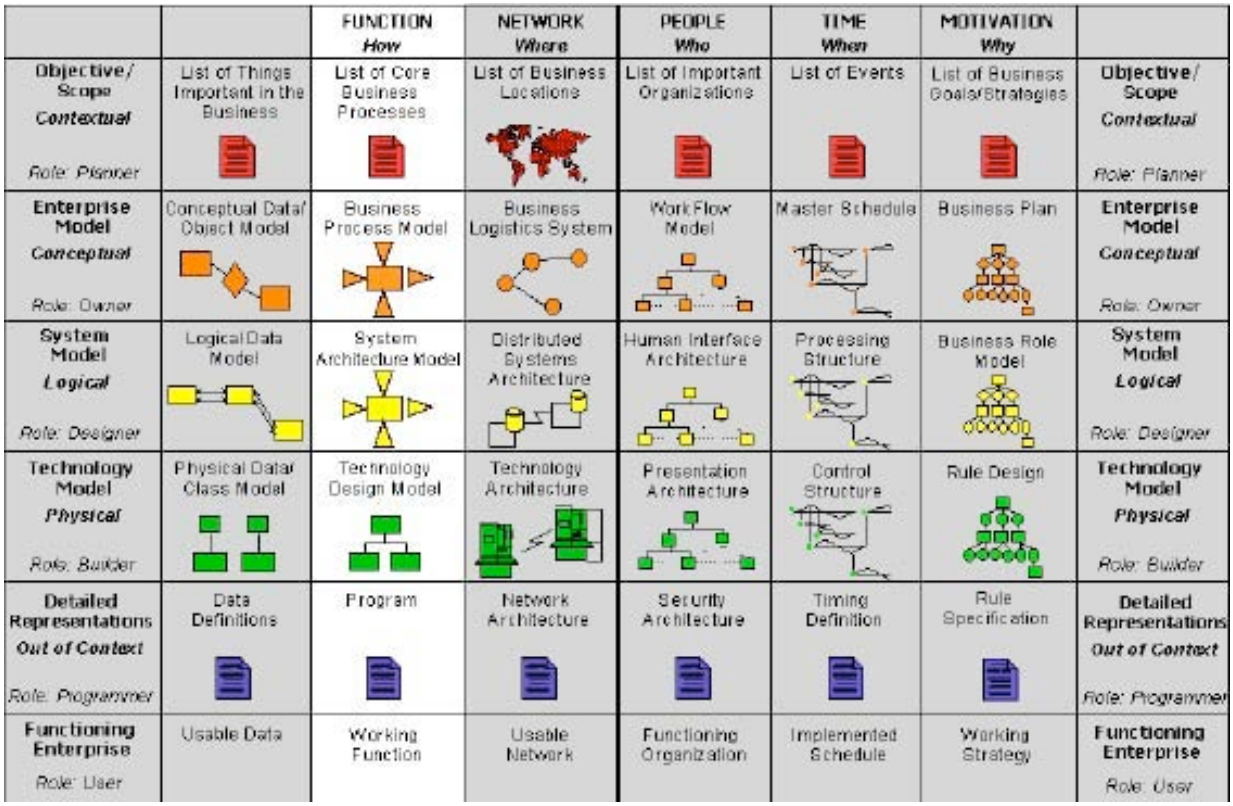

Figure 43: View of the Enterprise from One Focus

12.3 Constraints and Requirements

By definition, the perspectives in the Framework act as constraints upon one another (((Jonkers, 2003), (Hong and Theodore 2003), (Morganwalp and Sage 2002))). These constraints tend to flow from top to bottom. For example, within the FTC, the CEO's requirements constrain what the company's managers can do. The managers' requirements, in turn, constrain the line workers, and the line workers' knowledge, skills and abilities constrain what the Enterprise can produce ((Buchanan, 2001), (Toh,1999)).

Constraints can flow from the bottom up as well, though these tend to be less restrictive than those flowing from the top down. The most likely source of a bottom-up constraint is technology, e.g. in the "What/Data" focus a relational database, which does not have the desired functionality (Richardson et al, 1990). Most business people can think of at least one example in which a software system has constrained an industry, despite (of) the rules in practice within such industry (Suter, 2007). It is fortunate that newer and better technologies, (and in most cases) remove such constraints, however potential risks remain a challenge to industries.

As seen in the figure below, each perspective places constraints. These constraints are cumulative and dependent on one another. It is therefore vital to make them explicit with an Enterprise Architecture ((Schekkerman, 2004), (Jonkers et al, 2004))

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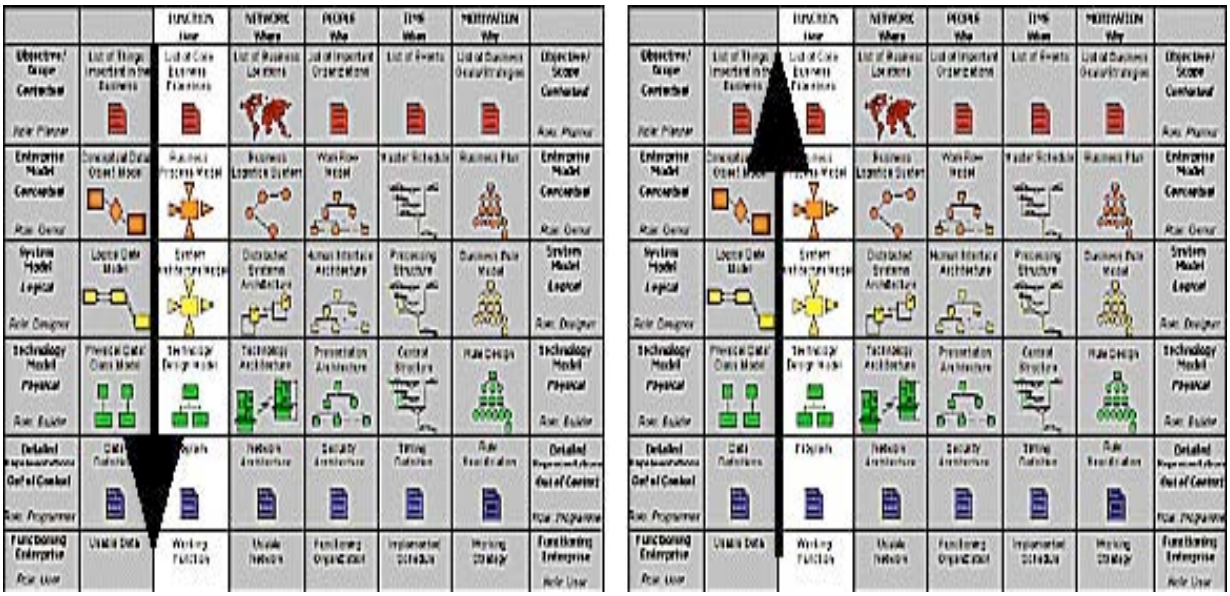

Figure 44: Constraint Flow of the Framework

12.4 Conclusion

A Framework is a mechanism for relating enterprise knowledge in a useful and relevant way. It helps to ensure the creation of a more robust enterprise. From the perspective of IT and IS, the framework is a tool which makes sure the "Technology solutions" delivered to the business case or units, are relevant. It also is a tool that provides a means for designing the solutions by integrating the technical design with the stated or defined business requirements. For the business manager, the Framework is a tool that helps him to understand the workings and interrelations of all aspects of the business (information, communication, processes, people, performance, etc.) It also helps him align **IT strategies** with business strategies. All the cells in the total framework represent the total knowledge base of an Enterprise. This total knowledge base is core to FTC governance and leverage to risk management.

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13 DEVELOP A CAPABILITY AND GOVERNANCE FRAMEWORK (CaGF): KEY ELEMENTS TO RISK MANAGEMENT

In order to ensure the linkage and sustainability between CaGF and FTC business operations / processes, the author has defined here below the FTC Mission and Objective - TO BE

13.1 Mission and Objectives: FTC (To-Be)

The following points describe the main points pursuant to the "TO BE" FTC mission and objectives:

- Establish specific Capabilities in line with the FTC programme requirements and in anticipation of Risk and its possible impacts
- Maintain a core product development and production competency in the interest of the FTC product portfolio
- Provide the needed technical support to our clients in defining, specifying, selecting, and integrating products, i.e. customised turnkey solutions to our clients.
- Provide a credible interface to the regional community and serve as a conduit between the original equipment manufacturer (OEM) community and the FTC programmes.
- Exploit commercial opportunities when they arise but not to be competitively active
- Expand and create new ventures/cooperation with platform manufacturers and users, and ensure confidence build-up.

However, before starting to analyse risks associated to the "outsourcing" activity, the cartography of the Flight Test Centre needs to be defined, in particular to evaluate the risks associated to each activity or context surrounding the function and mission of the Flight test centre.
The missions of the flight test centre need to be described in detail in order to determine together, all possible domains of activities of the said centre (e.g. flight tests, ground tests, objectives of each of these activities …)
The required means to function and operate the flight test centre will allow quantifying the risks associated to the missions. They will include the required infra-structure, and consequently the issues associated with the investments and obviously management (land, buildings …), the means and processes allowing conducting inspecting and checks, including the means to monitor and control the airspace and the tests.

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This cartography need in one part, to demonstrate the inherent risks associated with the activities regarding personnel at the flight test centre as well as the environment and the surroundings / neighbourhood (noise, accidents …)
A flight test centre is continuously subjected to and linked to new and innovative technologies and/or modernized industries, and the sensitivity of the confidentiality of information, and particular the need for processes to be equally understood and (the processes) established well in advance. A study showing the differences in handling of information in the civil world as compared to the military is essential and important. It shall allow us to define the risks associated with the confidentiality issues.
We need not forget in this cartography, the aspects pursuant to the laws, rules and regulations in force in the country (UAE), as well as other regional and international agreements and restrictions. This includes but not limited to: airspace regulations, military code of conduct, civilian airworthiness requirements for the civilian/commercial, aircraft such as Bureau Veritas, CAA, ICAO, etc.
This cartographic phase of risk linked to the activities of a flight test centre shall end with the first strategy for risk management. In support of this strategy, a certain number of interviews/meetings/discussions will be organized specialized and concerned individuals who are actively involved in military activities in a military flight test centre, as well as individuals engaged and operational in the management of flight test centres in the private commercial sectors.
It is foreseen too, the need to analyse a number of outsourced military projects to industries or to other competent parties. This obviously takes us to identify the other possible candidates in the subject matter, and their experience (both positive and negative) they may have. Such ideal candidates could be:

- CEV Istres et Cazaux
- CEV Airbus and Dassault
- THALES who own a test aircraft

All the above actors play an important part in the civil and military activities, in particular regarding the outsourcing from the military organizations. Examples include the strategic tankers, run by the industries, with services rented to the military.

13.2 Solution Framework

The enterprise architecture model is governed by a meta-model that specifies the relationships between all the various model element, in terms of connectivity, associativity and dependencies.

Key features:

- Integrated change management and impact analysis across all organizational elements.
- Integrated risk management and risk status reporting for all organizational elements.
- Integrated metrics collection to help support process improvement efforts.
- Integrated management status indicators for all organization elements, that features CMMI style reporting and helps identify areas of improvement.

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13.2.1 CaGF and Initial EA Consideration in FTC

In light of the extremely dynamic economic and geo-political context of the UAE, and having observed a fast pace of change in the UAE military evolution in past decade (especially in the Air Force), the chain of command in FTC set out to renew its planning and organization analysis capacity. With the ultimate goal to strengthen its internal operation in order to be of higher contribution to the UAE Air force capability development effort, FTC investigated numerous approaches from Risk & Quality Management concepts in a multi-discipline environment, to innovation frameworks.

In early 2007, FTC partnered with Telelogic Consulting Services to undertake various awareness sessions and training on Enterprise Architecture concepts and associated Tools (System Architect). Having investigated its fundamental theories and understood the potential explanatory, planning and governance capabilities of this evolving discipline, FTC's commandment considered Enterprise Architecture a possible solution to its organization analysis, planning challenge and thus Risk management. In 2007, the author within the FTC as part of his research project and objectives undertook the initiative, to define an appropriate approach to Enterprise Architecture adoption which will be of maximum benefits to the organization and operational planning process. These benefits are intended to contribute towards a risk management.

As part of the research project the Author, initiated a qualitative assessment (based on open ended interviews and organizational planning insight and benchmarks) of FTC's operation and identified various opportunities for improvement in the Organization Planning, Operation Setup and Risk management. The assessment provided evidence that the very obvious risk at FTC was the lack of visibility into Governance and capabilities. A framework to define capabilities and establish Governance, amongst many instant benefits, would constitute an immediate solution to start the journey into Operational excellence and risk mitigation.

The initial iteration of CaGF framework has been developed as a Capability and Governance Framework. The framework was devised to focus on maturing critical internal capabilities for FTC to evolve into a distinguished service provider in accordance with its mandate and projected aspirations in the fast developing UAE military. It was also intended to clarify and define Risk Management.

The motivations (why) and the reason of using EA and appropriate framework are:

- We looked at Enterprise Architecture as means to address enterprise Risks.
- The idea was not to limit Risk management to one area of the Enterprise, but rather have a holistic approach to Risk Management.
- A Framework had been chosen to implement Enterprise Architecture in the Organization.
- Initially for this matter the Zachman Framework was examined due to its scope, from Planning down to deployment of systems (see chapter EA framework). As a result the lack of methodology behind implementing Zachman became obvious.
- CaGF was proposed as a solution to implement Enterprise Architecture that answers to the following criteria:

a. Addressing Risk Management on a holistic approach, as a major area of the solution
b. Understand the context and the environment of FTC to ensure that we understand those Risks pertaining to a Flight Test Centre, based in the UAE
c. Include a clear Methodology to implement Enterprise Architecture
d. Ensure that the solution is achievable within a limited time-frame and to have Quick Wins earlier in the Project.
e. Ensure that the Solution is deployable within FTC and to address the Risks associated with EA becoming obsolete over time

13.2.2 CaGF Overview

CaGF is a multi-layered framework. It is defined as Capabilities and Governance Framework. The name clearly transpires the objectives of the Framework. The Framework work was developed using an Enterprise Architecture approach and supported by an automation Tool (System Architect) to ensure that the result of the work has a permanent impact on the organization. The front framework interface is intended to give a helicopter view of the FTC Capabilities from different perspectives described here under.

Horizontal Perspective of CaGF:

The framework has Four Horizontal layers. Each layer represents a category of Capabilities in FTC.

Vertical Perspective of CaGF:

Columns 1 represents FTC current (As-Is) capabilities, while column 2 shows the Planned Capabilities (To be).

Column 3 represents Initiatives required to mature the capabilities from the Now to Future. A fourth Column is intended to provide a visual of Guidance and Compliance items governing the Capabilities. Finally, a Fifth Column was introduced to display the overall Maturity for each category of Capabilities according to the assessment done by the Project team. The approach identified Risk management as a Major Capability that required a certain attention at the centre to ensure continuity and moving up the Quality maturity ladder - below shows CaGF front Interface.

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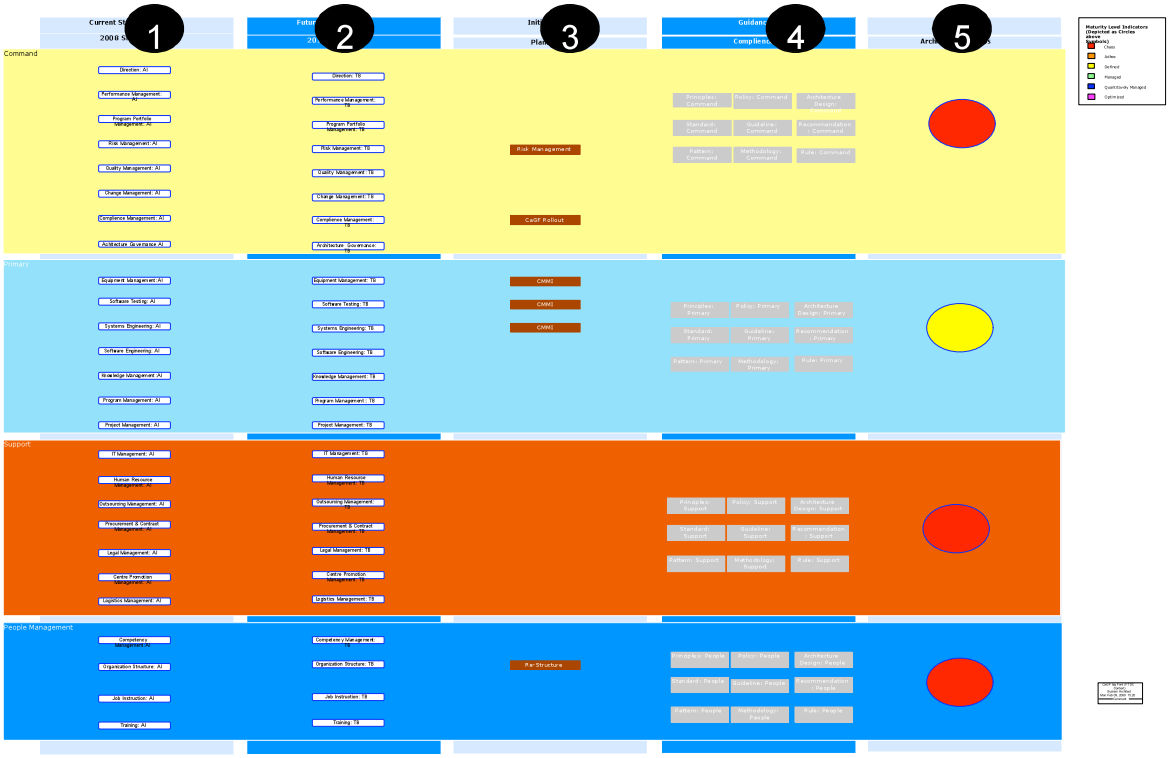

Figure 45: CaGF front interface

The subsequent layer of CaGF introduces the 4 Horizontal layers of Capability Categories in the context of Porter Value Chain to demonstrate how FTC interacts both internally and externally to provide value (Service). Each capability from this layer can be further explored (drilled down) to the set of Capabilities supporting it. This introduces the first element of Governance for each Capability across the entire Enterprise.

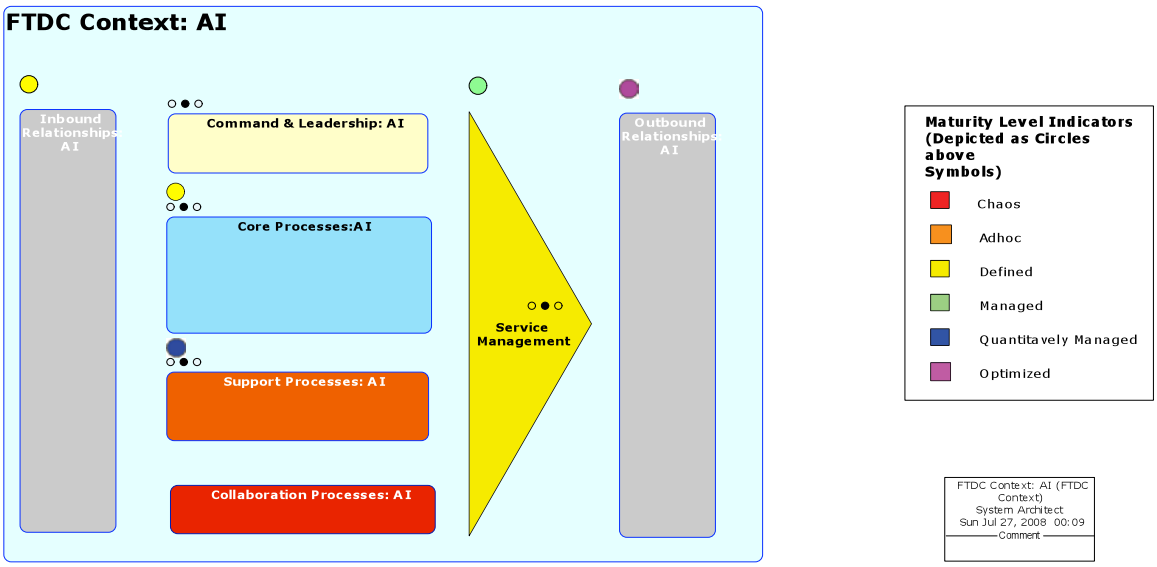

Figure 46: Layer Two of CAGF framework

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Each of the Capability Groups shown in the second layer decomposes to capabilities as seen in the below model (**Erreur ! Source du renvoi introuvable.**) for the Command & Leadership Capabilities

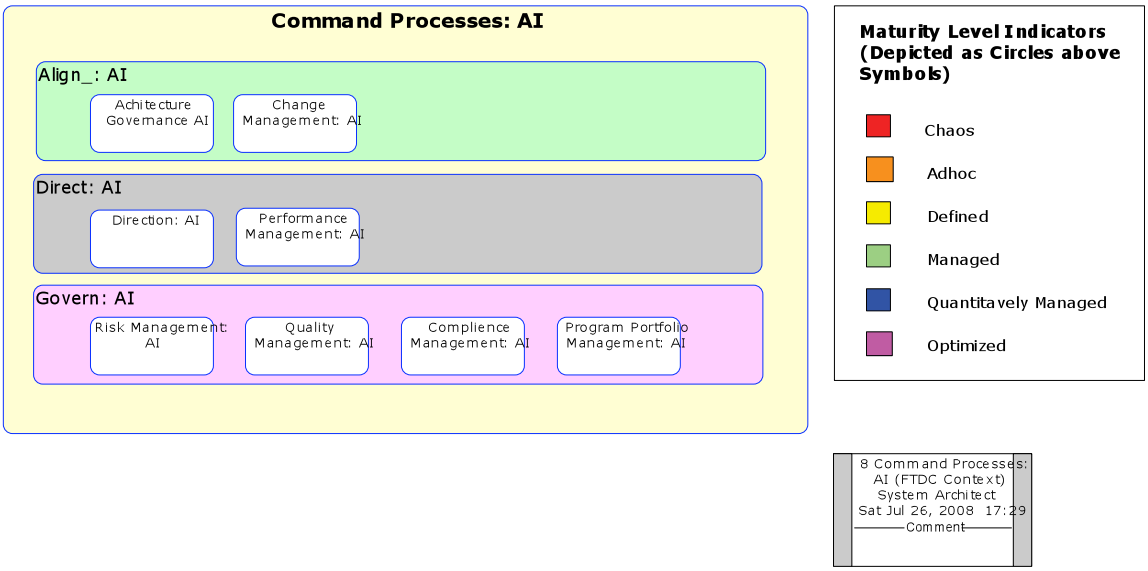

Figure 47: - Second layer decomposition

Finally each of the above capabilities further decomposes to processes.

13.2.3 CaGF Goals

The goals of the CaGF framework in FTC are defined as follows:

#	Goal
	To help position FTC as a regional leader in military aircraft capability improvement
	To help pro-actively manage critical internal capabilities
	To ensure visible alignment between FTC and the AirForce Goals
	To help maximize return on investment
	To instigate dynamic capabilities and maintain agility
	To bring about context to **Risk management** at FTC, amongst other Capabilities that the centre has to manage
	To Provide both Taxonomy and Ontology to **Risk** so as to ensure a good adoption and quality service within the Enterprise.

Table 9: The Goal of the CaGF framework

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13.2.4 CaGF Objectives, Vision, and Mission

This Enterprise Architecture initiative is aimed at establishing the foundations of EA within FTC, by developing the first release of a proprietary framework. The definition of a customized Enterprise Architecture Framework required a scrupulous study of the organization context, motivations and challenges in order to strike a balance between EA concepts, philosophies and operational pragmatic usage. Clear benefits had been articulated and operation hooks identified, targeted and integrated. The positioning of the EA framework is illustrated in the diagram below:

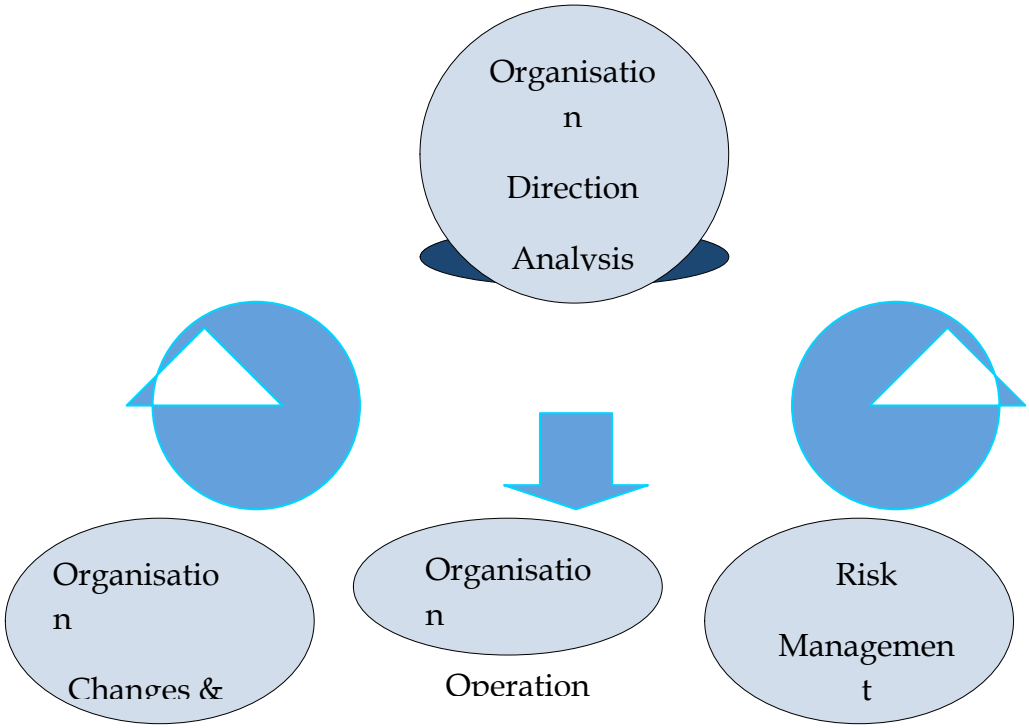

Figure 48: The positioning the EA framework

Vision: FTC will use Enterprise Architecture as a central planning capability for aligning direction, execution and change initiatives to implement operational excellence, reduce Risks , drive maximum agility, and purpose-oriented innovation.

Mission: Enterprise Architecture will maintain a thorough definitions, components and connected models across the organization layers to ensure that implemented initiatives primarily fulfils strategic needs. The EA artefacts will be used to develop key insights, support communication and build a strong consensus on critical operational capabilities, requirements and priorities. By externalizing and visualizing maturity gaps, EA will help continuously refocus capital and resources towards highest return investments, thus reducing the various Risks, including those pertaining to Capital loss and Operational inefficiencies.

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13.2.5 CaGF: The Planning

The development of an Enterprise Architecture framework is a relatively complex Endeavour that requires experience and insight on established frameworks structures and makeup. It encapsulates a cyclical process and a continuous injection of best practices, tools and references on organizations and capability science and thinking aligned with business needs. It builds on worldwide best practices and adds tools, templates, blueprints, and on-site training. It borrows from various frameworks such as TOGAF, EA2F, DoDAF, Zachman concepts to the extent practical. The diagram below (**Erreur ! Source du renvoi introuvable.**) illustrates the process aspect of the method which includes 6 phases.

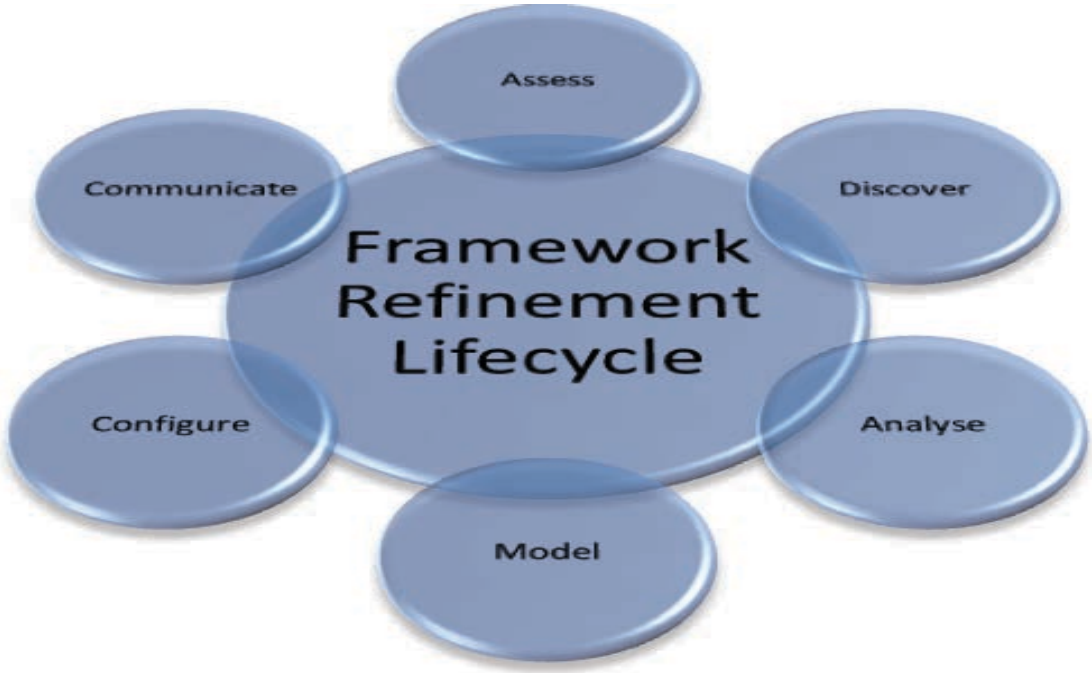

Figure 49: Framework Refinement Lifecycle Process CaGF

The method organizes the project activities logically and chronologically to facilitate the effective execution of the different tasks and the generation of their related deliverables in line with the suggested and agreed scope of work in FTC. The activities and the descriptions for each are:

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#	Phase	Description and Aim
	Assess	Preview Architecture approach and awareness to date. Review available documentation. Understand current **Risk Management** scope and reach at FTC Establish an understanding of the initial scope of Enterprise Architecture in FTC. Identify the key EA stakeholders and understand some needs, perspectives and priorities. Initiate the Enterprise Architecture program charter defining EA role, and its key principles and policies. Setup communication and practical project drive measures. Introduce initial organization planning and Architectural concepts of relevance to the context. Devise interview plan and develop interview questionnaire and approach.
	Discover	Define Enterprise Architecture initial Footprint based on scope, contribution view and project timeframe. Conduct interviews and gather necessary and available documentation to develop insight with case strategy. Define initial EA and Framework positioning following earlier assessment. Define an initial correlation between **Risk Management** and the Framework Introduce key organization planning and analysis concepts of relevance to context and environment Develop an intranet structure to publish all the Framework's components into an online repository for effective communication and reference;
	Analyze	Derive Enterprise Architecture components based on the stakeholders' needs, interests and perspectives; Select appropriate documentation standard for each component based on industry best practices; Analyze Risk interview responses and Provide a particular focus for **Risk** documentation Review organization Strategic Direction and Goals Develop Enterprise Architecture Framework maturity roadmap.
	Model	Design an Enterprise Architecture deployment strategy to maximize the value of the framework and ensure its effective use. Identify key properties for each Enterprise Architecture component based on the intended use; Design FTC's Framework after evaluating recognized frameworks and taking into account FTC specific components;

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#	Phase	Description and Aim
		Configure Telelogic System Architect (at least in Dev Environment Design the meta model required to map all the Enterprise Architecture components and their corresponding properties and relationships to the tool. The Meta-model should include an explicit model of the **Risk Component** Instantiate relevant aspects of the meta-model based on scope and timeframe. Define domains to organize FTC Frameworks components and identify corresponding guidelines and initial assessment
	Configure	Develop an effective communication plan to prepare the organization to endorse the culture of Enterprise Architecture. Design a plan to implement Enterprise Architecture governance; Develop Enterprise Architecture governance activities and links with other management processes; an Enterprise Architecture organization structure and assess current resource profiles and future strategic partnership needs; Configure Telelogic System Architect (at least in Pre-production Environment) Perform all necessary customizations and setup to configure the tool in line with the final structure of the meta model; Develop the framework on the tool and attach each cell to its corresponding Enterprise Architecture components; Provide a Placeholder for **Risk Management** in the Framework; Define Key Framework and organization processes integration points.
	Communicate	Release charter Release repository Release models Release initial analysis Agree on Governance plan Agree on Enterprise Architecture Awareness Campaign; Agree on follow-on phase in the definition and deployment of the Framework.

In the absence of a predefined standard EA Framework and method, the scope for an Enterprise Architecture practice was defined based on four sizing elements taken in the context and priorities of a the organization:

Span of Organization: Which aspects of the organization to include in the Framework Definition?
Breadth of EA: What structure and perspective to the identified aspects of the organization?
Depth of Models: What depth, history and information to capture on the selected components?

Planning Horizon: What projection timeframe should be considered in the capture of actual models content?

These descriptions present natural starting points and dimensions for the formalization of a customized Framework for the Enterprise Architecture function.

Span of Organization:

The span of the organization indicates what domains of the organization are intended for inclusion within the EA scope. Following the initial analysis of FTC context, the need has been identified by the author for a broad and all-encompassing context to the initial EA definition. This approach is necessary to set the most comprehensive context for analysis. At the highest level of abstraction, all major areas of the organisation operation are identified.

Considering the service nature of FTC's activities (i.e. the development of Aircraft Capability), the value chain concept (Porter, 1980) in the **Erreur ! Source du renvoi introuvable.** helps identify 3 majors aspects of FTC operation (Input, Throughput and Output):

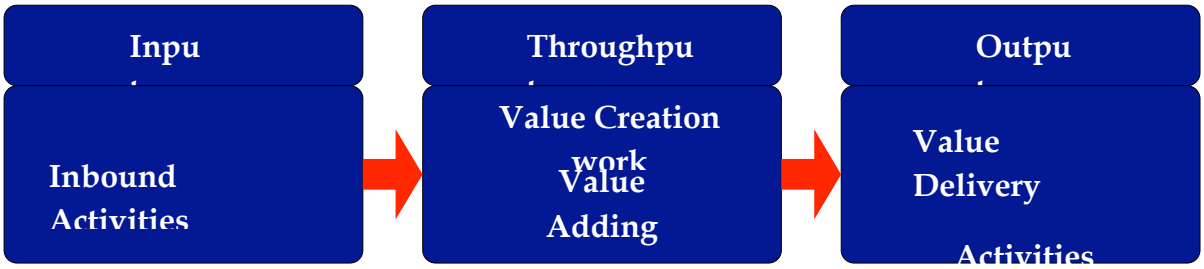

Figure 50: Span of Organization

Breadth of EA:

EA Breadth analysis matches the identified organization areas and priorities, against typical EA domain capabilities (i.e. from established Frameworks – Value Models). From the span of organization (technology and processes) specified above, the immediate breadth of EA has been expressed as follow in **Erreur ! Source du renvoi introuvable.**:

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Application, Infrastructure and Process

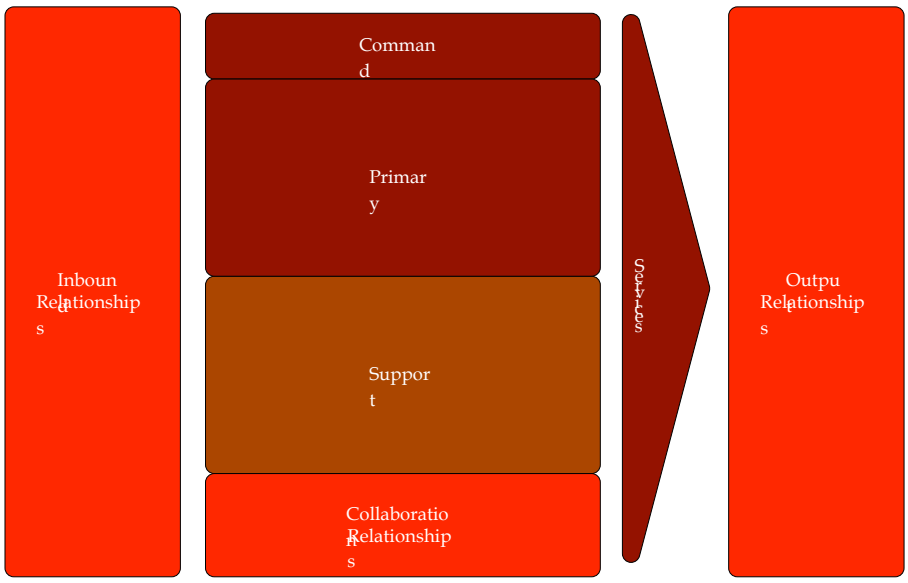

Figure 51: Breadth of EA

Depth of Models:

Depth determines the level of modelling to cater for within the identified areas/domains to yield the expected output and impact from EA. The immediate requirements in FTC, as derived from the assessment of the organization have been mapped to the following modelling capabilities of the Enterprise Architecture practice:

Concerns & Gaps	Suggestions	Theme	EA Mapping
What is the strategic direction of FTC? How does FTC align with AFAD What Business Elements are critical to the mission of FTC? What common understanding of purpose and shared accountability?	Understand, translate and document FTC vision, mission, strategy and main design traits i.e: Conops, Business Design, Principles, Main entities…	Strategic Directives Core components FTC high level Description	**TO_BE:** This includes high level models intended to provide a consolidated descriptive view of key areas across the business layers of the enterprise. Those models are mainly intended for common understanding and communication.

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Concerns & Gaps	Suggestions	Theme	EA Mapping
How to exert guidance? How to ensure concise synergistic contribution towards FTC's mission? How to introduce common language? How to drive and direct evolution and growth of the organization?	Establish a documentation framework and identify targeted end state for each identified area for guidance. i.e. Standards, BPM Methods… Organize components into an easy to reference structure to enable stakeholders to access and comply with directives set for each domain.	Target Components Management Choices Control and Guidance Trends and Roadmaps	**Guidance:** This level of models includes the definition of Standards, Principles and Guidelines. Those components will provide the roadmap for enabling EA to govern the transition from the current to the future state architecture in a planned and structured manner.
What Risk management means for FTC? Where to apply Risk Management What should Risk management be?	Assess Current Risk management practice Provide a structure for Risk management Governance Identify Risk meaning for FTC Identify Enterprise components impacted by Risk		
How to channel change patterns towards target? How to prioritise between the various requirements for change Which major initiatives should be undertaken and in which order?	Document environment and produce transition plan towards target. Govern change i.e. Roadmap, Current State…	Actual Documentation and Initiatives Governance	**Gap**: This provide the means and tools to undertake a delta analysis on the organization **Initiatives**: Provides a list of change initiatives to move the organization towards its desired state
What are the composites of the organization's operations environment? How do components interact and relate and how do they link back to the other model depths?	Document current situation to the appropriate level of components details for comparison	Operational state and current capabilities documentation and models	**AS_IS:** EA will include the modelling of current environmental components. The components captured at this level will represent actual occurrences of the

Concerns & Gaps	Suggestions	Theme	EA Mapping
What collection platform to maintain to ensure intelligence?			related objects within FTC. the modelling of the existing setup and maturity is required to facilitate a delta analysis with desired target states

Planning Horizon

FTC EA planning horizon is in line with that of the organization direction. In FTC no other process other than the yearly review has been identified. The EA planning horizon is suggested over 3 years. The EA lifecycle definition will introduce interim refresh intervals with clearly defined frequency and scale. The nature of entries in the various layers drives the actual update pattern in the fashion described below:

Layers	Typical Content	Horizon	Update Frequency
TO_BE	Direction, conceptual target models across layers	3 years	Yearly (exceptionally on quarterly basis)
Gap/Initiatives	Initiatives, Programs, Projects, major changes	Current	Quarterly thorough update Monthly review Ongoing project updates Real time as part of over EA governance
AS_IS	Org processes, structure, services, customers...	Current	Quarterly thorough update Monthly review Ongoing project updates Real time as part of over EA governance
Guidance	Policies, Principles, Standards, Guidelines ...	Current	Quarterly thorough update Monthly review Ongoing project updates Real time as part of over EA governance

13.2.6 Impact on Risk Analysis

Risk is not limited to one area of the Enterprise therefore the major differentiator for using the EA approach unlike other methodologies, EA will ensure that Risk is covered across all identified functions.

As a planning and governance practice, the promised benefits of Enterprise Architecture can only be realize if integrated into the running of the organization. This operational integration is better

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understood by the leadership/command line if the EA framework is initially defined to directly address operational issues and limitations in the current setup of the organization.
A major requirement for suitable position of Enterprise Architecture is the identification and communication of immediate organization planning limitations and concerns. An assessment of FTC's context has identified a number of planning challenges:

13.2.7 Assessment overview

The initial assessment is based on teleological Architectural Fitness test, which include two distinct analyses:

1) Organization Type: A quick analysis to determine the organization orientation, vertical focus and arrangement type (i.e. Service, Project, Product or matrix orientation…)
2) Perspective assessments: Based on the type of organization identified a qualitative fitness assessment is performed using benchmarks primarily derived from international best practices (i.e. eTOM for telecom, AIS for finance, ISO2000 for services….).

The assessment is based on a set of interviews undertaken with all major stakeholders and decision makers within the organization. In order to better position EA and CaGF framework within FTC, an analysis of the organization has identified a number of factors with major relevance planning and investment.

The typification review has identified a number of profile types for FTC:

Org. Types	Description	Relevance
Military Org.	FTC a non-combat unit in the UAE Military.	The military chain of command is often an advantage for EA initiatives (i.e. DoDAF) Buy-in is required at the highest level (i.e. DoDAF) The military impact should only remain structural as the efficiency drivers should be built on civilian type competitive principles.
Project based	FTC output to external parties through project	A strong project mindset and associated capabilities are needed. Project lifecycle (time-bound) and products lifecycle (service oriented) must be distinctively managed.
Services	FTC's outputs are generally abstract services	Service Recipients expectations must be managed as primary inputs to work planning. Activities measures must amount to service expectations.

NB: Combat scenarios requirements have not been explored as part of the type analysis.

Typical challenges to FTC with a growing capability in systems development as well as both ground and flight testing, include the following:

- Lack of adequate program management and process improvement tools
- Loss or unavailability of key competencies and skills

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- Unmanaged, incompatible documentation
- Weak estimating of task duration and control
- Weak program management, inadequate risk management,
- Weak or non-available progress measurement process
- Redundant tasks and responsibilities
- Lack of a dynamic Change management

13.2.7.1 The 4 Points Analysis Perspectives

To reason and communicate about these organizations, EA generally uses enterprise models. An *enterprise model* represents the resources and components found in the enterprise and in its environment, together with the processes in which they participate. The model represents only the entities of the enterprise and of its environment that are relevant for the planning context. Enterprise models are structured in organizational levels or layers.

In CaGF the concept of 4 points analysis is derived from Aristotle explanatory capability to better understand entities. This approach is intended as a simple abstraction of key areas for analysis within an organization. The 4 perspectives identified for the FTC analysis are illustrated in the diagram (**Erreur ! Source du renvoi introuvable.**) below:

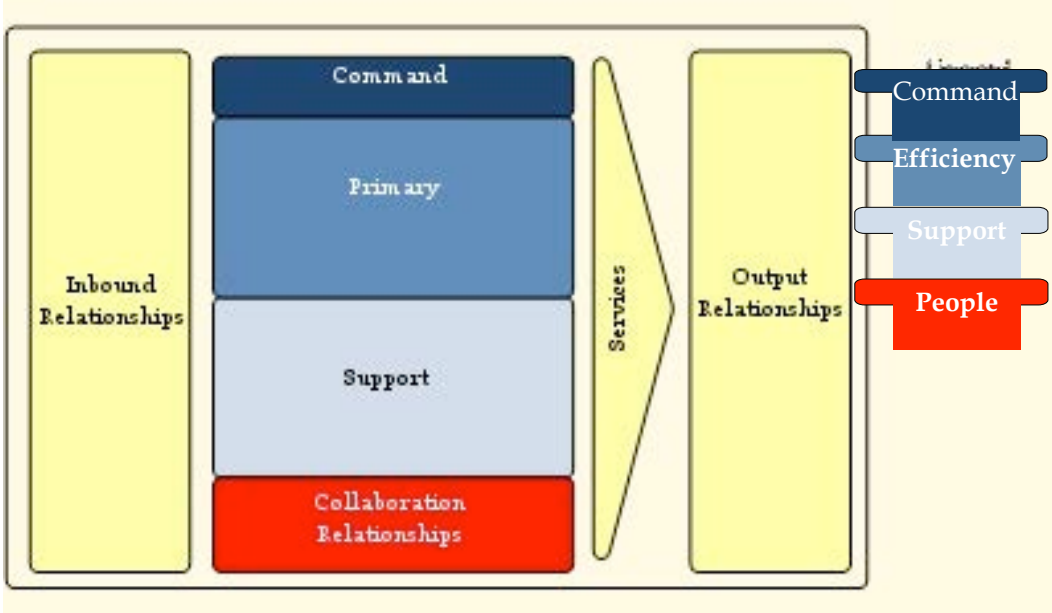

Figure 52: The 4 points analysis perspectives

Perspectives	Description
Command	The set of activities and processes owned by top executives and the chain of command to ensure the organization is steered and managed in the right direction.
Primary or Efficiency	Include the major activities from input to customer delivery which are necessary to successfully and efficiently deliver on the organization mandate.

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Support	Includes the set of collaborative, partner and secondary undertakings and processes needed to facilitate the efficiency layer.
People	Explains the human dimension and associated perspectives of the organization to fulfill its mandate.

13.2.7.2 4 points analysis domains and maturity

For each of the 4 perspectives, a set of analysis are identified following the type assessment of FTC. Identified domains are listed in below - the maturity measurement scale is also provided.

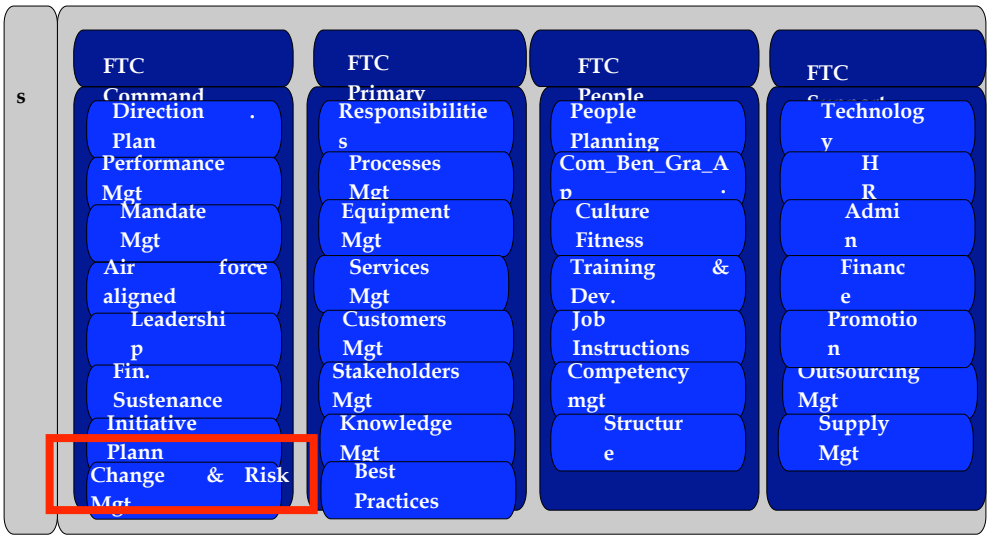


Figure 53: The maturity measurement scale

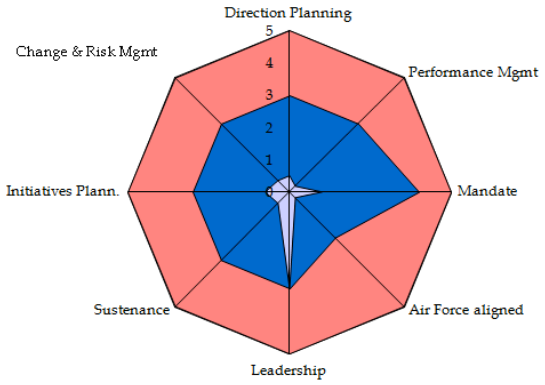
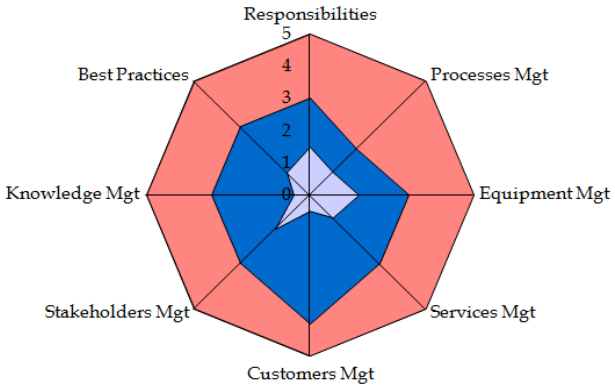
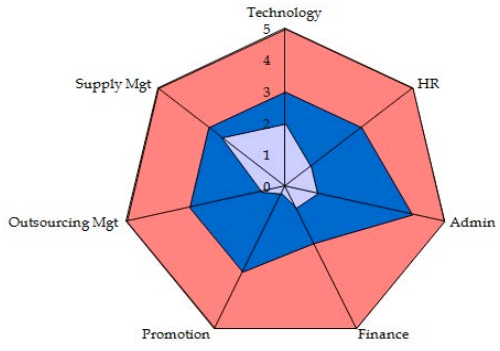
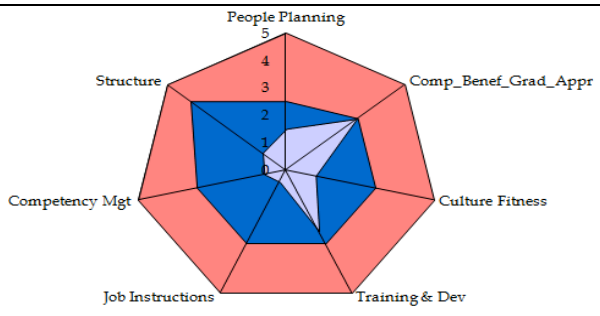
As seen above, Risk management is amongst the major domains that were analysed as Part of the "Command" Perspective.

13.2.7.3 Maturity Indicators

Maturity was gauged using the same scale used within the Capability Maturity Model (CMMI) published by the Software development Institute. CMMI has been already chosen earlier at FTC as a Methodology to assess Process Maturity;

Chaos
Adhoc
Defined
Managed
Measured
Optimised
Average
FTDC

Following a Qualitative assessment by the Enterprise Architecture Project team, FTC's maturity assessment (As-Is) is illustrated for each perspectives (and respective domains) in the spider charts below by the color defined above.

FTC Command – As is assessment	Primary – As is assessment
	
Support – As is assessment	**People – As is assessment**
	

The Situation Analysis and Findings elaborated in the above charts are described as follow:

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Perspectives	Major Findings
Command	A formal and systematic framework for planning and performance management is required. Limited visibility of FTC and AFAD alignment Holistic planning not formally documented Sincere efforts to address **Risk management** but no clarity into scope, Methodology and where to start
Efficiency	No holistic perspective of organization processes as a break-up of higher mandate. Limited visibility of customer and services lifecycle management
Support	Limited evidence of active outsourcing relationship management No promotion is actively undertaken Limited formal agreement on collaborative activities
People	Limited traceability processes, services and job instructions Training is not encapsulated into knowledge process Limited pro-active competency management

The summary of the findings in the table above also represent the key value drivers and initial investment areas for the Enterprise Architecture initiatives in FTC.

13.3 CaGF Benefits to FTC

The correct adoption of Enterprise Architecture as a central planning and management capability will allow FTC to plan, change and operation more efficiently; a breakdown of some the main benefits are here explained:

#	Benefits	Description
	Complexity Reduction	Provide the visualization technique to reduce complexity in planning and change. Help manage uncertainty in operational and project outcome Bring clarity into the organization mandate, purpose and focuses investment
	Re-alignment of Risk Management endeavours at FTC	Understand the Context of Risk in FTC Taking a wider approach for tackling Risk Management Establishing Risk management as an inseparable part of the Planning function at FTC Defining Risk management as a major Capability to acquire and Manage in FTC Methodology-driven Risk Management Enterprise-wide Risk management Risk Mitigation through a Risk Management function + Enterprise Architecture. This would bear the ultimate results for FTC A roadmap to implement Risk management as an initiative Prioritization of Risk Management initiative against a Portfolio of Programs that constitute the core of planning and budgeting at FTC

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#	Benefits	Description
	Enhance Decision Making	Provide a holistic view of the organization; Highlight the relationship and dependencies between organization's information components; Enable impact analysis across the organization's information components; Develop a continuous process for evaluating direction and strategy through the creation of a future state architecture and an integrated approach to the design and implementation of solutions.
	Enable Effective Change Management	Facilitate assessment of change impact on organization components; Eliminate discovery efforts; Facilitate transition from current to desired architecture by capturing As-Is and To-Be blueprints of the affected components; Provide guiding principles for managing the evolution of the organization's components; Ensure architecture driven evolution of organization's components.
	Automation Rationalization	Define technology standards, principles and guidelines; Implement architecturally aligned technology evolution roadmap; Promote reuse; Standardize, rationalize and align technology initiatives.
	Improve FTC and Air Force Alignment	Build a strategic partnership with the Air Force. Leverage the relationship between the Air Force strategy and their corresponding unit capability requirements for deriving the plan and approach to operational efficiency and optimisation; Demonstrate alignment by linking the initiatives to their related driving strategic objectives; Enable the definition, tracking, and reporting of business objectives related to all initiatives within FTC; Use the Air force and FTC strategic relevance as a base for qualifying and prioritizing initiatives.
	Improve Communication Across Organization Units	Create a common language for describing different organization's components; Facilitate the sharing and communication of organization's components by providing a shared platform (EA tool) for describing those elements; Enhance alignment and cooperation across business units (agencies and/or departments) on initiatives by focusing the efforts on achieving business objectives at organization level;

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#	Benefits	Description
	Improve Delivery Time	Standardize delivery methodology by using EA as a platform for best practice project governance; Enable reuse of components already defined; Ensure a consistent approach to delivering solutions Ensure a desired structure and substance for deliverables and project output is adhered to in all engagement – including external partners Reduce implementation risk and improve delivery time through reusable or shareable solutions.
	Improve Planning and acquisition cost	Increase flexibility in systematically managing personnel and skill profiles and evolving needs. Consolidate and eliminate redundant and overlapping projects by applying a consistent architecture discipline to projects and initiatives. Reduce aggregate systems integration costs by architecting flexible and reusable or shareable solutions, infrastructure and capability. Reduce aggregate systems and operational integration costs by architecting flexible and reusable or shareable solutions, infrastructure and capability across the enterprise. Reduce vendor costs by allowing for pre-selection and pre-negotiation of solution structures, requirements and resources.
	Productivity Optimization and effectiveness	Optimize productivity of valuable team members and resources by focusing resources on the most business-effective project portfolio mix, ensuring the organization is working on the right initiatives at the right time. Optimize and improve asset utilization, through enterprise strategy and planning and portfolio management.

The above benefits can be achieved at different stages of the EA practice maturity within FTC. The realization of those benefits will also require a tight integration between Enterprise Architecture and other core processes in FTC including but not limited to:

1. Strategic Direction Planning.
2. Portfolio Management.
3. Program Management.
4. Service Delivery Management.

   This requires a strong governance process at each integration point to ensure effective alignment and proper compliance. The primary success factor for Enterprise Architecture in organizations is the level of leadership and sponsorship in the execution and adoption of the defined framework

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13.4 Risk Management in CaGF

As a result of my research, Risk management was identified as a major Capability that FTC should develop and manage. Risk is a mandate for strategic direction. Below, the risk function is described in the two following figures

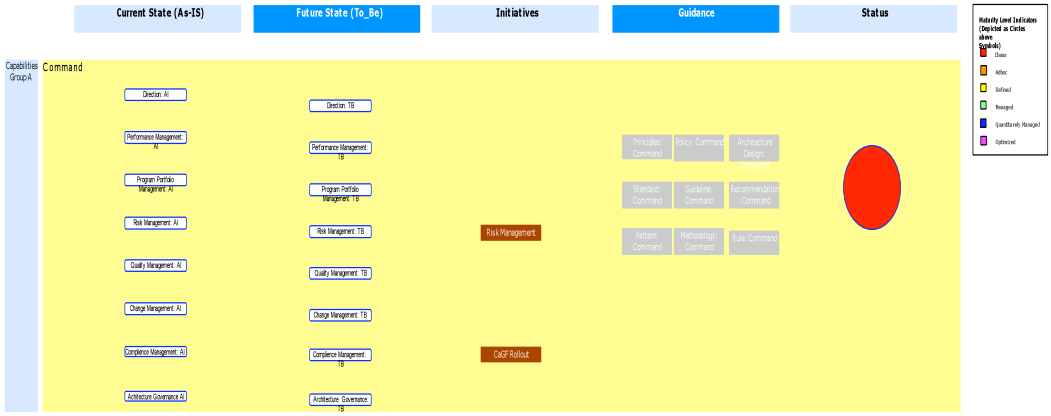

Figure 54: CaGF Command Capabilities Summary (front interface)

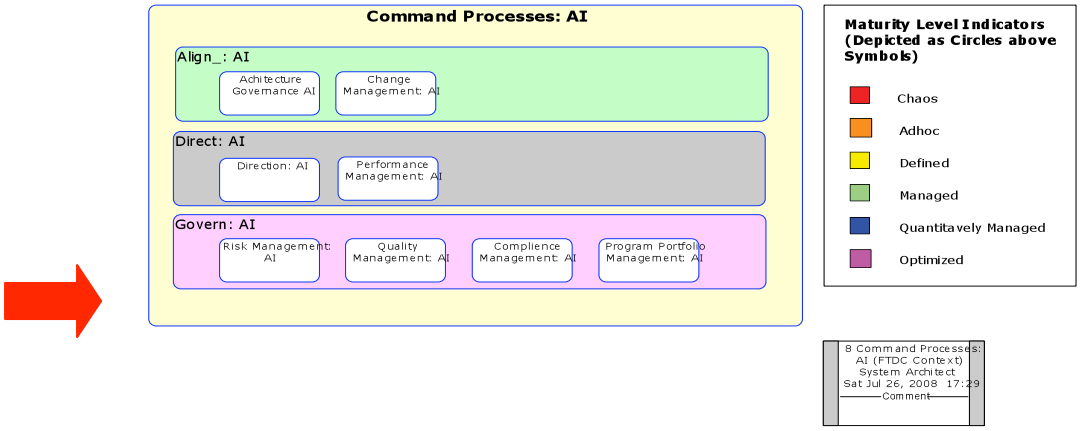

Figure 55: CaGF Command Capabilities Detail View Including Risk Management

Here are the major elements of Governance that we specified for Risk management:

a. Risk management Process:

i. A Process for Risk Management was introduced and mapped.

ii. The entire Test centre has to follow the Process. This is specifically applicable to programs, Projects and Initiatives.

iii. Risk and Risk process is also applicable to the areas specified in page 29 later.

iv. A Risk register has to be created for each of the

b. Ownership:

i. Responsibilities for Risk management were clearly identified

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ii. The Commander is ultimately responsible for Risk management

iii. Risk management is assigned to the Quality team, which needs to report directly to Commander

c. Compliance:

i. An assignment was given to the Quality team to issue the Policies related to Risk management

ii. The Policies are to be approved by the Commander of FTC

iii. CMMI methodology were to be used in System Development Processes to reduce Risks associated with inefficient resulting systems

Indeed Risk resides everywhere. There is Risk in Direction, Operations as well as Programs / Projects.

For this Purpose, our Enterprise Architecture approach addresses the relationship between Risk and various domains of Architecture in the Enterprise. The Definition of these domains would not be comprehensive unless the risk is documented for that domain.

The Relationship is established using the Concepts of Meta-Modelling in Enterprise Architecture.

The following diagram shows the Risk element and its Relationships from an Enterprise Perspective. It is an extract of the work done on the System Architect Tool, demonstrating how risks may impact all the functions of FTC.

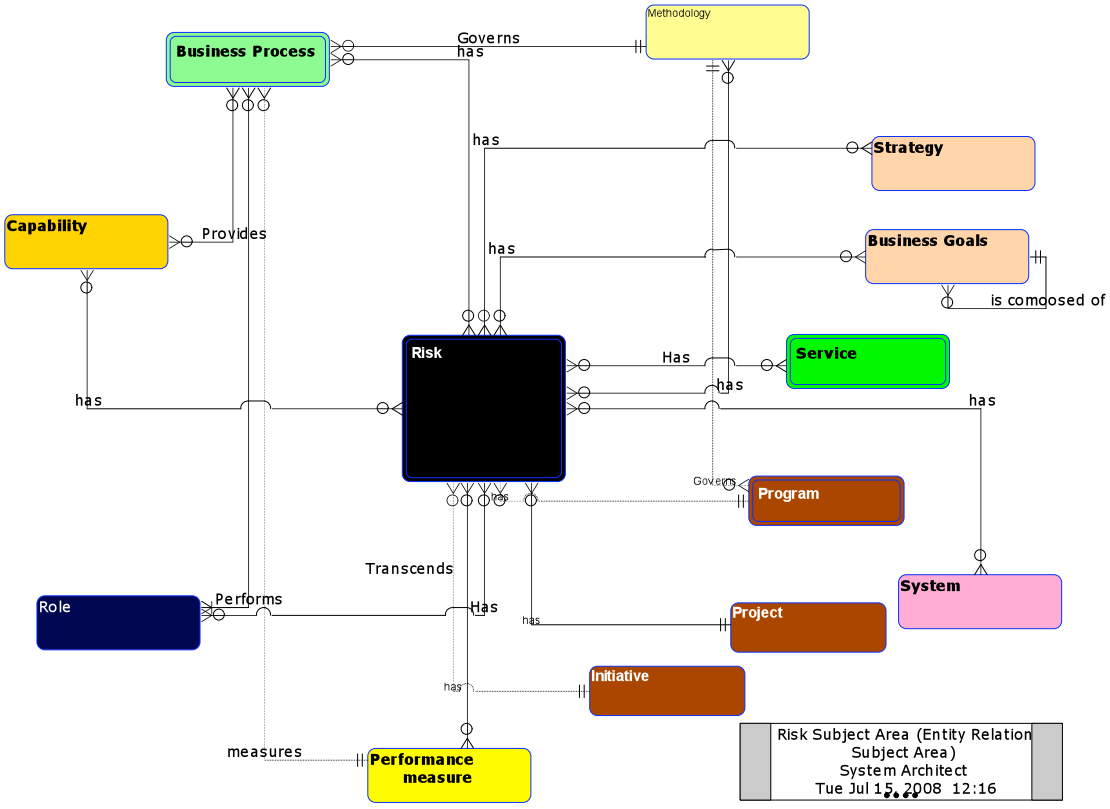

Figure 56: CaGF The Risk Meta model - An extract from CaGF

This is the major differentiator between an Enterprise Architecture approach to Risk from other methodologies. The precision in defining Risk and Risk reach / impact is Explicit.

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As can be seen from the above diagram, the Risk for FTC should be addressed for the following ***Areas:***

- Capability
- Service
- System
- Strategy
- Business Process
- Methodology
- Role
- Program
- Project
- Initiative

13.5 CaGF Deliverables

13.5.1 Project Artifact

The CaGF framework is intended as an operational framework with a set of supported artifacts delivered to support decision making, organisation design, planning and maturity. CaGF v1 was released in FTC in August 2008. The project artefacts are depicted in the diagram below:

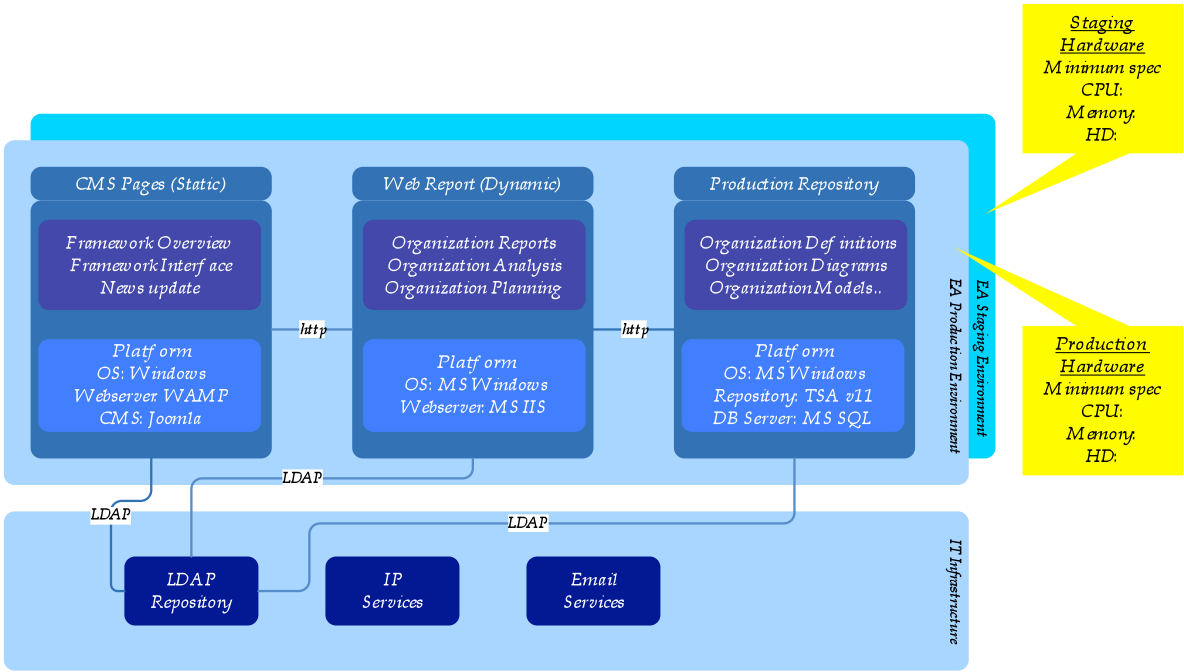

Figure 57: CaGF v1 Project artifacts

The 3 mains deliverables areas include:

- CMS Pages
- Reports
- TSA Repository

The framework definition project in FTC was based on Telelogic's Enterprise Architecture Framework Refinement lifecycle and Telelogic Harmony concept. The tasks included in the method are presented in the diagram below (**Erreur ! Source du renvoi introuvable.**):

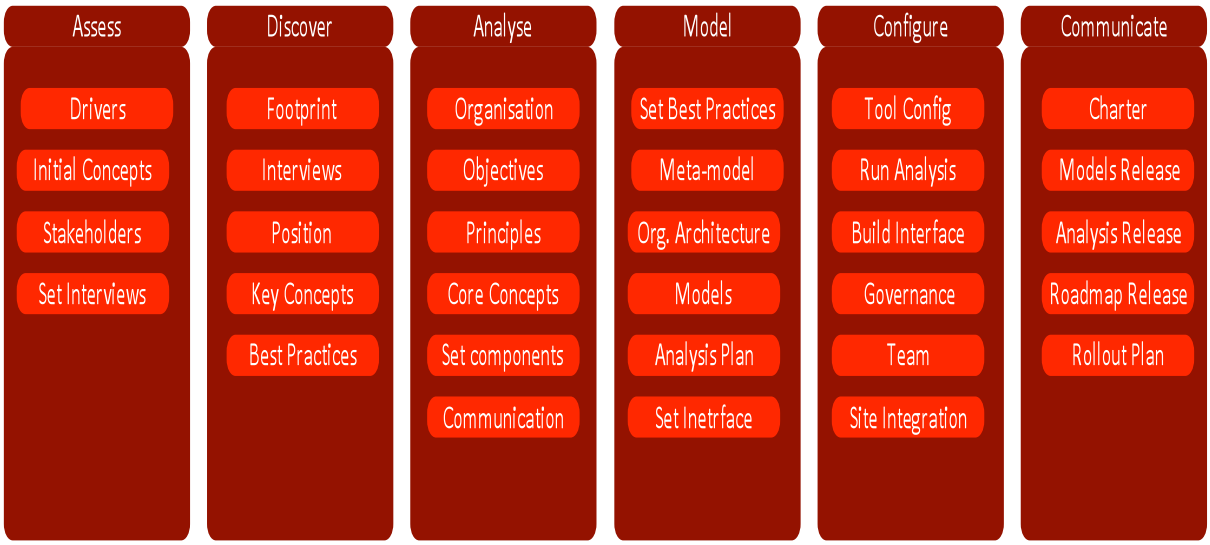

Figure 58: CaGF Project definition

The deliverables obtained as output from the execution of the project approach are described in the following table along with the tasks of the method:

#	Task	Description	Deliverables	End Format
	Assess			
	Drivers	An analysis of engagement documents to identify drivers, triggers and need	Triggers and Drivers Report	Charter site
	Initial Concepts	Workshops to introduce and discussed EA concepts in the context of organization planning and design	Workshops presentation	Charter site
	Stakeholders	An identification of all major stakeholders to consider and address with the project output	Stakeholders list	Charter site
	Set Interviews	A process to define, adapt and plan for the facts gathering exercise	Interviews schedule	Word document

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#	Task	Description	Deliverables	End Format
	Discover			
	Footprint	A technique to identify the initial footprint of the Framework to define	Footprint doc	Charter site
	Interviews	The actual undertaking of open-ended interviews to gather new and hidden insight on the organization operation. Samples should also be collected.	Interviews report	Charter site
	Position	The initial strategic position of the EA framework based on the assessment and review of interviews and samples collected	Positioning report	Charter site
	Key Concepts	The search and introduction of management concepts relevant to the context of the organization in support for the positioning	Workshops presentation	Charter site
	Best Practices	A review of Architectural best practices in support of the positioning	Workshops presentation	Charter site
	Analyze			
	Organization	A second round of assessment of the organization to ensure fit for best practices against identified limitation	Decomposition concept	Charter site
	Objectives	A final definition of objectives for the framework	Framework Positioning	Charter site
	Principles	A process to define the key principles underpinning the framework development	Principles Definition	Charter site
	Core concepts	The elaboration of core concepts to form the base of the framework and planning approach	Concepts integration	Charter site
	Set components	The identification of organization components to be further explored in this release of the framework	Capabilities identification	Charter site & Reports
	Communication plan	The initial definition of communication requirement to support the deployment of the framework in operation	Framework communication	Charter site

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#	Task	Description	Deliverables	End Format
	Org. Domains	A technique to define domains necessary as containers for the organization concepts	Framework layers & perspectives	Charter site
	Model			
	Set Best practices	The alignment of chosen best practices in the framework in classes and objects	Organisation decomposition approach and layers	Charter site
	Meta-model	The definition of the organization meta-model in support of the framework scope, positioning and best practices	Meta-model	Reports
	Org. Architecture	The definition of the organization operational model and reference architecture	TO_BE reference architecture	Repository & Reports
	Models	The instantiation the of meta-model into models based on scope and timeframe	Organisation models	Repository & Reports
	Analysis Plan	A process to identify meaningful analysis to be derived from the models definition and relationships	Gap Analysis	Charter site & Reports
	Set interface	The definition of framework interfaces to facilitate implementation and abstract complexity	Framework interface	Charter site & Reports
	Configure			
	Configure Tool	The configuration of Telelogic System Architect to support the defined models, meta-models and interfaces	Platform configuration	Repository
	Run Analysis	The execution and publication of analysis and planning outputs	Sample analysis reports	Charter site & Reports
	Build Interface	The configuration of the framework interface and integration with the tool	Framework interface	Charter site & Reports
	Governance	The definition of the Governance model and processes to support the deployment of the framework	Processes Definition	Repository & Reports
	Team	The definition of the internal team	Job Descriptions	Charter site

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#	Task	Description	Deliverables	End Format
		to lead the framework deployment		
	Site Integration	The integration and consolidation of the framework communication interface	Framework interface update	Repository & Reports
	Communicate			
	Charter site	The release of the integrated charter site	Site	Charter site
	Model Release	The release of the tool with necessary models	Models	Repository & Reports
	Analysis Release	The release of initial analysis and operational impact areas	Reports	Repository & Reports
	Roadmap Release	Discussions and agreement on the framework roadmap plan	Maturity Roadmap	Charter site
	Rollout Plan	Discussions and agreement on the framework rollout plan	NA	NA

The project timeline for the CaGF v1 framework definition is illustrated in the diagram below

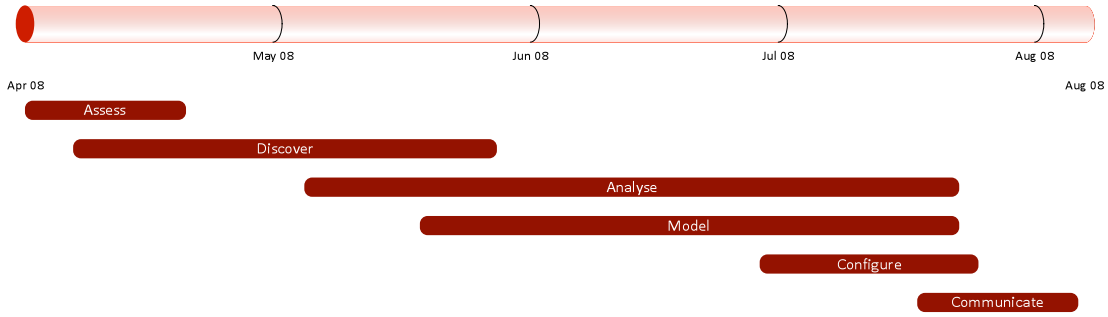

Figure 59: CaGF v1 project timeline

13.5.2 Entity – Risk

Description

It is a Potential Impact that indicates the possibility of loss, injury, disadvantage, or destruction. Some Risks are expressible as formulae of the type:

- Probability of loss. (e.g., 5% probability)
- Potential loss. (e.g., AED 500,000 loss)
- Unit-of-measure. (e.g., loss in AED)

Attributes

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Name	PK	FK	Req'd	Data Type	Length	Description
Risk ID	X		X	character	10	Unique Identifying code
Risk Name			X	character	10	Name of Risk being identified
Risk Mitigation Plan			X	character	10	Name of Plan used to mitigate the Risk
Risk Status			X	character	10	Status. A list with possible values: Identified, Mitigated, Managed, Unmanaged
Risk Description			X	character	10	Narrative describing the Risk being defined
Initiative Name		X	X	character	10	Name of the Initiative being defined
Project ID		X	X	character	10	Unique Identifying code

Related Entities

Relationship	Entity Name	From Multiplicity	To Multiplicity	Identifying	Excl. Arc
Has	**Business Process**	**Zero, One or Many**	**Zero, One or Many**	-	
Has	System	Zero, One or Many	Zero, One or Many	-	
Has	Business Goals	Zero, One or Many	Zero, One or Many	-	
Has	Capability	Zero, One or Many	Zero, One or Many	-	
	Party Role	Zero, One or Many	Zero, One or Many	-	
	Service	Zero, One or Many	Zero, One or Many	-	
	Performance measure	Zero, One or Many	Zero, One or Many	-	
	Business Objective	Zero, One or Many	Only One	-	
	Strategy	Zero, One or Many	Zero, One or Many	-	
	Portfolio	Zero, One or	Only One	No	

Relationship	Entity Name	From Multiplicity	To Multiplicity	Identifying	Excl. Arc
		Many			
	Program	Zero, One or Many	Only One	No	
	Initiative	Zero, One or Many	Only One	No	
	Project	Zero, One or Many	Only One	No	
	Directive	Zero, One or Many	Zero, One or Many	-	

13.6 CaGF Functions & Capabilities

The key challenge is how to get the utmost benefit deriving from the activities in the FTC: capturing opportunities and learning through innovation while insuring process and performance improvements as well as competitiveness in this world of continuous competition.

Taking into consideration both the FTC's and vendors' obligations and contributions in technical, engineering and program management, human resources and their working methods, disciplines, and processes are obviously the main driving factors of the FTC programs. The impact of methodologies, processes, and governance is most critical to the effective function of the FTC. The author, being the head of the FTC, has recognized the lack of a cohesive, system driven organization capable to respond to continuous demands and changes; thus the need to motivate and develop an effective working environment able to support and enhance the FTC sustainable productivity.

CaGF will be a major constituent of this new, improved working environment and a key tool in the hand of FTC managers and engineers.

CaGF Functions & Capabilities:

- Capabilities
- Classification
- Command
- Primary/Core
- Support
- Collaboration
- Modelling "As Is" & "To-Be"
- Time Frames
- Guidance and Principles
- Matrix Assessment + Color coding and SCAMPI Matrix

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CaGF Advantages:

- Building an integrated process
- Visualization
- Ability to establish “As-Is”
- Ability to measure and simulate impacts of change
- Enables a transformation from Ad-hoc to planned activities

As the FTC progresses towards its goals, the above features will contribute to lowering risks.

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14 HYPOTHESES

Within the context of author's research, he considered the following hypotheses as a basis for responding to the questions raised for this thesis.

H1	**Organizational change is better managed using an Enterprise Architecture framework**
H2	**Risks associated with organizational changes requiring evolution of existing organizational capabilities are better, assessed, analyzed, managed and governed using an EAF**
H3	**Process improvement efforts within the organization could potentially result in organizational changes, which in turn would have associated risks that would need to be addressed and managed using an Enterprise Architecture framework**

A wider description of each of the hypotheses is provided hereunder.

14.1 Hypothesis 1

Organizational Change Is Better Managed Using An EAF.

Using an enterprise architecture model allows direct assessment of the impact of change on all organizational model elements.
Prior to building the enterprise architecture model, and enterprise architect visualizes the various inter-connects and relationships between all the elements of an organization and represents this relationship in the form of a meta-model. A meta-model specifies the type of model elements that can be instantiated in the enterprise architecture model, and the type of relationships and associations that can be specified between model elements. A meta-model defines the overall architectural framework of an enterprise.
Once a governing meta-model for the enterprise has been defined, one can proceed with modelling the enterprise with information about the actual business units, roles and processes, thereby describing the overall functional architecture of the enterprise.
This is highlighted using an example in the following page.
Consider the following meta-model diagram for a business process:

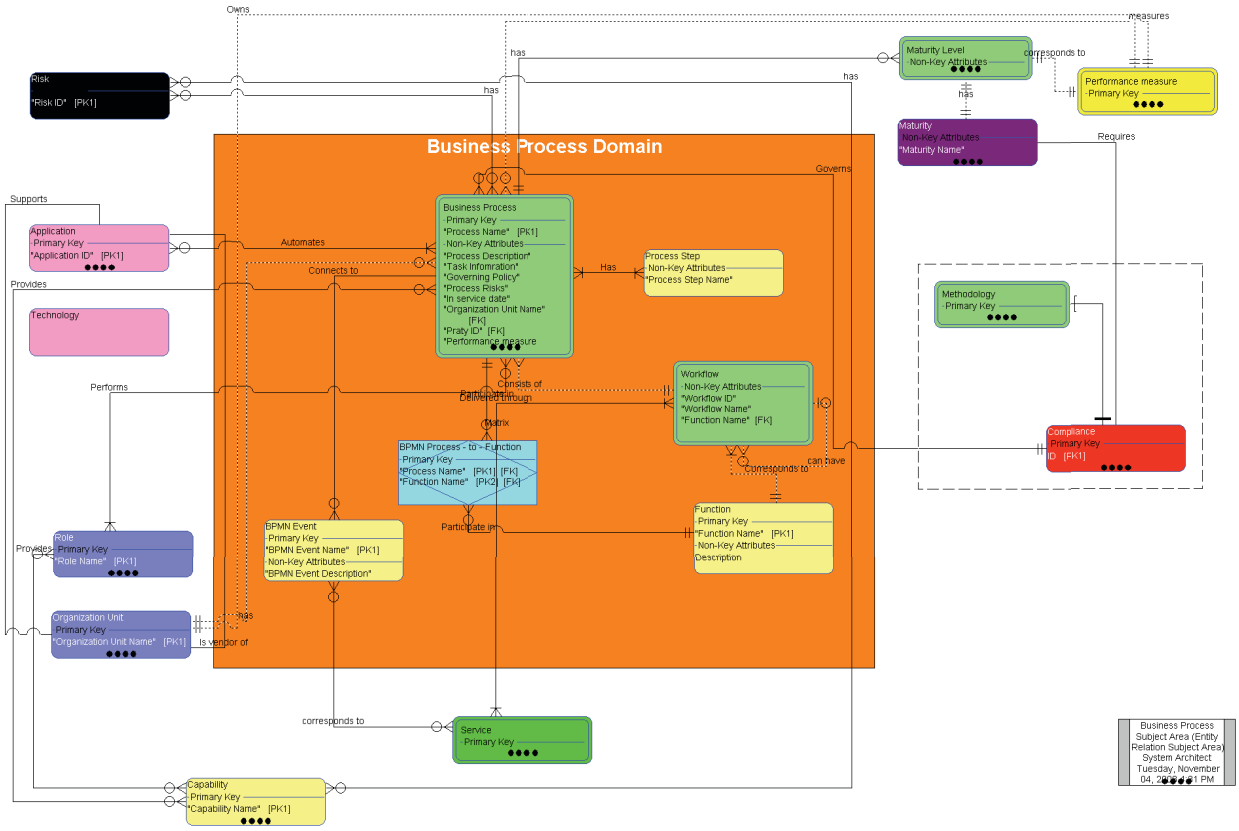

Figure 60: Business process subject area meta-model diagram

An instance model, for the above meta-model can potentially take the following form, e.g. the process for developing a new system or new system function.

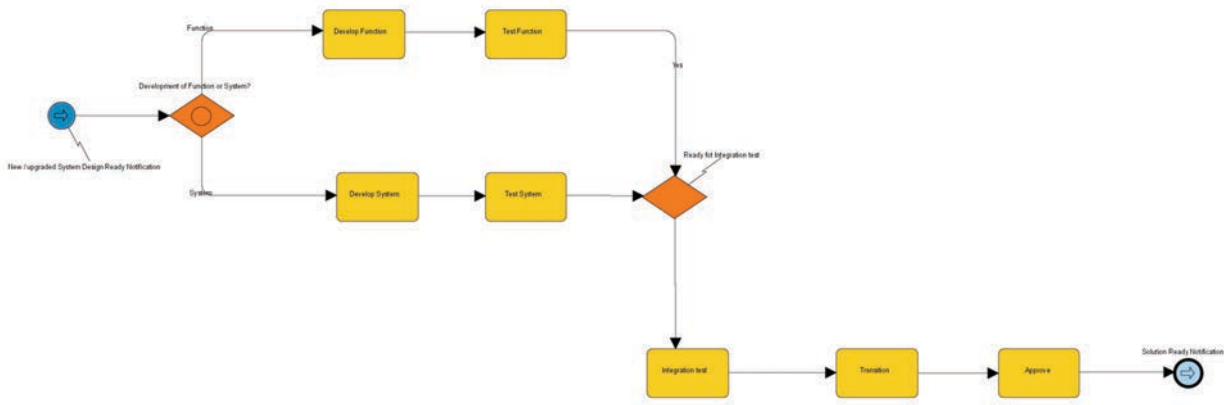

Figure 61: Business process diagram: Develop new system or system function

Once the new system or system function has been developed and tested, it is then deployed using a deployment process, as shown below:

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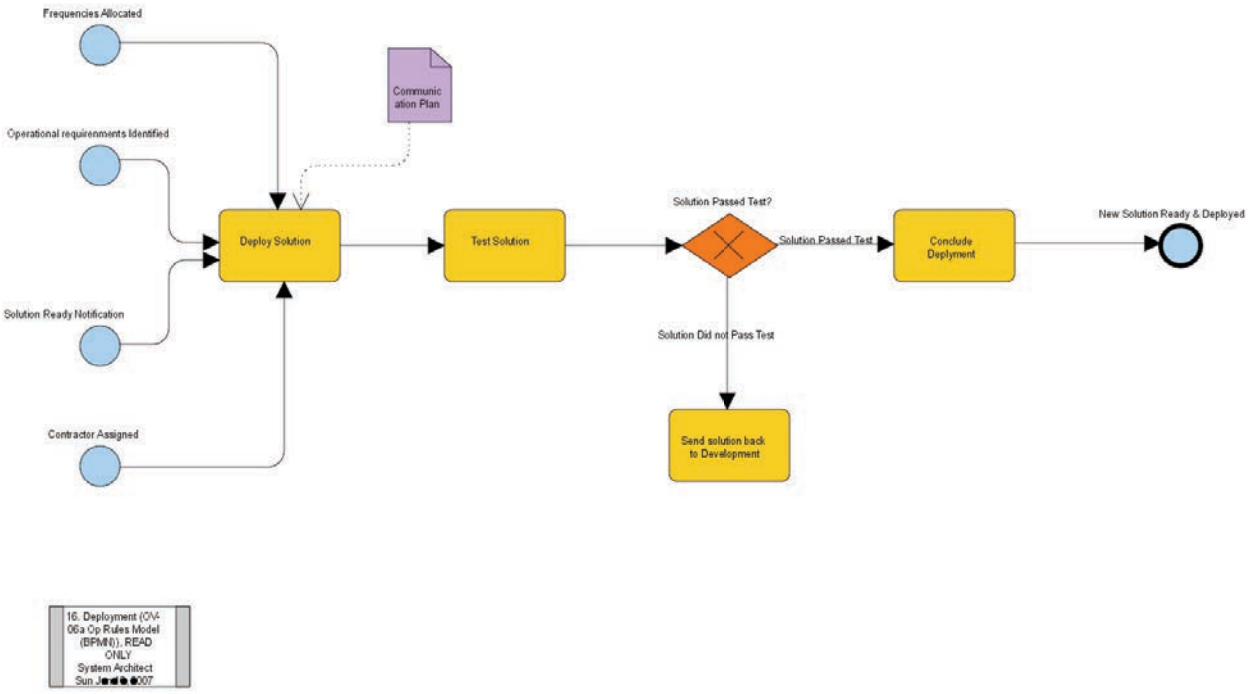

Figure 62: Business process diagram: Deployment of new system or system functions

Once the business process gets reviewed and approved, it will be base-lined. Base-lining allows for comparative analysis between different versions of the model and to facilitates what if-scenario analysis, for **as-is** and **to-be** model comparisons.

Whenever a change is to be considered or made to a model element, one can quickly assess the impact of the current change to all related model elements, by traversing the links and associations between the changed model element and its associated model elements, using the underlying meta-model representations.

As an example, consider the impact of changing a business process. A business process would have an owner, a person or system with an assigned role that executes business process, requires resources and inputs, and produces outputs in terms of work products (artifact, decision, outcomes). If a change is made to a business process, its impact on other business processes and other model elements can be assessed by traversing the links in the model, using explorer diagrams.

A decision to effect a change can be made with greater clarity and data on the impact of change, and by assessing the true nature of the impact of change on the reset of the enterprise.

The use of an enterprise architecture model and framework, therefore, facilitates rapid assessment of the impact of change to organizational elements on the rest of the enterprise, and facilitate the change management process.

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14.2 Hypothesis 2

Risks associated with organizational changes requiring evolution of existing organizational capabilities are better, assessed, analyzed, managed and governed using an (EAF) Enterprise Architecture Framework.

Using an enterprise architecture model with integrated risk management, will allow you to actively track and report on the risk status for all organizational elements. This facilitates the generation of consolidated risk register reports by initiatives, departments, line-of-business, programs, projects, activities and resources.
Consider the risk subject area meta-model in the diagram below, which associates a risk element to multiple subject areas such as organizational strategy, business goals, business processes, capabilities, services, programs, projects, systems, roles and initiatives.

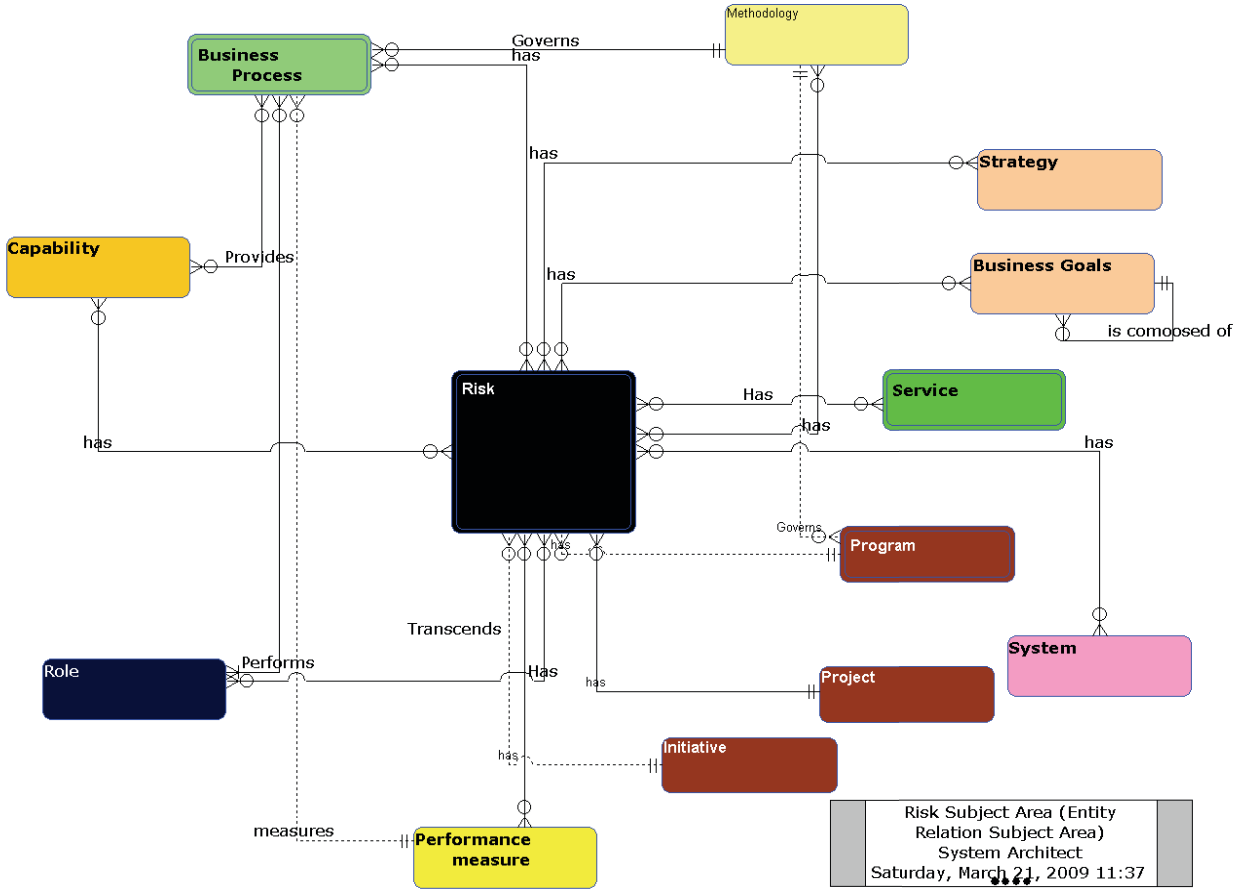

Figure 63: Risk subject area meta-model diagram.

This allows an organization to actively track and manage risks in these subject areas.

For example, a change in the operational context of an organization, like the transition of the Flight Test and Development Centre (FTC) from a military organization to a civilian entity, will necessitate a change in the operational business processes, as well as require additional capabilities to be developed within the new civilian entity.
A snapshot of the capability subject area meta-model has been provided in the following diagram:

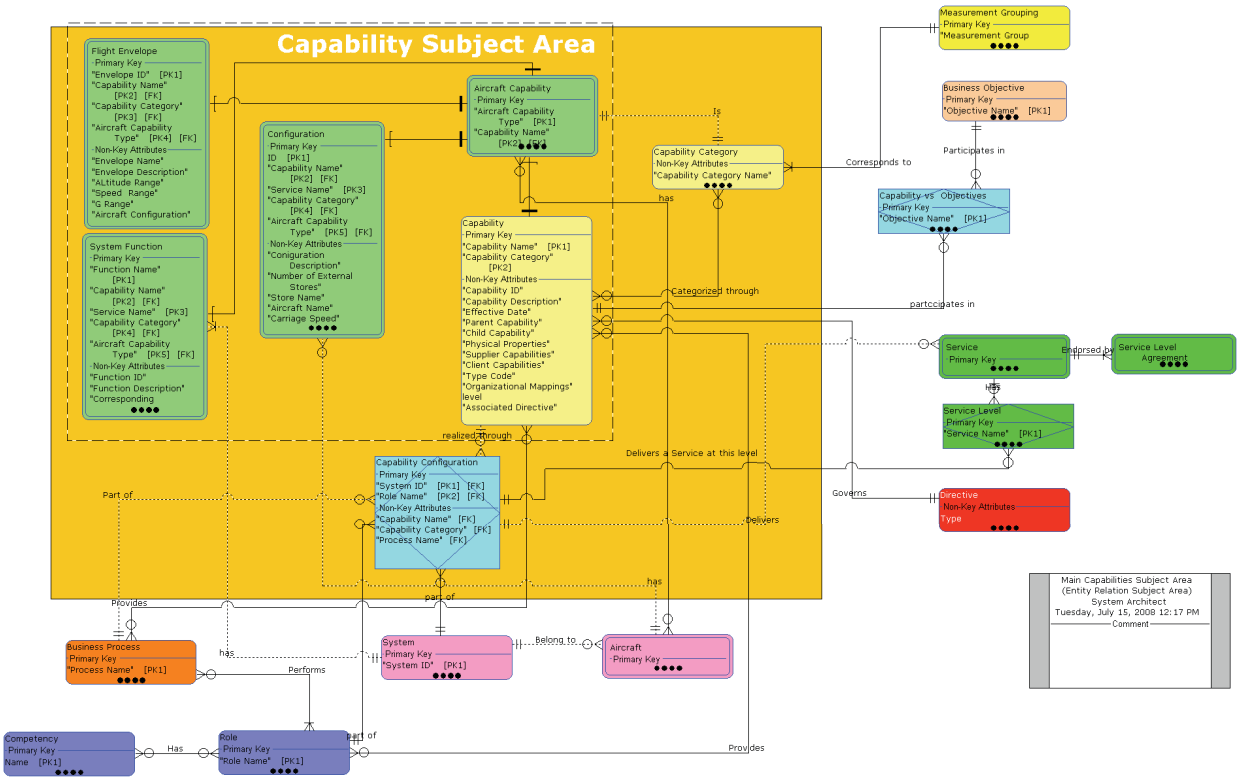

Figure 64: Capability subject area meta-model diagram

Continuing our example of the FTC, the change in operational business processes and the development of new capabilities will carry with it, a set of risks. These risks can be entered, tagged and associated with various organizational elements as shown in the figure above.
Static risks that have been identified at the start of a program, project or initiative can be monitored, as well as dynamic risks that manifests with time, during transition phase as the organization undergoes changes in terms of operational contexts, business processes and capabilities.
Risks are therefore better managed and governed within the context of an enterprise architecture framework integrated with risk management.

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14.3 Hypothesis 3

Process Improvement Efforts Within The Organization Could Potentially Result In Organizational Changes, Which In Turn Would Have Associated Risks That Would Need To Be Addressed And Managed Using An Enterprise Architecture Framework.

Once an organization has reached a certain level of maturity, and has stabilized its operational business processes, or at specific points in the implementation of a business process, ideas would begin to emerge from various stakeholders, for improving current business processes.
This could lead to potential changes in the business process and the structure of the organizational unit/department that owns and executes the business process.
The changes arising from the process improvement effort will in turn carry with it, a set of associated risks that would need to be managed.
Let us revisit the business process subject area meta-model diagram shown in Fig 3.1.
The business process meta-model element contains an attribute "Performance measure", for measuring the performance of a business process, which has been reproduced in Fig 3.7 below:

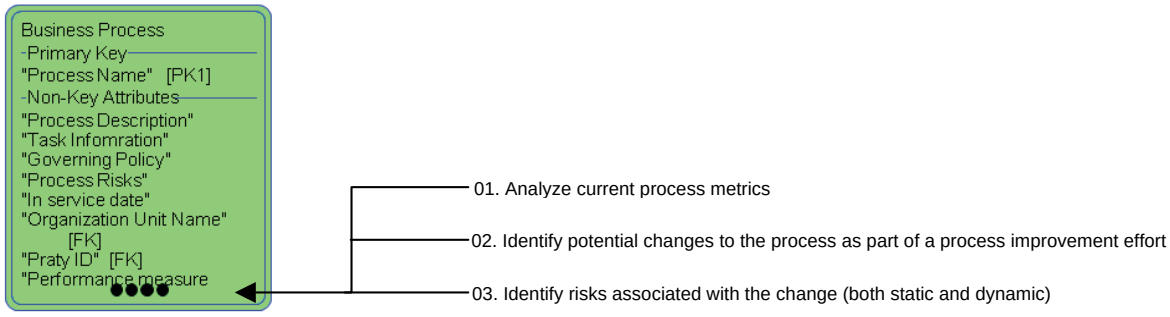

Figure 65: Business process attributes, with a focus on performance measurement

A typical workflow for improving a business process would be to

- Analyze current process metrics
- Identify potential changes to be made to the process, as part of a process improvement effort, e.g. in order to improve the current process in terms of execution time, cost, efficiency and accuracy.
- Identify the risks associated with the change in the business process. Some risks will be identified at the start and will exist during the lifetime of the change (static risks), while other risks may manifest during the lifetime of the change (dynamic risks).

Figures above, when taken in combination, represents a part of an integrated enterprise architecture framework meta-model that allows one to manage risks arising out of process improvement efforts in an integrated manner.

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14.4 Meta Model Element Mapping

Organization, Processes, Competences and Means (cf. 6.3) interact and have dynamic links; the interactions vary along the project. A Meta Model allows real time capture of these interactions and relevant risk analysis.
As the time scale is in years, the use of models facilitates / enables anticipation to implement mitigation actions.

The hypotheses stated above are key answers to the FTC's continuous business and operational challenges and risks. The CaGF provides the flexibility, including mapping of the entire FTC, to respond to the conceptual modelling of the hypotheses and to the dynamic evolutions associated with the resulting changes in the FTC.

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15 METHODOLOGICAL ISSUES

15.1 Overview of the research study

15.1.1 Premise for the study

In line with broad military trends the UAE Armed Forced in general and the FTC specifically are planning towards alternative sourcing models that involves non-military organizations providing more services into the Military and non-military. This general sourcing trend comes with numerous risks causing the approach to be widely criticized and jeopardized. This study explore the merits of underpinning the planning such sourcing transition by a governance model that leverages Enterprise Architecture and Process Management techniques through CMMi.

- Explaining importance of the existence processes involved in the change of FTC to civilian entity and identifies the processes that are needed to be designed or modified for a better performance based on CMMi level 3.
- To have a clear vision and understanding of the actual system by EA
- Using CMMi for amelioration and benchmarking
- Using EA and CMMi for risk identification and management
- Integration of the risk management in the global operations and management of the FTC as an independent, credible and competitive civilian entity

15.1.2 Objectives of the research study

Survivability, Efficiency and Management of a flight test centre within a military structure is becoming a real challenge due to a number of factors. To counter such a challenge, the military is now moving towards converting certain military sectors/organizations into private/civilian entities or outsourcing the activities to the civilian sectors. Although this transformation may appear to be an ideal approach, such transformation too does present new and complex challenges. It is therefore necessary to study and analyze the potential risks for such conversions and transformations. As a case study, we shall study and analyze the risks associated with the, transformation process and then those associated with running, the flight test centre in a civilian entity, while providing simultaneously, services to both the military and the civilian sectors (((COSO, 2004), (Parent and Reich, 2009), (Iacovou and Nakatsu, 2008))).

The outsourcing of a flight test centre deriving from a military organization into a civilian entity combines essentially two complexities/complications in the Risk Management process: the first is linked to intrinsic activities of a flight test centre, and the other to "outsourcing".

This combination is to be placed obviously in a local and regional geopolitical context. It is therefore necessary to establish the initial cartography of risk in a flight test centre and the outsourcing of such an activity and define the inter-actions; this first phase allows to obtain the initial start/launch status of the project, and define and establish the first strategy of risk management ((Noor et al, 2001), (Aron and Singh 2005)).

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The second phase shall focus in the dynamism of the project taking into account the progress and changes pursuant to each specific cartography, the rate of possible exchanges and inter-actions, and the consequential modifications resulting thereof.
Accordingly, it is necessary to create and establish reliable, effective and rapid methods, which will allow acquiring these cartographies and defining the rate of exchanges and inter-actions. It would by the way be interesting to analyze the possibilities of modelling certain dynamisms in order to pre-define the “Strategies” of management.

15.1.3 Methodology

Methodology is a particular set of process steps and techniques associated with a particular combination of ontological and epistemological stances which provide a coherent and acceptable approach for one specific research paradigm. It is to be reiterated here that the objectives of the current research study are:
As the scope of the study is restricted to a particular organization, viz., FTCM, the research philosophy of this study is grounded in abductive constructivism and a qualitative research (Action Research) methodology using team work technique and a Case Study is adopted. A discussion on the research philosophy and the aforesaid research methodologies follows.

15.2 Research Philosophy

Constructivism is a perspective in philosophy that views all of our knowledge as "constructed", under the assumption that it does not necessarily reflect any external "transcendent" realities; it is contingent on convention, human perception, and social experience (Denzin and Lincoln, 2005).
From the epistemological perspective, the research instruments are the experiences of the researcher himself. Further these experiences lead to conclusions which in turn result in the evolution of the research study. From the ontology stand point the research is based on multiple intangible mental constructions which are specific in nature (Miles and Huberman, 1994).
This is to say that the researcher’s personal experiences as the Director of system of the FTCM resulted in identification of the limitation of EA and CMMi approach to the implementation of the new civilian system. These are reflected in the various FTCM reports and used of EA modelling.
This led to the construction of specific propositions relating to the EA approach which overcome or reduce these limitations.

15.2.1 Abductive Reasoning

Abduction, or inference to the best explanation, is a method of reasoning in which one chooses the hypothesis that would, if true, best explain the relevant evidence. Abductive reasoning starts from a set of accepted facts and infers their most likely, or best, explanations. Abductive validation is the process of validating a given hypothesis through abductive reasoning. Under this principle, an explanation is valid if it is the best possible explanation of a set of known data. The best possible explanation is often defined in terms of simplicity and elegance. After obtaining results from an inference procedure, we may be left with multiple assumptions, some of which may be

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contradictory. Abductive validation is a method for identifying the assumptions that will lead to your goal (Lipton, 2001).

15.2.2 Qualitative Research Method

Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions.

Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live. Kaplan and Maxwell (1994) argue that the goal of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified (Miles and Huberman, 1994).

All research (whether quantitative or qualitative) is based on some underlying assumptions about what constitutes 'valid' research and which research methods are appropriate. In order to conduct and/or evaluate qualitative research, it is therefore important to know what these (sometimes hidden) assumptions are.

Action research

Action research is a reflective process of progressive problem solving led by individuals working with others in teams or as part of a "community of practice" to improve the way they address issues and solve problems. Action research can also be undertaken by larger organizations or institutions, assisted or guided by professional researchers, with the aim of improving their strategies, practices, and knowledge of the environments within which they practice (Lewin, 1946). He described action research as "a comparative research on the conditions and effects of various forms of social action and research leading to social action" that uses "a spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the action".

Action research is an iterative inquiry process that balances problem solving actions implemented in a collaborative context with data-driven collaborative analysis or research to understand underlying causes enabling future predictions about personal and organizational change (Reason & Bradbury, 2001).

15.3 Case Study Research

The term "case study" has multiple meanings. It can be used to describe a unit of analysis (e.g. a case study of a particular organization) or to describe a research method (Cooper and Schindler, 2006). The discussion here concerns the use of the case study as a research method.

Case study research is the most common qualitative method used in information systems (Orlikowski and Baroudi, 1991; Alavi and Carlson, 1992). Although there are numerous definitions, Yin (2002) defines the scope of a case study as follows:

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin 2002).

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A case may be complex or a simple singular case of which this research is an example. Rather than using large samples and following a rigid protocol to examine a limited number of variables, case study methods involve an in-depth, longitudinal examination of a single instance or event: a case. They provide a systematic way of looking at events, collecting data, analyzing information, and reporting the results. As a result the researcher may gain a sharpened understanding of why the instance happened as it did, and what might become important to look at more extensively in future research. Case studies lend themselves especially to generating (rather than testing) hypotheses. The case study offers a method of learning about a complex instance through extensive description and contextual analysis. The product articulates why the instance occurred as it did, and what one might usefully explore in similar situations. Case studies can generate a great deal of data that may defy straightforward analysis, which is achieved through quantitative research study. For the purpose of this study, a critical instance case study method is adopted which is further explained below.

15.3.1 Critical Instance Case Study

Critical instance case studies examine one or a few sites for one of two below mentioned purposes.
Examination of a situation of unique interest, with little scope for generalizability
Calling to attention a universal assertion and testing the same by examining one instance. This method is suitable to answer the cause-and-effect questions about the instance of concern
Mapping this to the research study, one case studies are presented below. This Case study details identification of problems in the implementation of the new civilian system in FTC using EA & CMMi models. It has been mentioned in the scope of the study and reiterated here that the problems identified in the implementation of the new system are particular to FTC and may not be generalized.
Preceding the case study which identifies the problems of transformation of the FTCM system to the FTCC and implementation of the new model using an EA and CMMi based approach in FTC, the researcher conducted Group Interviews with senior managers drawn from various department and services to identify general problems observed in the implementation of an effective Risk Management system. The outcomes of these interviews lead to the new model based on EA.

15.3.2 Group Interviewing

The group interview is a qualitative data-gathering technique that relies on the systematic questioning of individuals simultaneously in a formal or informal setting. The size of the group varies widely between two people and a small group of six to ten people which is called a focus group. The groups can either be homogeneous or heterogeneous.
The role of the interviewer varies with the format of the questions and the purpose of the research. In the current research a focus group of 12 executives working in FTC in UAE were drawn to identify the challenges in the transformation process. The interview format was structured and researcher assumed the role of interviewer who was directive in his approach. The outcome of this discussion served as a precursor to the identification of problems in the implementation of the new entity in general and further, a need for a management model pertaining to risk management implementation. This is described in detail in the subsection- Focus group interview.

15.3.3 Case study FTC - As is

This part describes the steps and process undertaken to develop the unique FTC framework, with a new dimension: “Risk Management”. Initially, the author focused in parallel, on the framework build-up and the associated methodologies.

To facilitate the Enterprise Architecture Framework implementation process in FTC, the following activities were put in place:

- Training
- Raise awareness of the value of EA across the organization
- Present and brief the approach to EA methodology
- Provide technical training on how to use the EA tools
- Business process modelling and the importance of having an integrated view between Processes and Strategy, Information, Applications, Technologies and so forth to plan Changes and make strategic, operational, technical decisions to support the Implementation Project Plan described as below.
  - Establish a phased approach with clear objective
  - Focus on Risk management
  - Establish a detailed Project Plan
  - Focus on building a framework to guide the scope of EA in the organization
  - Include knowledge transfer to the organization team
  - Understanding of the organization and identifying the gap, as part of risk management.

Fulfilling the gap adequately is fundamental to improvement, and thus maintaining an edge in this competitive environment. Sustainable performance within FTC is imperative in securing business, limiting risks of failure to deliver.

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16 LIMITATIONS & RECOMMENDATIONS

16.1 Limitations

L1. No change management model included in the default CaGF framework.
The CaGF framework does not currently include a change management model. Change management processes are organization-specific and as such will have to be added to the CaGF model.
The CaGF framework facilitates the analysis and impact of change, but does not prescribe a specific change management model or change management process. Organizations typically tend to use their own internal change management processes, and as such this has not been modeled in the CaGF framework. An organization can adapt the CaGF to include their own internal change management models and processes.

L2. No process improvement model included in the default CaGF framework.
The CaGF framework has a process management model, but does not provide a process improvement model. Process improvement models tend to be domain, context, activity and/or organization specific, and as such do not provide a process improvement model in the CaGF framework
The CaGF framework, however, facilitates the measurement of process metrics. These metrics can then be analyzed for potential improvements. As part of on-going process improvement efforts, changes may be identified for existing processes. These changes would have potential risks associated with the change, which impacts various organizational elements.
Thus, the CaGF framework allows one to view the change impacts, register risks associated with the change arising out of a process improvement effort, and allows one to assess the impact, feasibility and return-on-investment for a planned process improvement, without prescribing how to manage the life-cycle of a process improvement effort.

L3. CaGF is not a single all-encompassing tool.
The CaGF framework needs to be supported with other tools such as PLM, Incident Management, SAP or engineering specific tools. It does not, however, replace these.

L4. In Managing Large Programs – Organizational Changes are extremely Complex

16.2 Recommendations

Our analysis by the end of our research showed that a combination between CaGF and TOGAF framework would produce better results. Furthermore, TOGAF's new release version 9.1 does an excellent job in the area of Meta model, which is yet a very important criteria.

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Such conclusions were based on our appreciation of the high scores that TOGAF achieves (based on Roger Sessions research paper, http://msdn.microsoft.com/en-us/library/bb466232.aspx) in the processes, which is paramount for any EA endeavor in our view. These represent methodology by which EA is built and the important dependencies between various phases of developing an EA repository. This is what will ensure that an organization like FTC will continue using EA to build standard models and catalogues of information and use them on procedural basis to perform analysis in the areas of risk management, performance optimization and governance.

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17 BUSINESS RISK MITIGATION PLAN

17.1 Introduction

The case under study is related to the projected transformation of the UAEAF&AD Flight Test Centre (FTC) into a civilian organization.

This major project would be organized and conducted in two major critical operations:

- Outsourcing the FTC
- Transforming the FTC into a civilian organization

Each operation would bring specific risks, to be assessed, then relevantly mitigated, in order to secure properly the FTC project, all along its development, then bring it to success.

The analysis presented here below, points out that 10 major critical risks could jeopardize the outsourcing/transformation of the FTC, unless 8 major risk mitigation actions are placed in due time, all related to the rigorous application of the governance and/or the management processes.

17.2 Risk Assessment

17.2.1 FTC Outsourcing

The outsourcing of a government agency generally relates to a complex and risky operation.

The purpose of such an operation is to bring a government owned agency from a “government operated” status (“GOGO”) to a “company operated” status (“GOCO”):

- **GOGO model:** the government owns and operates all the equipment, staff and resources;
- **GOCO model: under such an arrangement, the government owns the hardware and software, but relies on a vendor to operate the infrastructure.**

If we consider that the ***FTC*** outsourcing project would be exclusively related to a ***GOGO***=>***GOCO*** transition, we can give a brief description of the significant changes to be generated on the ***FTC*** governance and management processes:

- Equipment and infrastructures would stay under the ownership and the responsibility of the government:
  - Development laboratories
  - System integration platforms
  - Planes (including fuel, ammunitions, …

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- Tests facilities (including firing facilities)

- Whereas, the followings would be placed under the direct responsibility of the company:
  - Operational management and contract management
  - Quality assurance
  - Human resources
  - Finances

So, the change ***GOGO***=>***GOCO*** would generate the following evolutions (and related risks) which would have to be handled carefully:

17.2.2 Government level

- ***R1:*** Need of a contractual frame and process dedicated to the guidance and control relationship between the *FTC* Company to be, and their governmental customers:
  - The *UAE AF&AD*: in order to satisfy their operational requirements;
  - The UAE government: in order to satisfy their upper level requirements such as:
  - Appeal for specific technological developments (e-g.: IR detection), and
  - Appeal for high caliber specialists to come from abroad into the UAE, and
  - Orientate and motivate the UAE University (e-g.: Khalifa University for Science and Applied Research) to develop their academic matters, in the most appropriate ways to feed the company competence requirements, on term.

- ***R2:*** ***Initial transfer*** of the relevant human resources (ideally: the FTC workforce as a whole) to the Company,

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17.2.3 Governance level

- ***R3: Transition from a hierarchical model to a company governance*:**
  - Need of a company governance baseline (in compliance with the UAE Commercial Law);
  - Company registration;
  - Company articles of association;
  - Appointment of Board members,
  - Need of a relevant governance process (including formal financial delegations to the company management);
  - Appointment of the CEO with relevant formal delegations (Finances, HR, …),

17.2.4 Management level:

- ***R4: Need to focus on the operational mission of the FTC company***:
  Set up, apply and maintain a clear process map and relevant quality policy,

- ***R5: Need of a suitable HR policy, approved by the Board,***

- ***R6: Need of a suitable industrial policy to be approved by the Board, and related to the contractual relations*** to be settled with the O.E.M community;

- ***R7: Need of a pluri-annual (5 years) budgetary planned vision***, in order to support and guide:
  - The company management,
  - The investment plan to be funded and conducted by the government, in order to maintain and upgrade the infrastructures required on term, to operate properly the company, and satisfy the operational requirements of the customers in time and budget.

17.2.5 Transition towards a civilian organization:

On term, the ambition developed for the FTC, by the UAE government would be to have the Centre becoming a renowned centre of excellence, and a major player, peerless world-wide, in the domain of air flight developments and tests, and neighbouring activities (e-g.: ground vehicles);

Such an ambition makes it compulsory to open worldwide the scope of activity (commercial, technical, industrial) of the Centre.

To save time and money, such a target would be easier, and less risky, if the FTC could join their efforts with a major industrial partner, belonging to the top-list players in the open market world-wide.

The transformation of the FTC into a civilian organization would comprise, so, a critical step, dedicated to the search for such a partner, then the opening of the capital shares of the FTC Company to such a partner.

In such a process, time should be the essence: that is to say, that, as soon as the outsourcing phase would be satisfactorily completed, and that the FTC company would have reached a satisfactory level of quality and profitability,

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the search for the required partner would have to be undertaken, under the guidance of the UAE government, as the sole shareholder of the Company, and under the control of the board.

Such an operation would have to prove and testify to the potential partners that the FTC would have already created and earned value, on their national market (UAE *AF&AD*), and that it would, then, qualify legitimately to address and promote jointly further developments on the civilian expanding markets.

The very document which would have to be presented to potential partners would have to be a comprehensive business plan, describing into accurate details and proofs:

- The current (i-e.: by year 3) and forecast business activity of the FTC,
- The product and services proposed and delivered by the FTC to their national customers,
- The current (AF&AD) and anticipated (e-g.: civilian flying vehicles, such as helicopters; "hot testing" services; etc…) market of the FTC,
- The competition (on the national and GCC markets, and on the world-wide markets),
- The detailed processes of the operations,
- The management team of the company,
- The risk/opportunity file of the FTC,
- The financial summary of the company situation (income statement, balance sheet: past, and for the 5 years to come),
- And finally, the amount of capital needed to expand the FTC business, and the schedule showing to the potential investor when they would get their money back.

As such, the transition phase would be submitted to the following major risks:

- ***R8: No business plan*** to present, in due time, to potential investors, or

- ***R9: A business plan, not in line*** with the expectations of potential investors:
  - Insufficient added value, or,
  - Insufficient financial results on term, or

- ***R10***: ***A significant delay on the agreement with a suitable partner***, which would not come into force before the end of the 5th financial exercise.

  One can notice that such risks would closely depend on the level of success of the critical outsourcing phase.

17.3 Risk Mitigation Action Plan

The evolutions anticipated for the FTC, would generate specific risks to be handled carefully and precisely, all along the outsourcing and transformation process.

So, the major issues to address in the risk mitigation plan, suitable to make the outsourcing, would be as follows:

17.3.1 Government/governance level

- Action n° G.1: Elaborate a clear 5-years contract to be awarded to the ***FTC*** company to be, when settled; such a contract would be extended and accordingly amended, on a yearly basis;

- Action n° G.2: Transfer to the ***FTC*** Company, as soon as settled, the whole set of human resources of the ***FTC;***

- Action n° G.3: Define, and adopt an clear and rigorous set of governance rules, when excepting the company:

- Company articles of association,
- Governance process (and organization of the Board meetings),
- Appointment of a Chairman, and of the Board members,
- Appointment of a competent and motivated CEO,
- Setting up of clear operational, financial and HR delegations to the management of the company.

- Action n° G.4: Control that the outsourcing phases is achieved by the end of the 3rd financial exercise: quality of the deliveries, ISO certification, profitability, and in any case, before looking for any external partner;

- Action n° G.5: Review carefully, and approve, by the end of the 3rd exercise, the 4th issue of the 5-years business plan, according to the governance rules and processes defined for the company; this issue would be, then, proposed to potentials partners to review, and audit (through a suitable "due diligences" process) before taking the strategic decision to enter the capital of the company, and to acquire shares, in compliance with the UAE Commercial Law.

17.3.2 Management Level

- Action n° M.1: Elaborate a clear 5-years budgetary/business plan to be proposed, every year, for approval by the board of the company; the major input of such a plan would be the 5 years contract awarded by the government; such a plan would be updated, every year, and applied after formal presentation and approval by the board.

- ***Action n° M.2:*** Define a clear and suitable process map for the company, and organize and run the company accordingly. Process maturity would be a major objective, to be acquired, ideally, one full year after the process map has been applied and certified (e-g.: ISO 9001). A reasonable target for ISO certification would be two years after the company inception (i-e: at the end of the 2nd financial exercise).

- Action n° M.3: Define, then negotiate and place a suitable set of partnership agreements, if and when suitable, with the O.E.M community.

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18 HOW TO ATTRACT GROWTH CAPITAL

18.1 Introduction and Background

The case under study is related to the projected transformation of the UAEAF&AD Flight Test and Development Centre (FTC) into a civilian organization.

This major project would be organized and conducted in two major critical operations:

- Outsourcing the FTC;
- Transforming the FTC into a civilian organization.

Each operation would bring specific risks, to be assessed, and then relevantly mitigated, in order to secure properly the FTC project, all along its development, and then bring it to success.

The analysis presented in the "FTC Business Risk Mitigation Plan"[216], has identified, and points out that 10 major critical risks could jeopardize the outsourcing/transformation of the FTC, unless 8 major risk mitigation actions are placed in due time, all related to the rigorous application of the governance[221] and/or the management processes.

In addition to the FTC Business Risk Mitigation Plan, the present document highlights some critical issues to be addressed and solved properly, and in due time, mainly through actions M.1 and G.5, in order to:

- Mitigate R8 and R9 risks, and therefore,
- Reduce R7 and R10 risks.

Note:

Risk Phrases as defined in Annex III of European Union Directive 67/548/EEC.The partial list was consolidated and republished in Directive 2001/59/EC.

R1: Explosive when dry
R2: Risk of explosion by shock, friction, fire or other sources of ignition
R3: Extreme risk of explosion by shock, friction, fire or other sources of ignition
R4: Forms very sensitive explosive metallic compounds
R5: Heating may cause an explosion
R6: Explosive with or without contact with air
R7: May cause fire
R8: Contact with combustible material may cause fire
R9: Explosive when mixed with combustible material
R10: Flammable

Action **M.1** would be dedicated to the writing of a business plan by the **FTC** management[218].

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Action **G.5** would be dedicated to the thorough review and approval of the business plan by the board of governance, before release to the potential investor(s).

18.2 The Writing of the Business Plan

According to the European Private Equity & Venture Capital Association experts[219], "the process of attracting private equity starts with the preparation of a business plan […]: the business plan is the main tool used by the financial investor to evaluate the prospect for the business".

The ***FTC*** business plan will have to fulfil two main functions:

a. Force the management team to:
   - clarify their vision of their business activities,
   - cover all strategic choices they are (or will be) facing,
   - forecast the performance they expect,
   - set out the business model they will use, and
   - fix their objectives;

b. Eventually, be the point of contact and communication with the potential investor.

The major points to cover with the ***FTC*** business plan will be:

a. The executive summary:
   - The most important section,
   - Although it will appear first in the business plan, it will have to be the last thing to write,
   - And will have to:
   - Present the logic behind the business activity, then the organisation behind the proposal, and
   - Acknowledge, if any, the weaknesses and challenges faced by the ***FTC***, and the way they would have to be addressed and overcome;

b. The FTC history:
   - How the business would have evolved, and
   - Its past performance (including created value)[220];

c. The FTC management team(including individuals such as: auditors, advisors, independent directors…):
   - Having in mind that this team will have to be able to deliver the business plan,
   - Setting out the experience, motivation and past achievements of the main members of the team,
   - Identifying, if any, the gaps which would need to be filled for the ***FTC*** to succeed on term,
   - So that the investor would be able to help the ***FTC*** fill them;

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d. The products and services proposed and delivered by the ***FTC*** to their customers:
   - Competitive advantages (i-e: compared to competition offer),
   - Stage of development, and potential patents,
   - Possible weaknesses;

e. The current (***AF***&***AD***) and anticipated (e-g.: civilian flying vehicles, such as helicopters; "hot testing" services; etc…) market of the ***FTC***:
   - Attractiveness of the ***FTC*** product and services,
   - Origin (and evolution) of the demand,
   - Identification and assessment of the competition,
   - Potential barriers to entry in the market (competences, investments, international regulations, …),
   - Distribution channels (i-e: commercial interfaces with customers: government agencies, O.E.M. companies, Airways companies …),
   - Past delivery difficulties, potential risks, and ***FTC*** responses to these risks;

f. The ***FTC*** commercialisation strategy:
   - Distribution strategy (National, international),
   - Time scale,
   - Pricing strategy,
   - Differentiation strategy (i-e: from the competition),
   - Communications and promotion policies;

g. Focus on the competition (on the national and ***GCC*** markets, and on the worldwide markets):
   - The positioning of the ***FTC*** different activities (and related business units), compared to their competitors, could be presented, using the ***BCG*** - Boston Consulting Group method:[222]

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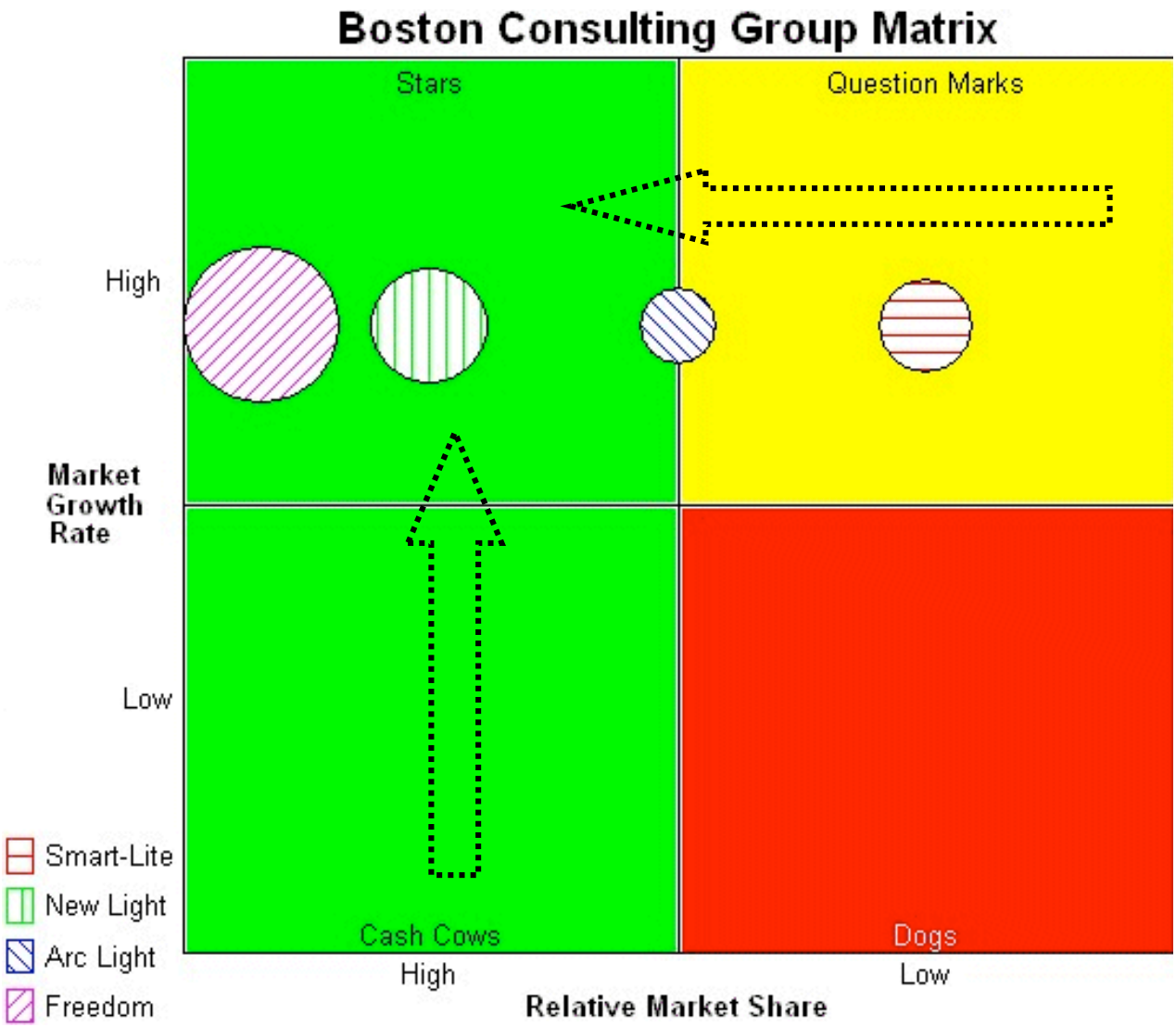

Figure 66: Boston Consulting Group Matrix

- The horizontal axis represents the market share relative to the industry leader. The leader will always be displayed on the far left of the chart. The vertical axis represents the market growth rate for the industry;
- The cash flow situation is different in each quadrant, which leads to the following classifications:
  - **Stars:** High-growth, high-share businesses that are likely to generate enough cash to be self-sustaining,
  - **Cash cows:** Low-growth, high-share businesses that generate excess cash that can be used to support other business units (especially question marks) and R & D efforts.
  - **Question marks:** High-growth, low-share businesses that normally require a lot of cash to maintain or increase their share. Management must often either invest additional cash to convert these business units into stars or divest themselves of the offering.
  - **Dogs:** Low-growth, low-share businesses that are often cash traps.

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BCG analysis of the FTC Position[222]			
Stars	**Cash Cows**	**Question Marks**	**Dogs**
High growth High share	Low growth High share	High growth Low share	Low growth Low share
Business is likely to generate enough cash to be self-sustaining. **Recommended tactics**: • promote aggressively • expand your product or service • invest in R & D	Business can be used to support other business units. • defend & maintain	Business requires a lot of cash to maintain market share. • invest more cash • or, divest	Business is a cash trap. • focus on short term • avoid risky project • limited future

Table 10: BCG analysis of the FTC Position

h. The detailed processes of the ***FTC** operations*:
- Description of the management of the operations on a day-to-day basis,
- Assessment of the internal resources,
- Supply chain,
- R&D policies,
- HR policies,
- Possible partnerships (O.E.M. companies, subcontractors, software houses, …);

i. The risk/opportunity file of the ***FTC***:
- The related file could be presented, using the ***SWOT*** analysis,[223]
- Strengths (***S***) and Weaknesses (***W***) are considered to be internal factors over which ***FTC*** management will have some measure of control, such as:
  - Ability to design/innovate,
  - Ability to source and produce,
  - Ability to market and service,
  - Ability to finance,
  - Ability to manage,
- Opportunities (***O***) and Threats (***T***) are considered to be external factors over which ***FTC*** management will have essentially no control, such as:
  - Political, economic, social, technology,
  - Market size and behaviour,
  - Constituent behaviour,
  - Benefits sought,
  - Potential new entrants,
  - Direct competitors performance, strategies, capabilities, intentions,
  - …

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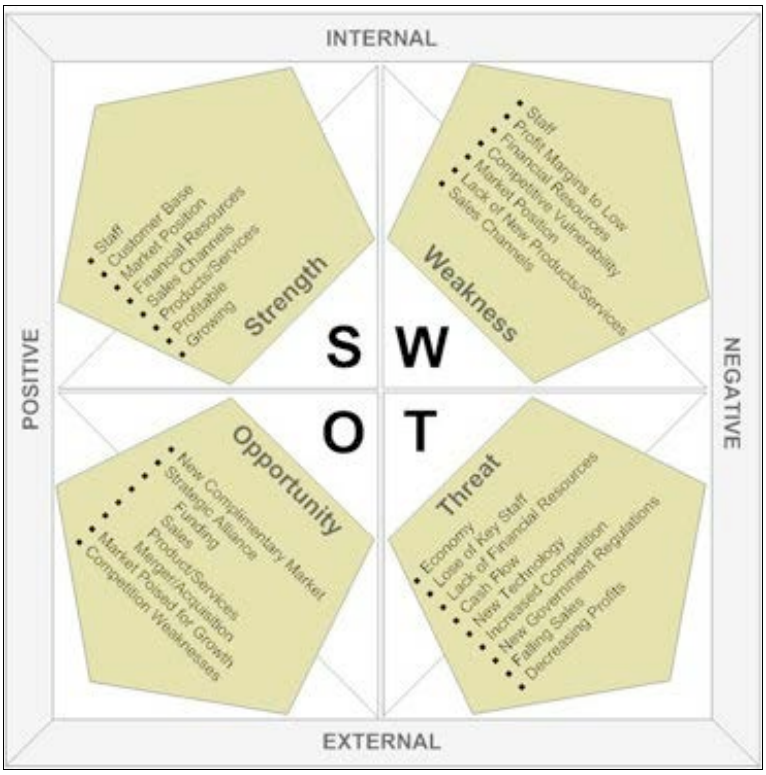

Figure 67: SWOT representation matrix

SWOT representation matrix [224]

- In order to mitigate the risks on the ***FTC*** development, the ***FTC SWOT*** analysis should result in decisions and scheduled actions:
- Capitalizing on the strengths,
- Filling in the weaknesses.

j. <u>The financial projection of the ***FTC*** situation</u> (income statement, balance sheet, operating accounts, cash flow tables: past, and for the 5 years to come):
   - Realistic projections,
   - Showing the growth potential of the ***FTC***,
   - Establishing clear links with the market analysis,
   - Taking business hypotheses and scenarios such as (e-g.):
   - turnover drops by 10%,
   - suppliers' costs rises by 5%,
   - ...

k. <u>And finally, the amount of capital needed</u> to expand the ***FTC*** business and the schedule showing to the potential investor when they would get their money back. The financial projections will determine the level and structure of the capital requirements: private equity, bank loans, government subsidies …

l. In addition, and albeit the potential investor(s) should bring industrial and long-term partnership, the final projections should indicate when and how the investor(s) would be able to <u>exit</u> from the investment.

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18.3 Conclusion

In the ambitious project under consideration to bring the current military ***FTC*** to a civilian enterprise, successful worldwide and on the long term, able to attract capital and dynamically capable to respond to the market demands, it clearly appears that business plan is a major, if not "the" critical process, which needs to be logically convincing. Technologically based, service oriented enterprises require generally medium to long term investments and this must clearly be outspoken. To enhance credibility towards the investors and attract capital, it is critical too that such a business plan, is supported by the higher management

Throughout this major process, the ***FTC*** business plan will certainly constitute the cornerstone, providing the basement of the whole project, as long as it effectively anticipates on, then covers, in a comprehensive and professional manner, the major challenges a modern international company in the position of the ***FTC***, has to cope with.

Much more than a "one-shot" writing, leading the way to a stable and definite document, the elaboration of the business plan will have to be considered as a strategic, upper level process, in the process map of the company, in order for the ***FTC*** business plan to become and stay:

a. The living reference guidebook of the ***FTC***,
b. Updated by the ***FTC*** management, periodically (i-e: yearly) and/or any time new events will impact the ***FTC*** strategic environment and position,
c. Thoroughly reviewed, then approved at the governance level of the ***FTC*** (e-g.: Board, Steering Committee, …), then
d. Applied practically to the operational conduct of the company.

As a straightforward consequence of the above, the governance and management executives of the ***FTC*** shall have to be selected and recruited, taking into the highest consideration, amongst other professional qualities, their actual ability to build and maintain for the ***FTC***, a clear and in-depth business plan, being both, ambitious and realistic.

The ultimate goal of the whole process will continue attracting, for a given period (i-e: between year 3 and year 5) relevant growth capital to support and speed up the development of the ***FTC*** as an open and competitive enterprise.

Being capable to present to a potential investor, a valid and living business plan, clearly showing that all relevant issues are carefully addressed, identified, and taken care off, both at the governance level, and the management level of the ***FTC***, will, with no doubt, give the project, the best chances to build rapidly the partner's confidence, from the preliminary stage of the discussion, and throughout the whole due diligence process, and up to the signing of the final closing.

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19 MAIN CONCLUSION

The study presented in this thesis identified a number of important findings contributing new insight to the management literature. The finding of this research adds knowledge to three important management disciplines with profound relevance for organization managers in organizations.

(1) Enterprise Architecture is planning discipline being increasingly adopted by organizations across the globe to assist in the realization of their strategic objectives, but the practice of Enterprise Architecture is still maturing and not very well understood by managers – this study has extended knowledge on the role and potential impact of Enterprise Architecture in organization change planning.

(2) Change management is at the centre of organization planning and optimization considering the rapidly changing operational context. Taking in account the impact of globalization, technology and dire economic climate, the management of change is a major challenge for organizations – hence this thesis provide timely new insight on how to integrate change management techniques with other disciplines such as Enterprise Architecture and Risk management

(3) As organizations change, the management of Risks is another key concern as instability associated with change can lead counter-productive outcomes and defeat the purpose initially intended.

This study brings together these critical planning concepts into a single analysis model and come out with compelling findings for both academics and organizations managers.

19.1 Major Findings

This study of planned organizational changes from the risk and architecture perspective in the context of the UAE Military Flight Testing and Development Centre (FTC) has unveiled some important conclusions.

(1) Bespoke & Adapted Approach to EA
Whilst academics and practitioners alike propose numerous frameworks for the implementation and management of Enterprise Architecture in organizations, this research identified that each organization must adapt available best practices to the specific context of their own operation. Many frameworks have been matured over the years for Enterprise Architecture, including the Zachman, TOGAF, DoDAF, MoDAF, FEAF (to name a few), but the bespoke CAGF framework was required as an umbrella integral adaptation of relevant Enterprise Architecture processes, features and concepts to the specific requirements of the UAE FTC. This finding suggests every

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organization should not just deploy a generic framework but identify specific business challenges and apply relevant EA concepts and processes from all available and established frameworks.

(2) Combinatory Approach including EA and CMMI
Enterprise Architecture is a discipline that facilitates systematic planning of key organization capabilities, but as observed in this study, a reference model providing a blueprint of best practices business models and processes for the industry in question is a critical addition and input to the Architecture planning work. In the case of the FTC as software testing and development organization the CMMI framework was the appropriate business model blueprint. The key finding in this study is that Enterprise Architecture should not be seen as a turnkey solution for organizational improvement. Enterprise Architecture should be extended with relevant industry models that provide clarity and proven illustrations for the end game in terms of organization processes and capabilities.

(3) Engagement for success
This research has also identified that the successful combination of Enterprise Architecture capabilities with CMMI has an industry business model blueprints into a comprehensive planning model (CAGF), were not enough to engage all the organization stakeholders in the change process. Positive improvement in the initiative only started to trickle-through with when active engagement of stakeholders. An extensive involvement stimulus program was required to accompany the CAGF initiative. Open communication and continuous education were the cornerstones of the involvement program established as a dedicate stream of work to engage employees at all level to understand the importance of such planning approach, the potential impact on the organization and personal benefits to aspire to. The key finding observed was that stakeholders' engagement remains key to success irrespective of the sophistication of the planning technique. Enterprise Architecture must be coupled with change governance to achieve desired outcomes. Traditional engagement tools such as communication for greater awareness and education (formal and informal) on the merit of Enterprise Architecture are fundamental to maximize the return on such transformational initiative.

19.2 Benefits to the Organization

The cumulative impact of Enterprise Architecture, in conjunction with CMMI, risks management and Change management adopted in this initiative has returned a number of observable benefits for the FTC of the UAE Air force. Overall the better clarity in the organization aspirations and objectives and the measurement of progress as the initiative progressed, led to better organizational credibility within the UAE armed forces. This in turn raised the motivation level of staff given the true sense of belonging and contribution towards a well-defined outcome for the organization. In summary, the unique integration of planning and management techniques from Architecture, Risk, and Change management was indeed an effective weapon in the instigation of such a major program of change within a well-established organization, which carried many operational legacies (which are always challenging to overcome).

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Additionally, our work on CaGF provided an optimized operational model with strong links to services and processes that were driven by value, and are constantly aligned and viewed in terms of Porter's value chain.

19.3 Implications

The findings of this research have two types of implications. On one side from and academics standpoint these findings contribute to knowledge on rapidly emerging management concepts and practices. On the other side, this study is also very important for managers around the globe seeking to make use of these management techniques.

(1) Knowledge Implication
The outcome of this study adds practical knowledge on Enterprise Architecture on several growing management disciplines with profound relevance to enterprise managers. It presents the merit of EA within the context of a major organization change, but also highlights its limits, hence the need to complement and extend this discipline with other management concepts to realize tangible outputs. This additional knowledge evaluated within the context of the UAE FTC highlights that contrary to previous research Enterprise Architecture is not a turnkey solution for organization challenges. It is a very powerful management concept, which must be carefully positioned along with other management practices to deliver value.

(2) Implications for managers
Through the case of the UAE FTC examined and presented in this thesis, managers across the globe (in both private and public sectors) are equipped with practical advice and insight on how to successfully deploy Enterprise Architecture in conjunction with Risk Management and, among other disciplines such as Change Management, to drive behaviors, consensus and organizational resources towards desired outcome. Much of the lessons and key findings of this study are exportable to the change challenges faced by many organizations. But as demonstrated in this research the organization must identify a clear set of objectives and motivations behind every change program prior to embarking on the adaption of best practices such as Enterprise Architecture and CMMI.

19.4 Limitations & Further Research

This study was conducted within the context of a single organization (the UAE armed forces FTC), as such some the parameters of the case study cannot be generalized. Further research on the model used in this research that combines Enterprise Architecture with Change and Risk management should be further tested in other scenarios and situations. As this study employed a case-base qualitative approach, it will be useful for further research on the same model to take a quantitative approach and employs a larger sample frame for evaluation.

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Our analysis by the end of our research showed that a combination between CaGF and TOGAF framework would produce better results.

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GLOSSARY

ADM (Architecture Development Method)—A process for creating an enterprise architecture that is part of the TOGAF standard.
Application architecture—The architecture of a specific application.
Architect—One whose responsibility is the design of an architecture and the creation of an architectural description.
Architectural artifact—A specific document, report, analysis, model, or other tangible that contributes to an architectural description.
Architectural description—A collection of products (artifacts) to document an architecture.
Architectural framework—A skeletal structure that defines suggested architectural artifacts, describes how those artifacts are related to each other, and provides generic definitions for what those artifacts might look like.
Architectural methodology—A generic term that can describe any structured approach to solving some or all of the problems related to architecture.
Architectural process—A defined series of actions directed to the goal of producing either an architecture or an architectural description.
Architectural taxonomy—A methodology for organizing and categorizing architectural artifacts.
Architecture—The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution (from IEEE-1471-2000).
Business architecture—An architecture that deals specifically with business processes and business flow.
Business reference model (BRM)—An FEA term that gives a business view of the various functions of the federal government.
Business services segment—An FEA term that refers to a *segment* that is foundational to most, if not all, political organizations, such as financial management.
CIO—Chief Information Officer, the executive in charge of information technology in a corporation.
CIO Council—A council consisting of CIOs from each of the federal governmental agencies that coordinates work related to common interests.
Clinger-Cohen Act of 1996—See *Information Technology Management Reform Act*.
Common-systems architectures—A TOGAF term referring to an architecture that is common to many (but not all) types of enterprises, in contrast to *foundation architectures* and *industry architectures*.
Component reference model (CRM)—An FEA term that gives an IT view of systems that support business functionality.
Data architecture—The architecture of the data (typically stored in databases) owned by the enterprise.
Enterprise architect—An architect who specializes in enterprise architectures.
Enterprise architecture—An architecture in which the system in question is the whole enterprise, especially the business processes, technologies, and information systems of the enterprise.

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Enterprise service—An FEA term referring to a well-defined function that spans political boundaries, such as security management.

FEA—See *Federal Enterprise Architecture (FEA).*

FEAF—See *Federal Enterprise Architectural Framework (FEAF).*

FEAPMO—The organization within the OMB that owns and administers the Federal Enterprise Architecture.

Federal Architecture Program EA Assessment Framework—A benchmark used by the OMB to measure the effectiveness of governmental bodies in using enterprise architecture.

Federal Enterprise Architectural Framework (FEAF)—An enterprise-architectural framework used by the U.S. federal government to describe how the various governmental agencies and their IT systems are related to each other.

Federal Enterprise Architecture (FEA)—An architectural description of the enterprise architecture of the U.S. federal government that includes various reference models, processes for creating organizational architectures that fit in with the federal enterprise architecture, and a methodology for measuring the success of an organization in using enterprise architectures.

Foundation architecture—A term used by TOGAF to refer to the most generic of architectures that can be used by any IT organization, in contrast to *common systems architectures*.

GAO—See *General Accountability Office (GAO).*

Gartner—An IT research and advisory organization.

Gateway—A transfer point of an autonomous system from which messages from the outside world are received or through which messages to the outside world are sent.

General Accountability Office (GAO)—A branch of the U.S. Government that is responsible for monitoring the effectiveness of different organizations within the U.S. Government.

Industry architecture—A TOGAF term that refers to an architecture that is common to most enterprises within an industry, in contrast to a *common-systems architecture* and an *organizational architecture.*

Information Technology Management Reform Act—An act passed by the U.S. Congress in 1996 that requires all governmental organizations to use effective strategies and frameworks for developing and maintaining IT resources.

OMB (Office of Management and Budget)—Part of the Executive Office of the President of the U.S. that serves the function of presidential oversight on federal agencies.

The Open Group Architectural Framework—See *TOGAF (The Open Group Architectural Framework) 8.1*.

Organizational architecture—A TOGAF term that applies to an architecture that is specific to a particular organization, in contrast to an *industry architecture*.

Performance reference model (PRM)—An FEA term that gives standard ways of describing terms related to measuring value.

Return on Investment (ROI)—A measure (in percent) of the business value of a project, based on the increase in profit (either because of increased income or decreased expenses) divided by the cost of the project. For example, a project with a cost of $100,000 that returned $200,000 in increased profit has an ROI of 200 percent.

ROI—See *Return on Investment (ROI).*

Segment—An FEA term that refers to a major line-of-business functionality, such as human resources, that might be shared across organizations.

Standards information base (SIB)—A TOGAF term that refers to a collection of information about standards, particularly in the area of open-source.

TAFIM (Technical Architecture Framework for Information Management)—An architectural framework developed by the Department of Defence and officially discontinued in 2000.

Technical architecture—Usually refers to the architecture of the technical infrastructure within which applications run and interact.

Technical reference model (TRM)—Part of TOGAF, a reference model that gives a common language for various pieces of IT architecture. This term is also used for a similar meaning within *FEA.*

TOGAF (The Open Group Architectural Framework) 8.1—An architectural methodology that is controlled by The Open Group.

Zachman Framework for Enterprise Architectures—An architectural framework in which an enterprise is modeled as 30 or 36 cells, each of which represents an intersection between a stakeholder perspective and an abstraction.

INFORMATION Security

1. ISO27001 – Information Technology –Security Techniques –Information Security Management Systems –Requirements ;
2. ISO7002-Information Technology –Security Techniques –Code of practice for Information Security Management ;
3. ISO17799-Information Technology. Code of practice for information Security Management (superseded by ISO27002)

- BS7799 part 1- Information Security Management System –Guidelines (superseded by ISO17799);
- BS7799 part 2- Information Security Management System –Guidelines (superseded by ISO27001);
- ITSEC-Information Technology Security Evaluation Criteria

APPENDICES

APPENDICES'S TABLE OF CONTENTS

APPENDICES'S LIST OF FIGURES 3

APPENDICES'S LIST OF TABLES 4

1 Mirage 2000-9 Master Schedule 5

1.1 Mirage 2000-9 Baseline Master Schedule 5

1.2 Mirage 2000-9 Updated Master Schedule 6

1.3 Mirage 2000-9 Master Schedule – Zoom on Upgrade 7

2 Multi-disciplinary Approach to Risk Management – Safety & Security 8

2.1 Background 8

2.2 Risk Management 9

2.3 Methodologies for Risk Management 9

2.4 Risk Analysis Theory 12

2.5 Tools 16

2.6 Use Cases 22

2.7 Detailed Analysis of the Functional Safety Use Case 25

2.7.1 System Characterization 25

2.7.2 Analysis Objectives Identification 27

2.7.3 Threat Identification 28

2.7.4 Vulnerabilities Identification 29

2.7.5 Countermeasures Identification 30

2.7.6 Knowledge Base Relational Details 31

2.8 Conclusion 37

3 CAPABILITY MATURITY MODEL (CMMI) 39

3.1 Introduction to CMMi 39

3.2 Model Components 40

3.3 Model Representation 42

3.4 Capability Levels 43

3.5 Maturity Levels 43

3.6 Process Improvement Life Cycle 45

4 A Comparison of the Top Four Enterprise-Architecture Methodologies 48

4.1 Introduction 49

4.2 A Brief History of Enterprise Architecture 52

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4.3 The Zachman Framework for Enterprise Architectures 56
4.4 The Open Group Architecture Framework (TOGAF) 60
4.5 Federal Enterprise Architecture (FEA) 65
4.5.1 FEA Reference Models 68
4.5.2 FEA Process 69
4.5.3 FEA Success Measurement 69
4.5.4 FEA Applied to MedAMore 70
4.6 Gartner 72
4.7 Comparison 74

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APPENDICES'S LIST OF FIGURES

FIGURE 1: ITERATIVE RISK ANALYSIS WORKFLOW 12
FIGURE 2: RISK ANALYSIS WORKFLOW 13
FIGURE 3: DIFFERENT DOMAINS RISK ANALYSIS WORKFLOWS COMPARISON 15
FIGURE 4: COMMON INTEGRATED WORKFLOWS 16
FIGURE 5: ARES KNOWLEDGE BASE AND RISK ANALYSIS WORKFLOW 19
FIGURE 6: RISK ANALYSIS SERVICES LAYER REPRESENTATION 20
FIGURE 7: VOID 21
FIGURE 8: SOA SOLUTION IMPLEMENTATION 22
FIGURE 9: SYSTEM CHARACTERIZATION 26
FIGURE 10: ANALYSIS OBJECTIVES IDENTIFICATION 27
FIGURE 11: THREATS IDENTIFICATION 28
FIGURE 12: VULNERABILITIES IDENTIFICATION 29
FIGURE 13: COUNTERMEASURES IDENTIFICATION 30
FIGURE 14: THREATS-VULNERABILITIES ASSOCIATION 31
FIGURE 15: VULNERABILITIES – COUNTERMEASURES ASSOCIATION 32
FIGURE 16: ASSETS- THREATS ASSOCIATION 34
FIGURE 17: OCCURRENCE IMPACT MATRIX 35
FIGURE 18: OCCURRENCE - IMPACT MATRIX 36
FIGURE 19: ASSETS QUOTING MATRIX 36
FIGURE 20: MODEL COMPONENTS RELATIONSHIP 42
FIGURE 21: THE 5 LEVELS OF MATURITY IN THE STAGED MODEL 45
FIGURE 22: IDEAL MODEL FIGURE 46
FIGURE 23: THOREAU'S CABIN AT WALDEN POND, AS DRAWN BY THOREAU'S SISTER, SOPHIA THOREAU 50
FIGURE 24: A MAP OF NEW YORK CITY 50
FIGURE 25: ENTERPRISE-ARCHITECTURE TIMELINE 53
FIGURE 26: ZACHMAN GRID 58
FIGURE 27: TOGAF'S ENTERPRISE ARCHITECTURE 60
FIGURE 28: THE TOGAF ENTERPRISE CONTINUUM 61
FIGURE 29: THE TOGAF ARCHITECTURE DEVELOPMENT METHOD (ADM) 62
FIGURE 30: SEGMENT MAP OF THE FEDERAL GOVERNMENT 67

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APPENDICES'S LIST OF TABLES

TABLE 1: CROSS-REFERENCE BETWEEN KEY CONCEPTS OF COSO AND D'APPLONIA METHODOLOGY 11
TABLE 2: MAPPING MATRIX AMONG SECURITY, SAFETY AND PROGRAM RISK MANAGEMENT 14
TABLE 3: THE MAIN RISK ASSESSMENT TOOLS ON THE MARKET 18
TABLE 4: ASSETS - THREATS ASSOCIATION MATRIX 33
TABLE 5: MODEL COMPONENTS 41
TABLE 6: CAPABILITY LEVELS 43
TABLE 7: MATURITY LEVELS 43
TABLE 8: PROCESS AREAS FOR MATURITY LEVELS 44
TABLE 9: IDEAL MODEL ACTIVITIES 46
TABLE 10: OMB RANKING OF ARCHITECTURAL COMPLETION, ADAPTED FOR PRIVATE SECTOR BY AUTHOR (ROGER SESSIONS) 70
TABLE 11: CRITERIA AND RATINGS FOR EACH METHODOLOGY 77

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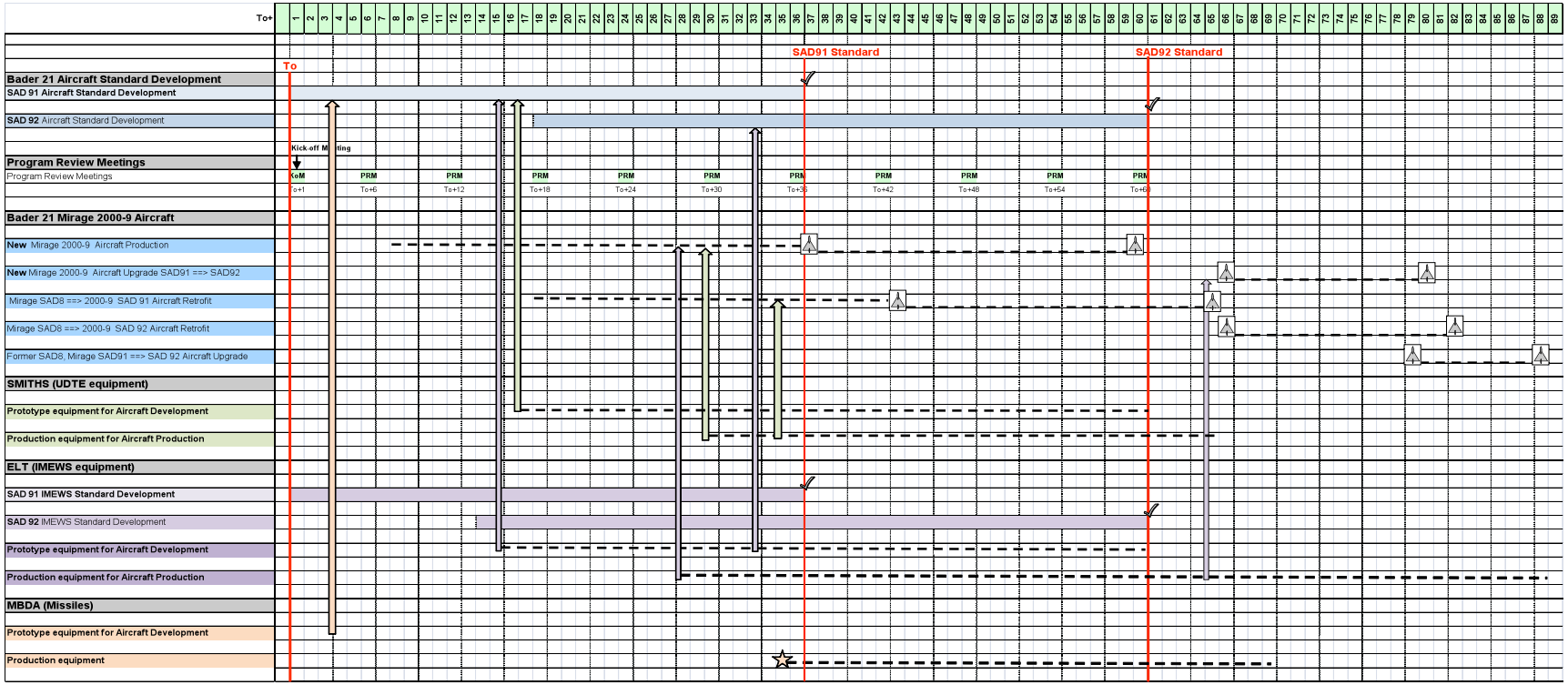
1 Mirage 2000-9 Master Schedule

1.1 Mirage 2000-9 Baseline Master Schedule



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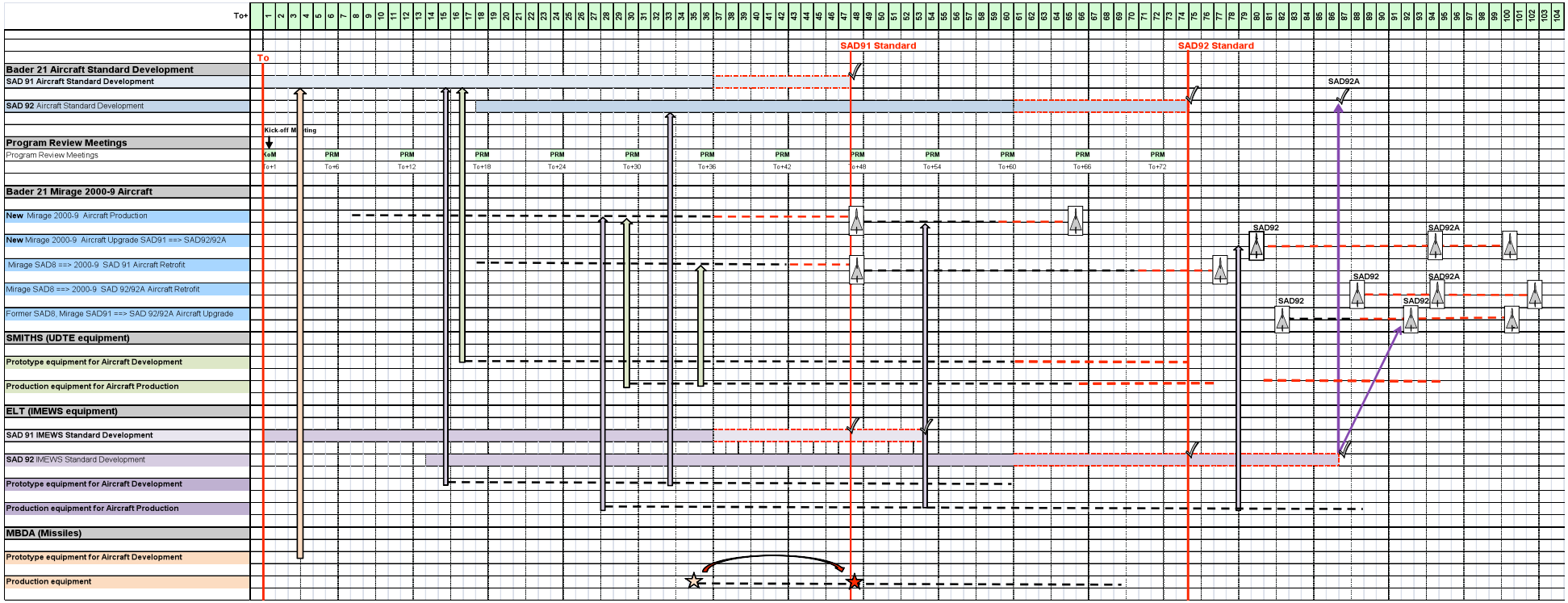
1.2 Mirage 2000-9 Updated Master Schedule



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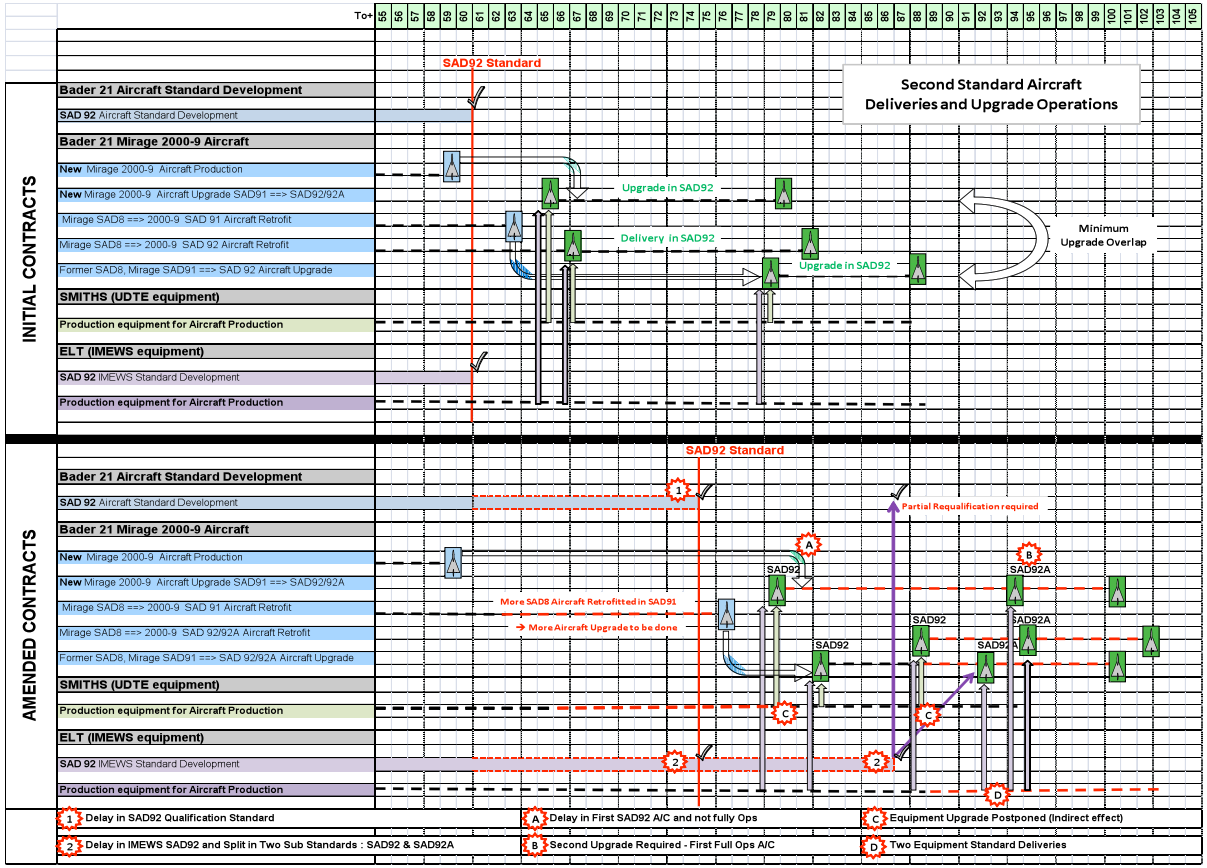
1.3 Mirage 2000-9 Master Schedule – Zoom on Upgrade



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2 Multi-disciplinary Approach to Risk Management – Safety & Security

2.1 Background

FTC has been running a project named “CMMI, Quality and Safety” where a company in the name of Abu Dhabi Systems Integration (ADSI) was the prime contractor. For FTC, the objective of this project concerns safety issues, measures and processes, specifically in relation to Safety Management System, in accordance with the guidelines of MIL-STD-882C, while taking into consideration the + SAFE V1.2 extension model to CMMI for Development .

The CMMIQS Program activities aim to improve the organizational processes and in this particular case, to reduce the safety risks involved with the conduction of FTC projects and operations, with risk analysis as a very relevant discipline within this domain.

The Safety part of the project is piloted by D’Appolonia team, supported by a combined FTC and ADSI teams, and led by the author, to provide an integrated engineering and management service, during the whole project life cycle.

In consideration of the interest of FTC, a workshop on Risk Analysis for safety, was organized to identify and analyze the potential safety risks within the FTC.

V1.2 is an extension to the continuous representation of CMMI ® for Development, Version 1.2 (CMMI-DEV, V1.2). This extension consists of two process areas added to CMMI-DEV to provide an explicit and focused basis for appraising or improving an organization’s capabilities for providing safety critical products.

+SAFE was designed to reduce the dependence of CMMI appraisers on safety domain expertise. This extension was developed for standalone use. It is not intended to be embedded in a CMMI model document, nor is it integrated in the official CMMI certification of any level. However, there are intentional overlaps with CMMI model content and some safety standards.

During a two-day’s workshop, Risk Analysis approach and methodology were discussed and introduced using D’Appolonia proprietary tool named ARES ,which was developed by D’Appolonia based on their extensive experience on Risk Analysis acquired during the many years in this sector .

Some preliminary findings relevant to the possibility of integration of the Risk Analysis service within the Enterprise FTC framework being implemented (in FTC) were presented. ARES represented the current implementation state, approach and methodology to Risk Analysis, and moving towards the evolution and customization of this tool: a valuable instrument that need to be developed, tailored and integrated in the existing FTC Framework.

The aims of the workshop were:

- Sharing of experiences, awareness and know-how on Risk Analysis;

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- Presentation of the methodology used by D'Appolonia in large programs;
- Evaluation of tools devoted to support risk management practices associated mainly with safety;
- Presentation through use of the tool and methods to perform studies and consultancies;

- Discussion about the certain of a framework (including methodologies, tools and services) of Risk Management for FTC to be integrated in the Overall FTC framework;

2.2 Risk Management

Events can have negative impact, positive impact, or both. In implementing their relevant projects, FTC needs to understand that events with a negative impact represent risks, which can prevent value creation or erode existing value. Events with positive impact may offset negative impacts or represent opportunities.

Opportunities are the possibility that an event will occur and positively affect the achievement of objectives, supporting value or preservation. Management channels opportunities back to its strategy or objective -setting processes and formulating plans to seize the opportunities.

Committee of Sponsoring Organization of the Tread Way commission (COSO) defines the Risk management as "a process, effected by an entity's board of directors, management and other personal, applied in strategy setting and across the organization, designed to identify potential events that may affect the entity, and manage risk to be within an acceptable level (risk tolerance), to provide reasonable assurance regarding the achievement of entity objectives ".

As can be easily noticed, the above definitions are purposefully broad. They can successfully apply to every project or operation where results and objectives are expected; additionally they can be relevant to several sectors that the enterprise it is dealing with (e.g. program Risk Management, Information Security, Safety, etc.).

An effective Risk Management process is therefore a key issue for the FTC organization. The principle goal of the risk management process for FTC is to protect FTC itself and its ability to perform its mission. Risk management has to be treated as an essential management function within FTC.

2.3 Methodologies for Risk Management

The common approach to Risk Management, as primary and fundamental step, required the FTC to perform a Risk Analysis in order to estimate and evaluate the actual status of risk. In those circumstances, the risk estimation could be qualitative or quantitative.

The Qualitative approach is the most widely used. This process can be accomplished in an abbreviated way by answering three basic questions:

- What could happen?

- How likely is it to occur?

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- What is the impact?

The Quantitative approach requires that one establishes a value for the assets and processes, estimates the probability of a threat occurring , and determine the return of investment for implementing countermeasures to reduce the impact caused by that threat occurring .

The author believed that the FTC should base its Risk Management on the following key general concepts:

- Risk evaluation shall need to be carried out several times and to allow the results to be reproducible for comparison purposes

- Controls selection must be done taking into account not only the risk analysis but legal and contractual requirement as well

- Effectiveness of the controls must be measured to demonstrate the objectives achievement

- Emphasize the risk evaluation to verify the controls effectiveness and to determine the update of the risk management plans

- Risk analysis methodology must be well documented

- Emphasize the management role in :

- the definition of risk mitigation and management strategies

- the evaluation of risk acceptance criteria

- the monitoring of the Risk Management system

Standard and best practices in risk analysis in different sectors gather for these key concepts. The main state –of-art standards and best practices that have to be considered are the following:

- Project Risk Management:

- ISO/IEC Guide 73 Risk Management –Vocabulary – Guidelines for use in standards;

- Committee of sponsoring Organizations of the Tread way commission (COSO) ENTERPRISE Risk Management Integrated Framework;

- COBIT 4.1 –control Objectives for Information and Related Technology.

Safety

- DEF STAN 00-56-Saftey Management Requirements for Defense Systems;

- MIL STD 882 (Rev C and Rev D) Military Standard, System Safety Program Requirements .

Whereas an Organization has multiple involvements from several applications areas, a multidisciplinary approach and shared commonalities (but in parallel catering for sector-specific issues), would represent the best response for the need to harmonically fit into an organic enterprise framework.

In the authors view, this would fit the FTC operations, where the application of a structured-multidisciplinary methodology seems to be the best response to the FTC needs. The methodology should be:

-Based on NATO standard information security or similar standards;

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-Based on best practices engineering approach;

-Based on quantitative approach;

- Assessed by external bodies (e.g. National Security Agencies) with

Operative Programs → best practice;

- Compliant with other standards and best practices (e.g. COSO, COBIT,

ISO/IEC 27001, MIL STD 882, CMMI);

- Able to exploit multidisciplinary combined approach;

- Train risk experts and utilize their experience on risk analyses (e.g. libraries of threats and vulnerabilities).

Compliance with standards and best practices that are worldwide recognized is an important factor to be taken into account when building viable enterprise processes. The methodology under evaluation has been verified against these standards by the team. As an example, the following table shows the cross-reference between key concepts and terminology of COSO and the D'Appolonia methodology.

D'APPLONIA	**COSO**
Organization /System Characterization	Internal Environmental
Objectives Definition and Quoting	Objectives Setting
Threats definition	Event identification
Impact/ occurrence Matrix	Risk Assessment
Risk Mitigation	Risk Response
Countermeasures definition	Control Activities
Output Dissemination	Information and Communication
Iteration Of the analysis	Monitoring

Table 1: Cross-reference between key concepts of COSO and D'APPLONIA Methodology

The Approach being followed determines an integrative workflow as depicted here below.

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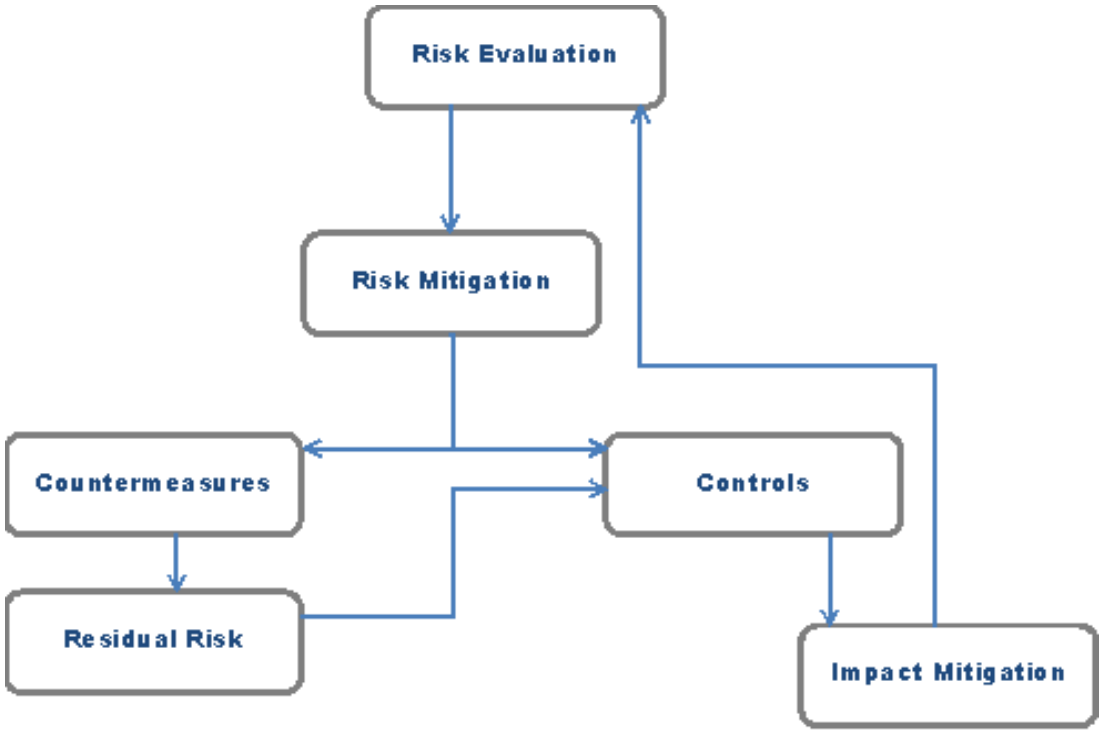

Figure 1: Iterative Risk Analysis Workflow

2.4 Risk Analysis Theory

In referring to different open sources literature, the author is hereafter describing the theory behind Risk Analysis as the process of identifying vulnerabilities and threats to recourses/assets used by the FTC organization in achieving objectives , and decide what countermeasures and necessary to reduce risk to an acceptable level .

System /Processes are subject of the analysis, and can be decomposed into primary items that hereafter are referred as to assets.

The Risk is defined depending on the estimation of threats occurrence probability and on their impact on the system assets.

A Vulnerability is a flaw or weakness in system procedures, design, implementation, or internal controls that could be exercised (accidentally triggered or intentionally exploited) and result in a violation of the objectives.

A threat contains the potential for an opportunity source to exercise (comparative analysis) as well as the improvements related to the countermeasure choice.

The outcome of the risk evaluation defines:

-The critical systems and subsystems having an “acceptable” level of risk and don’t require the risk reduction;

-The critical systems and subsystems having a level of risk “greater than acceptable” level:

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In this case, the level of risk of each single subsystem shall be reduced through the adoption of specific physical, procedural or technical countermeasure.

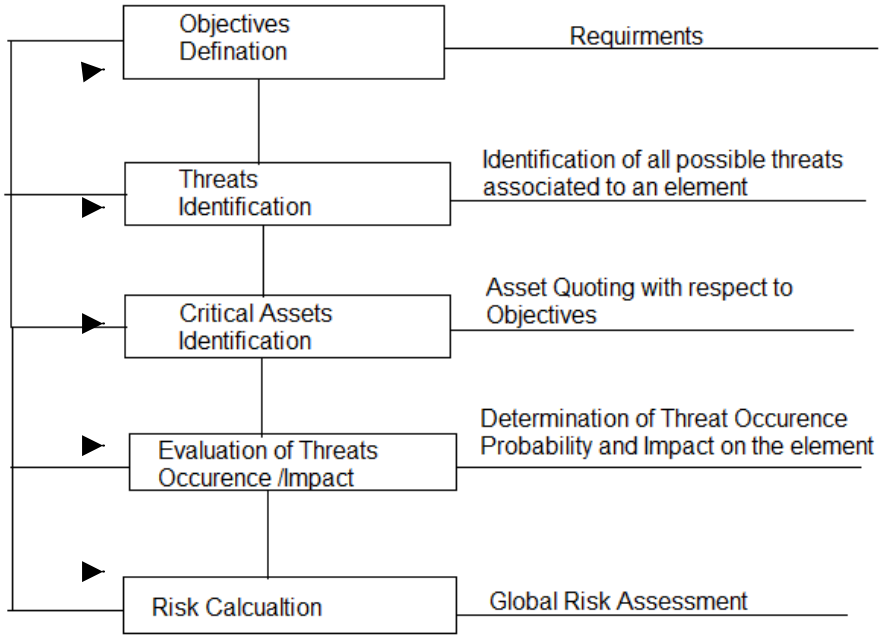

Figure 2: Risk Analysis workflow

In quantitative analysis, the assets are quoted by associating numerical weight values respect to the relevant objectives. Averaging these values define the system quote.

Risk associated to each threat applicable to an asset is evaluated according to its impact versus occurrence parameters, thus allowing to determine the overall risk associated to an asset. The system's risk is then calculated averaging the contribution of asset's risks that are above a predetermined threshold and a determined weighting the asset's risk threshold with the system quote.

The evaluation of the risk determines its acceptability or not, therefore indicates whether there is the need to implement a risk reduction by adopting proper or specific, physical procedural or technical countermeasures.

This generic theoretical approach can be applied to field-specific instances. As an example, a mapping matrix among Security, Safety and program Risk Management is provided hereafter.

PROGRAM RISK MANAGEMENT	SAFETY	SECURITY
Program Objectives (Time Scale , Cost plan , Performances)	Safety Objectives (personal safety , Equipment integrity , Environmental Safety)	Security Objectives (Availability , Integrity , Confidentiality)

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Risk	Hazards	Threats
Causes of the Risk	Weak points	Vulnerabilities
Contingencies /Actions	Safety Processes / Physical Countermeasures	Countermeasures
Program/Tasks /Resources	Facilities /system/subsystem	Subsystem /Asset
Probability (p)	Hazard occurrence (Risk)	Threat Occurrence
Risk factor (p * 1)	Severity Occurrence Matrix -→Hazard class	Threat Occurrence Matrix
Impact (I)	Hazard Severity (Based on consequences)	Threat Impact
Risk Exposure Evaluation	Fault tree + Analysis	Risk Evaluation
Risk Reduction (Risk Action Plan)	Risk Reduction (FT+)	Risk Reduction

Table 2: Mapping Matrix among Security, Safety and Program Risk Management

The steps of Risk Evaluation and Risk Reduction are Domain dependent, while other steps are common to each application.

Accomplishing to the general philosophy of the FTC intended framework, the common integrated workflow on different domains of Risk Analysis are of main importance .The following sequence of pictures shows how an integrated approach is possible unifying the domain independent steps and which the improvements are.

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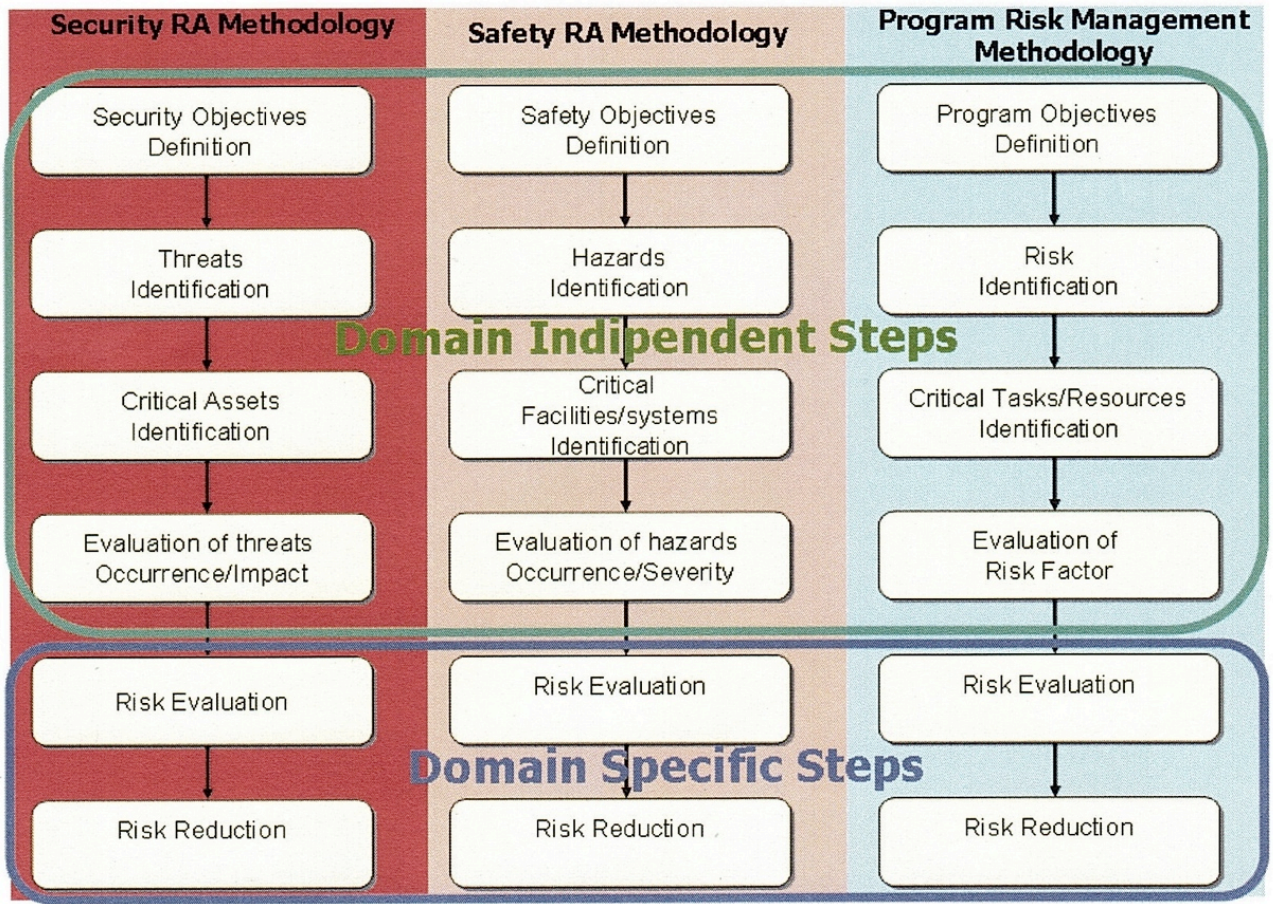

Figure 3: Different Domains Risk Analysis Workflows Comparison

In an effort of unifying the approach, this would result in common workflow for most of the Risk Analysis.

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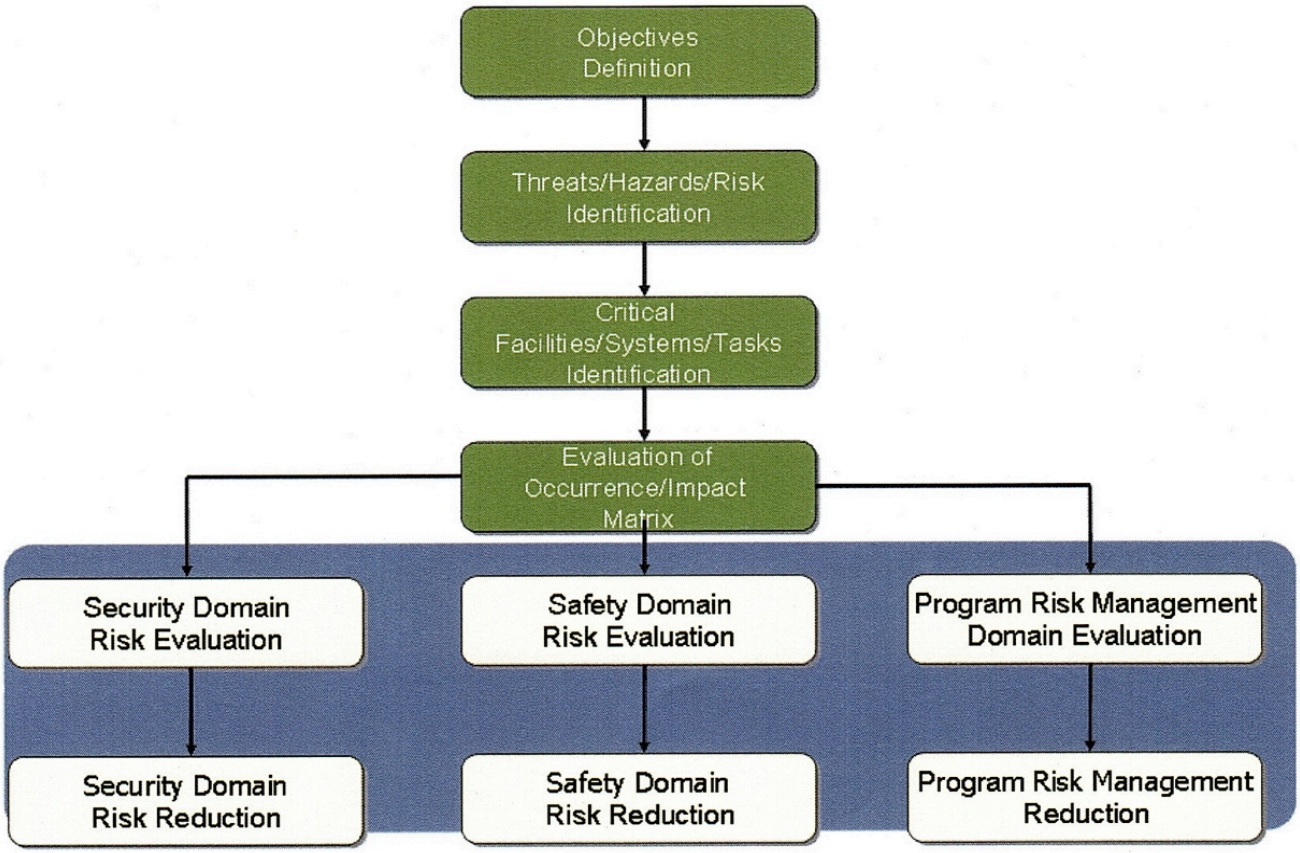

Figure 4: Common Integrated Workflows

The application of this concept in FTC puts the Risk Analysis as the lever on which to act to obtain significant improvements in terms of recourses, time, procedure, processes, data and costs in several disciplines contemporarily.

2.5 Tools

The practical application of the Standard Methodologies raised the need of using tools to supporting the Risks Analysis methodology.

In considering that any organization has its own specific needs, and that an actual added value is brought by tools particularly integrated in the overall framework of the FTC organization, thus becoming a unique tool covering homogenously all the relevant domains of the FTC organization and not several tools, implementing a different methodology for each domain.

The FTC has followed a harmonized approach, allowing exploiting the synergies derived from multidisciplinary approach. Tools must be used not only for analysis but also for monitoring; as such a proper integration of the tools in the organization framework is an important requirement.

Additionally, tools generate outputs and reporting, which should be tailored according to standard and guidelines (e.g. program templates) as well as to the organization's needs.

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To summarize, the key elements in the evaluation of a tool for the FTC are:

- Integration
- Customization
- Adoptable to the entire domain, using common baselines
- Unique high-level methodology
- Multidisciplinary approach

The Risk Assessment tools market is relativity small. The tools considered as State of the Art are COBRA, CRAMM, Risk Check, Risk PAK, Counter Measure, and iQRAS. A high level evaluation of each of them has been performed, and the following table reports the main features.

FEATURES	TOOL NAME
Knowledge base Questionnaires Reports What If Testing Information Security oriented	COBRA
Asset evaluation : -Cost -Impact What-if analysis Qualitative Approach Information Security Oriented	CRAMM
Health & Safety Oriented Environmental Configurable Reports	Risk Check
Business continuity Customized able Questionnaires What –if modelling and progress comparison	Risk PAC
Physical and Information Security oriented critical infrastructures Possibility to integrate documents Cost analysis of countermeasures Reports Cost-Benefits analysis	Countermeasures

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Safety & Security oriented Event sequence Diagrams Reports	iQRAS

Table 3: The main Risk Assessment tools on the market

Sub-Conclusion

As a general consideration on this tools' (ARES) survey and on the commercial tools scenario, the author has reached the following conclusion: the existing tools are;

- Qualitative based;

- Based on Questionnaires;

- Stand-alone tools (not easily enterable in the overall FTC organization frame work);

- Software programmers instead of risk experts have developed many of these products, and their quality of recommendation in safeguards, threats and vulnerabilities sometimes does not reflect the real world experience in this domain;

- Each one is designed for specific selected domains;

- Not necessarily fitting with all specific FTC needs and not easily customizable.

Conclusion

To conclude, a custom solution would probably best fit the needs of FTC, having the primary characteristic of:

- Multidisciplinary approach;

- Integration with the enterprise EA framework;

- Collection of the organizational knowledge base.

Additionally, when assessing the best way to support their projects dealing with Risk Analysis, and among other risks, appeared the need to supporting projects in the fields of Information Security, and ARES became. a viable candidate for a possible solution or a part of FTC wider integrated EA solution.

Basically ARES is a tool suite, which supports the entire Risk Analysis Process by providing the following main functionalities:

- Knowledge base Management which provides the facilities to collect in a library all the information necessary to carry our Risk Analysis and to share experience and Knowledge ;

- Risk Analysis Scenario Management which provides support in the composition , versioning and duplication of scenario , object of the risk analysis ;

- Risk Analysis Calculation and Evaluation, which provides instruments and algorithms to calculate, quantify, evaluate and mitigate risk.

The functions are linked to each other each other in an iterative workflow as described in the diagram below:

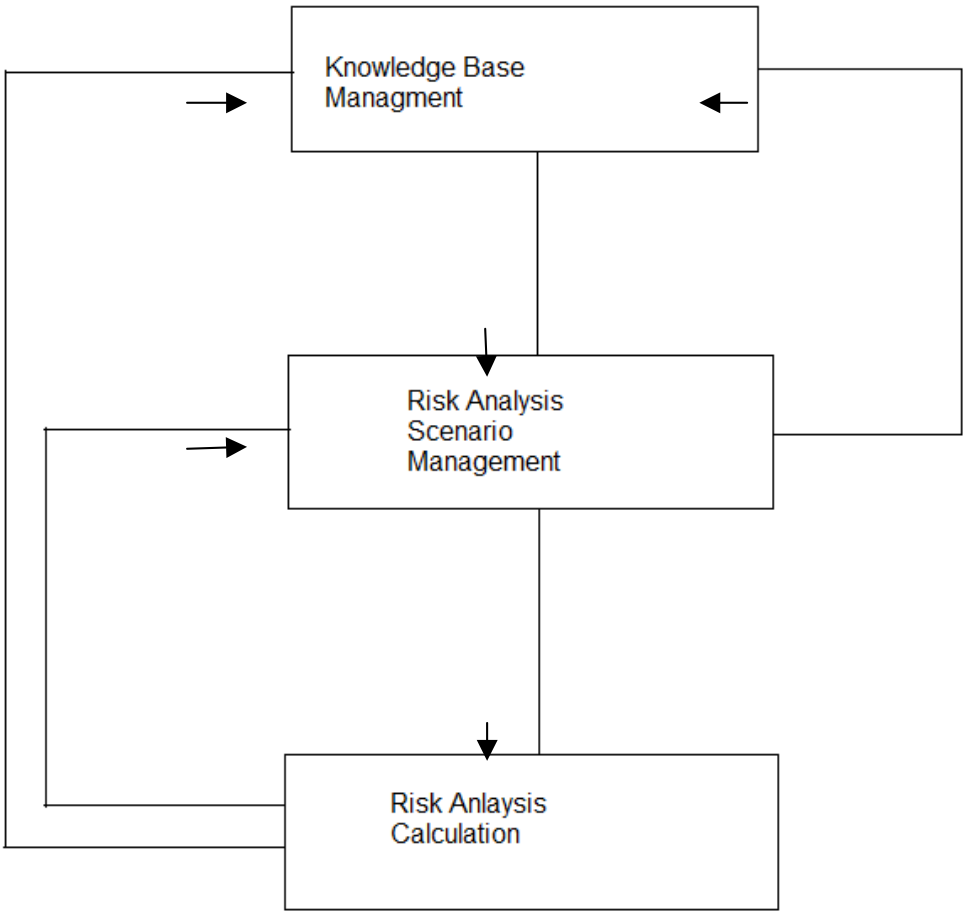

Figure 5: ARES Knowledge Base and Risk Analysis Workflow

The ARES tool suite is a development product, which is already in use. In the authors view, any future tool for FTC needs to cater for continuous and on-going upgrades of features to fit at best the needs of engineers and analysts that use in their daily work.

The flexibility of a custom solution, along with the extension of its use to a multi-disciplinary domain based on a common methodology makes it a viable solution to be further studied in the effort of coping with FTC needs.

In this process, D'Appolonia and FTC intended to evolve and customize the tool in their endeavor to re-align with FTC needs in the operations domain.

The most challenging factor, as mentioned earlier, is to maximize the added value that a tool can bring by integrating it in the overall EA framework of the organization. FTC is currently implementing the enterprise framework, which was jointly undergoing development by FTC and Telelogic. The scope is to create a structure of decision making process that take advantages of some tools like Enterprise Architect , Rhapsody , Focal point, Synergy, Doors as well as tools from other vendors that will support the operation and elaboration of the FTC data .

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Capabilities, interfaces and integration of the various tools within the framework are an essential element in creating the framework itself.

Within this scenario, an initial feasibility evaluation of the D'Appolonia Risk Analysis tool as well as an integration assessment within the FTC intended Framework has been performed, to consider if FTC and Telelogic approach in the representation of the systems to be developed for FTC are compatible with D'Appolonia tool .

The Enterprise descriptions are done by decomposing the main systems into subsystems. The FTC framework is based on System Architect, and it is a derivative of DoDAF 1.5. The DoDAF model defines system that implements Services Oriented Architect (SOA); therefore all the members of the framework will have to be integrated like services consuming and supplying information managed inside the system. In this perspective, the inclusion of Risk Management can be seen as the addition of a Services Layer interfacing with the other components of the Framework through events and methods, as shown in the following picture.

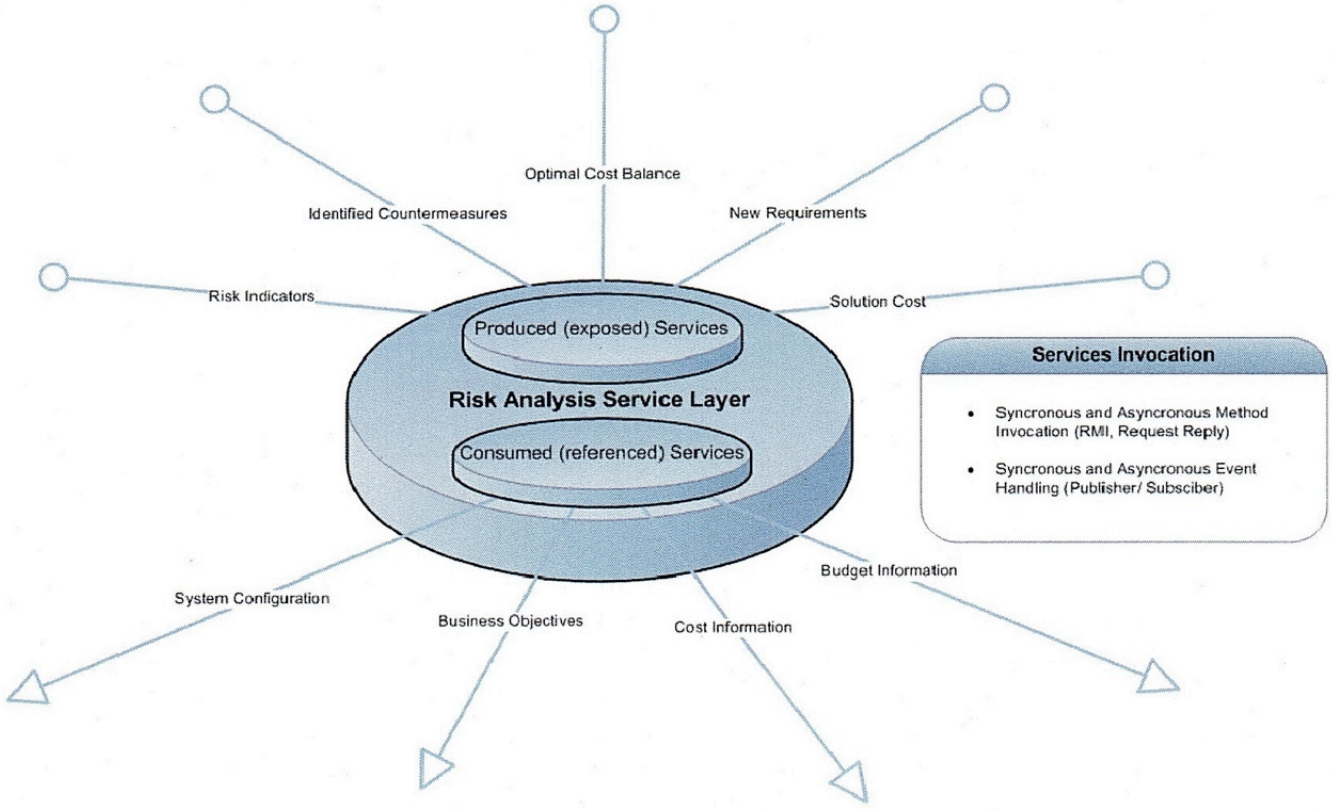

Figure 6: Risk Analysis Services Layer Representation

Just as an example, the risk analysis tools will take as input the description of the system and provides as output the risk values and the evaluation of the countermeasures.

As a general hypothesis of integration of Risk Analysis layer in the design for FTC framework, the following pictures helps to understand the logical and holistic view proposed by the author

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Figure 7: VOID

Zachman framework, as well as many other enterprise architecture frameworks, has its weak point or limitations in the weak attention to risk management.
Zachman has been hailed as a framework because it really takes a holistic approach towards building Enterprise Architects models. This is quite an important point since FTC cannot afford to lose important aspects and perspective of the Enterprise system that the author wishes to support architecting, and obtain a connected view and relationships of such aspects and perspectives.
Moreover, Zachman framework does not come with a methodology to build the required EA framework for FTC. Scientists introduced the DNA version of Zachman framework or the Integrating Architecture. This version of the framework combines the artifacts, disciplines and infrastructure to make a business work.
This three-dimensional schema uses an unchanged two-dimensional schema and adds an unlimited number of depth segments. Each depth segment mirrors the six arrangement of the two-dimensional schema.
The introduced third dimension, is exploited according to scope and needs the under analysis Enterprise/System.

Risk Management is generally one of the most interesting methodologies that can be included as third dimension, solving the intrinsic weakness of the FTC framework in this field.
Quality is a general methodology processes.
On the other hand, FTC core business is system Development and Test , therefore it may require another possible methodology to be evaluated, proposed and possibly integrated . Moreover, System /software development is tightly dependent on the IT infrastructure and process within the FTC. A methodology to build and run our IT infrastructure will complement the picture within the FTC.
In the authors opinion, other integration are possible, necessary, useful and envisaged, however would need a more detailed study and discussion. The main identified technical solutions that would allow this integration are through API (Application Programming Interface) using service oriented Architecture (SOA) . A principle view of this last implantation is shown below.

API (Application Programming Interface) is a set of rules for writing function or subroutines calls that access function in a library. Programs that use these rules function in their API calls can communicate with any others that use the API, regardless of others specifics. APIs work with a wide spectrum of application dialogues (i.e.. inter-program communication schemes) to

facilities information exchange. These include database access, client /server, peer-to-peer, real-time, event-driven, store and forward, and transaction processing.

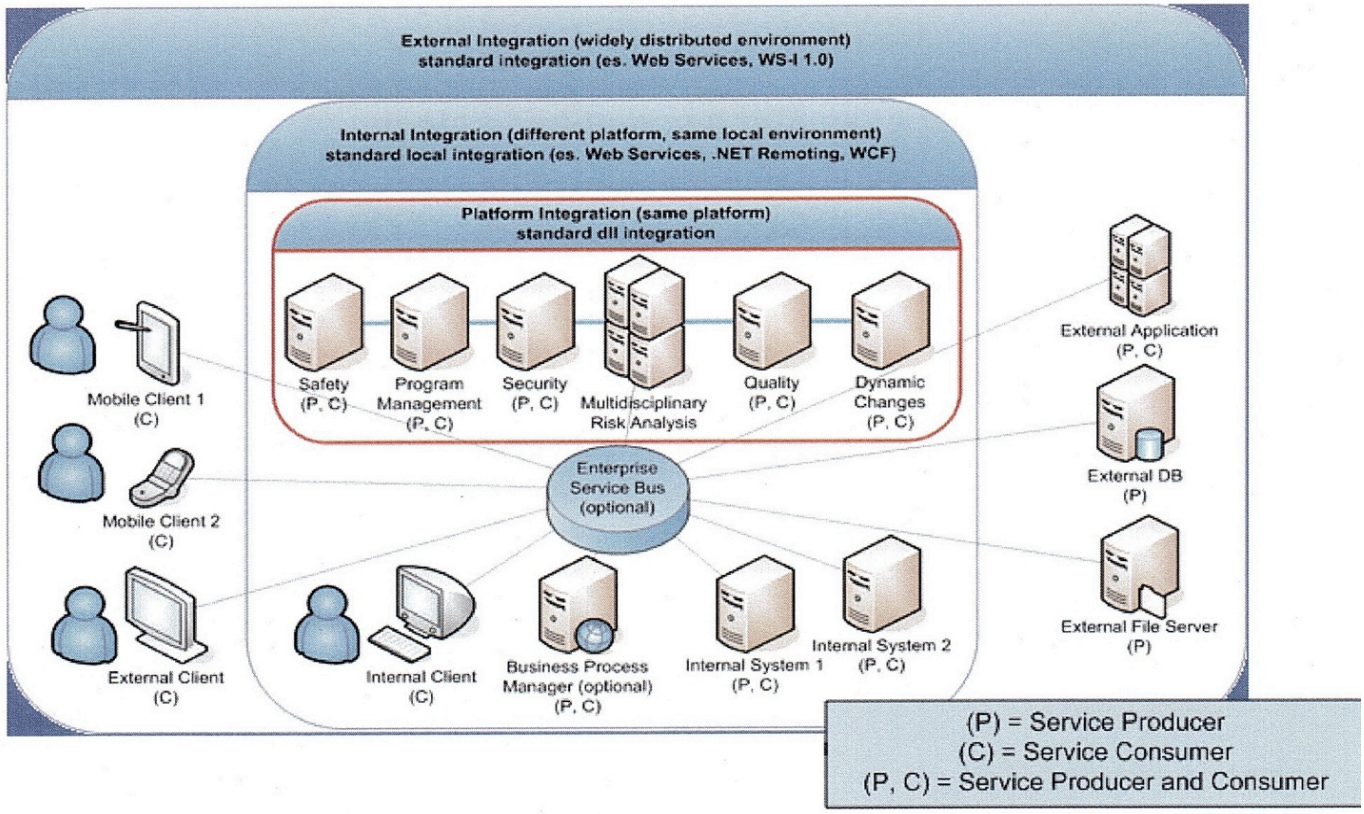

Figure 8: SOA Solution Implementation

2.6 Use Cases

The methodology and the validity of the multidisciplinary approach have been reviewed by presenting some User Cases coming from the experience of the FTC situation.
Five use cases have been prepared for the Workshop:
- Safety
- Functional Safety
- OSHA Safety
- Program Risk Management
- Security
- Information Security
- Physical Security

However, only the first use case was discussed in detail during the workshop due to the in-depth level of detail and to the constructive intervention of the audience.
The general approach to the use case definition was in sequence:
- Knowledge Base Analysis.
- Risk Analysis Creation;

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- Scenario Composition;
- First Risk Evaluation (Continue If Risk is not acceptable) ;
- New Risk Analysis Version Creation;
- New Countermeasure Definition;
- Scenario Update;
- Second Risk Evaluation (Lower Risk but continue if the risk is not acceptable yet)
- New Risk Analysis Version Creation;
- New Countermeasure Definition;
- Scenario Update;
- Third Risk Evaluation (Loop until the Risk is considered acceptable or if further countermeasures are not considerably cost –effective).

Studies performed in the frame of the CMMIQS safety program were taken as reference for the definition of the threats and the system breakdowns.

USE CASES INTRODUCTION

In the following the five user cases are introduced as they were presented during the Workshop.

Functional Safety Use Case

Functional Safety addresses all operational aspects of FTC artifacts such as flight test and data analysis.

It mainly relates to equipment's and data integrity. Functional Safety Analysis is carried out to identify hazards associated with the activates of the system under analysis while in operative mode: in the specific FTC case, main devices involved in the operations are aircrafts, navigation systems, weapons and communication systems, while data are collected by on-board and ground instruments for offline analyses on the results of the flight test.

Along the CMMIQ program, this hazard analysis and the related risk evaluation was carried out at the lowest reasonable level reaching the detail of a numerical quantification of the system breakdown and related risk. Anyway, it can be approached as well according to a higher –level (functional oriented) point of view. This approach is being presented throughout this user case since it is the ARES approach to systems description.

OSHA Safety Use Case

"Occupational Health Hazard Analysis "and "Operating and support Hazard Analysis "are both applicable to FTC and they have many common aspects and principles. In the context of the CMMIQS program, they are considered as only one analysis named Occupational Safety Hazard Analysis (OSHA) that covers both maintenance and operational aspects.

In this user case, the OSHA analysis is approached according to ARES Risk Analysis Tool Philosophy as performed for the Functional Safety User Case.

As well as for the Functional Safety User Case, the different level of system breakdown definition and threats identification, represented an interesting alternative approach compared

to the one followed in the CMMIQS program; the opportunity of carrying out this second hazard analysis was taken in great consideration also as an added value for the validation of results obtained in the CMMIQS program.

Program Risk Management Use Case

Program Risk Management involves all the artifacts within FTC, aiming at identifying and measuring the risks in projects development and implementation in the attempt to create effective risk response strategies and to deliver projects that meet stakeholder expectations.
Applying the same methodology used for other Use Case, a hypothetical project on the enhancement of the physical security of the Mirage 2000-9 Hangar had been broken down in its composing parts (Work carried out in the FTC Scenario allowed to analyze a specific situation without interfering with restricted information such FTC projects details.

Information Security Use Case

Information security means protecting information and information systems within FTC, from unauthorized access, use, disclosure, disruption, modification, or destruction. Its goal is to protect the availability, confidentiality and integrity of information. This is achieved through the identification of vulnerabilities and associated threats of the system and then, by the identification of the possible countermeasure. Vulnerabilities, threat and countermeasures are strictly linked to the system used and to the security objectives.
All details specified in this use case have been produced according to FTC and D'Appolonia team joint experience and knowledge about FTC facilities but not necessarily on the specific network configuration (save in the case of restricted areas for D'Appolonia)

Physical Security Use Case

Physical security describes countermeasures preventing or deterring attackers from accessing the FTC facility, recourses, or information kept in a physical place. It deals with prevention from unauthorized intrusion, terroristic attacks, thefts intrusion and anything else concerning the protection of borders and private property. It can be as simple as a locked door or as elaborate as multiple layers of armed guard posts or technological products such as biometric detection systems.
The system and sub-system have been detailed according to the FTC current situation, while threats, vulnerabilities and countermeasures have been listed according to general assessments and previous experience.
Specific critical situation have been analyzed. For example, the most critics are the ITR, installations being far from the Al Dhafra Base limits and being usually unmanned, representing a weakness in the FTC equipment's safety and protection.

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2.7 Detailed Analysis of the Functional Safety Use Case

As already explained at the beginning of this paragraph, during the FTC workshop, only the functional safety use cases were discussed. The discussion brought to several clarifications and details adjustment on technical and practical specifications. Thus, to be sure to provide verified and validated information, only details about the discussed use case are being provided in the following paragraphs:
The first step presented was the definition of the system, its breakdown structure, objectives, threats, vulnerabilities and countermeasures.
Being a preliminary study performed only for the sake of an example of how the D'Appolonia methodology can be applied to the specific subject, only a small part of the system FTC had been considered.

2.7.1 System Characterization

FTC is composed of several facilities, only two over all had been analyzed, and only some of the equipment /operations concerning them had been considered as assets.

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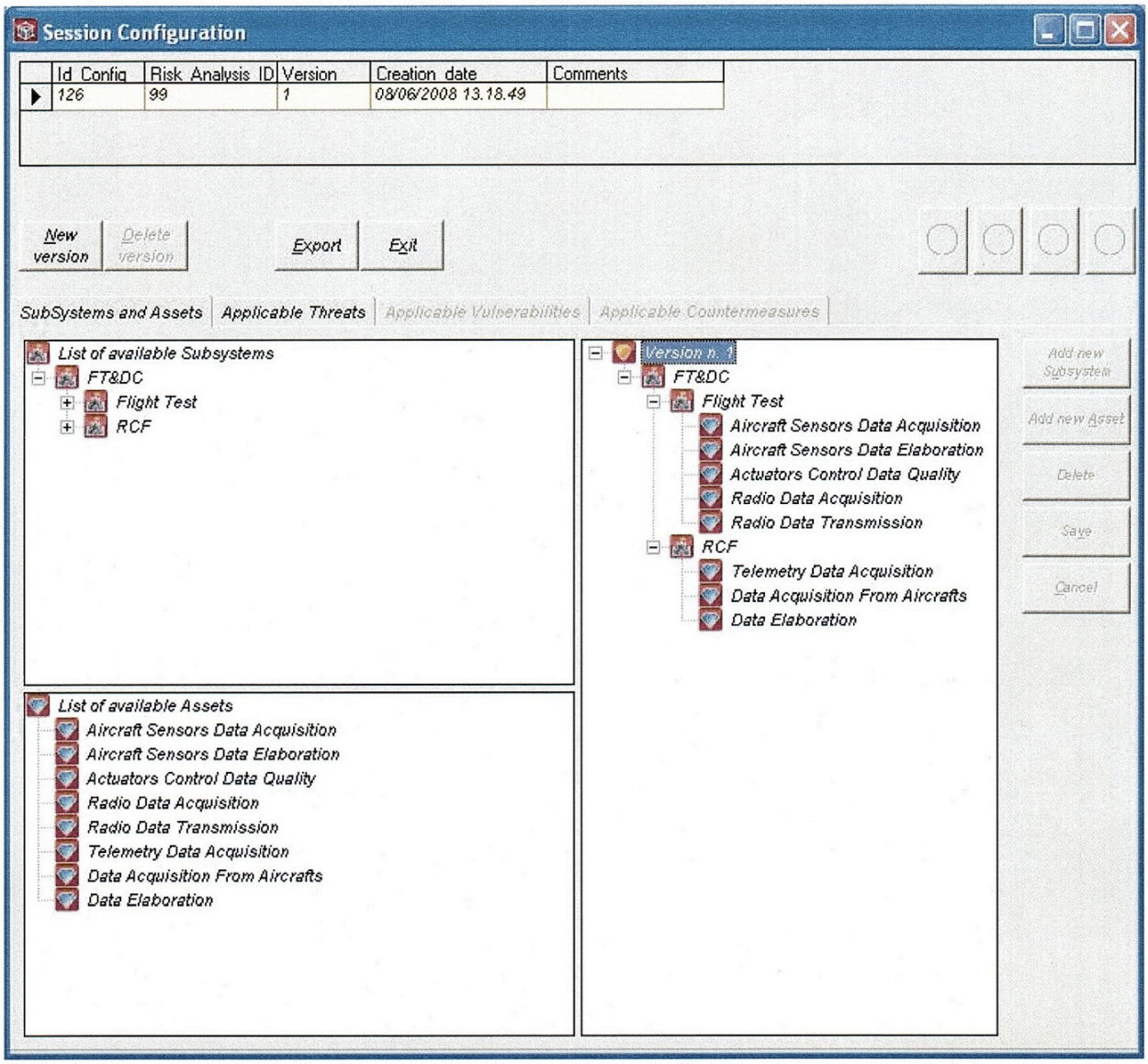

Figure 9: System Characterization

- FTC
- Flight Test
- Aircraft Sensors data acquisition
- Aircraft Sensors data elaboration
- Actuators control data quality
- Radio Data acquisition
- Radio Data Transmission
- RCF
- Telemetry Data Acquisition
- Data from aircrafts acquisition
- Data elaboration

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2.7.2 Analysis Objectives Identification

As in literature, the following step consisted in identifying Objectives, they embody the organization aims, and they have to be defended against threats that might exploit vulnerabilities of the system to harm the organization itself.

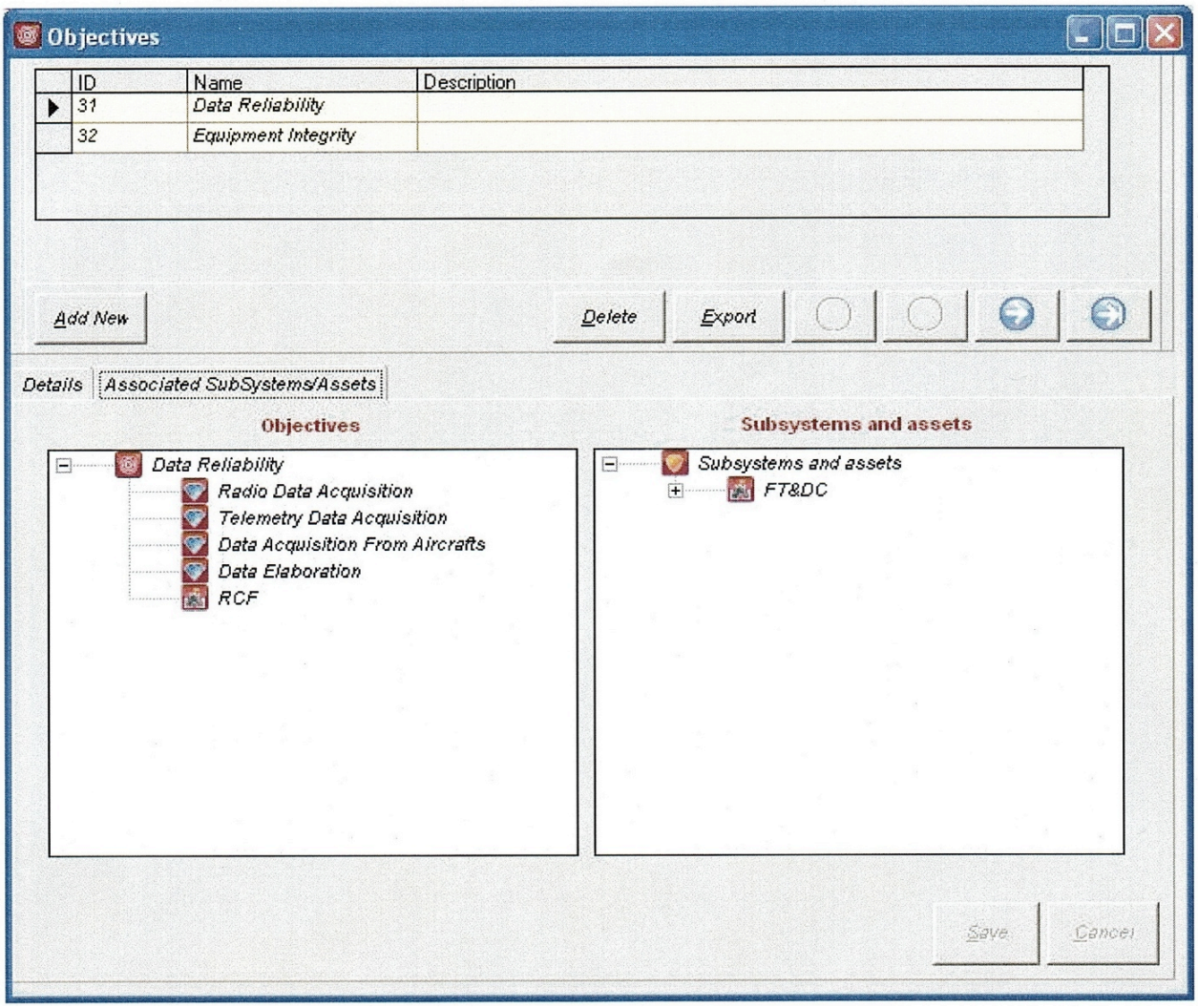

Figure 10: Analysis Objectives Identification

Typical objectives of the Functional Safety Risk Analysis are:

- Data Reliability
- Equipment's Integrity

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2.7.3 Threat Identification

As previously discussed, Threats are the potential for a threat-source to exercise (accidently trigger or intentionally exploit) a specific vulnerability.

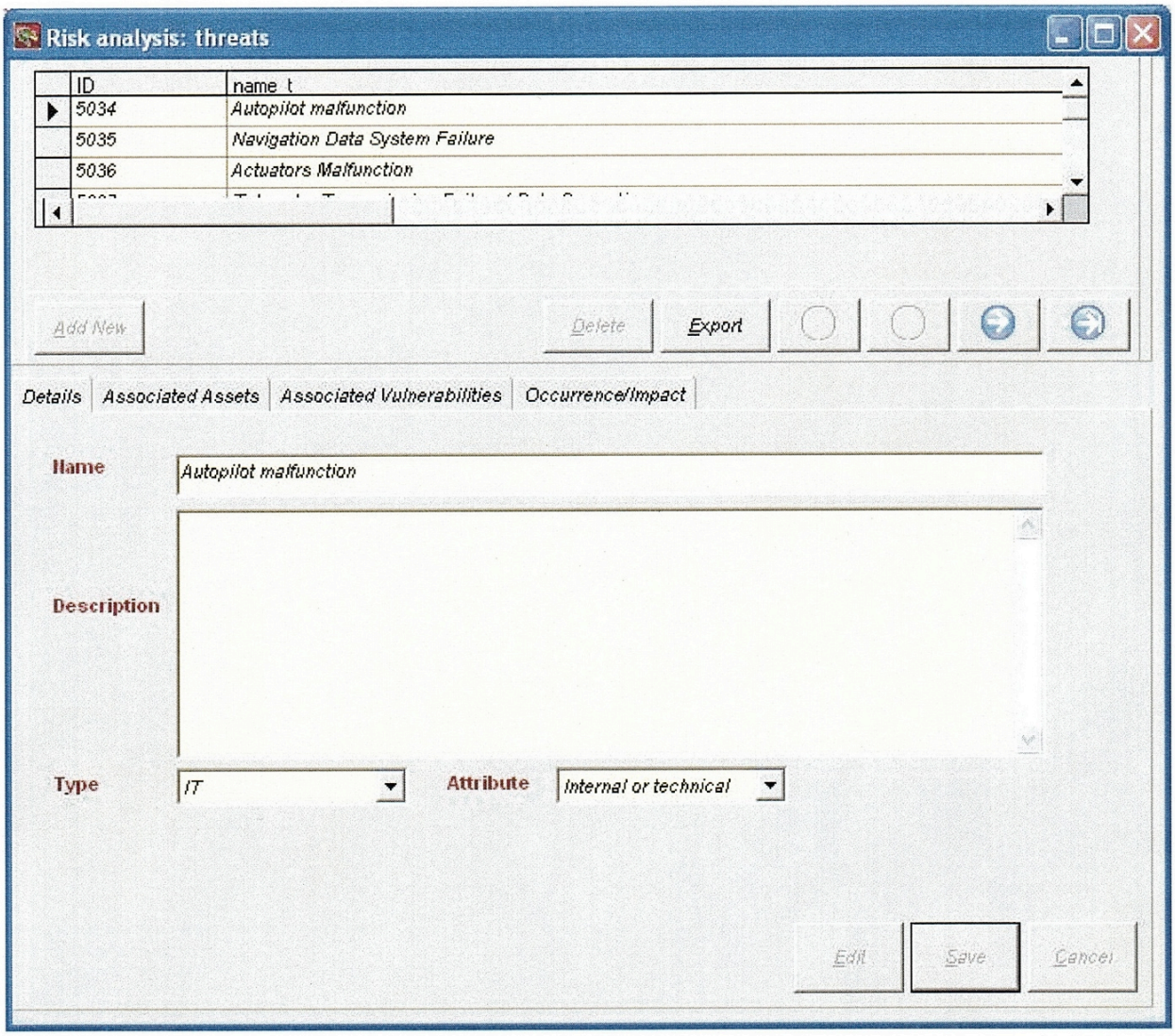

Figure 11: Threats Identification

As Threats for the specific Use Case, some of the Functional Hazards identified along the CMMIQS Program were listed:

- Autopilot Malfunction
- Navigation Data System Failure
- Actuators Malfunction
- Telemetry Transmission Failure/Data Corruption
- Radio Subsystem malfunction

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2.7.4 Vulnerabilities Identification

As previously discussed, a Vulnerability is a flaw or weakness in system procedures, design, implementation, or internal controls that could be exercised (accidently triggered or intentionally exploited) and result in a violation of the objectives.

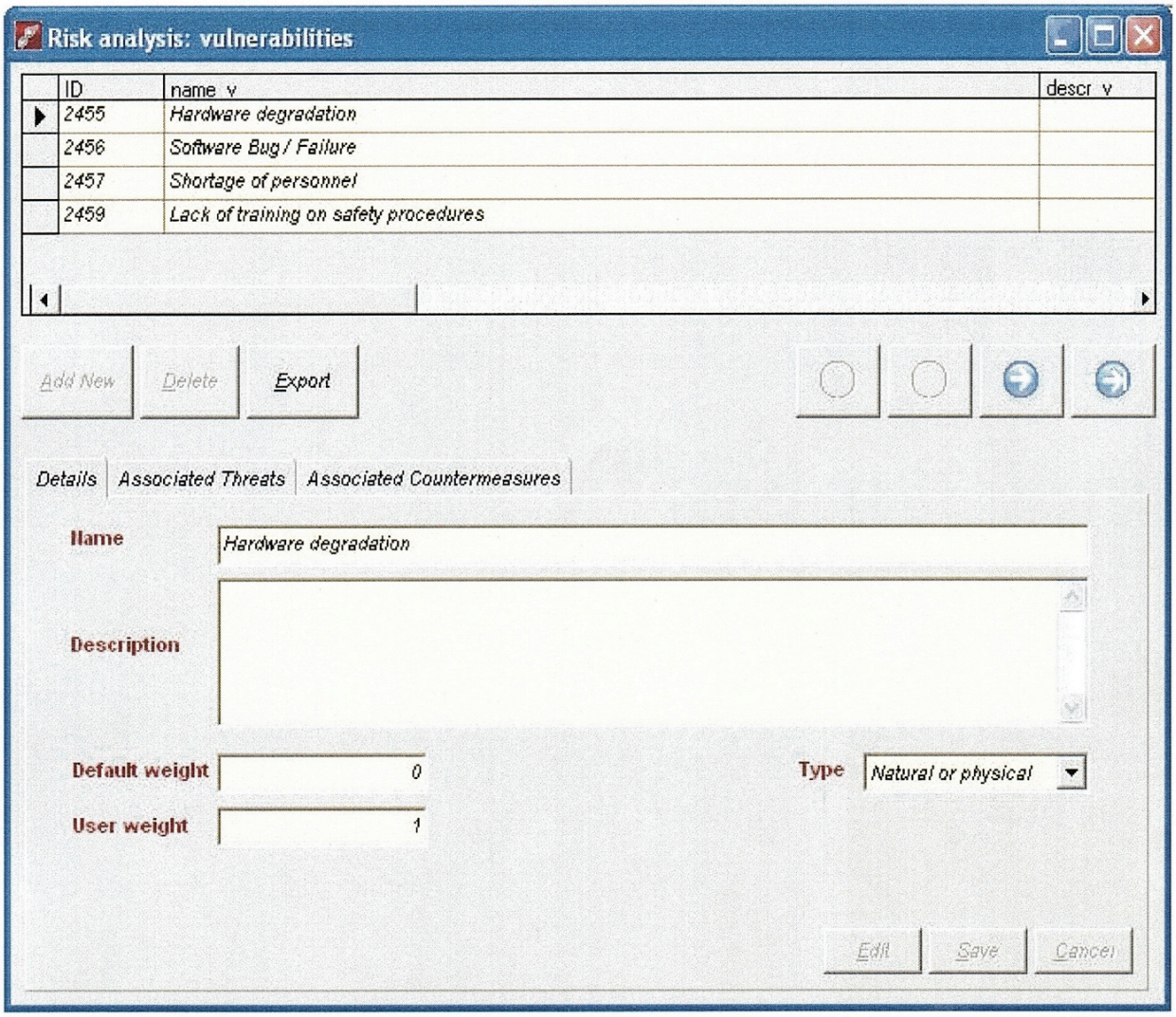

Figure 12: Vulnerabilities Identification

In this case, generic system vulnerabilities were listed:

- Hardware degradation
- Software bug/failure
- Shortage of Personnel
- Lack of Safety Signs
- Lack of training on Safety Procedures

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2.7.5 Countermeasures Identification

Countermeasures are the procedural, managerial or physical modifications of the system intended to limit the vulnerability critically reducing the risk. Thus, reduced the probability of a vulnerability to be exploited by a threat, the related assets are protected.

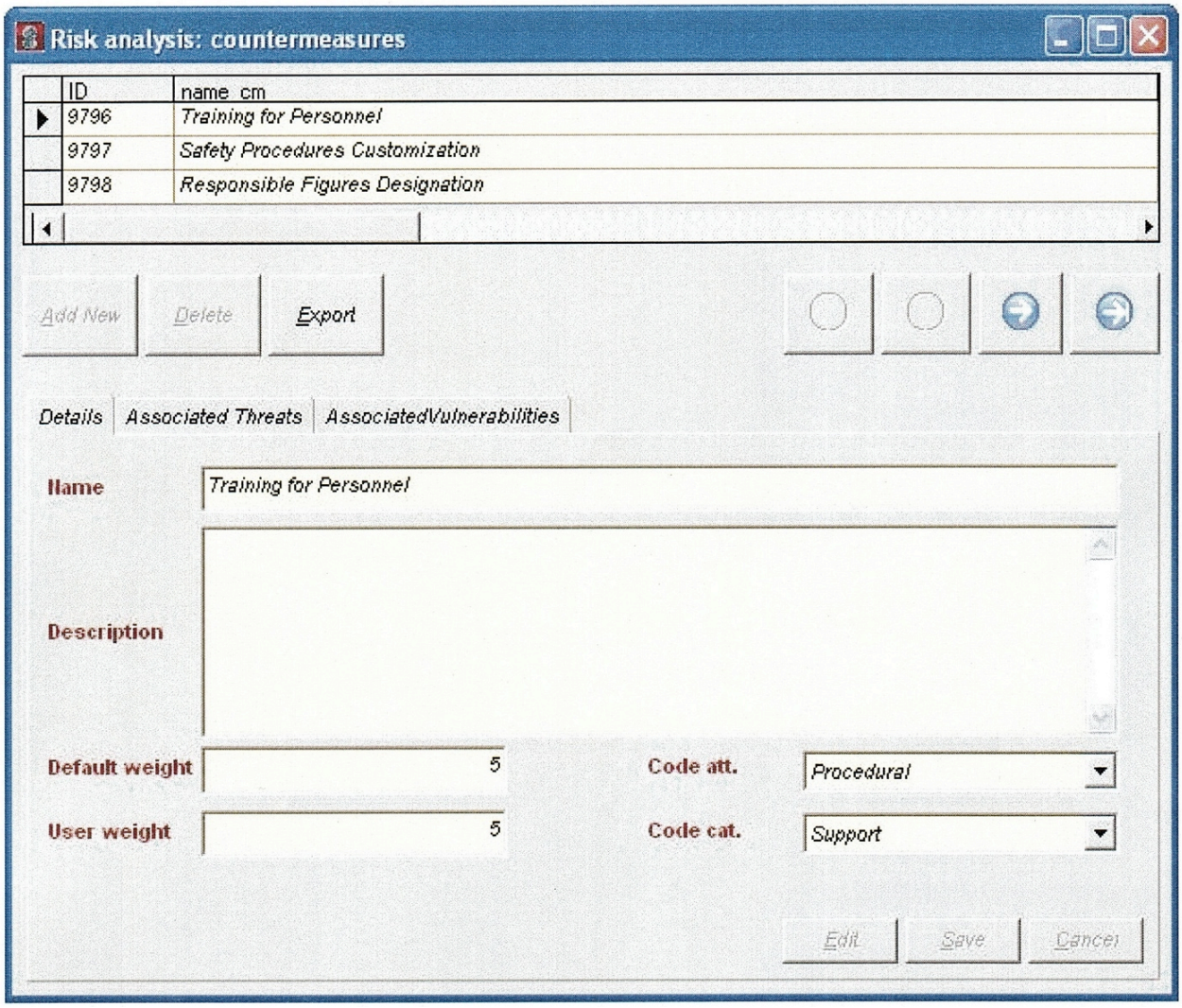

Figure 13: Countermeasures Identification

A list of countermeasures applied as hypothesis in the Use Case Risk Analysis is reported in the following:

- Software Quality Assurance (CMMI aspects)
- Maintenance/Audit Plan definition
- Training for Personnel
- Safety Procedures Customization
- Responsible Figures Designation

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2.7.6 Knowledge Base Relational Details

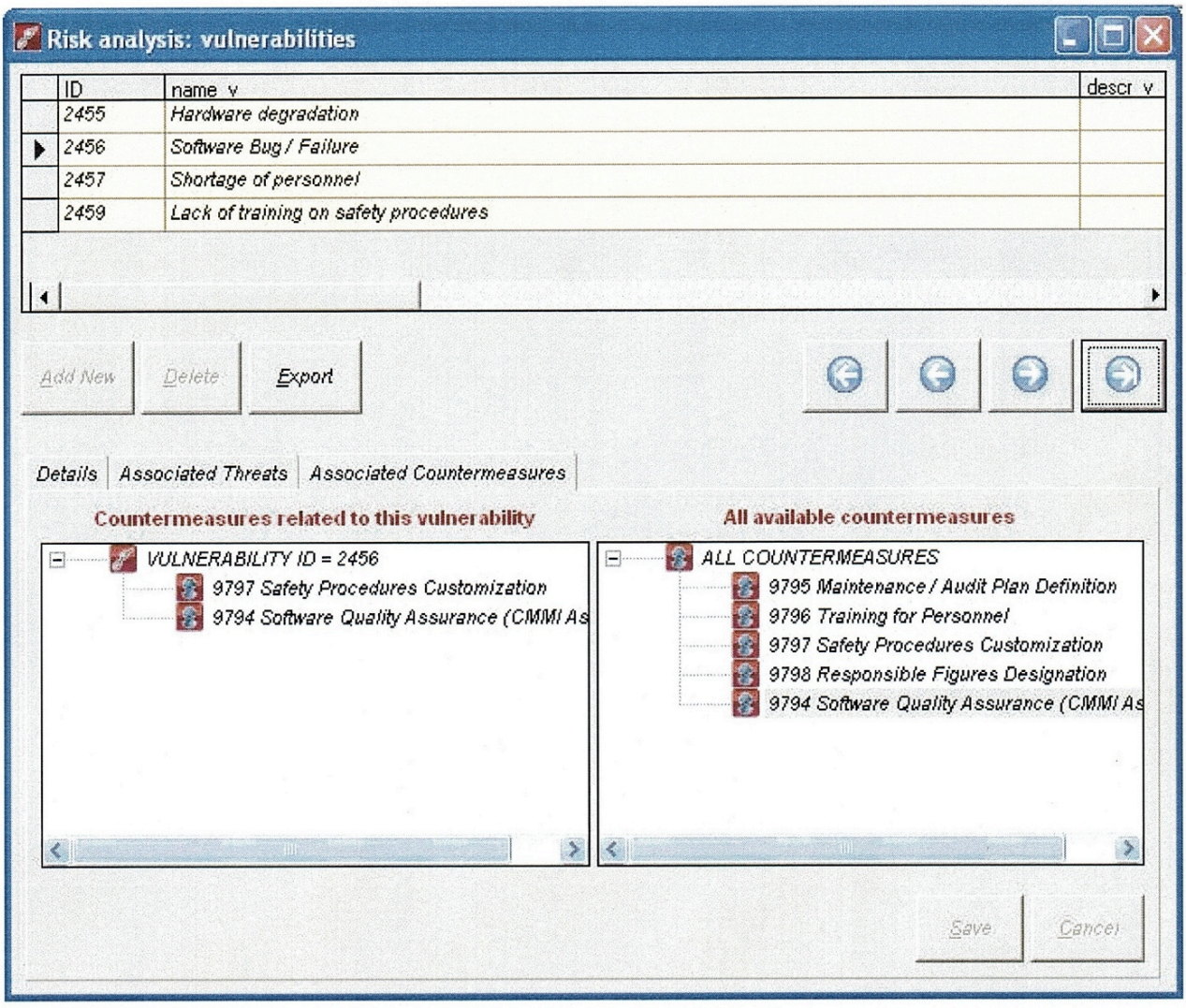

Figure 14: Threats-Vulnerabilities Association

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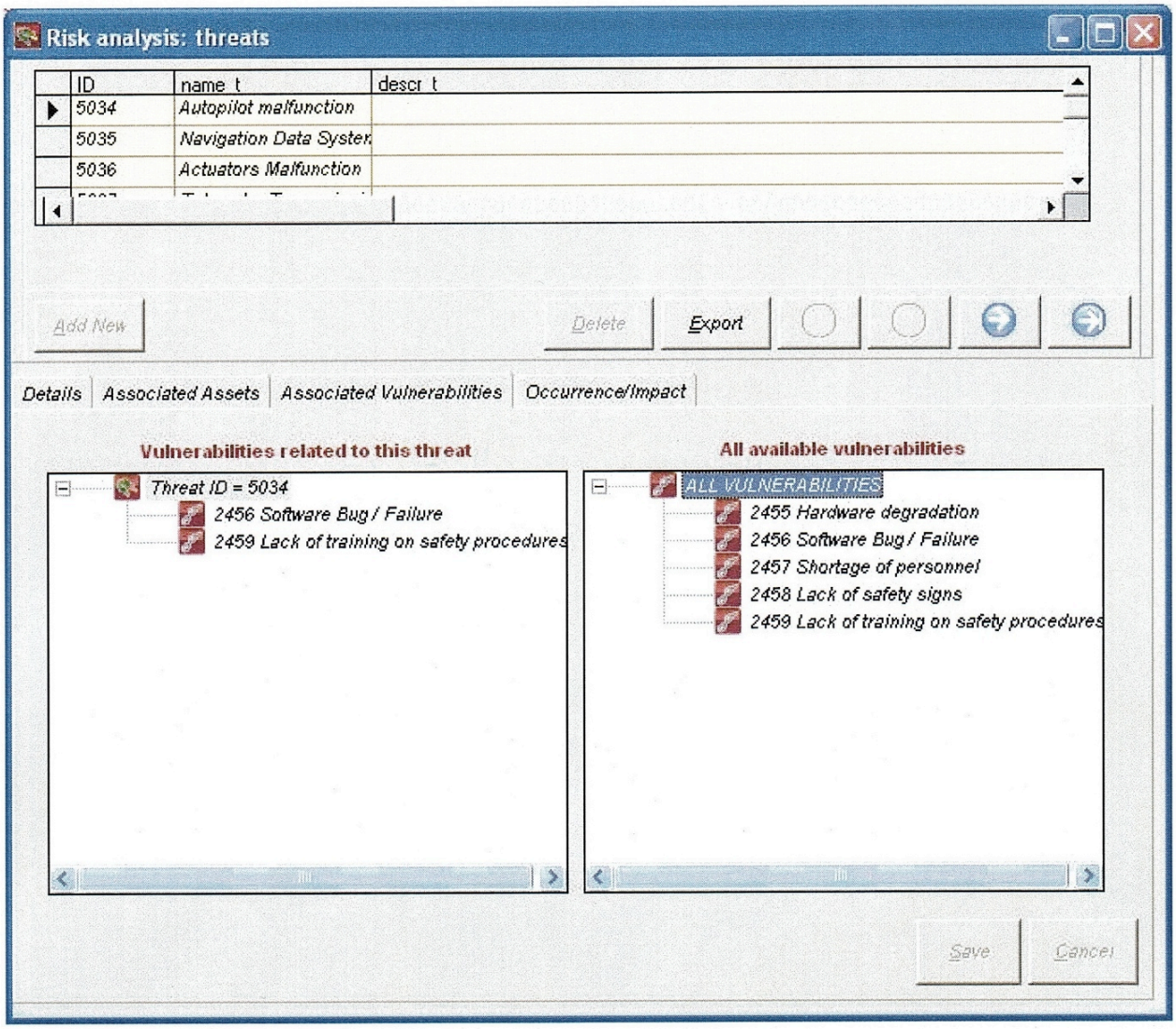

Figure 15: Vulnerabilities – Countermeasures Association

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Association Assets → Threats

In x-axis are reported identified Assets and in y-axes are reported identified Threats.

Circles represent the crossing where the association is consistent.

	Flight Test					RCF		
	Aircraft Sensors data acquisition	Aircraft Sensors data elaboration	Actuators control data quality	Radio Data acquisition (from RCF, Control Tower, other aircrafts)	Radio Data Transmission (from the aircraft to RCF, Control Tower, other aircrafts)	Telemetry Data Acquisition	Data from aircrafts acquisition	Data elaboration
Autopilot Malfunction	O	O						
Navigation Data System Failure	O			O				O
Actuators Malfunction	O	O	O					
Telemetry Transmission Failure\Data Corruption					O	O	O	O
Radio Subsystem Malfunction	O			O	O			

Table 4: Assets - Threats Association Matrix

Figure 16: Assets- Threats Association

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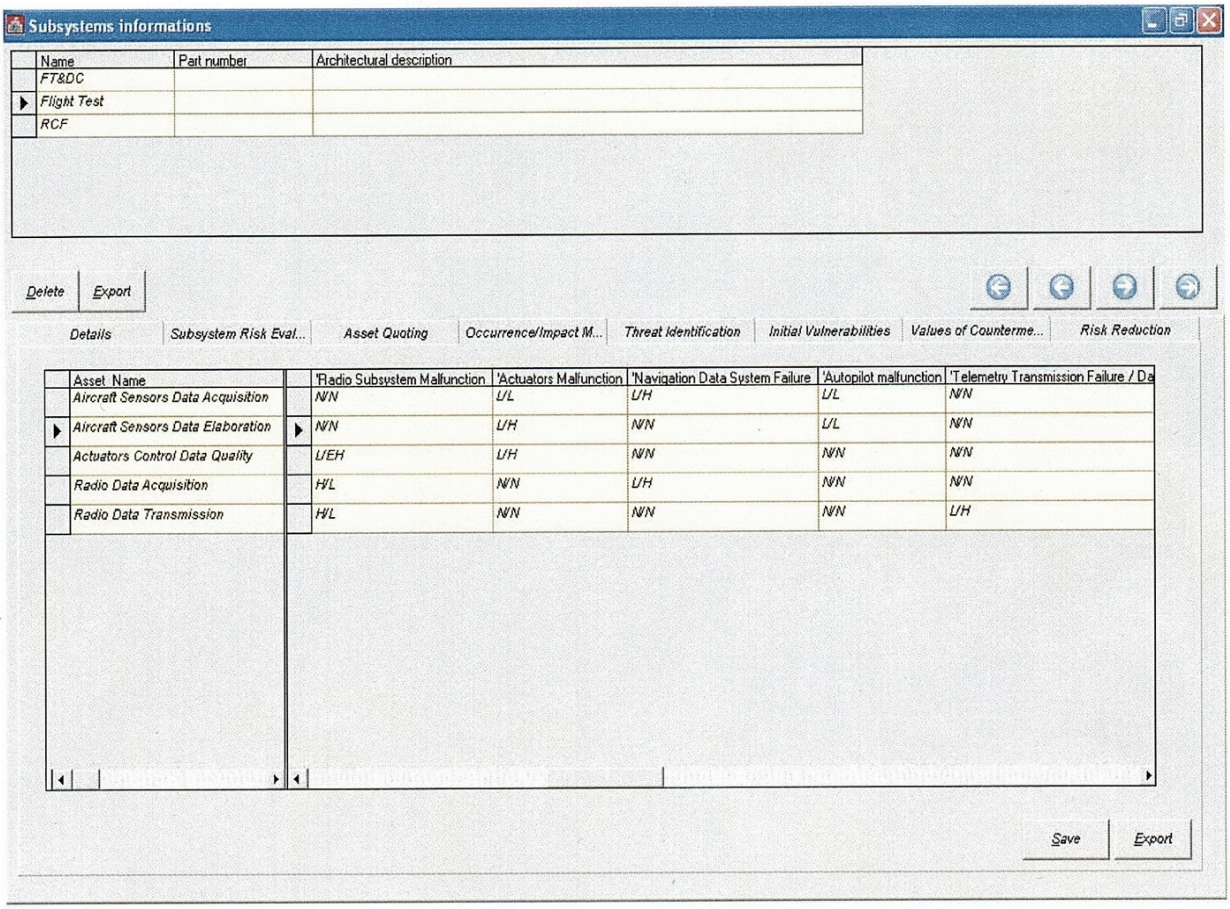

Figure 17: Occurrence Impact Matrix

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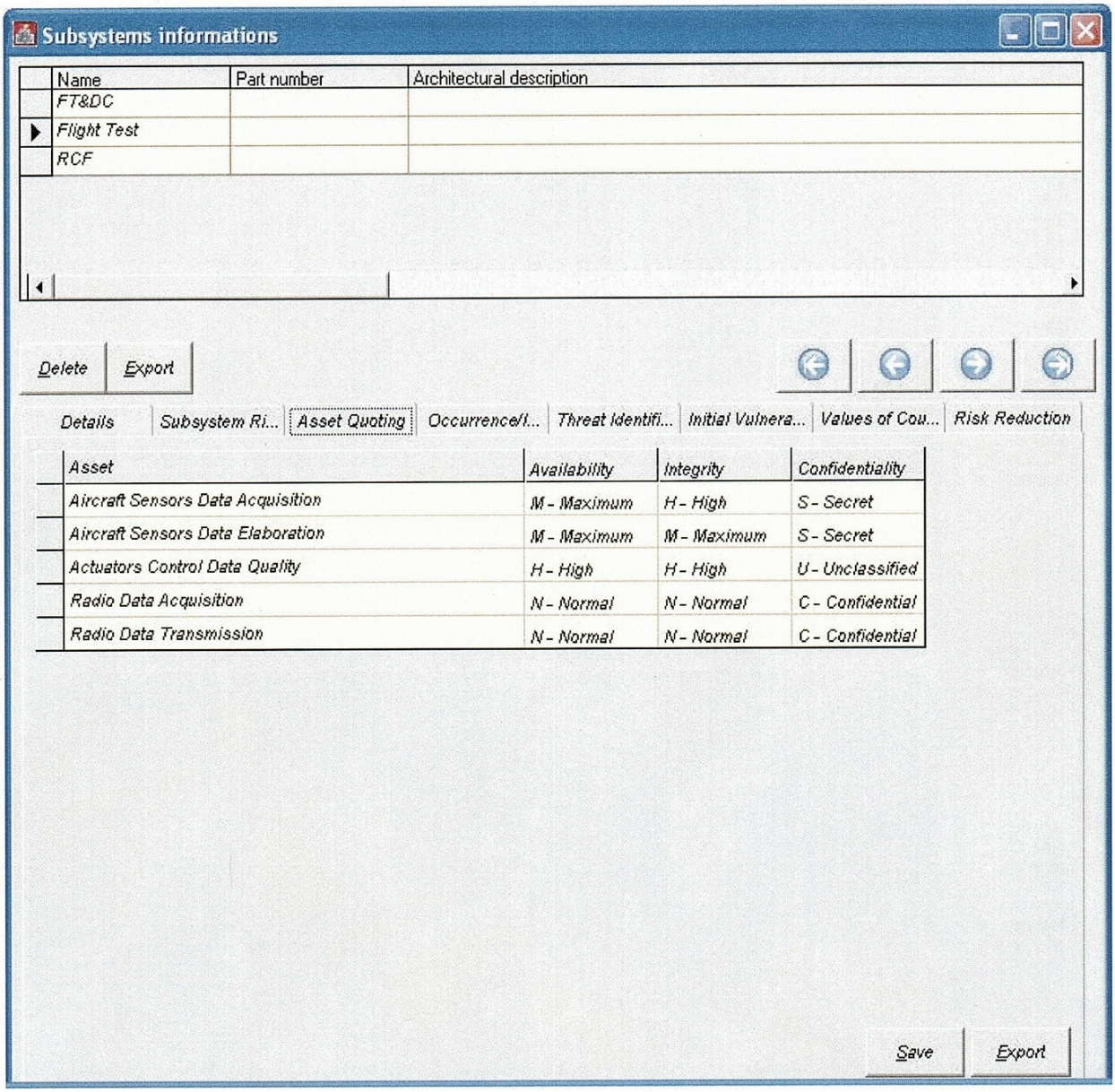

Figure 18: Occurrence - Impact Matrix

Asset / Objective	Availability	Integrity
Aircraft Sensors Data Acquisition	M - Maximum	H - High
Aircraft Sensors Data Elaboration	M - Maximum	M - Maximum
Actuators Control Data Quality	H - High	H - High
Radio Data Acquisition	N - Normal	N - Normal
Radio Data Transmission	N - Normal	N - Normal

Figure 19: Assets Quoting Matrix

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2.8 Conclusion

In conclusion, an integral Risk Analysis tool is needed in the FTC organization since there is no logical and realistic reason to consider the FTC as not vulnerable to any risk.
The availability of an integrated tool allows:
- Constant and structured monitoring;
- To make available post experiences and lessons learned;
- Save time and resources while using an automatic interfaced instrument;
- Avoid human errors in reporting data into tool;
- Limit the need for specialized personnel to a team of well-trained Risk Analyst expert in the tool usage.
- Choosing the right tool is a key point for the future satisfaction of the FTC needs for risk analysis, performance and effectiveness. Thus, generally speaking and not referring to the specific solution proposed by D'Appolonia, a customized solution is suggested as to be the best way ahead for the requirements:
- Any organization has its own specific needs ;
-Tools gain considerable added value when integrated in the overall IT framework of an organization ;
- A unique tool covering homogenously all the domains should be adopted by the organization and not several tools, avoiding the implementation a different methodology for each domain;
- An harmonized approach has to be followed;
- Synergies derived from multi-disciplinary approach should be exploited;
- Tools must be used not only for analysis but also for monitoring (integration in organization framework is a must);
- Output and reporting must be tailored according to standard and guidelines (e.g. program templates).
- Once the tool has been chosen, it has to be integrated not only in the IT framework, but in the organization itself thought its personnel. Specific needs necessitate addressing:
- Establishing a specific team for Risk Management;
- Identify a responsible figure for the organization Risk Management;
- Train people to use the tool and processes;
- Get into contact with the consultant (risk analyst) to build the functional and data integration in the complete framework;
- Establish and regularly update a knowledge base at organizational level.

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Author's Findings:

The findings of the author, resulting from an initial study, have found that each framework is suited to solving particular aspects of a problem or oriented towards a given objective. Each framework has its limitations and none of them addresses fully the integrated approach. None of the framework possesses a complete solution to address the problems faced through a complete integrated approach. However, the author has initially selected the Zachman Framework to implement Enterprise Architecture in this project. He considered the framework as having the most generic framework from which other frameworks can be derived and one which the author believes provides the flexibility to adopt it to an integrated approach to risk management. It has been identified that the Zachman Framework has limitations. Therefore for the purposes of this project we will expand the capabilities of the Zachman Framework by adding an additional axis to deal with risk management.

The case study in this paper, therefore proposes the development of a dedicated Framework specifically tailored to the FTC, in order to help understand thoroughly the risks a unit or an organization faces when outsourcing. Furthermore, we will study, evaluate and assess as to how the framework and its associated models can be utilized to manage the possible risks. It is hoped that visualization of an enterprise in terms of governance and capability will help to provide better understanding of the risks various units are exposed to, and to see new best practices methodology using models can be developed.

The prototype of the tool will be evaluated with industrial partners to provide input for improvements and to determine if the related effort of employing our approach is effective from a cost-benefit view. Future plans include the extension of the approach to provide a quantitative measurement method for calculating the risks and atomizing the causes, consequences and impacts of potential risks.

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3 CAPABILITY MATURITY MODEL (CMMI)

As part of the author's efforts in developing the path towards the "FTC - To Be", he introduced the CMMi process improvement methodology in the FTC. Below is the description of the CMMi, as well as the steps undertaken to implement it.

3.1 Introduction to CMMi

CMM (Capability Maturity Model) methodology, developed by Software Engineering Institute (SEI), was chosen firstly in the USA and then in many other countries, as a reference for evaluation and improvement of processes ((Deepa et al, 2010),(Agarwal and Lucas, 2005)). It is composed of sets of process descriptions adapted to various companies (Model) and focuses two complementary aspects:

- Capability, level of adequacy of a process with respect to the scope for which it has been defined;
- Maturity, level of reusability (consolidation) of a process within an organization.

CMMI (Capability Maturity Model for Integration) is the result of a long integration process of different models in the ambit of CMM (((Anand and Khanna, 2000),(Anderson and Narus 1990), (Argyres, 1999))). The current version of CMMI includes two basic disciplines that are Software Engineering (SW) and System Engineering (SE), incorporating product and service acquisition, Supplier Sourcing, (SS) and for the broad applicability of Integrated Product and Process Development, the IPPD. Moreover, it has been structured in order to constitute the infrastructure for future processes related to new disciplines ((Argyres and Liebeskind, 1999), (Armstrong and Overton, 1977)).

CMMI is also coherent to Total Quality Management (TQM) as it continuously stimulates process improvement (((Aron and Singh, 2003), (Aundhe,2003), (Bagozzi and Phillips, 1991))). In authors perspective, it'll support and assist the FTC when implemented mainly in:

- Identification of strengths and weaknesses of processes;
- Measurement of corrective actions effectiveness;
- Evaluation of necessary process improvement investments;

SEI developed CMMI model with the support of USA DoD, which included the contribution of world leading companies in SW Development, System Development and highly-software-embedded development((Baker, 1990), (Bensaou and Venkatraman1995)). As for the FTC, the principal reasons for introducing and implementing CMMI, are the followings:

- Support the objectives in terms of time, cost and quality;
- Apply and manage frameworks using learned lessons and guidelines;
- Increase the objectives predictability;
- Increase the objectives quality;
- Reduce time and cost of projects;
- Identify evolution stages in process improvement, creating standard benchmarks;
- Standardize management of products and services (((Borman, 2006),(Chung and Charoenwong 1998),(Daft and Lengel,1986))).

In their endeavour to introduce CMMI in to the FTC, the author undertook the initiative to establish a team within FTC, under his leadership, to conduct the following in support of the FTC:

- Analyze, define and evolve Organization processes in accordance to the objectives of FTC business;
- Establish common language and metrics due Knowledge management between FTC, companies and organizations;
- Verify, by means of objectively self-evaluation standard processes (conforming to the requirements defined in the Appraisal requirements for CMMI) the progress of a program (as-is) with its objectives (to-be).

3.2 Model Components

CMMI groups in 4 categories 22 Process Areas (PA), these include a wide range of activities related to some Disciplines.

Category	Process Area
Process Management	Organizational Process Focus
	Organizational Process Definition + IPPD
	Organizational Training
	Organizational Process Performance
	Organizational Innovation and Deployment
Project Management	Project Planning
	Project Monitoring and Control
	Supplier Agreement Management
	Integrated Project Management + IPPD
	Risk Management
	Quantitative Project Management
Engineering	Requirements Management
	Requirements Development
	Technical Solution
	Product Integration

	Verification
	Validation
Support	Causal Analysis and Resolution
	Configuration Management
	Process and Product Quality Assurance
	Measurement and Analysis
	Decision Analysis and Resolution

Table 5: Model components

For each PA is provided a unique structure, composed of:

- Goals that can be of two type:

1) **Specific Goals**:
   A specific goal describes the unique characteristics that must be present to satisfy the process area. A specific goal is a required model component and is used in appraisals to help determine whether a process area is satisfied;
   Generic Goals:
   The same goal statement is applied to multiple process areas. A generic goal describes the characteristics that must be present to institutionalize the processes that implement a process area. A generic goal is a required model component and is used in appraisals to determine whether a process area is satisfied.

- Practices to perform, that can be:

2) **Specific Practices**:
   A specific practice is the description of an activity that is considered important in achieving the associated specific goal. The specific practices describe the activities that are expected to result in achievement of the specific goals of a process area. A specific practice is an expected model component.

- **Generic Practices**:
  Generic practices are called “generic” because the same practice applies to multiple process areas. A generic practice is the description of an activity that is considered important in achieving the associated generic goal. A generic practice is an expected model component.
- Capability levels to achieve in PA.
  Goals and practices specify requirements (what to do) while the methods (how to do) are responsibility of the Organization that is implementing the process improvement (((Davenport and Short, 1990),(Dibbern et al, 2004), Dyer and Singh, 1998))).
  The figure that follows depicts the relations between the components of the model.

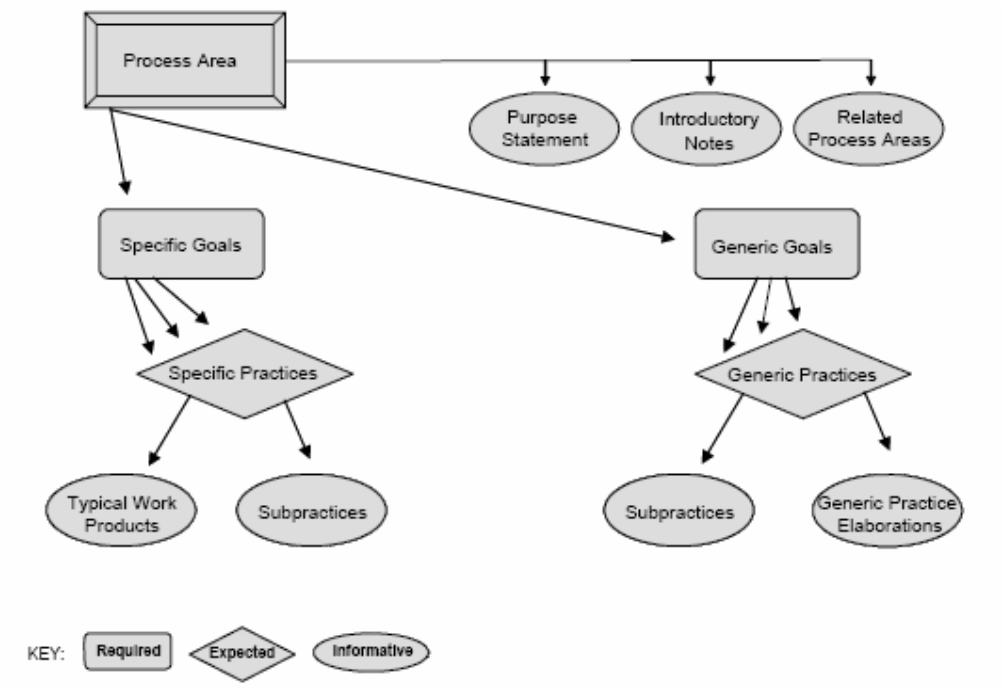

Figure 20: Model components relationship

3.3 Model Representation

The CMMI Model foresees two different representations finalized to process improvement for the achievement of business objectives (Fehr and Gachter, 2000).
The *continuous* representation is oriented to capability improvement in single PA, chosen depending upon the objectives of the Organization ((Fitzgerald and Willcocks, 1994), (Baets and Nijenrode, 1973))
The *staged* representation aims to evolution of the Organization *maturity*, depending upon the improvement in predefined PA to achieve in subsequent steps (Gardner and Cooper, 1988), (Ghoshal and Moran, 1996), (Grover et al, 1996).
These two approaches are based on the same *bestpractice* model and are not mutually exclusive.
When is chosen the continuous approach, the capability of various process areas has implications on organizational maturity, and when is chosen the staged approach, the organizational maturity has implications on the maturity of process areas (Geanakoplos, 1992).
Process improvement is the driving force, and process improvement does not happen for its own sake (Gulati et al, 2005). Every organization must focus on its own business objectives and vision. It must determine where problems or process weaknesses are and, based on these, must determine the path to process improvement. When is looked at business objectives and is known what the model content is, it is possible then to start thinking about what are the needs to do to address business issues. This is not thinking continuous or staged . Simply do process

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improvement to satisfy business issues, and to do this a mixed approach *continuous/staged* (*constagedeous*) can be used (Gulat and Nickerson,2006),(CMMISM Product Development Team. CMMISM for Systems Engineering, 2001), (Deming, 2004),Humphrey, (1990).

3.4 Capability Levels

CMMI has 6 capability levels for single processes:

5	Optimizing
4	Quantitatively Managed
3	Defined
2	Managed
1	Performed
0	Incomplete

Table 6: Capability levels

Capability levels, which belong to a continuous representation, apply to an organization's process improvement achievement in individual process areas. These levels are a means for incrementally improving the processes corresponding to a given process area ((ISO=IEC15939 , 2000),(Juran, 1988)).

3.5 Maturity Levels

CMMI contains 5 maturity levels for process categories:

5	Optimizing
4	Quantitatively Managed
3	Defined
2	Managed
1	Initial

Table 7: Maturity levels

Maturity levels, which belong to a staged representation, apply to an organization's process improvement achievement across multiple process areas. These levels are a means of predicting the general outcomes of the next project undertaken.

The table below shows the process areas which characterize each Maturity level.

Level	Focus	Process Area
5 Optimizing	Continuous Process Improvement	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	Quantitative management	Organizational Process Performance Quantitative Project Management
3 Defined	Process Standardization	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition + IPPD Organizational Training Integrated Project Management + IPPD Risk Management Decision Analysis and Resolution
2 Managed	Basic project management	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		

Table 8: Process areas for maturity levels

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The following figure depicts the 5 maturity levels of the Staged Model.

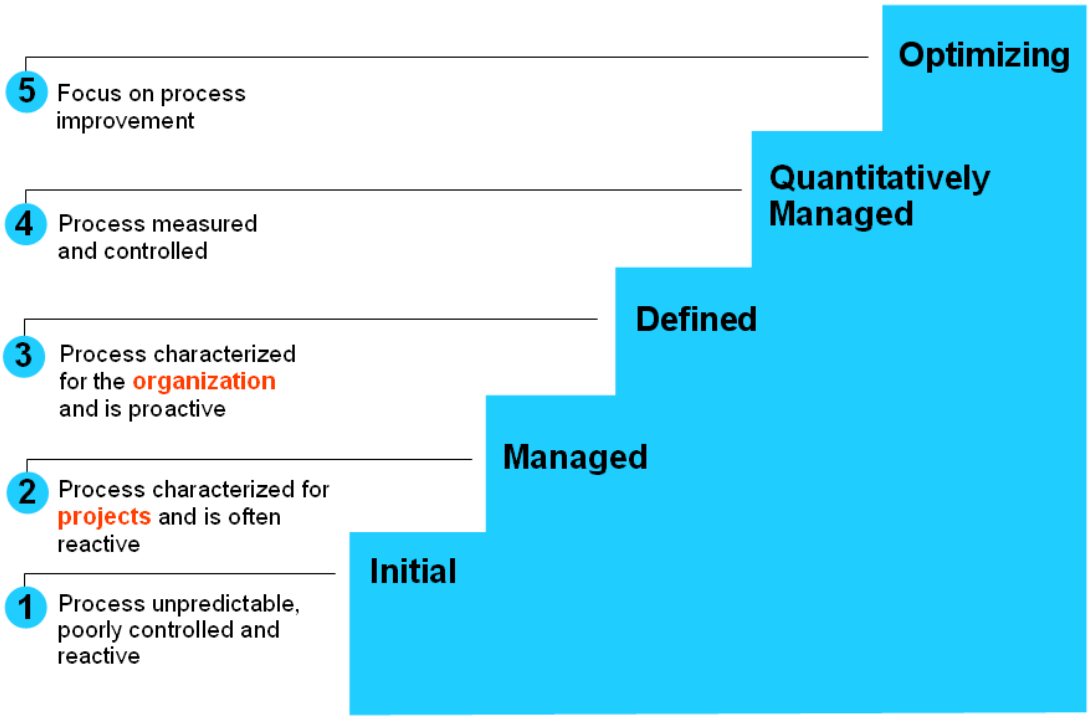

Figure 21: The 5 levels of maturity in the staged model

3.6 Process Improvement Life Cycle

In the implementation process in the FTC, the author considered that the suitable way to apply the CMMI model practices for Process Improvement life cycle is by using the IDEAL model with its five phases (Initiating, Diagnosing, Establishing, Acting and Learning)

For the author, the IDEAL model, with its recursive 5 phases, provides a usable, understandable approach to continuous improvement by outlining the steps necessary to establish a successful improvement program and establishes the foundation for a long-term improvement strategy. Following the phases and principles of the IDEAL model with a program based on the implementation of the practices as they are described in each CMMI key process area has proven beneficial in many improvement efforts in FTC and enables an FTC to reach the maturity level proper for its needs (Paulk et al,1995), (U.S.EPA. EPA, 2001), (Zubrow, 2001),(Mills,2001))))

The following figure describes the activities of the IDEAL model.

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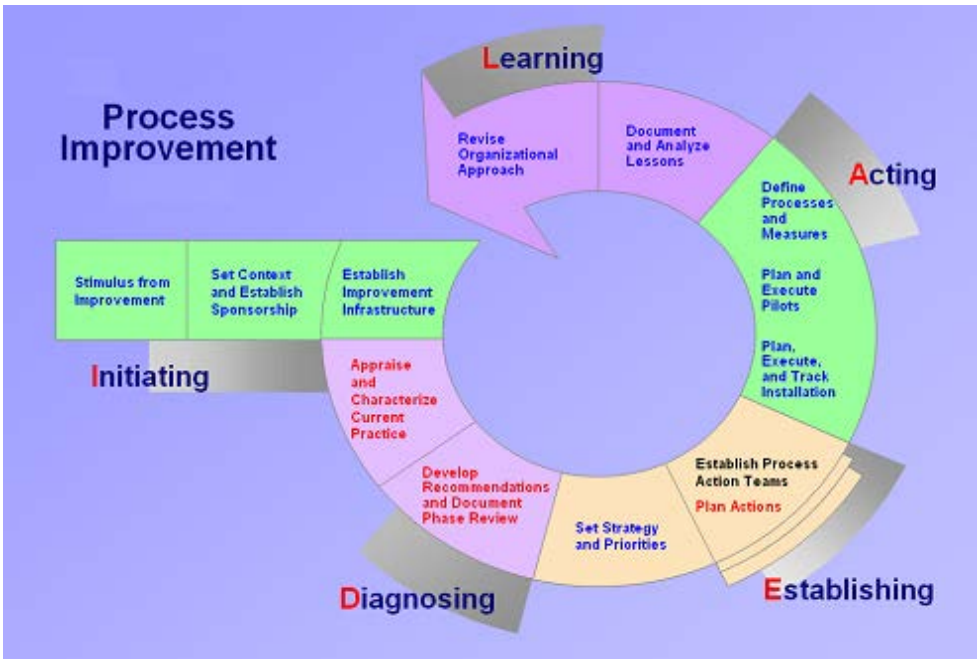

Figure 22: IDEAL Model Figure

IDEAL Phases			**CMMI Support**
I	**Initiating**	Laying the groundwork for a successful improvement effort	CMMI models assisted FTC in understanding how to build sponsorship and in developing the infrastructure for improvement
D	**Diagnosing**	Determining where you are relative to where you want to be	The "Standard CMMI Appraisal Methodology for Process Improvement" (SCAMPI)" has provided in the FTC, a yardstick for appraising processes based on CMMI.
E	**Establishing**	Planning the specifics of how you will reach your destination	CMMI process areas focus the FTC process improvement teams
A	**Acting**	Doing the work according to the plan	CMMI models provide guidance for defining or improving processes in FTC.
L	**Learning**	Learning from the experience and improving your ability to adopt new technologies in the future	Lessons learned in all FTC activities, are documented and are the basis for revision of an organizational approach within FTC.

Table 9: IDEAL Model activities

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The author considers the above stages, are critical to the FTC, both in terms of identifying and managing risks, and its consequent success. Initially, the FTC is in the "Ad-Hoc" stage. This in itself, contains numerous risks as everything is adhoc and unstructured. The second stage, in my opinion, is the learning stage, with a lot of human resistance – "a resistance to change" - bringing awareness to the FTC engineers and technicians. This is an important stage, as it demonstrates value, even though it is only limited to a project base. Stage 3 combines the whole organization, at a larger scale. Hierarchy support, in this case the HQ UAEAF&AD, is essential, as a project is necessary to pass this level.

Under the author's guidance and authority, the FTC were engaged in the following activities:

Scampi appraisal methods

CMMI provides also methods for doing the appraisal process.

Regarding the Appraisal, SEI has defined in the ambit of CMMI, 3 "classes" of self-evaluation (Appraisal):

Class A

It lasts from 7 to 15 days, depending on the number of PA, projects, disciplines involved and dimension of the Organization;

The Appraisal team composition is 50% of the Organization;

It is conducted by an authorized SEI Lead Appraiser;

It assigns Maturity levels (or a Capability profile) and produces a report to be notified to SEI, which can be published at discretion of the Organization.

Class B

It uses the structure defined for Class A but is less formal;

It lasts from 5 to 10 days;

The Appraisal team can be supported by the Organization;

It produces a report that constitutes the base for the improvement plan.

Class C

It is addressed to a quick analysis over a single project;

It lasts typically 1 or 2 days;

It can be based upon a unique interview by the appraiser or project manager.

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) provides precise indications on objective evidence judgment due practices: it is required to have evidenced and documented at least a single *Direct Artifact* and single *Indirect Artifact* and that these be confirmed by an *affirmation* during the interview.

CMMI provides also training support. In particular the following courses were conducted at the FTC:

"Introduction to CMMI®, Ver. 1.2", Carnegie Mellon, Software Engineering Institute

"Standard CMMI Appraisal Method for Process Improvement (SCAMPI)",

Training of the Appraisal Team, Carnegie Mellon, Software Engineering Institute.

4 A Comparison of the Top Four Enterprise-Architecture Methodologies

The author has conducted numerous research on Enterprise Architecture frameworks. Many papers and books around the subject exist (see References). The author has reflected, analyzed and came up with his findings deriving from a paper published by Roger Sessions from ObjectWatch, Inc. in May 2007 (http://msdn.microsoft.com/en-us/library/bb466232.aspx), which provided a brief history of Enterprise Architecture, a case study and four renowned frameworks.
According to Roger Sessions, more than two decades ago, enterprise architecture started appearing as a new domain, or discipline which addressed two problems:

- **System complexity**—Organizations were spending more and more money building IT systems; and
- **Poor business alignment**—Organizations were finding it more and more difficult to keep those increasingly expensive IT systems aligned with business need.

In the authors experience, the above two elements are of considerable importance and remain very challenging fort he FTC. The use of IT structure and its alignement with both engineering and business processes are fundamental to build a cohesive FTC enterprise.
Fort he FTC, the basic objective will be to counter the two main issues: more cost and less value. These two challenges are increasingly reaching crisis levels with potentially higher risks. The cost and complexity of IT systems continue to rise, while the possibilities of creating or obtaining real value from existing systems have widely decreased.

Actual/present situation show us that the costs have increased even more, yielding lesser value. Consequently, organizations are not anymore able to ignore these facts. The subject of enterprise architecture that two decades ago seemed quaintly unrealistic today seems impressively realistic.
Although numerous enterprise architecture methodologies have appeared and disappeared in the last two decades. Today, it is most probable that more than 90 percent of the enterprise architecture users utilize one of these four methodologies:

- The Zachman Framework for Enterprise Architectures—Although self-described as a *framework*, is actually more accurately defined as a *taxonomy*
- The Open Group Architectural Framework (TOGAF)—Although called a *framework*, is actually more accurately defined as a *process*
- The Federal Enterprise Architecture—Can be viewed as either an *implemented enterprise architecture* or a *proscriptive methodology* for creating an enterprise architecture
- The Gartner Methodology—Can be best described as an *enterprise architectural practice*

The white paper by Roger Sessions discusses these four approaches to enterprise architecture. It does so within the context of a fictional company that is facing some very nonfictional operations problems which include:

- IT systems that have become unmanageably complex and increasingly costly to maintain.
- IT systems that are hindering the organization's ability to respond to current, and future, market conditions in a timely and cost-effective manner.
- Mission-critical information that is consistently out-of-date and/or just plain wrong.
- A culture of distrust between the business and technology sides of the organization.

How should this company choose from among these four very different approaches to enterprise architecture? The white paper by Roger Sessions traces the pathway an organization is likely to encounter in using any one of these methodologies.
When exploring each of these methodologies in depth, one discovers the fact that none of these methodologies is all encompassing or comprehensive. Every one of them has weaknesses in some areas and strengths in others.
In various organizations, none of these methodologies will hence provide a comprehensive solution. For such organizations, the white paper by Roger Sessions proposes a different approach, one that he described as a *blended methodology*. Choosing parts from each of these methodologies, modifying and merging them according to the specific needs of your organization. This white paper provides a recommendation to developing such a blended methodology that best meets your organization's needs.
However, even a blended methodology will only be as good as an enterprise commitment to bring about changes. This commitment must be driven by the higher management in your organization. With a strong willingness and commitment to change, combined with a customized methodology for supporting and guiding that change, a goal to a reduced enterprise cost with increased business value is now potentially within reach, which in turn, will improve your competitiveness in the global market.
To facilitate the reader’s understanding, the author decided to insert the following paragraphs from Roger Sessions‘ paper, providing a chronological step on the subject matter towards the author’s findings and conclusions at the end.

4.1 Introduction

The year 2007 marks the 20-year anniversary of enterprise architecture. In that time, a number of enterprise-architectural methodologies have come and gone. Today, four dominate the field: the Zachman Framework for Enterprise Architectures, The Open Group Architecture Framework (TOGAF), the Federal Enterprise Architecture (FEA), and Gartner (formerly, the Meta Framework).
Should you care about a field that is 20 years old? It depends. This field was inaugurated to address two major problems in information technology (IT) that were then already becoming apparent. The first problem was managing the increasing complexity of information-technology systems. The second problem was the increasing difficulty in delivering real business value with those systems.
As you can imagine, these problems are related. The more complex a system, the less likely it is that it will deliver maximum business value. As you better manage complexity, you improve your chances of delivering real business value.
So, should you care about this field? It depends on how you feel about positively affecting your organization's bottom line. If managing system complexity and delivering business value are key priorities for you, you should care about enterprise-architecture methodologies. If you are focused on maintaining, or rebuilding, IT's credibility in your organization, or if you strive to promote the use of IT to maintain a competitive position in your industry, you should continue reading this white paper. If these issues don't concern you, these methodologies have little to offer.
As systems become more complex, they generally require more planning. It is easy to see this in buildings. When Henry David Thoreau built his little cabin on Walden Pond (shown in Figure 22), he embraced simplicity and needed no architects. If you are building New York City (shown in Figure 23), simplicity is out of the question, and you will need many architects.



Figure 23: Thoreau's cabin at Walden Pond, as drawn by Thoreau's sister, Sophia Thoreau



Figure 24: A Map of New York City

The author agrees with the analagy in the paper by Roger Sessions. The complexities facing large and medium size organizations are real challenges. As always, „how or where do we start“ remains the real question, in building a sustainable and dynamic organization.

The relationship between complexity and planning for buildings and cities is similar for information systems. If you are building a simple, single-user, nondistributed system, you might need no architects at all. If you are building an enterprise-wide, mission critical, highly distributed system, you might need a database architect, a solutions architect, an infrastructure architect, a business architect, and an enterprise architect.

This paper is about the methodologies needed to develop the overall architectural vision for an organization. This is the responsibility of the *enterprise architect*. This is the architect who specializes in the broadest possible view of architecture within the enterprise. This is the architect's architect, the architect who is responsible for coordinating the work of all of the

other architects. Do you need such an architect? It all depends on what you are building: Thoreau's cabin or New York City.

Building a large, complex, enterprise-wide information system without an enterprise architect is like trying to build a city without a city planner. Can you build a city without a city planner? Probably. Would you want to live in such a city? Probably not.

Of course, hiring a city planner; it merely improves your chances. Similarly, having an enterprise architect does not guarantee a successful enterprise architecture. There are many examples of failed enterprise architectures in the world today, and all of them had enterprise architects (probably dozens). Architectural methodologies can help, but they go only so far. I'll discuss some of the reasons for these failures, and how to avoid them, also in this paper.

Before I get too far into comparing the methodologies that make up the enterprise architect's toolkit, I need to define some terms. This is especially important in an article that is comparing methodologies, because the different methodologies sometimes use similar terms to mean different things.

For example, we have two methodologies that describe themselves as enterprise-architectural frameworks: the Zachman Framework for Enterprise Architectures and The Open Group Architectural Framework (TOGAF). Yet these two methodologies share little in common other than the words *enterprise*, *architecture*, and *framework*.

So, I will start by defining the terms as I will use them in this case study / paper. Those definitions marked with an asterisk (*) are taken mostly from IEEE-1471-2000 [01], whose definitions I use where they exist and make sense.

architect—One whose responsibility is the design of an architecture and the creation of an architectural description

architectural artifact—A specific document, report, analysis, model, or other tangible that contributes to an architectural description

architectural description*—A collection of products (artifacts) to document an architecture

architectural framework—A skeletal structure that defines suggested architectural artifacts, describes how those artifacts are related to each other, and provides generic definitions for what those artifacts might look like

architectural methodology—A generic term that can describe any structured approach to solving some or all of the problems related to architecture

architectural process—A defined series of actions directed to the goal of producing either an architecture or an architectural description

architectural taxonomy—A methodology for organizing and categorizing architectural artifacts

architecture*—The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution

enterprise architecture—An architecture in which the system in question is the whole enterprise, especially the business processes, technologies, and information systems of the enterprise

Now that we have a common understanding of these key terms, I can take you through the history of enterprise-architecture methodologies, discuss the problems these methodologies are trying to solve, and compare the top four methodologies in terms of their approach and their relationship to each other.

In most of our organizations today, „terminology“ acknowledging the contracdictions and misunderstanding or misinterpretation of vocabularies is what the author calls „the unpurpose tabou“. In the authors opinion, this tabou is mainly due to a lack of a unified and common processes: key to a common vocabulary.

4.2 A Brief History of Enterprise Architecture

The field of enterprise architecture esssentially started in 1987, with the publication in the *IBM Systems Journal* of an article titled "A Framework for Information Systems Architecture," by J.A. Zachman. In that paper, Zachman laid out both the challenge and the vision of enterprise architectures that would guide the field for the next 20 years. The challenge was to manage the complexity of increasingly distributed systems. As Zachman said:

The cost involved and the success of the business depending increasingly on its information systems require a disciplined approach to the management of those systems. [02]

Zachman's vision was that business value and agility could best be realized by a holistic approach to systems architecture that explicitly looked at every important issue from every important perspective. His multiperspective approach to architecting systems is what Zachman originally described as an *information systems architectural framework* and soon renamed to be an *enterprise-architecture framework*.

Zachman was a major influence on one of the earliest attempts by a branch of the U.S. Government, the Department of Defense, to create an enterprise architecture. This attempt was known as the Technical Architecture Framework for Information Management (TAFIM) [03] and was introduced in 1994.

The promise of enterprise architectures, such as TAFIM, to better align technical projects with business need was noticed by no less a body than the U.S. Congress. Most likely influenced by the promised benefits of TAFIM, Congress in 1996 passed a bill known as the Clinger-Cohen Act of 1996 [04], also known as the Information Technology Management Reform Act, which mandated that all federal agencies take steps to improve the effectiveness of their IT investments. A CIO Council, consisting of CIOs from all major governmental bodies, was created to oversee this effort.

In April 1998, the CIO Council began work on its first major project, the Federal Enterprise Architecture Framework (FEAF). Version 1.1 [05] of this framework was released in September of 1999. This document contained some innovate ideas, such as "segmented architectures"—that is, architectural focus on segmented subsets of the larger enterprise.

Over time, responsibility for federal enterprise architecture moved from the CIO Council to the Office of Management and Budget (OMB). In 2002, the OMB evolved and renamed the FEAF methodology as the Federal Enterprise Architecture (FEA). I will describe FEA in greater detail, in the section dedicated to it.

Despite the very significant enterprise-architectural activity in the Federal Government (one could argue that no organization has spent more money attempting to develop an enterprise architecture than the U.S. Government), progress has been slow and success stories are overshadowed by higher-profile failures. In 2004, a full eight years after the Clinger-Cohen Act mandated the use of effective IT planning processes, the General Accounting Office (GAO) reported the following:

Only 20 of 96 agencies examined had established at least the foundation for effective architecture management. Further, while 22 agencies increased in maturity since 2001, 24 agencies decreased in maturity and 47 agencies remained the same. [06]

Since January of 2005, the General Accounting Office (GAO, not to be confused with the OMB) has severely chastised a number of U.S. agencies for failures in their adoption or use of

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enterprise architecture. A few examples include the FBI [07], the Department of Defense [08], the Department of Homeland Security [09], and NASA [10].

In 1998, four years after TAFIM (remember TAFIM?) was introduced and two years after it became codified as Clinger-Cohen, TAFIM was officially retired by the Department of Defense.

The work done on TAFIM was turned over to The Open Group. They morphed it into a new standard that is today known as The Open Group Architectural Framework—better known by its acronym, TOGAF. I will discuss the TOGAF work in the section dedicated to that topic.

In 2005, about the same time that OMB was becoming the dominant EA force in the public sector, another organization was taking steps to become a dominant force in the private sector. This group was Gartner.

By 2005, Gartner was already one of the most influential organizations specializing in CIO-level consulting. However, in the specific area of enterprise architecture, the best known IT research and advisory group was not Gartner, but Meta Group.

Gartner had struggled to build an enterprise-architecture practice, but never achieved the status of the Meta Group. In 2005, Gartner decided that if they couldn't compete with Meta Group, they would do the next best thing: They would buy it.

Following the purchase of Meta Group, Gartner/Meta spent a year looking at what each company brought to the table as far as enterprise-architecture experience and methodologies. The two companies discussed how best to reconcile their often quite different approaches.

In the end, a fairly simple algorithm was applied: If Meta Group liked it, it was in; if Meta Group didn't like it, it was out. Gartner liked architectural frameworks. The Meta Group liked architectural process. So, frameworks were out; processes were in. I'll discuss this Gartner/Meta process in detail, in the section devoted to Gartner.

Figure 24 summarizes this history with an enterprise-architecture timeline. This brings us up to date in the history of enterprise architecture. Now, let's look more closely at today's main methodologies and introduce a case study that will be used in this white paper.

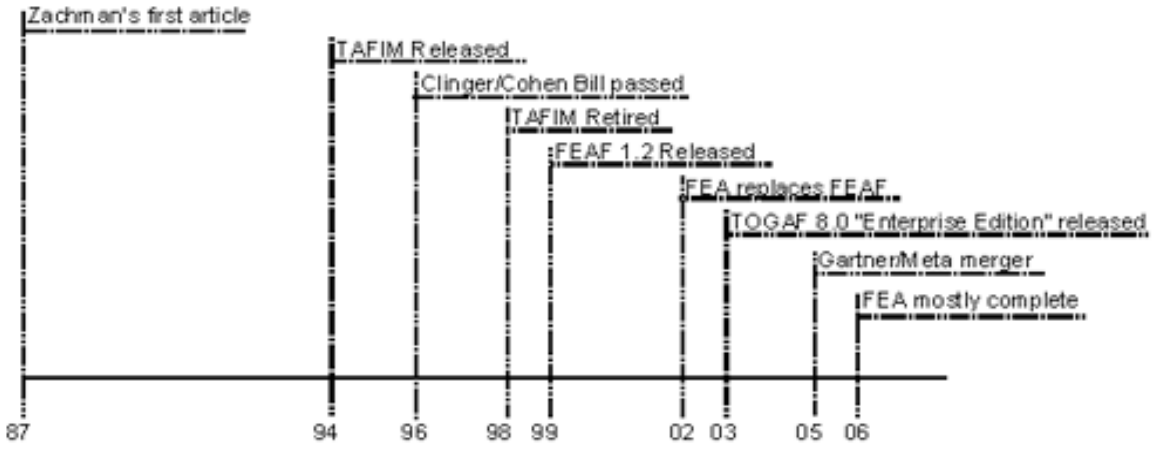

Figure 25: Enterprise-architecture timeline

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In the author's opinion, the above EA evolutions provide us with a number of outcomes: EA has been on continuous evolutions, with lessons learnt e.g TAFIM, TOGAF … The most important observation by the author is the implication and introduction of new legislations such as Clinger/Cohen Bill. This bill, in the author opinion, is a clear recognition of the added-value for EA in government and its implications on non-government organizations.

Case Study

So that we can compare and contrast the four major approaches to enterprise architectures, I am going to illustrate how each would approach a similar scenario. This fictitious scenario is a composite of several enterprises with which I have worked over the past several years. So, while it is fictitious, it is very realistic. I'll first describe the scenario.

MedAMore is a chain of drug stores. It started as a regional chain in 1960. In 1995, it developed an innovative software system that enabled it to run drug stores very efficiently. It called this system MedAManage, or MAM. MAM incorporated some innovate business ideas, such as patient-relationship management, inventory management, automated insurance billing, and even utility optimization.

MAM consisted of three programs: MAM/Store, which ran on a small computer at a drug store; MAM/Warehouse, which ran on a server in a regional warehouse; and MAM/Home, which ran on a large server at the home office.

These three programs communicated through files that were transferred from one location (for example, a store) to another (for example, a regional warehouse). When reliable communications lines existed, file transfers could occur through FTP. The system was also flexible enough to accommodate transfers through courier, where necessary.

By 2000, MedAMore was doing quite well—in part, because of the cost-cutting moves enabled by the MAM system. MedAMore decided to begin expansion. To do this, it purchased three regional chains. With these purchases, MedAMore extended its reach through the southeast quadrant of the U.S.

By 2002, it was clear that the same software systems that had initially fueled MedAMore's success were now hampering its future. Some of the problems MedAMore was running into were the following:

MAM/Store required regional specializations. For example, different insurance plans needed to be supported in different regions, and these all required changes to the MAM/Store module.

The regional warehouses that had been acquired through acquisition each had different ways of receiving orders from the retail stores and different procedures from ordering supplies from the wholesalers. Each of these differences required changes to the MAM/Warehouse module.

The file-transfer approach to information sharing that had worked so well when MedAMore consisted of 30 drugstores, one regional warehouse, and one home office were turning out to be difficult to coordinate among 200 drugstores, four regional warehouses, two geographic offices, and one home office. Files were often delivered late, sometimes not at all, and occasionally multiple times. This made it difficult for the home office to access reliable, up-to-date financial information, especially in the areas of sales and inventory.

It was clear to MedAMore management that the MAM system needed many enhancements. However, upgrading this system was difficult. Each of the three modules (store, warehouse, and home office) was huge, inefficient, and cumbersome, and each included functionality for everything that each entity might need.

The modules had grown to over 1 million lines of code each. It was difficult to change one function without affecting others. All of the functions accessed a single database, and changes to one record definition could ripple through the system in an unpredictable fashion. Changing even a single line of code required a rebuild of the entire multimillion-line module.

MedAManage had become MedANightmare. Debugging was difficult. Software builds were torturous. Installing new systems was hugely disruptive.

These technical problems soon created internal conflicts within the home office of MedAMore. The business side of MedAMore wanted to acquire two more regional chains, but IT was still struggling to bring the existing acquisitions online.

This resulted in a rapidly growing divide between the business and the technical sides of MedAMore. The business side saw IT as reducing business agility. The technical side saw the business side as making impossible demands and blamed it for refusing to consult IT before entering into acquisition discussions.

The distrust had reached such a point that, by 2005, the CIO was no longer considered part of the executive team of MedAMore. The business side distrusted IT and tried to circumvent it at every opportunity. The technical side built its IT systems with little input from the business folks. Several large and expensive IT initiatives were ignored by the business side and were eventually abandoned.

By 2006, MedAMore was in crisis. It clearly needed to revamp its technical systems to make them easier to specialize for regional requirements. This was going to be an expensive proposition, and MedAMore couldn't afford for the effort to fail.

Just as importantly, MedAMore also had to rebuild its internal relationships. The constant bickering and distrust between business and IT was affecting morale, efficiency, and profitability. A company that only five years earlier was an industry leader in profitability—in large part, because of its innovative use of IT—was now struggling to stay out of the red—in large part, because of the inflexibility of those same IT systems.

Cath, the CEO of MedAMore, desperately needed a solution. At a CEO conference, she heard how many of her peers were using enterprise architectures to build stronger partnerships between their technical and business groups and deliver more cost-effective IT systems that enabled business agility.

Cath decided that this approach merited further investigation. She asked Irma, her CIO, to prepare a recommendation on the use of an enterprise architecture within MedAMore. Irma was impressed with the approach, but recognized that any such initiative needed to be driven from the top and needed to involve the business side from the start.

On Irma's recommendation, Cath called a meeting with Bret, the Vice-President of Business, and Irma. Cath announced that she had decided to create common enterprise architecture for MedAMore that would unite its technical and business people. This common enterprise architecture would be named MedAMore-Enterprise Architecture, or MAM-EA. After it was completed, MAM-EA would drive all new IT investment and ensure that every dollar invested in IT was delivering the maximum value to the business.

Cath knew that MAM-EA was a bet-the-company decision for MedAMore. The MAM-EA vision *had* to work. Cath was depending on Bret (the business side) and Irma (the IT side) to make it work.

So, that is the problem. Now, let's see how each of the EA approaches might provide a solution for MedAMore.

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4.3 The Zachman Framework for Enterprise Architectures

The first thing we need to understand about the Zachman Framework is that it isn't a framework—at least, by my definition of a framework. According to the American Heritage Dictionary, a framework is defined as:

A structure for supporting or enclosing something else, especially a skeletal support used as the basis for something being constructed; An external work platform; a scaffold; A fundamental structure, as for a written work; A set of assumptions, concepts, values, and practices that constitutes a way of viewing reality. [11].

Taxonomy, on the other hand, is defined as:

The classification of organisms in an ordered system that indicates natural relationships; The science, laws, or principles of classification; systematics; Division into ordered groups or categories [12]

The Zachman "Framework" is actually a taxonomy for organizing architectural artifacts (in other words, design documents, specifications, and models) that takes into account both who the artifact targets (for example, business owner and builder) and what particular issue (for example, data and functionality) is being addressed.

The author disagrees with Roger Session's view that Zackman framework, by his interpratation, "isn't a framework". The author considers the Zackman definition better suits the principles of EA Framework, as compared to the definition by American Heritage Dictionary. Zackman supports his definition by a "Framework', providing a global view from both "perspective and focus", not just a definition in generic terms.

As John Zachman retrospectively described his work:

The [Enterprise Architecture] Framework as it applies to Enterprises is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise, as well as to the development of the Enterprise's systems. [13]

Many proponents of the Zachman Framework see it as cross-disciplinary, with influence extending far beyond IT. One popular book on Zachman, for example, says:

...in due course, you will discover that the Framework exists in everything you do, not only IT projects. When you thoroughly understand the Framework, you can become more effective in everything you do. This means everything. This statement is not made lightly. [14]

John Zachman himself told me, in an interview that I recently conducted with him:

...the Framework schema has been around for thousands of years and I am sure it will be around for a few more thousands of years. What changes is our understanding of it and how to use it for Enterprise engineering and manufacturing. [15]

Zachman originally explained his IT taxonomy using the building industry as an analogy. In that industry, architectural artifacts are implicitly organized using a two-dimensional organization. One dimension is the various "players in the game." For a physical building, some of these players are the owner (who is paying for the project), the builder (who is coordinating the overall construction), and a zoning board (who is ensuring that construction follows local building regulations).

A building architect prepares different artifacts for each of these players. Every player demands complete information, but what constitutes completeness differs for the different

players. The *owner* is interested in a complete description of the functionality and aesthetics of the building. The *builder* is interested in a complete description of the materials and construction process. The owner doesn't care about the placement of studs in the walls. The builder doesn't care how the bedroom windows line up with the morning sun.

As Zachman said in his original article:

...each of the architectural representations differs from the others in essence, not merely in level of detail. [16]

The second dimension for architectural artifact organization is the descriptive focus of the artifact: the what, how, where, who, when, and why of the project. This dimension is independent of the first. Both the builder and the owner need to know *what*, but the owner's need to know *what* is different from the builder's need to know *what*. What *what* is what depends on who is asking the question.

In his first paper and Zachman's subsequent elaboration in 1992 [17], Zachman proposed that there are six descriptive foci (data, function, network, people, time, and motivation) and six player perspectives (planner, owner, designer, builder, subcontractor, and enterprise.) These two dimensions can be arranged in a grid, as shown in Figure 4.

From the business owner's perspective, "data" means business entities. This can include information about the entities themselves, such as customers and products, or information about relationships between those entities, such as demographic groups and inventories. If you are talking to a business owner about data, this is the language you should use.

From the perspective of the person implementing the database, "data" does not mean business entities, but rows and columns organized into tables and linked together by mathematical joins and projections. If you are talking to a database designer about data, don't talk about customer demographic groups, but talk about third-normal relational tables.

It's not that one of these perspectives is better than the other or more detailed than the other or of a higher priority than the other. *Both* of these perspectives on data are critical to a holistic understanding of the system's architecture. As Zachman said:

We are having difficulties communicating with one another about information systems architecture, because a set of architectural representations exists, instead of a single architecture. One is not right and another wrong. The architectures are different. They are additive and complementary. There are reasons for electing to expend the resources for developing each architectural representation. And there are risks associated with not developing any one of the architectural representations. [18]

I discussed the historical importance of the Zachman Framework in the history section. Here, I will discuss the actual framework itself and how it could be used to help build MAM-EA, the problem proposed in the case-study section.

As I mentioned earlier, the Zachman Framework consists of six functional foci, each considered from the perspective of a major player. The Zachman Framework as it is portrayed today is shown in Figure 25.

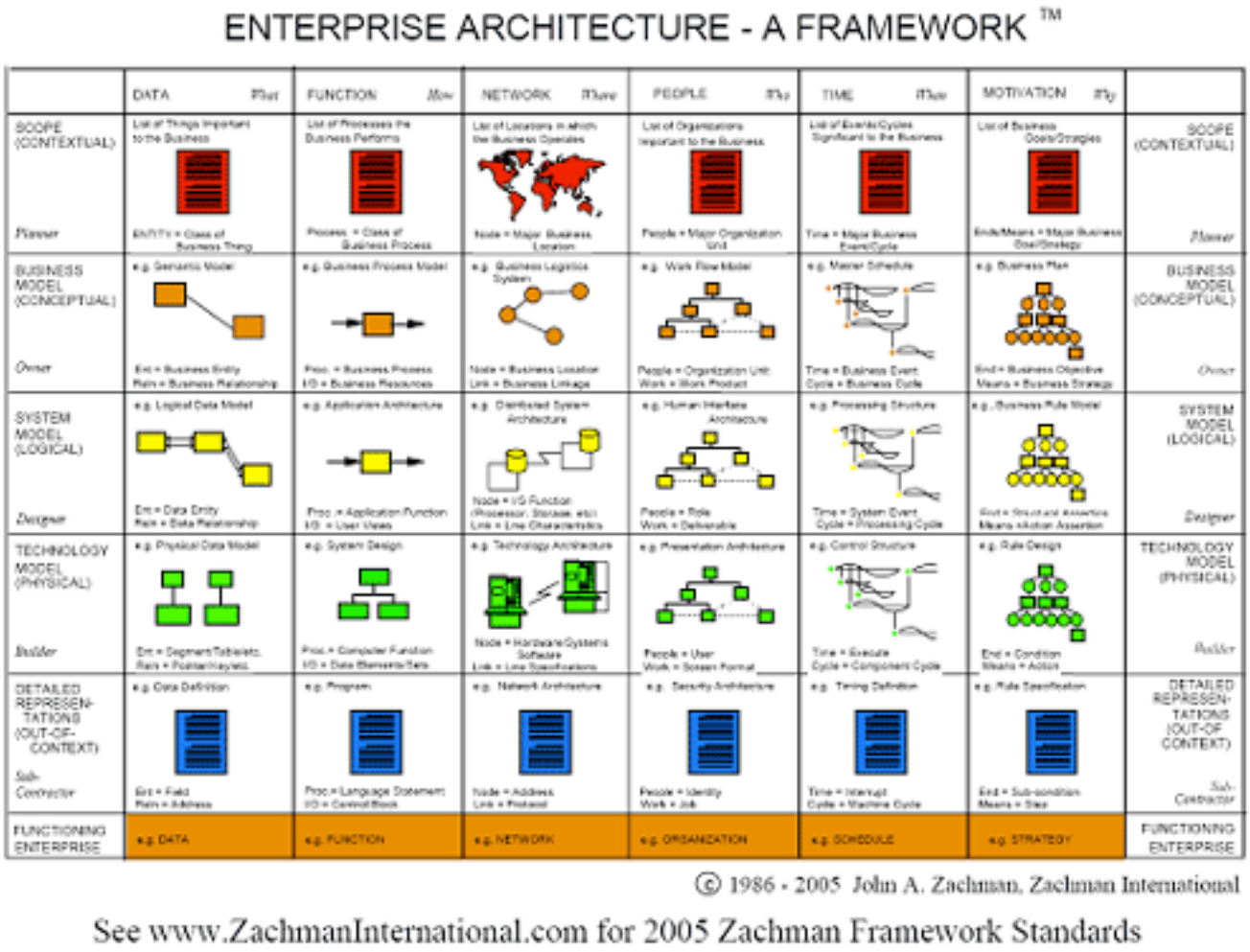

Figure 26: Zachman grid

As you can see from Figure 4, there are 36 intersecting cells in a Zachman grid—one for each meeting point between a player's perspective (for example, business owner) and a descriptive focus (for example, data.). As we move horizontally (for example, left to right) in the grid, we see different descriptions of the system—all from the same player's perspective. As we move vertically in the grid (for example, top to bottom), we see a single focus, but change the player from whose perspective we are viewing that focus.

There are three suggestions of the Zachman grid that can help MedAMore in the development of MAM-EA.

The first suggestion of the Zachman taxonomy is that every architectural artifact should live in one and only one cell. There should be no ambiguity about where a particular artifact lives. If it is not clear in which cell a particular artifact lives, there is most likely a problem with the artifact itself.

As MedAMore begins accumulating artifacts in the development of MAM-EA, it can use the Zachman grid to clarify the focus of each of these artifacts. For example, artifacts relating to a service-oriented architecture live mostly in the third row (designer's perspective). They generally will not be of interest to the business owner (Bret, in the MedAMore case study).

The second suggestion of the Zachman taxonomy is that architecture can be considered a *complete* architecture only when every cell in that architecture is complete. A cell is complete

when it contains sufficient artifacts to fully define the system for one specific player looking at one specific descriptive focus.

When every cell is populated with appropriate artifacts, there is a sufficient amount of detail to fully describe the system from the perspective of every player (what we might today call a *stakeholder*) looking at the system from every possible angle (descriptive focus). So, MedAMore can use the Zachman grid to ensure that appropriate discussions are occurring between all of the important stakeholders of MAM-EA.

The third suggestion of the Zachman grid is that cells in columns should be related to each other. Consider, for example, the data column (the first column) of the Zachman grid. From the business owner's (Bret's) perspective, *data* is information about the business. From the database administrator's perspective, data is rows and columns in the database.

While the business owner thinks about data quite differently from the database administrator, there should be some relationship between these perspectives. Somebody should be able to follow Bret's business requirements and show that the database design is, in fact, being driven by those requirements. If Bret has requirements that are not traceable down to the database design, we must ask if the business needs will be met by this architecture. On the other hand, it there are database-design elements that do not trace back to business requirements, we might ask if we have included unnecessary design at the database level.

So, we can see five ways in which the Zachman grid can help in the development of MAM-EA. It can help:

Ensure that every stakeholder's perspective has been considered for every descriptive focal point.

Improve the MAM-EA artifacts themselves by sharpening each of their focus points to one particular concern for one particular audience.

Ensure that all of Bret's business requirements can be traced down to some technical implementation.

Convince Bret that Irma's technical team isn't planning on building a bunch of useless functionality.

Convince Irma that the business folks are including her IT folks in their planning.

But Zachman by itself is not a complete solution for MedAMore. There are far too many issues that will be critical to MAM-EA's success that Zachman does not address. Zachman does not give us a step-by-step process for creating a new architecture. Zachman doesn't even give us much help in deciding if the future architecture we are creating is the best architecture possible. For that matter, Zachman doesn't even give us an approach to show a need for a future architecture. For these and other issues, we are going to need to look at other methodologies.

The author agrees in principle that Zackman framework in the above specific case does not provides a complete solution: a lack of defined process is a real example. The author furthermore does not share Roger Session’s view that “Zachman doesn't even give us an approach to show a need for a future architecture “.In the author’s view, future architectures are a result of lessons learnt from the implementation of present frameworks. Figure C. Enterprise-architecture timeline – above indicates the continuous evolutions of various frameworks, supporting the author’s argument that it is difficult and not advisable to build a future framework within an existing framework. The only area the author agrees is from the IT perspective, to include flexible interfaces and growth potential.

4.4 The Open Group Architecture Framework (TOGAF)

The Open Group Architecture Framework is best known by its acronym, TOGAF. TOGAF is owned by The Open Group [19]. TOGAF's view of enterprise architecture is shown in Figure 26.

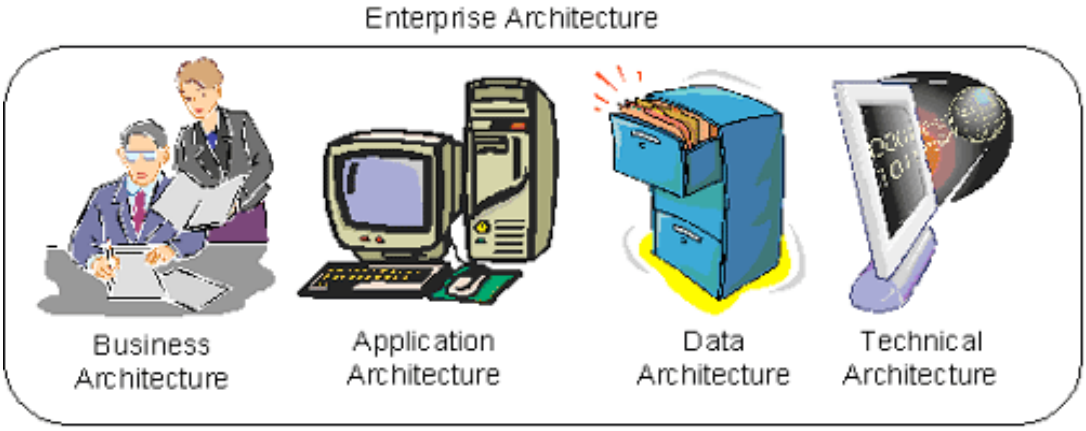

Figure 27: TOGAF's enterprise architecture

As shown in the figure, TOGAF divides enterprise architecture into four categories, as follows:

Business architecture—describes the processes the business uses to meet its goals

Application architecture—describes how specific applications are designed and how they interact with each other

Data architecture—describes how the enterprise data stores are organized and accessed

Technical architecture—describes the hardware and software infrastructure that supports applications and their interactions

TOGAF describes itself as a "framework," but the most important part of TOGAF is the Architecture Development Method, better known as ADM. ADM is a recipe for creating architecture. A recipe can be categorized as a *process*. Given that ADM is the most visible part of TOGAF. I categorize TOGAF overall as an *architectural process*, instead of either an *architectural framework* (as The Open Group describes TOGAF) or a *methodology* (as it describes ADM).

Viewed as an architectural *process*, TOGAF complements Zachman—which, recall, I categorized as an architectural *taxonomy*. Zachman tells you how to categorize your artifacts. TOGAF gives you a process for creating them.

TOGAF views the world of enterprise architecture as a continuum of architectures, ranging from highly generic to highly specific. It calls this continuum the Enterprise Continuum. It views the process of creating a specific enterprise architecture, such as MAM-EA, as moving

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from the generic to the specific. TOGAF's ADM provides a process for driving this movement from the generic to the specific.

TOGAF calls most generic architectures *Foundation Architectures*. These are architectural principles that can, theoretically, be used by any IT organization in the universe.

TOGAF calls the next level of specificity *Common Systems Architectures*. These are principles that one would expect to see in many—but, perhaps, not all—types of enterprises.

TOGAF calls the next level of specificity *Industry Architectures*. These are principles that are specific across many enterprises that are part of the same domain—such as, in our MedAMore case study, all pharmaceutical enterprises.

TOGAF calls the most specific level the *Organizational Architectures*. These are the architectures that are specific to a given enterprise, such as MedAMore.

Figure 27 shows the relationship between the Enterprise Continuum and the Architecture Development Method (ADM).

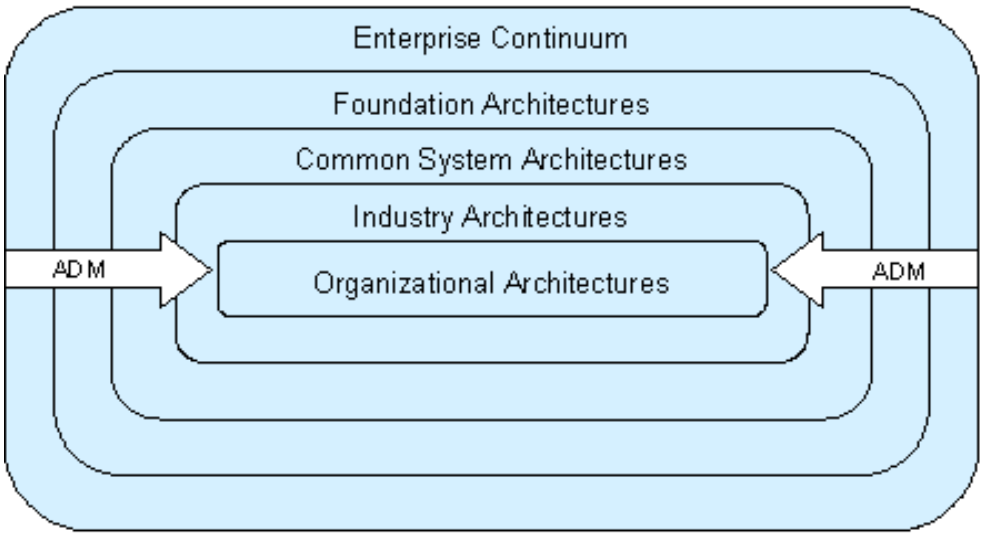

Figure 28: The TOGAF Enterprise Continuum

TOGAF defines the various knowledge bases that live in the Foundation Architecture. Two that you might run into are the *Technical Reference Model* (TRM) and the *Standards Information Base* (SIB). The TRM is a suggested description of a generic IT architecture. The SIB is a collection of standards and pseudo-standards that The Open Group recommends that you consider in building an IT architecture.

TOGAF presents both the TRM and the SIB as suggestions; neither is required. In my view, both the TRM and the SIB are flawed for the same reason: They are biased toward application *portability*, at the expense of application *interoperability* and application *autonomy*. I consider this an outdated view of technical architectures.

Although Roger Session's view adds clarity to certain issues such as

For an organization such as MedAMore, TOGAF largely boils down to the Architecture Development Method (ADM). Individuals within MedAMore will be exposed to the Enterprise Continuum, the SIB, and the TRM (as well as a few other TOGAF features), which

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is why I discussed them. But the day-to-day experience of creating enterprise architecture will be driven by the ADM, a high-level view of which is shown in Figure 28.

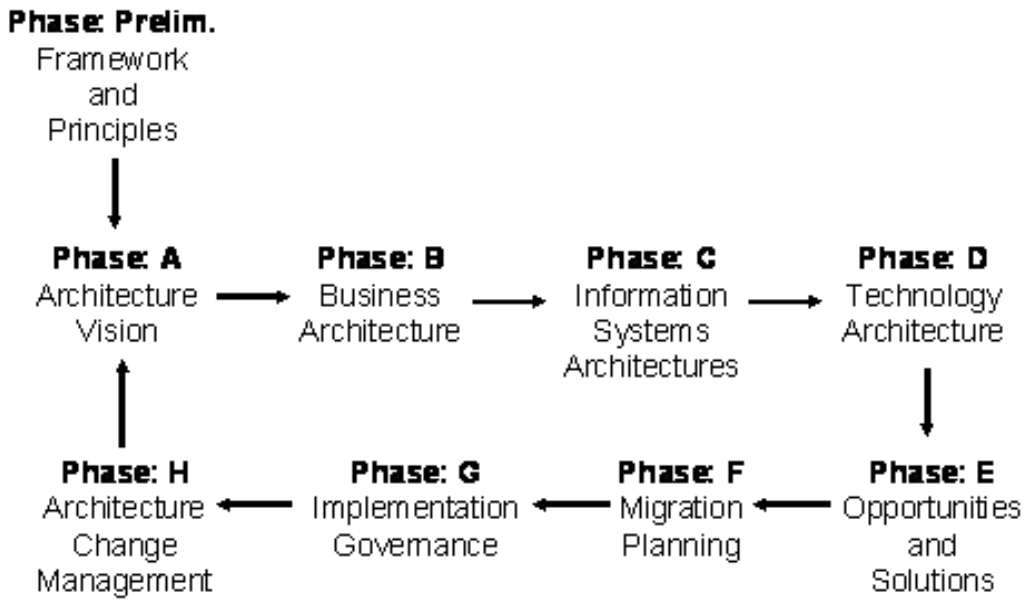

Figure 29: The TOGAF Architecture Development Method (ADM)

As shown in Figure 28, the TOGAF ADM consists of eight phases that are cycled through after an initial "priming of the pump." I'll take you through these phases as they could be applied to the MedAMore case study. But, before MedAMore can start the ADM, it needs to gain some experience with TOGAF. MedAMore will have two choices on how it can get this experience.

First, MedAMore can train itself in TOGAF. MedAMore can download the TOGAF documentation [20]—which describes all of TOGAF, including the ADM, in considerable detail. It can purchase books on TOGAF [21]. There is probably more free and inexpensive available information about TOGAF than about all other architectural methodologies combined.

Second, MedAMore can buy expertise in TOGAF. There are consultants who specialize in TOGAF and have earned Open Group certification [22]. Because MedAMore wants to minimize any chances of failure, it has chosen to call in a TOGAF consultant. MedAMore has brought in Teri, an Open Group–certified TOGAF architect. Remember that the other players at MedAMore are Cath, the CEO of MedAMore; Bret, the Business VP; and Irma, the CIO.

In the Preliminary Phase, Teri meets with the major players at MedAMore to introduce the TOGAF process. Her three goals in the preliminary phase are to:

Make sure everybody is comfortable with the process.

Modify the TOGAF process, as necessary, to fit within the MedAMore culture.

Set up the governance system that will oversee future architectural work at MedAMore.

Teri will work closely with Bret to understand the business philosophy, business models, and strategic drivers of MedAMore. She will work closely with Irma to define the architectural

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principles that drive technological architectures at MedAMore and document those principles using the TOGAF-recommended format.

In some organizations, achieving buy-in on the need for an enterprise architecture could be very difficult. This is especially true when the effort is driven from the IT organization, and even more so when there is a history of discord between the business and the technical sides of the organization. MedAMore does have this history of animosity. However, it has another fact going for it from which Teri should take heart: The effort is not driven by IT, but is driven by Cath, the CEO. This gives the project high visibility and creates a positive incentive for cooperation from all sides.

As soon as Teri and MedAMore have completed the Preliminary Phase, they are ready to start Phase A. Phase A begins, at least in theory, with a *Request for Architecture Work* from some organization within MedAMore. This document includes the business reasons for the request, budget and personnel information, and any constraints that need to be considered. Because MedAMore has never done a *Request for Architecture Work*, Teri will probably need to work with the sponsoring organization in creating such a request.

As soon as the Request for Architecture Work (or some equivalent) has been received, Teri (the TOGAF consultant) starts MedAMore on Phase A. In Phase A, Teri will ensure that the project has the necessary support within MedAMore, define the scope of the project, identify constraints, document the business requirements, and establish high-level definitions for both the baseline (starting) architecture and target (desired) architecture.

These baseline and target definitions will include high-level definitions on all four of the EA sub-arch**itectures shown back in Figure 26**—namely, business, technology, data, and application architectures.

The culmination of Phase A will be a Statement of Architecture Work, which must be approved by the various stakeholders before the next phase of the ADM begins. The output of this phase is to create an architectural vision for the first pass through the ADM cycle. Teri will guide MedAMore into choosing the project, validating the project against the architectural principles established in the Preliminary Phase, and ensure that the appropriate stakeholders have been identified and their issues have been addressed.

The Architectural Vision created in Phase A will be the main input into Phase B. Teri's goal in Phase B is to create a detailed baseline and target business architecture and perform a full analysis of the gaps between them. She will work primarily with Bret (or Bret's team) to achieve this.

Phase B is quite involved—involving business modelling, highly detailed business analysis, and technical-requirements documentation. A successful Phase B requires input from many stakeholders. The major outputs will be a detailed description of the baseline and target business objectives, and gap descriptions of the business architecture.

Phase C does for the information-systems architecture what Phase B does for the business architecture. In this phase, Teri works primarily with Irma (or her team). TOGAF defines nine specific steps, each with multiple sub-steps:

Develop baseline data-architecture description

Review and validate principles, reference models, viewpoints, and tools

Create architecture models, including logical data models, data-management process models, and relationship models that map business functions to CRUD (Create, Read, Update, Delete) data operations

Select data-architecture building blocks

Conduct formal checkpoint reviews of the architecture model and building blocks with stakeholders

Review qualitative criteria (for example, performance, reliability, security, integrity)

Complete data architecture

Conduct checkpoint/impact analysis

Perform gap analysis

The most important deliverable from this phase will be the Target Information and Applications Architecture.

Phase D completes the technical architecture—the infrastructure necessary to support the proposed new architecture. This phase is completed mostly by engaging with Irma's technical team.

Phase E evaluates the various implementation possibilities, identifies the major implementation projects that might be undertaken, and evaluates the business opportunity associated with each. The TOGAF standard recommends that Teri's first pass at Phase E "focus on projects that will deliver short-term payoffs and so create an impetus for proceeding with longer-term projects."

This is good advice in any architectural methodology. Therefore, Teri should be looking for projects that can be completed as cheaply as possible, while delivering the highest perceived value. A good starting place to look for such projects is the organizational pain-points that initially convinced Cath (the MedAMore CEO) to adopt an enterprise architectural-based strategy in the first place. These pain-points, described earlier, included difficulties in completing regional/warehouse specialization and unreliability in data sharing.

Phase F is closely related to Phase E. In this phase, Teri works with MedAMore's governance body to sort the projects identified in Phase E into priority order that include not only the cost and benefits (identified in Phase E), but also the risk factors.

In Phase G, Teri takes the prioritized list of projects and creates architectural specifications for the implementation projects. These specifications will include acceptance criteria and lists of risks and issues.

The final phase is H. In this phase, Teri modifies the architectural change-management process with any new artifacts created in this last iteration and with new information that becomes available.

Teri is then ready to start the cycle again. One of the goals from the first cycle should be information transfer, so that Teri's services are required less and less as more and more iterations of the cycle are completed.

Much of the results of the TOGAF process will be determined as much by the Teri/MedAMore relationship as it will by the TOGAF specification itself. TOGAF is meant to be highly adaptable, and details for the various architectural artifacts is sparse. As one book on TOGAF says:

TOGAF is not wholly specific with respect to generated documents; in fact, it provides very little in the way of prescriptive document templates—merely guidelines for inputs and outputs. [23]

The TOGAF specification is also flexible with respect to the phases. As the specification itself says:

One of the tasks before applying the ADM is to review its components for applicability, and then tailor them as appropriate to the circumstances of the individual enterprise. This activity might well produce an "enterprise-specific" ADM. [24]

TOGAF allows phases to be done incompletely, skipped, combined, reordered, or reshaped to fit the needs of the situation. So, it should be no surprise if two different TOGAF-certified consultants end up using two very different processes—even when working with the same organization.

TOGAF is even more flexible about the actual generated architecture. In fact, TOGAF is, to a surprising degree, "architecture-agnostic". The final architecture might be good, bad, or indifferent. TOGAF merely describes *how* to generate an enterprise architecture, not necessarily how to generate a *good* enterprise architecture. For this, you are dependent on the experience of your staff and/or TOGAF consultant. People adopting TOGAF in the hopes of acquiring a magic bullet will be sorely disappointed (as they will be with any of the methodologies).

In the authors opinion, TOGAF is a more matured system. TOGAF has seen itself shifting and transforming itself from TAFIM, to FEAF and later TOGAF. This passage of transformation has earned TOGAF the benefits and added value from the lessons learnt deriving from its original status. The author further agrees with Roger Session that one could view TOGAF as a continuum of architectures, ranging from highly generic to highly specific. It calls this continuum the Enterprise Continuum, which incorporates the process of creating a specific EA, while shifting from the generics to a dedicated purpose or framework. The author shares the opinion as well that TOGAF's ADM supports a process for moving from the generic to a dedicated purpose although Roger Sessions indicated, it provides very little in the way of prescriptive document templates—merely guidelines for inputs and outputs. Excellent EA Framework itself is not sufficient: a higher management commitment, ability to demonstrate early gains and the ability to bond the business unit and the IT unit towards a common workable strategy, is critical to success.

4.5 Federal Enterprise Architecture (FEA)

The Federal Enterprise Architecture (FEA) is the latest attempt by the federal government to unite its myriad agencies and functions under a single common and ubiquitous enterprise architecture. FEA is still in its infancy, as most of the major pieces have been available only since 2006. However, as I discussed in the history section, it has a long tradition behind it and, if nothing else, has many failures from which it has hopefully learned some valuable lessons.

FEA is the most complete of all the methodologies discussed so far. It has both a comprehensive taxonomy, like Zachman, and an architectural process, like TOGAF. FEA can be viewed as either a methodology for creating an enterprise architecture or the result of applying that process to a particular enterprise—namely, the U.S. Government. I will be looking at FEA from the methodology perspective. My particular interest here is how we can apply the FEA methodology to private enterprises.

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Most writers describe FEA as simply consisting of five reference models, one each for performance: business, service, components, technical, and data. It is true that FEA has these five references models, but there is much more to FEA than just the reference models. A full treatment of FEA needs to include all of the following:

A perspective on how enterprise architectures should be viewed (the *segment* model, that I will describe shortly)

A set of reference models for describing different perspectives of the enterprise architecture (the five models, mentioned earlier)

A process for creating an enterprise architecture

A transitional process for migrating from a pre-EA to a post-EA paradigm

A taxonomy for cataloging assets that fall within the purview of the enterprise architecture

An approach to measuring the success of using the enterprise architecture to drive business value

You can see that the FEA is about much more than models. It includes everything necessary to build an enterprise architecture for probably the most complex organization on earth: the U.S. Government. As the FEA-Program Management Office (FEAPMO) says, FEA, taken *in toto*, provides:

...a common language and framework to describe and analyze IT investments, enhance collaboration and ultimately transform the Federal government into a citizen-centreed, results-oriented, and market-based organization as set forth in the President's Management Agenda. [25].

While it might be a stretch to imagine that anything short of divine intervention could "transform the Federal government into a citizen-centreed, results-oriented, and market-based organization," there is at least hope that some of the FEA methodology could help our beleaguered MedAMore corporation deal with its much more mundane problems. So, let's take a look at what FEA has to offer.

The FEA Perspective on EA

The FEA Perspective on EA is that an enterprise is built of *segments*, an idea first introduced by FEAF [26]. A segment is a major line-of-business functionality, such as human resources. There are two types of segments: *core mission-area segments* and *business-services segments*.

A *core mission-area segment* is one that is central to the mission or purpose of a particular political boundary within the enterprise. For example, in the Health and Human Services (HHS) agency of the federal government, *health* is a core mission-area segment.

A *business-services segment* is one that is foundational to most, if not all, political organizations. For example, *financial management* is a business-services segment that is required by all federal agencies.

Another type of enterprise-architecture asset is an *enterprise service*. An enterprise service is a well-defined function that spans political boundaries. An example of an enterprise service is *security management*. Security management is a service that works in a unified manner across the whole swath of the enterprise.

The difference between *enterprise services* and *segments*, especially *business-service segments*, is confusing. Both are shared across the entire enterprise. The difference is that business-service segments have a scope that encompasses only a single political organization. Enterprise services have a scope that encompasses the entire enterprise.

In the federal government, for example, both HHS and the Environmental Protection Agency (EPA) use the *human resources* business-service segment. However, the people who are managed by human resources are a different group for HHS from what they are for the EPA.

Both HHS and the EPA also use the *security management* enterprise service. But the security credentials that are managed by the security-management service are not specific to either of those agencies. Security credentials are managed effectively only when they are managed at the scope of the enterprise.

Resist the temptation to equate either *segments* or *services* with services, as in *service-oriented architectures*. There are two reasons such a comparison would be flawed. Firstly, enterprise services, business-service segments, and core mission-area segments are all much broader in focus than services found in service-oriented architectures. Secondly, segments are an organizational unit for enterprise *architecture*, whereas services are an organizational unit for *technical implementations*. As organizational units for enterprise architecture, their depth includes not just the technical, but also the business and the data architectures.

One final note about segments: Although segments *function* at the political (that is, agency) level, they are *defined* at the enterprise (that is, government) level. Enterprise services, of course, both function and are defined at the enterprise level.

The fact that segments are defined globally facilitates their reuse across political boundaries. One can map out the usage of segments across the political boundaries of the enterprise, then use that map to seek opportunities for architectural reuse. Figure 29, for example, shows a segment map of the federal government from the FEA Practice Guide [27]. As you can see, there are many segments (the vertical columns) that are used in multiple agencies, and any or all of these are good candidates for sharing.

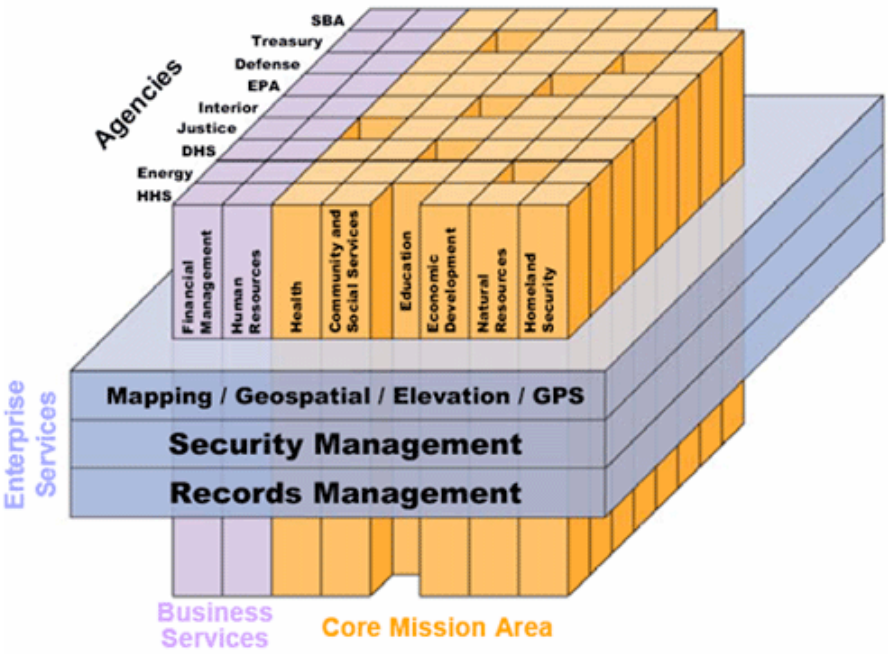

Figure 30: Segment map of the federal government

4.5.1 FEA Reference Models

The five FEA reference models are all about establishing common languages. The goal here is to facilitate communication, cooperation, and collaboration across political boundaries. According to the FEAPMO:

The FEA consists of a set of interrelated "reference models" designed to facilitate cross-agency analysis and the identification of duplicative investments, gaps, and opportunities for collaboration within and across agencies. Collectively, the reference models [compose] a framework for describing important elements of the FEA in a common and consistent way. [28]

Why do we need a common language? Consider this exchange:

James: Do you have a torch I can borrow?

Roger: No, I'm afraid not.

James: Do you know where I can get one?

Roger: The hardware store in town should have one.

So, James goes out to the hardware store and buys himself a torch. He returns.

Roger: Did you get your torch?

James: Yes, here it is.

Roger: That's not a torch! That's a flashlight. Why didn't you say so? I have one you could have borrowed.

James: Well, why didn't you say so?

The problem, of course, is that James comes from England, where what I call a *flashlight* they call a *torch*. And when I hear *torch*, I think of a *blowtorch*. Although we both speak English, we don't necessarily speak the same English. The result is that James goes out and unnecessarily spends money on something that I could have lent him.

This is exactly the problem that the FEA Reference Models are trying to solve on a much larger scale. Suppose the Internal Revenue Service (IRS) decides it needs a *demographics* system to track taxpayer data. They ask around to see if anybody has one they can modify for their purposes. Nobody does.

Little do they know that, right next door, the Government Printing Office (GPO) has a perfectly good demographics system that is almost exactly what the IRS needs. They just happen to call it a *customer-analytics* system.

So, the IRS goes out and builds its system from scratch, instead of just modifying the one already built (and paid for) by the GPO. And, in doing so, the IRS will waste considerably more money than James spent on his unnecessary flashlight.

This, in a nutshell, is the goal of the five FEA reference models: to give standard terms and definitions for the domains of enterprise architecture and, thereby, facilitate collaboration and sharing across the federal government. The five reference models are as follows:

1. The *Business Reference Model (BRM)* gives a business view of the various functions of the federal government. For example, the BRM defines a standard business capability called *water resource management* that is a sub function of *natural resources* that is considered a *line-of-business* of the broader *services for citizen's* business area. [29]
2. The *Components Reference Model (CRM)* gives a more IT view of systems that can support business functionality. For example, the CRM defines a *customer-analytics* system that I described earlier in the hypothetical interchange between the IRS and the GPO. [30]

3. The *Technical Reference Model (TRM)* defines the various technologies and standards that can be used in building IT systems. For example, the TRM defines *HTTP* as a *protocol* that is a subset of a *service transport* that is a subset of *service access and delivery*. [31]
4. The *Data Reference Model (DRM)* defines standard ways of describing data. For example, the DRM defines an *entity* as something that *contains attributes* and *participates in relationships*. [32]
5. The *Performance Reference Model (PRM)* defines standard ways of describing the value delivered by enterprise architectures. For example, the PRM describes *quality* as a technology measurement area that is defined as "the extent to which technology satisfies functionality or capability requirements." [33]

4.5.2 FEA Process

The FEA Process is primarily focused on creating a segment architecture for a subset of the overall enterprise (in FEA's case, the enterprise is the federal government and the subset is a governmental agency) and is described in the FEA Practice Guidance [34]. I discussed the FEA vision on enterprise segments earlier. The overall segment-architecture development process is (at a very high level) as follows:

- Step 1: Architectural Analysis — defines a simple and concise vision for the segment, and relates it back to the organizational plan.
- Step 2: Architectural Definition — define the desired architectural state of the segment, document the performance goals, consider design alternatives, and develop enterprise architecture for the segment, including business, data, services, and technology architectures.
- Step 3: Investment and Funding Strategy — consider how the project will be funded.
- Step 4: Program-Management Plan and Execute Projects—Create a plan for managing and executing the project, including milestones and performance measures that will assess project success.

4.5.3 FEA Success Measurement

The FEA framework for measuring organizational success in using enterprise architecture is defined in the Federal Enterprise Architecture Program EA Assessment Framework 2.1 [35]. Federal agencies are rated on their overall maturity levels in three main categories:

1. Architectural completion—Maturity level of the architecture itself
2. Architectural use—How effectively the agency uses its architecture to drive decision-making
3. Architectural results—The benefits being realized by the use of the architecture

OMB assigns each agency a success rating, based on its scores in each category and a cumulative score, as follows:

- Green—the agency rates quite well in the *completion* area (it has a quite mature enterprise architecture). It also rates well in both the *use* area (it is effectively using that enterprise architecture to drive ongoing strategy) and the *results* area (the usage of that architecture is driving business value).

- Yellow—the agency rates quite well in the *completion* area. It also rates well in either the *use* area or the *results* area.
- Red—the agency either does not have a completed architecture and/or is not effectively using that architecture.

The framework is interesting beyond the confines of the public sector. The category ratings can be fruitfully adapted by many enterprises to assess the maturity level of their own architectural efforts. Figure 9, for example, shows my own interpretation of the OMB maturity rankings for *architectural completion*, as I adapt them for the private sector. Similar adaptations can be created for *architectural usage* and *architectural results*.

Category: Architectural Completion
Description: This category measures the architectural maturity of an enterprise's architecture in terms of performance, business, data, service, and technology. This includes an assessment of the architectural artifacts and both the baseline (existing) and target (goal) architectures.

Level	Name	Description
1	Initial	The enterprise is using informal and ad-hoc EA processes. Some architectural artifacts for a given architectural level may exist, but the levels are not linked, or the linkage is incomplete.
2	Baseline	The enterprise has developed a baseline (as-is) architecture. The architecture has enterprise-wide scope and the linkages between levels are well established and clearly articulated.
3	Target	The enterprise has developed both a baseline architecture (as described above) and a target (goal) architecture. The target architecture is aligned to enterprise-wide goals and organizational responsibilities. The target architecture addresses the priorities and performance objectives identified in the enterprise business plan.
4	Integrated	The enterprise has developed at least vertically partitioned architecture that has been approved by the business owner in writing. The relevant organization(s) within the enterprise are actively migrating toward the relevant architecture.
5	Optimized	The enterprise has developed multiple vertically partitioned architectures that support core mission business functions, all approved by the appropriate business owners.

Table 10: OMB ranking of architectural completion, adapted for private sector by author (Roger Sessions)

4.5.4 FEA Applied to MedAMore

Now that I have taken you through the FEA approach, let's see what this might mean to MedAMore. Let's assume that Cath (MedAMore's CEO) has heard about FEA and how it is promising to streamline the federal government. If it can do this for the federal government, she reasons, surely it can do this for her company.

Cath hires a consultant, Fred, who is an expert on FEA (if such a thing can be said to exist for a methodology that is, at the time of this writing, less than a year old!). Fred's job is to show MedAMore how to do FEA—of course, not the real FEA, but FEA as it might be applied to

the private sector. Cath introduces Fred to Bret (the business VP) and Irma (the CIO), and tells them to build her anMEA—FEA adapted for MedAMore.

Keep in mind that Cath has taken quite a risk. No other company to date has attempted to apply FEA to the private sector; and even the experience of using FEA within the public sector is nominal, at best.

The first thing that Fred will want to do is build enthusiasm for MEA. Keep in mind that he is coming into an organization in which the business folks barely speak to IT folks. If MEA is going to succeed, it needs to transform not only processes, but people. He will want to create a series of seminars explaining the value of the soon-to-be-defined MEA and how MEA will benefit not only MedAMore as a whole, but the individual units specifically.

Fred will next build a governance structure—MedAMore's equivalent to FEAPMO. I'll call this group MEAPMO. MEAPMO will own MEA, including the processes, the models, and the architecture itself.

The next thing that Fred will likely do is create reference models that can be used by all of the organizations across MedAMore. The five reference models from FEA can serve as a starting point. Some, such as the Technical Reference Model, might be usable with few modifications. Others, such as the Business Reference Model, will require extensive renovation. He shouldn't do these in excruciating detail, but create starting points and build them up as MEA evolves.

Next, Fred will probably want to create a description of the segment architecture as it applies to MedAMore. Note that he will not be doing a complete segment architecture—just a high-level description. The actual process of completing the architecture will be a constantly evolving project.

By this point, a lot of work will have been done with few results. Fred will probably want to take a first pass at a segment-architecture process. FEA's process will be a good starting point, but will require specialization to MedAMore at the detail level (such as who the team members are and what form the generated artifacts should take).

Now, Fred will test-drive the process with the first segment delivery. He will need to build a team, and then lead this team in analyzing and prioritizing the segments—mapping them to business value, determining their architectural options, delivering the work, and, perhaps most importantly, measuring the results. These measurements will be critical in building momentum for future work.

Soon after completing the first segment, Fred might decide that it is time to measure the progress of the different groups in MedAMore in using MEA effectively. To do so, Fred needs a yardstick to measure the success of the different groups within MedAMore in driving business value with MEA. Fred thus leads MEAPMO in building a MedAMore equivalent to the Federal Enterprise Architecture Program EA Assessment Framework [35]. This yardstick will be Cath's main tool for ensuring that both the different groups are taking MEA seriously and her investment is paying off.

And, finally, after Fred has completed this process, he will start the process again. Each iteration will result in new segments being delivered, more business value being generated, and more substance being added to the MEA methodology. At least, this is the theory. As I said earlier, with MEA, we are working at the bleeding edge.

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4.6 Gartner

So far, I have written about three different methodologies that come together under the banner of enterprise architectures. This last methodology is a little different. It isn't a taxonomy (like Zachman), a process (like TOGAF), or a complete methodology (like FEA). Instead, it is what I define as a *practice*. It is the enterprise-architecture practice of one of the best known IT research and consulting organizations in the world: Gartner.

Let me spend a moment exploring my use of the word *practice*. I use the word "practice" much like I would to describe a physician's practice. A physician—say, Dr. Pérez—does not diagnose a disease by studying taxonomies, although taxonomies do help him communicate to other healthcare providers. He does not diagnose a disease by following a process, although he might go through an informal process in his head. He diagnoses a disease by applying his practice skills. These practice skills include his experience, training, and ongoing relationships with his colleagues.

How do you choose a physician? Do you grill candidates on how well they know the taxonomy of medicine? Do you sit candidates down and ask for a detailed description of the methodology each follows to diagnose illness? Probably not. You might ask your friends, but they probably only know a limited pool of candidates.

One approach to choosing a physician is to go to a well-known institution (a hospital or medical school) and choose from among their staff. In this approach, you are counting on the institution to choose highly qualified physicians and to have developed a community that encourages collaboration and best practices.

Does that institution insist on a rigid methodology for its physicians to follow? Probably not. Even if it does, it is not your primary concern. You are not even concerned with who the physicians in the institution are—although, in time, that will be of more interest to you. Your initial concern is only the reputation of the institution.

This is very similar to the Gartner approach to enterprise architecture. You don't bring in Gartner because they do or don't use TOGAF. You don't go to Gartner because they do or don't follow Zachman's taxonomy. You go to Gartner because they are well-known in their field. You assume both that they hire well-qualified specialists and that they have developed a community that encourages collaboration and best practice.

If you are a Gartner customer and you check the Garner library for research notes describing their enterprise-architecture practice, you can find many such documents. For example, there is "Gartner Enterprise Architecture Process: Evolution 2005" [36] and "Gartner Enterprise Architecture Framework: Evolution 2005" [37]. However, these documents contain little descriptive information and, in any case, are dated in the late-2005 timeframe. Gartner contends that these best practices are timeless, and they continue to augment them as appropriate. The current Gartner methodology was not solidified until probably April of 2006, after the Gartner/Meta merger that I described in the history section.

The best summation of the Gartner practice that I have heard is the following:

Architecture is a verb, not a noun.

What does it mean to say that architecture is a verb, not a noun? It means that it is the ongoing process of creating, maintaining, and, especially, leveraging an enterprise architecture that gives an enterprise architecture its vitality. An architecture that is just a bunch of stiff artifacts that sit in a corner gathering dust is useless, regardless of how sophisticated your taxonomy is for categorizing those artifacts or how brilliant your process is that guided their development.

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Gartner believes that enterprise architecture is about bringing together three constituents: business owners, information specialists, the technology implementers. If you can bring these three groups together and unify them behind a common vision that drives business value, you have succeeded; if not, you have failed. Success is measured in pragmatic terms, such as driving profitability, not by checking off items on a process matrix.

Gartner believes that the enterprise architectures must start with where an organization is going, not with where it is. If we are going to clean house, we don't need to exhaustively document everything we are throwing out. Let's focus our energy on what we want to end up with. As soon as we know our goal, we can see how what we have relates to that goal.

Gartner recommends that an organization begin by telling the story of where its strategic direction is heading and what the business drivers are to which it is responding. Gartner will want this story in plain language, without worrying about prescribed documentation standards, acronyms, or techno-babble. The only goal is making sure that everybody understands and shares a single vision.

Most organizations are facing major changes in their business processes. The process of creating an enterprise-architecture vision is the organization's opportunity to sit down, take a collective breath, and ensure that everybody understands the nature, the scope, and the impact of those changes.

As soon as an organization has this single shared vision of the future, it can consider the implications of this vision on the business, technical, information, and solutions architectures of the enterprise. The shared vision of the future will dictate changes in all of these architectures, assign priorities to those changes, and keep those changes grounded in business value.

Enterprise architecture, in the Gartner view, is about strategy, not about engineering. It is focused on the destination. The two things that are most important to Gartner are *where an organization is going* and *how it will get there*. Any architectural activity that is extraneous to these questions is irrelevant. "Just enough enterprise architecture, just in time," is another saying you will hear from the Gartner analyst.

Let's say Cath (MedAMore's CEO) likes what she hears. How is a Gartner engagement likely to proceed? With FEA, TOGAF, or Zachman, Cath needs to start by finding a qualified consultant who understands the methodology. With Gartner, this step is much easier: She merely calls Gartner.

Let's say Gartner sends Greg, the Gartner EA consultant. The first thing Greg will want to do is make sure the architecture is driven from the highest levels of the corporation. The fact that he is being called by MedAMore's CEO will be very reassuring.

Exactly how Greg will proceed is difficult to predict, because Gartner does not have a firm, step-by-step process. However, it is likely that he will start by focusing on Cath's strategic vision for MedAMore. He will want her to specify her vision in business terms and resist any temptation to discuss technology. Here are some possible business-vision statements Greg might elicit:

- MedAMore will have stores in at least 30 states, spread out over 8 geographic regions, by the year 2010. It will accomplish this mainly through acquisition of regional pharmacies.
- MedAMore will be able to assimilate new regional systems within 120 days of finalization of purchase.
- MedAMore will reduce its purchasing costs by 10 percent, by consolidating all regional purchasing into a central system.

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- MedAMore's central office will be able to view consolidated sales and inventory reports from all stores that include data up to and including the previous day.
- MedAMore will be able to reduce its inventory on-hand to no more than a five-day supply.
- MedAMore will be able to invoice insurance companies by the end of the day on which the prescription was delivered to the patient.
- Patients will be able to transfer prescriptions from any MedAMore pharmacy to any other.
- Patients will be able to request prescription refills though a Web interface and receive e-mail notification of their availability for pick-up.

Notice that none of these visionary statements mentions technology (except as a delivery mechanism, in the last statement). Greg is purposely keeping these early discussions focused on business strategy.

Any one of Cath's vision "bullets" will have major ramifications across the business, information, and technical architectures. Part of Greg's job will be to prioritize the bulleted items. Let's say Cath decides that her highest priority is consolidating purchasing, because this will improve profitability in the near term.

Greg will soon work to turn Cath's idea about consolidated purchasing into a common-requirements vision (CRV). The CRV is where we will see some of the changes that will be required to drive Cath's vision for MedAMore. Greg will be going over the business changes with Bret and the technical and information changes with Irma, but he will also be working to bring everybody together as a unified team.

Greg will work with Bret (the business VP) to develop a target business architecture that supports consolidated purchasing. As soon as they have spec'd out the future system, they will also look at their current architecture to see what can be recycled.

Greg will work with Irma (the CIO) to develop a target information architecture that allows the home office to track regional inventories and consolidate procurement. They will also work on the technical architecture for the IT systems that will support the new business architecture. After they understand the future, they will look at current architectures for opportunities to reuse existing technology assets.

After Greg has completed the broad-brush architecture for their strategic vision, he will probably step back from the picture until the consolidated purchasing system has been implemented. If Cath needs help with the implementation of the architecture, she will likely look outside of Gartner, because Gartner does not do implementations.

As soon as the implementation of consolidated purchasing has been completed, Greg will step back in to help with the next iteration. His approach will be to keep the architecture at a high level, business-focused, and hone in on details only when and where necessary. He will continue to see his role not as creating an enterprise architecture for MedAMore, but helping them institute a process for allowing an enterprise architecture to emerge and evolve from the business strategy.

4.7 Comparison

As you can see, the leading enterprise-architecture methodologies are very different in their approaches. Which one is best for your organization? There is no one answer to this question. I'll take you through the 12 criteria that I most often use for comparing and evaluating

enterprise-architectural methodologies. Not all of these criteria might be relevant to your organization, and some might be more important than others. But, at least, this section can serve as a starting point for your own evaluation.

I'll rank each methodology in each criteria. The ratings will be assigned as follows:

- 1: Does a very poor job in this area
- 2: Does an inadequate job in this area
- 3: Does an acceptable job in this area
- 4: Does a very good job in this area

Keep in mind that these ratings are subjective. I'm sure most people would disagree with at least one of my ratings.

Taxonomy completeness refers to how well you can use the methodology to classify the various architectural artifacts. This is almost the entire focus of Zachman. None of the other methodologies focuses as much on this area. Ratings:

- Zachman: 4
- TOGAF: 2
- FEA: 2
- Gartner: 1

Process completeness refers to how fully the methodology guides you through a step-by-step process for creating an enterprise architecture. This is almost the entire focus of TOGAF, with its Architecture Development Method (ADM). Ratings:

- Zachman: 1
- TOGAF: 4
- FEA: 2
- Gartner: 3

Reference-model guidance refers to how useful the methodology is in helping you build a relevant set of reference models. This is almost the entire focus of FEA. TOGAF also provides support; however, I am less impressed with the TOGAF reference models. Ratings:

- Zachman: 1
- TOGAF: 3
- FEA: 4
- Gartner: 1

Practice guidance refers to how much the methodology helps you assimilate the mindset of enterprise architecture into your organization and develop a culture in which it is valued and used. This is a primary focus of Gartner's architectural practice. Ratings:

- Zachman: 1
- TOGAF: 2
- FEA: 2
- Gartner: 4

Maturity model refers to how much guidance the methodology gives you in assessing the effectiveness and maturity of different organizations within your enterprise in using enterprise architecture. Ratings:

- Zachman: 1
- TOGAF: 1
- FEA: 3
- Gartner: 2

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Business focus refers to whether the methodology will focus on using technology to drive business value, in which business value is specifically defined as either reduced expenses and/or increased income. Ratings:

- Zachman: 1
- TOGAF: 2
- FEA: 1
- Gartner: 4

Governance guidance refers to how much help the methodology will be in understanding and creating an effective governance model for enterprise architecture. Ratings:

- Zachman: 1
- TOGAF: 2
- FEA: 3
- Gartner: 3

Partitioning guidance refers to how well the methodology will guide you into effective autonomous partitions of the enterprise, which is an important approach to managing complexity. Ratings:

- Zachman: 1
- TOGAF: 2
- FEA: 4
- Gartner: 3

Prescriptive catalog refers to how well the methodology guides you in setting up a catalogue of architectural assets that can be reused in future activities. Ratings

- Zachman: 1
- TOGAF: 2
- FEA: 4
- Gartner: 2

Vendor neutrality refers to how likely you are to get locked-in to a specific consulting organization by adopting this methodology. A high rating here indicates low vendor lock-in. Ratings:

- Zachman: 2
- TOGAF: 4
- FEA: 3
- Gartner: 1

Information availability refers to the amount and quality of free or inexpensive information about this methodology. Ratings:

- Zachman: 2
- TOGAF: 4
- FEA: 2
- Gartner: 1

Time to value refers to the length of time you will likely be using this methodology before you start using it to build solutions that deliver high business value. Ratings:

- Zachman: 1
- TOGAF: 3
- FEA: 1
- Gartner: 4

The criteria and ratings are summarized in the following table.

	Ratings			
Criteria	Zachman	TOGAF	FEA	Gartner
Taxonomy completeness	4	2	2	1
Process completeness	1	4	2	3
Reference-model guidance	1	3	4	1
Practice guidance	1	2	2	4
Maturity model	1	1	3	2
Business focus	1	2	1	4
Governance guidance	1	2	3	3
Partitioning guidance	1	2	4	3
Prescriptive catalog	1	2	4	2
Vendor neutrality	2	4	3	1
Information availability	2	4	2	1
Time to value	1	3	1	4

Table 11: Criteria and ratings for each methodology

One of the important points of Figure 31 is that none of the enterprise-architecture methodologies is really complete. Each has its strengths and weaknesses.

How do you choose which methodology is best for you? Below could be a useful approach:

1. Go through the rows (criteria) in Figure 10, removing any that you feel are not relevant or unimportant to your enterprise.
2. Add more rows (criteria) that you see are important, and rate each of the methodologies in that domain.
3. Modify any of the ratings with which you do not agree.

At the end of this exercise, you should have a good idea about the strengths and weaknesses of each methodology with respect to your enterprise's needs. If a clear winner emerges, consider yourself very lucky. Seek a consultancy firm who specializes in helping enterprises implement that methodology, and just go for it.

For many organizations, there will be no clear winner. For such organizations, I recommend you use a blended approach, in which you create your own enterprise-architectural methodology consisting of bits and pieces of each of the methodologies that provide the highest value in your specific areas of concern.

You will want a different kind of consultant—one who has a broad perspective of all of these methodologies and specializes in helping enterprises create a methodology that works best, given the specific needs and political realities of that enterprise.

In his white paper, Roger Sessions has made the following conclusion:

This paper has covered a broad introduction to the field of enterprise architecture. The history of the field goes back 20 years, but the field is still evolving—and rapidly so. Two of the four

major methodologies (Gartner and FEA) have undergone major changes in the last two years alone.

As I have shown, these methodologies are quite different from each other, both in goals and in approach. This is good news and bad. It is bad news, in that it increases the difficulty for many organizations in choosing one single enterprise-architectural methodology. How do you choose between methodologies that have so little in common? Choosing between Zachman and TOGAF, for example, is like choosing between spinach and hammers.

But the good news is that these methodologies can be seen as complementing each other. For many organizations, the best choice is all of these methodologies, blended together in a way that works well within that organization's constraints. This white paper should provide a good starting place for understanding the value of each of these methodologies and how they can complement each other.

Whichever route you choose, remember that enterprise architecture is a path, not a destination. An enterprise architecture has no value unless it delivers real business value as quickly as possible. One of the most important goals of any enterprise architecture is to bring the business side and the technology sides together, so that both are working effectively toward the same goals.

In many organizations, there is a culture of distrust between the technology and business folks. No enterprise-architecture methodology can bridge this divide unless there is a genuine commitment to change. *That commitment must come from the highest level of the organization.* Methodologies cannot solve people problems; they can only provide a framework in which those problems can be solved.

But, as soon as you have that commitment to change, an enterprise-architecture methodology can be a valuable tool for guiding that change. This change can manifest itself in many ways. Some of the predicted benefits from a successfully implemented enterprise architectural include:

- Improvements in using IT to drive business adaptability.
- Closer partnership between business and IT groups.
- Improved focus on organizational goals.
- Improved morale, as more individuals see a direct correlation between their work and the organization's success.
- Reduced numbers of failed IT systems.
- Reduced complexity of existing IT systems.
- Improved agility of new IT systems.
- Closer alignment between IT deliverables and business requirements.

Naturally, an enterprise that does well in these main domains will be more effective than an organization that does not. This is evident irrespective of whether success is measurable (tangibles), such as profitability and return on investment, or immeasurable (intangibles), such as customer satisfaction and employee turnover.

Some critical self-analysis are important as a starting point for any enterprise architecture and Roger Sessions considered the following questions just as critical:

- Does your organization spend too much money building IT systems that deliver inadequate business value?
- Is IT seen as improving or hampering business agility?
- Is there a growing divide between your business and IT folks?

- And, finally, perhaps the most important question of all: Is your organization truly committed to solving these problems, and does that commitment come from the highest levels of the organization?

If the answer to all of these questions is "yes," enterprise architecture is your path. It's up to you to take that next step.

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