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Handbook on Business Process Management 1

Introduction, Methods, and Information Systems

2nd Edition

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Handbook on Business Process Management 1

Introduction, Methods, and Information Systems

Second Edition

Springer

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to my wonderful wife Christina and our lovely kids Moritz and Marieke

from Jan

to Louise, Noah and Sophie – with love

from Michael

Foreword to the 2nd Edition

The *BPM Handbook* brings the thought leaders around the globe together to present the comprehensive body of knowledge in Business Process Management (BPM). The first edition summarized the work of more than 100 of the world's leading experts in the field in 50 chapters and two volumes. Following the structure of BPM's six well-established core elements—strategic alignment, governance, methods, information systems, people, and culture—the *BPM Handbook* provides a comprehensive view of the management of processes using an enterprise-wide scope. After more than 5,000 hard copies sold and more than 60,000 single chapters downloaded, we are overwhelmed by and grateful for the positive reception of this book by BPM professionals and academics. Today, the BPM handbook ranges among the top 25 % most downloaded eBooks in the Springer eBook Collection.

Since the first edition was published in 2010, BPM has further developed and matured. New technologies provide new process design options. For example, in-memory databases afford new opportunities in the form of real-time and context-aware process execution, monitoring, and mining, and social media plays a vital role in embedding business processes in corporate and wider communities. At the same time, new challenges, such as increased demand in process innovation, process analytics, and process agility, have emerged. These and other organizational developments have expanded the status and the possibilities of BPM and motivated us to conduct a detailed review, update, and extension of the *BPM Handbook*, the second edition.

The structure of this second edition still centers on the six core elements of BPM while incorporating new topics and providing substantial revisions in the areas of theoretical foundations of BPM, practical applications to real-life scenarios, and a number of updates in order to reflect the most current progress in the field.

The new chapters address recent developments, such as in-memory technology and social media, as well as cases that show how BPM can be applied to master the contemporary challenges of process innovation, agility, and sustainability. We learned from our readers that introductory chapters to the six core elements of BPM are useful, as are advanced chapters that build on rigorous BPM research.

Therefore, we added a number of chapters to provide such introductions to the work on process frameworks, process simulation, process value, process culture, and process technologies. In the process, we welcomed a number of BPM experts to our team of authors, including Anna Sidorova, Jerry Luftman, and Hasso Plattner and their respected co-authors.

Some parts of the Handbook remain untouched, such as the contributions from Michael Hammer and Geary A. Rummler, who both passed away in 2008. Their thoughts remain and will always be inspirational for the BPM community.

We are grateful to the many people who worked enthusiastically on making the second edition of the *BPM Handbook* possible. In particular, we thank Christian Sonnenberg, from the Institute of Information Systems of the University of Liechtenstein, who brought order and discipline to the first edition and who has again been instrumental in the editorial process of the second edition. His strong commitment to this Handbook has been a critical factor in its success. We also thank Christian Rauscher from Springer for his strong support of this second edition and all of the authors for the significant time and effort they invested in writing and revising their chapters.

We trust that this consolidated work will find a wide audience and that this updated and extended edition will further contribute to shaping the BPM field as a management discipline.

May 2014 — Jan vom Brocke
Vaduz, Liechtenstein/Brisbane, Australia — Michael Rosemann

Foreword to the 1st Edition

Business Process Management (BPM) has emerged as a comprehensive consolidation of disciplines sharing the belief that a process-centered approach leads to substantial improvements in both performance and compliance of a system. Apart from productivity gains, BPM has the power to innovate and continuously transform businesses and entire cross-organizational value chains. The paradigm of "process thinking" is by no means an invention of the last two decades but had already been postulated by early economists such as Adam Smith or engineers such as Frederick Taylor.

A wide uptake of the process paradigm began at an early stage in the manufacturing sector, either as a central principle in planning approaches such as MRP II or as a factory layout principle. Yet, it took an amazingly long period of time before the service industries actually recognized the significance of processes as an important organizational variable. The ever increasing pressure in the ultimate journey for corporate excellence and innovation went along with the conception of a "process" as a unit of analysis and increasingly appeared in various disciplines.

As part of quality management, the critical role of process quality led to a plethora of process analysis techniques that culminated in the rigorous set of Six Sigma methods. In the information technology discipline, the process became an integral part of Enterprise Architectures and conceptual modeling frameworks. Processes became a "first class citizen" in process-aware software solutions and, in particular, in dedicated BPM-systems, formerly known as workflow management systems. Reference models such as ITIL or SCOR postulated the idea of best (process) practices, and the accounting discipline started to consider processes as a controlling object (Activity-Based Costing). Universities are now slowly starting to build Business Process Management courses into their curricula, while positions such as business process analysts or chief process officers are increasingly appearing in organizational charts.

However, while the role of processes has been widely recognized, an all-encompassing discipline promoting the importance of process and providing integrated BPM methodologies has been lacking for a long time. This may be a major reason why process thinking is still not as common as cost awareness, employee focus, or ethical considerations.

BPM is now proposed as the spanning discipline that largely integrates and completes what previous disciplines have achieved. As such, it consolidates how to best manage the (re-)design of individual business processes and how to develop a foundational Business Process Management capability in organizations catering for a variety of purposes and contexts.

The high demand for BPM has encouraged a number of authors to contribute and capture different facets in the form of textbooks. Despite a substantial list of references, the BPM community is still short of a publication that provides a consolidated understanding of the true scope and contents of a comprehensively defined Business Process Management.

It has been our motivation to fill the gap for a point of reference that reflects the holistic nature of BPM without compromising the detail. In order to structure this Handbook, we defined BPM as consisting of six core factors, i.e., Strategic Alignment, Governance, Methods, Information Systems, People, and Culture. These six factors had been derived as part of a multiyear global research study on the essential factors of BPM maturity.

We now present a Handbook that covers these six factors in two volumes comprising more than 1,500 pages from over 100 authors including the world's leading experts in the field. Different approaches of BPM are presented reflecting the diversity of the field. At the same time, we tried to provide some guidance, i.e., by means of the six core elements, to make it easy to open up the various facets of BPM according to individual preferences. We give further comment on that in the "how to read this book" section.

Both volumes together reflect the scope of BPM. Each volume has been organized to have its own focus. The first volume includes the introduction to BPM and concentrates on its Methods and Process-Aware Information Systems. The second volume captures in three sections: Strategic Alignment, Governance, and People, and Culture. Both volumes combine the latest outcomes of high standing BPM research with the practical experiences gained in global BPM projects.

This first volume is clustered in three sections.

1. A set of five introductory chapters provides an overview about the current understanding of the aims, boundaries, and essence of BPM. We are particularly proud that we were able to secure the contributions of the global BPM thought leaders for this critical section.
2. The second section is dedicated to the heavily researched area of BPM Methods covering, in particular, process lifecycle methods such as Six Sigma and the essential role of process modeling in 12 chapters. Further, complementary chapters discuss process simulation, process variant management, and BPM tool selection.
3. The third section covers Process-Aware Information Systems and elaborates in nine chapters on the foundational role of workflow management, the agility that results from service-enabled business processes and the new potential related to the uptake of recommender systems or collaborative networking tools.

We are very grateful to the outstanding, carefully crafted, and responsibly revised contributions of the authors of this Handbook. All contributions have undergone a rigorous review process, involving two independent experts in two to three rounds of review. The unconditional commitment to a high quality Handbook required, unfortunately, in some cases, rejections or substantial revisions. In any case, all authors have been very responsive in the way they addressed the requested changes. We are very much aware of the sum of the work that went into this book and cannot appropriately express our gratitude in the brevity of such a foreword.

While producing this Handbook, the authors' enthusiasm was truly interrupted as we in the community were confronted with and saddened by the tragic loss of two of the most inspirational BPM thought leaders the world has seen. Michael Hammer, founder of the Business Process Reengineering discipline and maybe the most successful promoter of the process paradigm, passed away in September 2008. Shortly after, Geary A. Rummler, a pioneer in terms of the role of business process as part of the corporate search for organizational performance, died in October 2008. We are honored that this Handbook features some of the last inspirations of these two admirable individuals; we also recognize that the BPM community will be a poorer place without them.

A special expression of our gratefulness goes to Karin-Theresia Federl and Christian Sonnenberg, Institute of Information Systems, University Liechtenstein, who brought order and discipline to the myriad of activities that were required as part of the compilation of this Handbook. We hope that this Handbook on Business Process Management will provide a much appreciated, sustainable summary of the state of the art of this truly exciting discipline and that it will have the much desired positive impact for its future development and uptake.

June 2010 Jan vom Brocke
Vaduz, Liechtenstein/Brisbane, Australia Michael Rosemann

How to Read this Handbook

This book brings together input from BPM experts worldwide. It incorporates a rich set of viewpoints all leading towards an holistic picture of BPM. Compiling this Handbook, we did not intend to force all authors to go under one unique doctrine. On the contrary, we felt that it is rather the richness of approaches and viewpoints covered that makes this book a unique contribution. While keeping the original nature of each piece, we provide support in navigating through the various chapters.

- *BPM Core Elements:* We identified six core elements of BPM that all authors are using as a framework to position their contribution. You will find an introductory chapter in volume 1 of this Handbook explaining these elements in detail.
- *BPM Cross-References:* We asked each author to thoroughly read corresponding chapters and to include cross-references to related sections of the BPM Handbook. In addition, further cross-references have been included by the editors.
- *BPM Index:* Both volumes have a detailed index. In order to support a maximum of integration in each volume the keywords of the other volume are also incorporated.
- *BPM Who-is-Who:* We added an extended author index to each volume serving as a who-is-who. This section illustrates the individual background of each author that might be helpful in contextualizing the various contributions to the BPM Handbook.

We truly hope that these mechanisms help you in choosing the very the chapters of this BPM Handbook most suitable for your individual interest.

Contents

Part I
Introduction

The past 20 years have brought increasing interest in the domain of Business Process Management (BPM) by an ever-growing community of managers, end users, analysts, consultants, vendors, and academics. This growing interest is visible in a substantial body of knowledge, an expanding scope, and a plethora of methodologies, tools, and techniques. While the demand for BPM increases and BPM capabilities mature, the challenge to provide concise and widely accepted definitions, taxonomies, and overall frameworks for BPM has grown.

Being able to attract the world's leading minds from within the BPM community behind the ambitions of this Handbook has been a great honor for us. This introductory section features the contemporary views of global thought leaders who have shaped the understanding, development, and uptake of BPM.

In the opening chapter Michael Hammer seeks to answer the essential question, "What Is Business Process Management?" Hammer characterizes BPM as the first fundamental set of new ideas on organizational performance since the Industrial Revolution, discussing the origins of BPM, the process management cycle, and its benefits, enablers, and necessary capabilities. All these lead to an extended set of BPM principles and the role of enterprise process models.

In the next chapter, Thomas Davenport correlates BPM with knowledge management to explore the challenges of process design for knowledge-intensive processes. In this context Davenport discusses the creation, distribution, and application of knowledge, contrasts the processes and the practice in knowledge work, and lists process interventions. The chapter raises awareness of the challenges of BPM that emerge once the transactional processes are covered.

Critics often describe BPM as a concept with a limited lifespan, but Paul Harmon argues convincingly in the third chapter that BPM is the culmination of a series of mature concepts sharing a passion for process. Harmon outlines the concepts and outcomes of three important process traditions—quality management, business management, and information technology—and reflects on the thought leaders for each of the three traditions and the "today and tomorrow" of BPM. Harmon's differentiation between the enterprise level and process level is picked up in a number of contributions in this handbook.

One of the earliest contributors to the field of process-based management, Geary Rummler provides thoughts on the structure of work. Co-authored with Alan Ramias, Rummler's chapter focuses on the business layer in an enterprise architecture and discusses the importance of a sound understanding of value creation and a corresponding management system. Rummler and Ramias stress that business (process) architectures cannot stand in isolation but must be linked to other architectural frameworks in order to form a complete value creation architecture.

The fifth chapter, by Michael Rosemann and Jan vom Brocke, introduces the underlying structure for both volumes of the *BPM Handbook*. Six complementary core elements of BPM, which provide a framework for BPM, must be addressed as part of enterprise-wide, effective BPM initiatives. This chapter describes the essence of these factors, which are explored in more detail in the various sections of this handbook.

1. What is Business Process Management?
   by Michael Hammer
2. Process Management for Knowledge Work
   by Thomas Davenport
3. The Scope and Evolution of Business Process Management
   by Paul Harmon
4. A Framework for Defining and Designing the Structure of Work
   by Geary Rummler and Alan Ramias
5. The Six Core Elements of Business Process Management
   by Michael Rosemann and Jan vom Brocke

What is Business Process Management?

Michael Hammer†

Abstract Googling the term "Business Process Management" in May 2008 yields some 6.4 million hits, the great majority of which (based on sampling) seem to concern the so-called BPM software systems. This is ironic and unfortunate, because in fact IT in general, and such BPM systems in particular, is at most a peripheral aspect of Business Process Management. In fact, Business Process Management (BPM) is a comprehensive system for managing and transforming organizational operations, based on what is arguably the first set of new ideas about organizational performance since the Industrial Revolution.

1 The Origins of BPM

BPM has two primary intellectual antecedents. The first is the work of Shewhart and Deming (Shewhart 1986; Deming 1953) on statistical process control, which led to the modern quality movement and its contemporary avatar, Six Sigma. This work sought to reduce variation in the performance of work by carefully measuring outcomes and using statistical techniques to isolate the "root causes" of performance problems – causes that could then be addressed. Much more important than the details of upper and lower control limits or the myriad of other analytic tools that are part of quality's armamentarium are the conceptual principles that underlie this work: the core assumption that operations are of critical importance and deserve serious attention and management; the use of performance metrics to determine whether work is being performed satisfactorily or not; the focus on hard data rather than opinion to isolate the root causes of performance difficulties; the concept of blaming the process not the people, that performance shortcomings are rooted in objective problems that can be identified and dealt with; and the notion

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of never-ending improvement, that solving one set of problems merely buys an organization a ticket to solve the next round.

The quality approach suffered from two limitations, however. The first was its definition of process as essentially any sequence of work activities. With this perspective, an organization would have hundreds or even thousands of processes, from putting a parts box on a shelf to checking customer credit status, and the machinery of quality improvement could be applied to any and all of these. Focusing on such narrow-bore processes, however, is unlikely to have strategic significance for the enterprise as a whole; on the other hand, it is likely to result in a massive number of small-scale projects that can be difficult to manage in a coherent fashion. Even more seriously, the quality school took as its goal the elimination of variation and the achievement of consistent performance. However, consistent is not a synonym for good. A process can operate consistently, without execution flaws, and still not achieve the level of performance required by customers and the enterprise.

The other primary antecedent of BPM, my own work on Business Process Reengineering (Hammer 1990; Hammer and Champy 1993), had complementary strengths and weaknesses. On the one hand, at least in its early days, reengineering was positioned as an episodic rather than an ongoing effort; it lacked the continuous dimension of quality improvement. It also did not have as disciplined an approach to metrics. On the other hand, it brought two new wrinkles to the process world. The first was its refined definition of process: end-to-end work across an enterprise that creates customer value. Here, putting a box on a shelf would not qualify as a meaningful process; it would merely be a small part of an enterprise process such as order fulfillment or procurement. Addressing large-scale, truly end-to-end processes means focusing on high-leverage aspects of the organization's operations and so leads to far greater results and impacts. In particular, by dealing with processes that cross functional boundaries, reengineering was able to attack the evils of fragmentation: the delays, nonvalue-adding overhead, errors, and complexity that inevitably result when work transcends different organizations that have different priorities, different information sources, and different metrics. The other new theme introduced by reengineering was a focus on process design as opposed to process execution. The design of a process, the way in which its constituent tasks are woven together into a whole, was not of much concern to the founders of the quality school; they made a tacit assumption that process designs were sound, and that performance difficulties resulted from defects in execution. Reengineering recognized that the design of a process in fact created an envelope for its performance, that a process could not perform on a sustained basis better than its design would allow. Should performance requirements exceed what the design was capable of, the old design would have to be discarded and a new one substituted in its place.

2 The Process Management Cycle

Over the last decade, these two approaches to process performance improvement have gradually merged, yielding modern Business Process Management – an integrated system for managing business performance by managing end-to-end

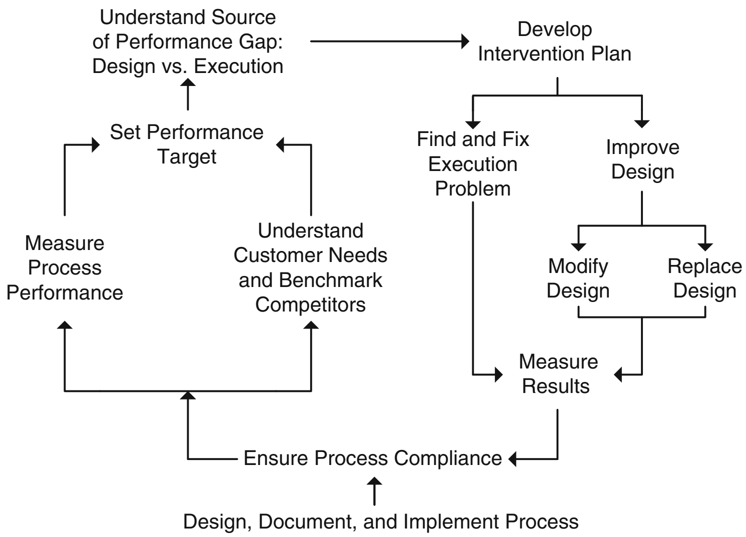

Fig. 1 The essential process management cycle

business processes. Figure 1 depicts the essential process management cycle. It begins at the bottom, with the creation of a formal process. This is not a minor, purely formal step. Many organizations find that certain aspects of their operations are characterized by wild variation, because they lack any well-defined end-to-end process whatsoever. This is particularly true of low-volume, creative processes such as product development or customer relationship management. In essence, they treat each situation as a one-off, with heroics and improvisation substituting for the discipline of a well-defined process. Such heroics are of course unreliable and unsustainable.

Once a process is in place, it needs to be managed on an ongoing basis. Its performance, in terms of critical metrics that relate to customer needs and company requirements, needs to be compared to the targets for these metrics. Such targets can be based on customer expectations, competitor benchmarks, enterprise needs, and other sources. If performance does not meet targets, the reason for this shortcoming must be determined. Broadly speaking, processes fail to meet performance requirements either because of faulty *design* or faulty *execution*; which one is the culprit can generally be determined by examining the pattern of performance inadequacy. (Pervasive performance shortcomings generally indicate a design flaw; occasional ones are usually the result of execution difficulties.) If the fault lies in execution, then the particular root cause (such as inadequate training, or insufficient resources, or faulty equipment, or any of a host of other possibilities) must be determined. Doing so is a challenging undertaking, because of the large number of possible root causes; as a rule, however, once the root cause has been found, it is easy to fix. The opposite is true of design problems: they are easy to find (being indicated by consistently inadequate performance) but hard to fix (requiring a wholesale rethinking of the structure of the process). Once the appropriate intervention has been chosen and implemented, the results are assessed, and the entire cycle begins again.

This cycle is derived from Deming's PDCA cycle (Plan Do Check Act) (Deming 1986), with the addition of the attention to process design. Although this picture is quite simple, it represents a revolutionary departure for how enterprises are managed. It is based on the premise that the way to manage an organization's performance is not by trial and error, not by pushing people harder, and not through financial manipulation, but through the deliberate management of the end-to-end business processes through which all customer value is created. Indeed, BPM is a customer-centered approach to organizational management. Customers neither know nor care about the many issues that typically are at the center of most executives' attention: strategies, organizational designs, capital structures, succession plans, and all the rest. Customers care about one thing and one thing only: results. Such results are not acts of God or the consequence of managerial genius; they are the outputs of business processes, of sequences of activities working together. Customers, results, and processes form an iron triangle; an organization cannot be serious about anyone without being equally serious about the other two.

To illustrate the process management cycle in action, consider the claims handling process at an auto insurance company. The old process consisted of the claimant reporting an accident to an agent, who passed it on to a customer service representative at the insurer, who passed it on to a claims manager, who assigned it with a batch of other claims to an adjustor, who then contacted the claimant and scheduled a time to inspect the vehicle. Because of the handoffs in this process, and the associated inevitable misunderstandings, it typically took 7–10 days before the adjustor arrived to see the vehicle. While this was no worse than others in the industry, the insurer's CEO recognized that this represented an opportunity to improve customer satisfaction at a "moment of truth," and insisted that this cycle time be reduced to 9 hours. No amount of productivity improvement in the individual activities would have approached this target, since the total actual work time was very little – the problem was in the process, not in the tasks. Accordingly, the company created a completely new process, in which claimants called a toll-free phone number and were connected directly to an adjustor, who took responsibility for the case and dispatched a teammate driving a mobile claims van in the field to the vehicle; upon arriving, the teammate would not only estimate the amount of damage but try to settle the claim on the spot. This new process was both much more convenient for customers and less expensive for the company, and was key to the company increasing revenue by 130% while increasing headcount by only 5%.

However, this was the beginning, not the end, for the process. Just having a good design does not guarantee continued good results, because problems are inevitable in the real world. Computers break, people do not absorb their training, data gets corrupted, and so on and so forth, and as a result a process does not achieve the performance of which it is capable. The company used process management to monitor the performance of the process and recognize and correct such performance problems. It also stayed alert to opportunities to modify the process design to make it perform even better. At one point, the company realized that the process as designed was not necessarily sending the most appropriate adjustor to the scene of the accident but just the next available one; a change to the design was made to address this. Of late, the company's management has gone further. They recognized flaws in the process design – for instance, that it required adjustors to make damage estimates "at midnight in the rain". Accordingly, they have come up with an even newer process, in which the claimant brings the damaged car to a company facility and picks up a loaner car; the adjustor estimates the damage at this facility and then arranges for the repair to be done by a garage. When the car is fixed, the claimant comes back and exchanges the loaner for his own car. This is much easier for the customer, and much more accurate and less costly for the company.

3 The Payoffs of Process Management

Through process management, an enterprise can create high-performance processes, which operate with much lower costs, faster speeds, greater accuracy, reduced assets, and enhanced flexibility. By focusing on and designing end-to-end processes that transcend organizational boundaries, companies can drive out the nonvalue-adding overhead that accumulates at these boundaries. Through process management, an enterprise can assure that its processes deliver on their promise and operate consistently at the level of which they are capable. Through process management, an enterprise can determine when a process no longer meets its needs and those of its customers and so needs to be replaced.

These operational benefits of consistency, cost, speed, quality, and service translate into lower operating costs and improved customer satisfaction, which in turn drive improved enterprise performance. Process management also offers a variety of strategic benefits. For one, process management enables companies to respond better to periods of rapid change (such as ours). Conventional organizations often do not even recognize that change is happening until it is reflected in financial performance, by which time it is too late; even should they recognize that change has occurred, they have no mechanism for responding to it in a disciplined fashion. Under a process management regime, by contrast, change is reflected in the decline of operational performance metrics, which are noted by the process management system; the design of the process is then the tool through which the organization can respond to this change. Process management also provides an umbrella for a wide range of other performance improvement initiatives, from globalization and merger integration to ERP implementation and e-business. Too many enterprises treat each of these phenomena as independent, which leads to a proliferation of uncoordinated and conflicting change initiatives. In fact, they are all either mechanisms for supporting high-performance processes or goals that can be achieved through them. Linking all of a company's improvement efforts under the common umbrella of process management, and managing them in an integrated fashion, leverages a wide range of tools and deploys the right tool to the right problem.

Thousands of organizations, large and small, private and public, are reaping extraordinary benefits by managing their end-to-end business processes. A handful of recent examples:

- A consumer goods manufacturer redesigned its product deployment process, by means of which it manufactures goods and delivers them to its distribution centers; inventory was reduced by 25% while out-of-stock situations declined by 50%.
- A computer maker created a new product development process, which reduced time to market by 75%, reduced development costs by 45%, and increased customer satisfaction with new products by 25%.
- A capital goods manufacturer increased by 500% the accuracy of the availability dates on new products that it gave customers and reduced its supply chain costs by up to 50%.
- A health insurer created a new process for engaging with its customers and reduced costs by hundreds of millions of dollars while improving customer satisfaction.

Something to note in these and many other cases is the simultaneous achievement of apparently incompatible goals: reducing inventory, say, while also reducing out-of-stocks. Traditional organizations view these as conflicting goals and trade one off against another; process-managed organizations recognize that they can be improved by creating a new process design.

4 The Enablers of Process

Despite its elegance and power, many organizations have experienced difficulties implementing processes and process management. For instance, an electronics company designed a new product development process that was based on cross-functional product teams, but they were unable to successfully install it and get it operating. The reason, as they put it, is that "you can't overlay high performance processes on a functional organization". Traditional organizations and their systems are unfriendly to processes, and unless these are realigned to support processes, the effort will fail.

There are five critical enablers for a high-performance process; without them, a process will be unable to operate on a sustained basis (Hammer 2007).

Process design. This is the most fundamental aspect of a process: the specification of what tasks are to be performed, by whom, when, in what locations, under what circumstances, to what degree of precision, with what information, and the like. The design is the specification of the process; without a design, there is only uncoordinated individual activity and organizational chaos.

Process metrics. Most enterprises use functional performance metrics, which create misalignment, suboptimization, and confusion. Processes need end-to-end metrics that are derived from customer needs and enterprise goals. Targets need to be set in terms of these metrics and performance monitored against them. A balanced set of process metrics (such as cost, speed, and quality) must be deployed, so that improvements in one area do not mask declines in another.

Process performers. People who work in processes need a different set of skills and behaviors from those who work in conventional functions and departments. They need an understanding of the overall process and its goals, the ability to work in teams, and the capacity to manage themselves. Without these characteristics, they will be unable to realize the potential of end-to-end work.

Process infrastructure. Performers need to be supported by IT and HR systems if they are to discharge process responsibilities. Functionally fragmented information systems do not support integrated processes, and conventional HR systems (training, compensation, and career, etc.) reinforce fragmented job perspectives. Integrated systems (such as ERP systems and results-based compensation systems) are needed for integrated processes.

Process owner. In a conventional organization, no one is responsible for an end-to-end process, and so no one will be in a position to manage it on an end-to-end basis (i.e., carry out the process management cycle). An organization serious about its processes must have process owners: senior managers with authority and responsibility for a process across the organization as a whole. They are the ones who perform the work illustrated in Fig. 1.

Having some but not all of these enablers for a process is of little or no value. For instance, a well-designed process targeted at the right metrics will not succeed if performers are not capable of carrying it out or if the systems do not support them in doing so. Implementing a process in effect means putting in place these five enablers. Without them, a process may be able to operate successfully for a short term but will certainly fail in the long run.

5 BPM Capability for Process

The experiences of hundreds of companies show that not all are equally able to install these enablers and so succeed with processes and process management. Some do so effectively, while others do not. The root cause of this discrepancy lies in whether or not an enterprise possesses four critical capabilities that are prerequisites to its summoning the resources, determination, and skills needed to succeed with processes (Hammer 2007).

Leadership. The absolute sine qua non for effective deployment of process management is engaged, knowledgeable, and passionate senior executive leadership of the effort. Introducing processes means introducing enormous change – realigning systems, authority, modes of operation, and more. There is no change that most organizations have experienced that can compare to the disruption that the transition to process brings. Unless a very senior executive makes it his or her personal mission, process will run aground on the shoals of inertia and resistance. Moreover, only a topmost executive can authorize the significant resources and changes that process implementation requires. Without such leadership, the effort is doomed; with it, all other problems can be overcome.

Culture. A Chief Operating Officer once remarked to me, "When one of my people says he doesn't like process, he really means that he doesn't want to share power". Process, with its focus on customers, outcomes, and transcending boundaries is anathema to those who are focused on defending their narrow bit of turf. Process demands that people at all levels of the organization put the customer first, be comfortable working in teams, accept personal responsibility for outcomes, and be willing to accept change. Unless the organization's culture values these principles, processes will just roll off people's backs. If the enterprise culture is not aligned with these values, leadership must change the culture so that it does.

Governance. Moving to process management, and institutionalizing it over the long run, requires a set of governance mechanisms that assign appropriate responsibilities and ensure that processes integrate with one another (and do not turn into a new generation of horizontal silos). In addition to process owners, enterprises need a process office (headed by a Chief Process Officer) that plans and oversees the program as a whole and coordinates process efforts, as well as a Process Council. This is a body consisting of the process owners, the executive leader, and other senior managers, which serves as a strategic oversight body, setting direction and priorities, addressing cross-process issues, and translating enterprise concerns into process issues. These mechanisms need to be put in place to manage the transition to process, but continue on as the essential management superstructure for a process-managed enterprise.

Expertise. Implementing and managing processes is a complex and high stakes endeavor, not for the inexperienced or the amateur. Companies need cadres of people with deep expertise in process design and implementation, metrics, change management, program management, process improvement, and other relevant techniques. These people must have formal methodologies to follow and must be sustained with appropriate career paths and management support. While not an insuperable barrier, many organizations fail to develop and institutionalize this capability, and then unsurprisingly find themselves unable to carry out their ambitious programs.

Organizations without these four capabilities will be unable to make process management work, and must undertake urgent efforts to put them in place. Developing leadership is the most challenging of these; it typically requires the intervention of a catalyst, a passionate advocate of process with the ear of a potential leader, who must patiently familiarize the candidate with the concepts of process and their payoffs. Reshaping culture is not, despite myths to the contrary, impossible, but it does take time and energy. The other two are less difficult, but are often overlooked.

6 The Principles of Process Management

It can be helpful to summarize the concepts of process management in terms of a handful of axiomatic principles, some obvious, some not, that together express its key themes.

All work is process work. Sometimes the assumption is made that the concepts of process and process management only apply to highly structured, transactional work, such as order fulfillment, procurement, customer service, and the like. Nothing could be further from the truth. The virtues of process also adhere to developmental processes, which center on highly creative tasks, such as product development, demand creation, and so on. Process should not be misinterpreted as a synonym for routinization or automation, reducing creative work to simplistic procedures. Process means positioning individual work activities – routine or creative – in the larger context of the other activities with which it combines to create results. Both transactional and development processes are what is known as *core* processes – processes that create value for external customers and so are essential to the business. Organizations also have *enabling* (or support) processes, which create value for internal customers; these include hire to retire, information systems development, and financial reporting. Such processes have customers and create value for them (as must any process, by definition), but those customers are internal. The third category is *governing* processes, the management processes by means of which the company is run (such as strategic planning, risk management, and performance management). (Process management is itself a governing process!) All processes need to be managed as such and so benefit from the power of process management.

Any process is better than no process. Absent a well-defined process design, chaos reigns. Individual heroics, capriciousness, and improvisation rule the day – and results are inconsistent and unsustainable. A well-defined process will at the least deliver predictable, repeatable results, and can serve as the staging ground for improvement.

A good process is better than a bad process. This statement is not as tautological as it seems. It expresses the criticality of process design, that the caliber of a process design is a critical determinant of its performance, and that some processes are better designed than others. If a company is burdened with a bad process design, it needs to replace it with a better one.

One process version is better than many. Standardizing processes across all parts of an enterprise presents a single face to customers and suppliers, yields profound economies in support services such as training and IT systems, allows the redeployment of people from one business unit to another, and yields a host of other benefits. These payoffs must be balanced against the intrinsically different needs of different units and their customers, but our bias should be in favor of standardization.

Even a good process must be performed effectively. A good process design is a necessary but insufficient prerequisite for high performance; it needs to be combined with carefully managed execution, so that the capabilities of the design are realized in practice.

Even a good process can be made better. The process owner needs to stay constantly vigilant, looking for opportunities to make modifications to the process design in order to further enhance its performance.

Every good process eventually becomes a bad process. No process stays effective forever in the face of change. Customer needs change, technologies change, competition changes, and what used to be a high level of performance becomes a poor one – and it is time to replace the formerly good process with a new one.

7 The EPM as a Management Tool and BPMS

The foundation of process management is the Enterprise Process Model (EPM). This is a graphical representation of the enterprise's processes (core, enabling, and governing), showing their interconnections and inputs and outputs. Figure 1 is an example of such an EPM, from a large distributor of industrial products. An effective EPM should be simple and clear, fitting on one page, and typically including no more than 5–10 core processes. Such a high-level representation is then decomposed to provide additional detail, breaking each top-level process into a number of subprocesses, which are further decomposed into activities. There is as yet no standard (nor even near-standard) notation or architecture for process representation or for how many levels of detail are appropriate.

The EPM does more than just provide a vocabulary for a process program. It offers something few companies have, a coherent and comprehensible description of the company's operations. It is remarkable to note that conventional representations of an enterprise – the organization chart, the P&L and the balance sheet, the mission and value statements, the product catalog and customer list – say nothing about the actual work of the company and what people do on a regular basis. The EPM provides such an operational perspective on the enterprise and as such should be used as the basis for managing those operations.

In particular, the EPM offers a way of dealing with the projects and programs that constantly changing times raise, since ultimately every business issue must be translated into its impacts on and implications for operating processes. The following is a representative set of such issues that companies have recently needed to address:

- A risk management group has identified areas of high risk to the company. The processes that impact these risks need to be identified and redesigned in ways to help mitigate them.
- A new company has been acquired and there is a need to perform comparisons between the processes of the acquiring company and those of the acquired one, to help produce a roadmap for integrating the two companies by moving from the old processes to the new ones (Fig. 2).

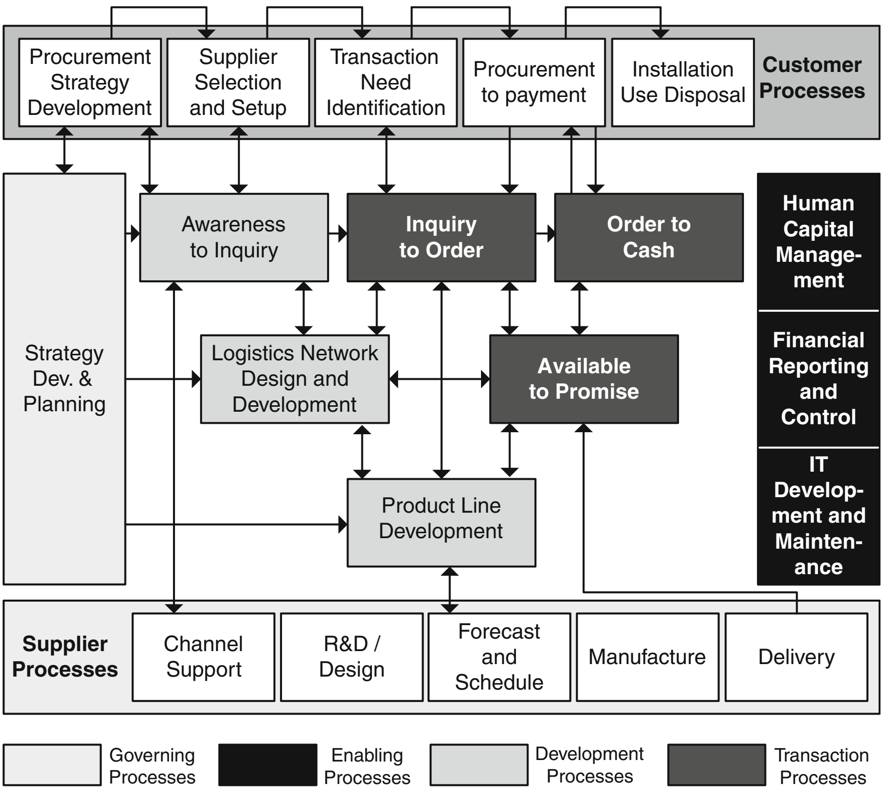

Fig. 2 Example of an enterprise process model (EPM)

- A new corporate strategy or initiative is announced, which entails changing the definitions of some of the company's key performance indicators (KPIs). The company needs to determine those process metrics that are drivers of these KPIs and update them appropriately.
- A change is made to some modules of an enterprise software system, and managers of different processes need to be made aware of the impact of the change on them.
- An activity that is used in several processes is modified in one of them, and these changes need to be reflected in all other occurrences of that activity.
- When a change is made to a business policy, it is necessary to make appropriate corresponding changes to all those processes in which it is embedded.

The EPM needs to be used as an active management tool for situations like these. More than that, companies focused on their processes need automated tools to help them actively manage their processes, for purposes like these and others. Such tools could legitimately be called Business Process Management Systems (BPMS), a term used at the opening of this chapter.

As of this writing, BPMS is a notoriously, broadly, and vaguely defined product area. Vendors with very different offerings, providing different features and supporting different needs, all claim the mantle of BPMS. However, to oversimplify, but slightly, contemporary BPMS software is principally used for two kinds of purposes: to create descriptions of processes (in terms of their constituent activities), which can be used to support process analysis, simulation, and design efforts; and to generate executable code that supports the performance of a process, by automating certain process steps, integrating systems and databases used by the process, and managing the workflow of documents and other forms passing through the process. While (as is often the case in the software industry) vendor claims and market research forecasts for these systems are somewhat exaggerated, they nonetheless do provide value and have been successfully deployed by many companies. Unfortunately, despite the name, contemporary BPM systems do little to support the management of processes (rather than their analysis and implementation).

A software system designed to support true process management would build on the capabilities that contemporary BPMS products provide (to define and model processes), but go far beyond them. It would embed these processes in a rich multidimensional model of the enterprise that captures at least these facets of the enterprise and the relationships among them:

- Definitions of processes and their activities, and their designs
- Interconnections and interrelationships between processes, including definitions of inputs and outputs and mutual expectations
- Metrics, both enterprise KPIs and process-level metrics, including current and target performance levels
- Projects and activities associated with process implementation and improvement
- Business organizations that are engaged in implementing and executing processes
- Process versions and variations
- Information systems that support processes
- Data elements created by, used by, and owned by processes
- Enterprise programs and initiatives and their connections to processes
- Control points and risk factors
- Roles in the organization involved in performing the process, including their organizational position, skill requirements, and decision-making authorities
- Management personnel associated with the process (such as the process owner)
- Enterprise strategies and programs that are impacted by processes.

Such a system would need to know the “semantics” of organizations and of these facets, so that instead of operating as merely a passive repository, it could act as an intelligent model of an enterprise and its processes. As such, it could serve as a powerful tool to support management decision-making and action in a complex, fast-changing environment. Such a model would not be populated by data created by operational systems but by a rich representation of the enterprise. It would be a tool for managing processes and not for executing them.

Some companies are using existing BPMS systems for these purposes, but they report that these tools offer little or no active support for these purposes, other than providing a relational database and a graphical front-end. There are no built-in semantics in contemporary systems that capture the characteristics of organizations and their many dimensions, nor do they have an embedded model of process management.

8 The Frontiers of BPM

Despite its widespread adoption and impressive results, BPM is still in its infancy. Even companies that have implemented it are far from finished and many companies – indeed many industries – have yet really to begin. Unsurprisingly, there are a host of issues with which we have yet to come to grips, issues that relate to truly managing an enterprise around its processes and to the impacts of Business Process Management on people, organizations, and economies. The following is a sampler of such issues, some of which are being actively investigated, some of which define challenges for the future.

Management structure and responsibility. As more power and authority get vested in process owners, other management roles and responsibilities change dramatically. Functional managers become managers of resource pools; business unit heads become agents of customers, representing their needs to process owners. These are radical shifts, and are still being worked out. Some companies are experimenting with moving many standard processes (not just support ones) from multiple business units into what amounts to shared service organizations. Others are outsourcing whole processes. The shape of the process-managed enterprise is still emerging.

IT support. How do developments in new information technologies impact processes and process management? ERP systems (somewhat belatedly) have come to be recognized as process software systems, since their cross-functional architecture enables them to address work on an end-to-end basis. What implications will SOA (service-oriented architecture) have on process design and implementation? How will process management impact data management? For instance, some companies are starting to give process owners responsibilities for master data management.

Interenterprise processes. Most organizations focus on processes that run end-to-end within their companies; however, in many cases, the real ends of these processes reside in different companies altogether. Supply chain processes, for instance, typically begin in the raw material supplier's operations and end with the final customer; product development processes are collaborative and must encompass suppliers' efforts. Some companies have been working on these processes, but we lack models for their governance and management. Who is the process owner? How should benefits be allocated? What are the right metrics?

Standards. Are there standard EPMs for companies in the same industry? Are there standard sets of enabling and governing processes that all companies should deploy? Will we see the emergence of best-in-class process designs for certain widely occurring processes, which many different companies will implement? What would these developments imply for enterprise differentiation?

Processes and strategy. Processes are, on the one hand, the means by which enterprise strategies are realized. On the other, they can also be determinants of such strategies. A company that has a world-class process can deploy it in new markets and in support of new products and services. At the same time, companies may decide that processes that do not offer competitive advantage should conform to industry standards or be outsourced.

Industry structure. How will process management affect the structure of industries? As companies recognize that certain processes represent their core capabilities, while others are peripheral, will we see greater outsourcing of the latter – perhaps to organizations that will provide processes on a service basis? Will customer and supplier organizations intertwine their processes to create what are in effect operational (rather than financial) *keiretsus*?

Beyond these macro questions, even the basic aspects of process management – designing processes, developing metrics, training performers, and all the rest – are far from settled issues. There is much work to be done. But even absent solutions to these challenges, it is clear that process management has moved from the wave of the future to the wave of the present, and that we are indeed in the Age of Process.

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Process Management for Knowledge Work

Thomas H. Davenport

Abstract In this chapter, the topic of using process improvement approaches to improve knowledge work is addressed. The effective performance of knowledge work is critical to contemporary sophisticated economies. It is suggested that traditional, engineering-based approaches to knowledge work are incompatible with the autonomy and work approaches of many knowledge workers. Therefore, a variety of alternative process-oriented approaches to knowledge work are described. Emphasis is placed on differentiating among different types of knowledge work and applying process interventions that are more behaviorally sensitive.

1 Introduction

Knowledge workers are the key to innovation and growth in today's organization.[1] They invent products and services, design marketing programs, and create strategies. In sophisticated economies, they are the horses that pull the plow of economic progress. If our companies are going to be more profitable, if our strategies are going to be successful, if our societies and economies are going to become more advanced – it will be because knowledge workers did their work in a more productive and effective manner.

In the early twenty-first century, it is likely that a quarter to a half of the workers in advanced economies are knowledge workers whose primary tasks involve the manipulation of knowledge and information. Even if they are not a majority of all workers, they have the most influence on their companies and economies. They

[1]This chapter draws from several published sources, including Chaps. 1–3 of Davenport (2005) and Davenport and Iyer (2009).

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are paid the most, they add the most economic value, and they are the greatest determinant of the worth of their companies. Companies with a high proportion of knowledge workers – let's call them knowledge-intensive – are the fastest-growing and most successful in the US and other leading economies, and have generated most of their growth in the past couple of decades. The market values of many knowledge-intensive companies – which include the market's perception of the value of knowledge and knowledge workers – dwarf their book values, which include only tangible assets (and the ratio of market to book value in US companies has doubled over the past 20 years, suggesting a great acceleration of knowledge asset value). Even in the so-called "industrial" companies, knowledge is increasingly used to differentiate physical goods and to diversify them into product-related services. As James Brian Quinn has pointed out, high proportions of workers in manufacturing firms (roughly 90% in semiconductors, for example) never touch the manufacturing process, but instead provide knowledge-based services such as marketing, distribution, or customer service (Quinn 1992).

It is already apparent that the firms with the highest degree and quality of knowledge work tend to be the fastest-growing and the most profitable ones. Leading IT firms, which are almost exclusively knowledge-based, are among the most profitable organizations in the history of the planet. Pharmaceutical firms not only save peoples' lives with their drug treatments but also tend to have high profit margins. "Growth industries" generally tend to be those with a high proportion of knowledge workers.

Within organizations, knowledge workers tend to be closely aligned with the organization's growth prospects. Knowledge workers in management roles come up with new strategies. Knowledge workers in R&D and engineering create new products. Knowledge workers in marketing package up products and services in ways that appeal to customers. Without knowledge workers, there would be no new products and services, and no growth.

Yet, despite the importance of knowledge workers to the economic success of countries, companies, and other groups, they have not received sufficient attention. We know little about how to improve knowledge workers' performances, which is very unfortunate, because no less an authority than Peter Drucker has said that improving knowledge worker performance is the most important economic issue of the age (Drucker 1968). In this chapter, I will describe how business process management – not in its traditional formulation, but using several modified variants of the idea – can contribute to better performance of knowledge work.

2 Improving Knowledge Work Through Process Management

A time-honored way of improving any form of work is to treat it as a process. To treat something as a process is to impose a formal structure on it – to identify its beginning, end, and intermediate steps, to clarify who the customer is for it, to measure it, to take stock of how well it is currently being performed, and ultimately to improve it. This process-based approach to improving performance is very familiar (and is described in various forms in the rest of this Handbook) and is an obvious candidate for improving knowledge work activities.

But knowledge work and knowledge workers have not often been subject to this sort of analysis. In some cases, they have actively avoided it, and in others, it escaped application to them by happenstance. Knowledge workers often have the power to resist being told what to do, and process analysis is usually a sophisticated approach to having someone else tell you how to do your job. It is not easy to view knowledge work in terms of processes, because much of it involves thinking, and it is often collaborative and iterative, which makes it difficult to structure.

When I had interviewed knowledge workers about their jobs, they had often said that they did not think that their workdays were consistent and repeatable enough to be viewed as processes. This does not mean, of course, that a process perspective could not be applied, or that there could not be more structure to knowledge work jobs – only that there has not been thus far.

Given the historical antipathy of knowledge workers to formalized processes, it is an obvious question to ask how a process orientation is in their interest. Many knowledge workers will view a formal process approach as a bureaucratic, procedural annoyance. A much more appealing possibility is that a process orientation is beneficial to knowledge workers – that they would benefit from the discipline and structure that a process brings, while remaining free to be creative and improvisational when necessary and desirable. In other words, a process can be viewed as art rather than science (Hall and Johnson 2009). Whether this is true, of course, varies by the process involved, by the way a process is implemented and managed, and by the particular individuals involved.

There is some case for optimism in this regard, however. Several researchers studied the issue of what happens to one type of knowledge workers – software developers – as a process orientation increases (Adler et al. 2003). In that particular process domain, there is a widely used measure of process orientation, the Software Engineering Institute's Capability Maturity Model (CMM), which allows analysis of different levels of process maturity. The researchers looked at two groups within a company that were at CMM Level 5, the highest level of process maturity, and two other groups in the same firm at Level 3.

They found that, for the most part, software developers experienced the increased process orientation as positive. He noted, for example, that

> "...the more routine tasks in software development were rendered more efficient by standardization and formalization, leaving the non-routine tasks relatively unstructured to allow more creativity in their performance."

> "...process maturity was experienced by many developers as enabling and empowering rather than coercive and alienating."

> "The key to ensuring a positive response to process discipline was extensive participation..." "People support what they help create."

This is good news for anyone interested in taking a process perspective on knowledge work. Of course, the findings do not necessarily generalize to all knowledge work, and much more research is needed. But it is a signal that a process orientation can make knowledge work more productive as well as “enabling and empowering” if managed correctly, i.e., with extensive participation.

There will probably also be cases in which knowledge workers will actively resist or ignore a process orientation. In these cases, imposing it becomes a power struggle. The outcome of such struggles will vary across situations, but adopting more effective and productive processes in many industries may sometimes conflict with knowledge worker autonomy. As one expert in the health care industry, for example, puts it, “Less discretion for doctors would improve public safety.” (Swidey 2004). Other industries are likely to face similar tradeoffs.

3 Processes and Knowledge Work Segments

Of course, all knowledge workers are not alike, and there are some key differences in process orientations among different types of knowledge work and workers. In the matrix shown in Fig. 1, there are four key types of knowledge work based on the degree of expertise and the level of coordination in the work. “Transaction” work is generally more easily structured in process terms than any other, because the work is normally repeatable, and because the people who do the work have less discretion to do it the way they like. At the opposite extreme are “Collaboration” workers, who present a challenge for process-oriented managers. These workers typically have a more iterative, collaborative approach to work for which patterns are more difficult to discern. They may deny that their work has any structure at all – “every day is different,” they have often said to me. And if a process analyst should figure out a process to recommend to these workers, they have the power and the independence to be able to successfully resist it.

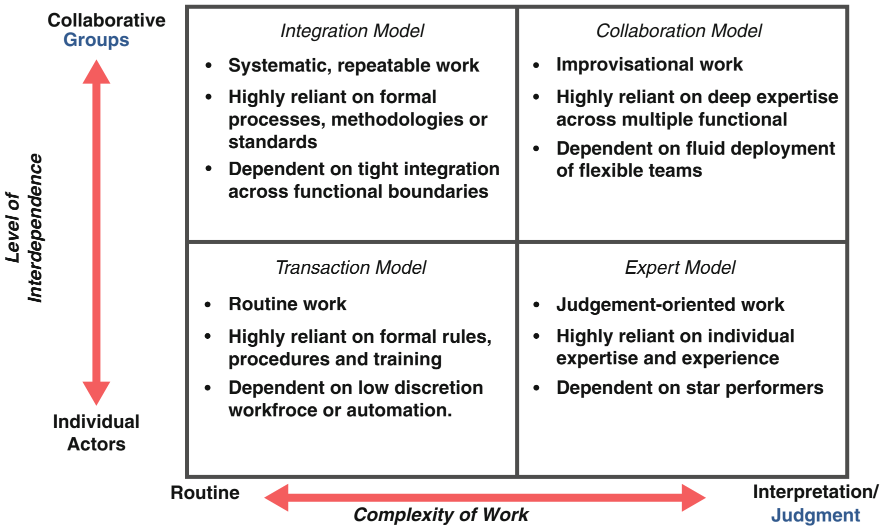

Fig. 1 Four approaches to knowledge work

"Integration" and "Expert" workers are somewhere in the middle in this process-orientation continuum. Integration work is often fairly structured, although higher levels of collaboration often lead to more process complexity. Integration-oriented workers are relatively likely to adopt process interventions. Expert work can be made more process-oriented, but experts themselves often resist an imposed process. Typically, one has to give them the ability to override or step out of the process, and they are often wary of "cookbook" approaches to their work.

Of course, it is not a binary question whether a process orientation is relevant to a particular type of knowledge work. For each of these types, there are rules of thumb about how best to move in a more process-oriented direction:

Transaction workers. These workers need to understand the flow of their work and the knowledge needed to perform it, but they rarely have time to consult external guidelines or knowledge sources. Fortunately, it is often relatively easy to embed a process flow into some form of computer-based application. These typically involve structured workflows or scripts. Such systems usually bring the work – and all information and knowledge required to perform it – to the worker, and they measure the process and worker productivity at the same time.

Integration workers. With this type of work, it is possible to articulate the process to be followed in documents, and workers typically have enough time and discretion to consult the documents. There is nothing new about describing a process, but the practice continues across many industries. Medical technicians, for example, often follow health care protocols in administering tests and treatments. Salespeople at the electronics retailer Best Buy follow a series of "standard operating procedures" for working with customers and making a sale. Even the US Army describes in detail its "doctrine" for how work is done – and with new technologies and war fighting methods, that work is increasingly knowledge-oriented.

Expert workers. These workers have high autonomy and discretion in their work, but there are some examples of organizations, such as several leading health care providers, which have applied technology to key aspects of the process (in their cases, ordering medications, tests, referrals, and other medical actions) (Davenport and Glaser 2002). But unless there is a way to embed a computer into the middle of the work process, experts will be a challenge from the standpoint of structuring work. Instead of specifying detailed aspects of the workflow, those who attempt to improve expert knowledge work should provide templates, sample outputs, and high-level guidelines. It is unlikely that expert workers will pay much attention to detailed process flows anyway.

Collaboration workers. As I have noted, this is the most difficult category to address in traditional process terms. The cautions above for experts also apply to collaborators – a gentle process touch is desirable. Rather than issuing process flow charts, specifying and measuring outputs, instilling a customer orientation, and fostering a sense of urgency are likely intervention approaches. If external knowledge and information are necessary to do the job, they must generally be made available through repositories and documents – it is very unusual for work in this category to be fully mediated and structured by a computer. Of course, this means that it is relatively less likely that the knowledge and information will be used.

4 Knowledge Creation, Distribution, and Application

But the four types of knowledge work I have discussed above are not the only way to segment it in terms of processes. Perhaps a more obvious segmentation approach is to think about processes in terms of the knowledge activity involved. That is, the process orientation differs by whether workers create knowledge, distribute it, or apply it.[2] This simple three-step model – a process in itself – is a useful way to think about how different knowledge activities require different process interventions.

4.1 Creation

The bugaboo of process management is knowledge *creation*. This is widely viewed as a creative, idiosyncratic, "black box" activity that is difficult to manage as a process but not impossible. Perhaps there are circumstances in which knowledge creation is totally unstructured, unmeasured, and unrepeatable – but in most situations, progress can still be made in this direction.

One common approach to knowledge creation processes is simply to decompose them into several pieces or stages. Many companies in the 1980s and 1990s, for example, divided their new product development processes into a series of stages or phases. The objective was to allow evaluation of the new knowledge created at the transition from one stage to another – stage gates. A new drug compound, a new car design, or a new toy model would move through a stage gate if it met the criteria for moving ahead – typically a combination of technical and market feasibility factors. If this approach is employed in a disciplined fashion, it has the virtue of freeing up resources from unproductive projects without imposing too heavy a process burden on new product developers. However, this approach does not really address the activities within the stages, or treat the new product development activity as an end-to-end process (Holmes and Campbell 2003).

Another challenge to the use of process thinking in new product development is that the early stages of the process are often called the "fuzzy front end." At this stage it is not clear what the customer requirements are, what the new product should do, or how it will work. There are things that can be done to make the fuzzy front end somewhat less fuzzy (Quality Function Deployment, for example, is a method for clearly articulating customer requirements; Conjoint Analysis is a statistical technique used to calculate the relative value of different product attributes to customers). However, no amount of technique or process management is going to make the fuzzy front end as clear and well-structured as the final stages of new product development, e.g., manufacturing or market testing. A process orientation may be less relevant to the beginning of the process than to the end based on the inherent degree of structure in each stage.

[2] I first employed this distinction in an article with Sirkka Jarvenpaa and Michael Beers, "Improving Knowledge Work Processes" (Davenport et al. 1996).

Other knowledge creation processes have been the subject of alternative approaches, but still with a relatively low degree of process orientation. Scientific research, for example, is the prototypical example of an unstructured knowledge creation process. While there are valid aspects of scientific research that are difficult to structure, there are plenty of approaches and tactics for bringing more process discipline to research. One is simply to measure outputs – number of patents or compounds or published papers per researcher per year, for example. Another is to assess quality – the number of citations a researcher receives per year, for example, is a widely used measure of scientific influence. A third approach is to involve customers of the research (either internal or external to the organization) in the creation process so that their influence is more directly felt. A number of corporate research laboratories – including IBM's Watson Labs and GE's Corporate Research organization – have adopted this approach over the past several years as they attempt to become more productive and profitable. If an organization is creative – and does not automatically resort to process flowcharts – there are a number of ways to make knowledge creation processes more effective and efficient.

Another knowledge creation process is oil exploration. Geologists and geological engineers create seismological knowledge of a targeted drilling area and try to progressively lower the risk of a dry hole with more knowledge over time. At Amerada Hess, a medium-sized oil firm with many exploration projects scattered around the globe, an attempt was made to document the process of oil exploration – the "Exploration Decision-Making Process." This was a cultural stretch for Hess, in that exploration had historically been a highly unstructured and iterative activity, and the people who did it enjoyed a free-thinking, "maverick" culture. Certainly, there were benefits from the exercise; depicting the Exploration Decision-Making Process in a visual format greatly enhanced the ability of participants to understand their roles, responsibilities, and interactions throughout the process. But the creation of a document was perhaps of greater value than the process map, which had strong support from some exploration managers and less from others. A "Prospect Evaluation Sheet" reviewed the story and history of how the lead progressed to its current prospect level. This documentation served to encourage open discussions among peers of alternative interpretations and enabled them to make sense of ambiguities. Even more important was the insistence that peer reviews and peer assists (carried out by peers within other parts of the Hess organization) take place prior to prospects qualifying to pass through decision gates. The Prospect Evaluation Sheet was just a way of recording how the prospect field was maturing through the process.

In general, it seems that workers engaged in knowledge creation should be given some structure, but not too much. IDEO, the highly successful new product design firm, for example, provides its employees with a structured brainstorming process, but few other processes have much if any structure or formality. Corning's R&D lab, like many scientific research organizations, employs a "stage gate" model of the innovation process, but there is substantial freedom within stages. Alessi, the Italian design studio, allows considerable creativity and intuition from designers in the early stages, and imposes more structure and evaluation on designs later in the process. More structure than these organizations provide would begin to seem heavy-handed, and indeed some organizations have had difficulty in applying process-oriented disciplines such as Six Sigma to innovation (Hindo 2007; Conger 2014). Some observers feel that Six Sigma enforces too much structure and process-based discipline for traditionally creative activities such as innovation.

4.2 Distribution

As for knowledge *distribution* – sharing or transfer are other words for this activity – it is also difficult to structure. Some professions, such as customer service, journalism, and library workers, are only about distribution. For most knowledge workers, however, this is a part of the job, but not all of it. The lawyer or consultant is primarily responsible for generating solutions for clients, but also for sharing that solution with colleagues, and for searching out whether existing knowledge is already available that would help the client. This sharing is difficult to enforce, since we do not know what any person knows, or how diligently they have searched for available knowledge. Yet, there is a substantial body of research suggesting that knowledge worker groups that share knowledge perform better than those that do not.[3]

The most viable approach to managing knowledge distribution or sharing is not to manage the process itself, but rather the external circumstances in which knowledge distribution is undertaken. This typically involves changing where and with whom people work. Chrysler, for example, formed “platform teams” to improve the circulation of new car development knowledge across all the functions involved in building a car. Managers specified a process for the platform teams to follow, but they got much more knowledge sharing from the fact that platform teams were put together in the same sections of the Auburn Hills, MI Technical Center than from a process that instructed them to share at various points.

4.3 Application

Then there is the application of knowledge, which is filtered through the human brain and applied to job tasks. Examples of this type of work include sales, computer programming, accounting, medicine, engineering, and most professions. All of these jobs involve a degree of knowledge creation, but that is not the primary objective. In such cases, we generally want these knowledge workers not to invent new knowledge but to apply existing knowledge to familiar or unfamiliar situations. We do not want computer programmers to create new programming languages, but rather use existing ones to program applications. At best we want “small ideas” from these individuals – not reinvention of their jobs and companies.

[3]For an example of the relationship between knowledge sharing and performance, see Cummings (2004).

How do we make knowledge application better? In many cases, the goal is to reuse knowledge more effectively. We can greatly improve performance by having a lawyer reuse knowledge created in another case, or having a programmer employ a subroutine that someone else created.

Knowledge asset reuse is a frequently stated objective for organizations, but it is hard to achieve. Many organizational and professional cultures reward – sometimes unconsciously – knowledge creation over knowledge reuse. Furthermore, effective knowledge asset reuse requires investment in making knowledge reusable: documentation, libraries, catalogs, modular structures for knowledge objects. Many organizations and managers just do not take a sufficiently long view of reuse processes to make those investments.

When some colleagues and I researched knowledge asset reuse processes across several types of organizations (Davenport et al. 2003), there were several factors explaining whether organizations were successful with reuse. Leadership was one of the factors – having an executive in charge who understood the value of reuse and was willing to manage so as to make reuse a reality. Another factor was asset visibility, or the ability to easily find and employ the knowledge asset when there was a desire to do so. The third and final factor was asset control, or the activities designed to ensure that the quality of knowledge assets was maintained over time. Therefore, if you are interested in knowledge reuse as a means of improving knowledge use processes, you should try to put these three factors in place.

There are other factors that can be employed to improve use. Computers, of course, can oversee the process of reuse. At General Motors, for example, the Vehicle Engineering Centers want new car designers to reuse knowledge and engineering designs when possible, rather than create new ones. So they ensure that the desirable dimensions of new vehicles, and the parameters of existing component designs, are programmed into the computer-aided design systems that the engineers use, and it becomes difficult not to use them. One GM executive told me that you cannot force the engineers to reuse designs and components – you just have to make it much easier for them to do that than to create new ones.

Today, in most organizations, reuse is only addressed at the institutional level if at all. But it stands to reason that the most effective knowledge workers reuse their own knowledge all the time. A productive lawyer, for example, would index and rapidly find all the opinions and briefs he has ever written and reuse them all the time for new clients. But while we know this is true, organizations have yet to help knowledge workers do this sort of reuse. If they were smart, they would make it easier – and provide taxonomies, training, role models, and encouragement.

5 Process Versus Practice in Knowledge Work

In addition to taking a process perspective on knowledge work, it is important to remember that there is also a *practice* side to this type of work, which has to be balanced with the process perspective. This balance, first defined by Brown and

Duguid (1991), is an important consideration for anyone attempting to address knowledge work.[4]

Every effort to change how work is done needs a dose of both *process* – the design for how work is to be done – and *practice*, an understanding of how individual workers respond to the real world of work and accomplish their assigned tasks. Process work is a designing, modeling, and engineering activity, sometimes created by teams of analysts or consultants who do not actually do the work in question and often have only a dim understanding of how it is being done today. A process design is fundamentally an abstraction of how work should be done in the future. Process analysts may superficially address the "as is" process, but generally only as a quick preamble to the "to be" environment.

Practice analysis is a well-informed description of how work is done today by those who actually do it. Some analyses of work practice are done by anthropologists (ethnographers), who observe workers carefully over months, either through participant observation or through video. To really understand work practice, it requires detailed observation and a philosophical acceptance that there are usually good reasons for why work gets done by workers in a particular way. Just the acceptance of the practice idea suggests a respect for workers and their work, and an acknowledgement that they know what they are doing much of the time.

A pure focus on process in knowledge work means that a new design is unlikely to be implemented successfully; it probably would not be realistic. On the other hand, a pure focus on practice is not very helpful either – it leads to a detailed description of today's work activities, but it may not improve them much. Some anthropologists go just as far in the practice direction as some consultants go in the process direction. They argue that you have to observe work for a year or so in order to have any chance of understanding it at all, which is clearly unrealistic in a business context.

It is certainly true that some processes can be designed by others and implemented successfully – because they are relatively straightforward to begin with or because it is easy to use people or systems to structure and monitor their performance. Other jobs – particularly those involving knowledge and experts – are very difficult for outsiders to understand and design, and require a high proportion of practice orientation.

What does it mean to combine a process and practice orientation? Here are some obvious implications:

- Involve the knowledge workers in the design of the new process. Ask them what they would like to see changed and what is stopping them from being more effective and efficient.
- Watch them do their work (not for a year, but a few weeks is not unreasonable). Talk to them about why they do the things they do. Do not automatically assume that you know a better way.

[4] Brown and Duguid have elaborated on the process–practice distinction in their book "The Social Life of Information" (Brown and Duguid 2000, p. 91–116).

- Enlist analysts who have actually done the work in question before. If you are trying to improve health care processes, for example, use doctors and nurses to design the new process.
- Take your time. Devote as much attention to the "as is" as the "to be." Knowledge work is invisible, and it takes a while to understand the flow, rationale, and variations for the work process.
- Exercise some deference. Treat experienced workers as real experts (they probably are!). Get them on your side with credible assurances that your goal is to make their lives better.
- Use the Golden Rule of Process Management. Ask yourself, "Would I want to have my job analyzed and redesigned in the fashion that I'm doing it to others?"

6 Types of Process Interventions

There are many different types of process-oriented interventions that we can make with knowledge work. Some, such as process improvement, measurement, and outsourcing, have long been used with other types of business processes. Others, such as agile methods and positive deviance, are only present in particular knowledge work domains, but could be generalized.

6.1 Process Improvement Approaches for Knowledge Work

There are many ways to improve processes. Which work best with knowledge work? Process improvement can be radical or incremental, participative or top-down, one-time or continuous, focused on large, cross-functional processes or small ones at the work group level, and oriented to process flows or other attributes of processes. There is no single right answer to the question of which variant makes sense – it obviously depends on the organization's strategy, the degree of improvement necessary, and the type of work.

However, as I have noted, with knowledge work it is a good idea to make the improvement process as participative as possible. Knowledge workers are much more likely to agree with and adopt any process changes if they have been a party to designing them. This begins to restrict the change options somewhat. It is very difficult to have thousands of people participate in a highly participative change approach, so that largely dictates a focus on small processes. Participative change also typically yields more incremental change results, in that it is somewhat difficult for large numbers of people who are highly conversant with a process to develop a radical new approach to performing it. Participative, incremental change processes are often also continuous in their orientation, as opposed to one-time. It does not make sense to make one-time incremental changes if the organization is not going to follow them up with more improvements over time.

Based on this logic, the most desirable forms of process improvement for knowledge work are participative, incremental, and continuous. An example of this type of approach would be Six Sigma, which has been adapted and adopted for knowledge work by a variety of firms (although, as I noted above, some firms have found it burdensome for innovation-oriented processes). General Electric, for example, has employed the approach extensively within its Global Research organization. It applies Six Sigma in research and design processes using its “Design for Six Sigma” (DFSS) methodology, which is about understanding the effects of variation on product performance before it is manufactured. Many of its researchers and engineers have Six Sigma green or black belts, and are experts in the application of statistical analysis to research and engineering processes. GE is perhaps the most advanced of all organizations in applying process management techniques to research. Even at GE, however, managers I have recently interviewed have suggested that the influence of Six Sigma over innovation-oriented processes is waning.[5]

The other key aspect of selecting a process-oriented intervention is the particular attribute of process management an organization addresses. As I have mentioned, it is all too common for organizations to interpret “process” as “flow diagram.” It specifies “first you do this, and then you do this. . .” Such an engineering orientation to processes breaks down work into a series of sequential steps, and it is the aspect of process management that knowledge workers like least. Similar forms of this orientation are found when organizations attempt to create detailed methodologies for knowledge work, such as a system development methodology. It may be necessary in some cases to engineer the process flow, but it should not be the centerpiece of a knowledge work improvement initiative.

A simpler form of a highly detailed process flow is a straightforward checklist of what activities a knowledge worker needs to perform. This may seem obvious and simplistic, but there are some industries in which knowledge workers are benefitting from it. Medical workers such as doctors and nurses, for example, are increasingly using checklists to ensure that all major steps in a surgical operation are performed. One study found that a 19-item surgery checklist improved communication between surgical team members and reduced death rates by almost half (Haynes et al. 2009).

6.2 Agile Methods

Another alternative to highly engineered processes might be called “agile” methods. They are less focused on the specific steps to be followed in a process, and more oriented to the managerial and cultural context surrounding the process. Instead of detailed process flows, for example, agile methods might emphasize the size and composition of process teams, a highly iterative workflow, and a culture of urgency. This is the case, for example, in the agile method known as “extreme programming.”

[5]For more on the relationship between Six Sigma and process management in general, see Conger (2014).

Martin Fowler, an expert on agile methods, describes the contrast between engineered methodologies and agile approaches in common-sense language on his web site:

- *Agile methods are adaptive rather than predictive*. Engineering methods tend to try to plan out a large part of the software process in great detail for a long span of time, this works well until things change. So their nature is to resist change. The agile methods, however, welcome change. They try to be processes that adapt and thrive on change, even to the point of changing themselves.
- *Agile methods are people-oriented rather than process-oriented*. The goal of engineering methods is to define a process that will work well whoever happens to be using it. Agile methods assert that no process will ever make up for the skill of the development team, so the role of a process is to support the development team in their work (Fowler 2005).[6]

As of now, agile methods are only established within software development, but over time they may migrate to other knowledge work processes.

It is not hard to imagine that before long we will see, for example, "extreme product development" or "extreme marketing."

6.3 Measurement

A key component of process management has always been to measure the performance of workers. In the industrial age, this was a relatively easy task; an individual worker's performance could be assessed through outputs – work actually produced – or visible inputs, including hours worked or apparent effort expended. Output measures over input measures, of course, are typically described as "productivity." The appeal of measuring productivity for knowledge workers is that it is a universal measure. Productivity-oriented approaches convert the value of outputs to currency. It is very appealing to look across an entire corporation or even a country and argue that we have increased productivity by an exact percentage – and economists often do so.

In the world of knowledge work, evaluating productivity and performance is much more difficult. How can a manager determine whether enough of a knowledge worker's brain cells are being devoted to a task? What is the formula for assessing the creativity and innovation of an idea? Given the difficulty of such evaluations, managers of knowledge workers have traditionally fallen back on measuring visible inputs, e.g., hours worked. Hence the long hours put in by attorneys, investment bankers, and consultants. However, the increasing movement of knowledge work out of the office and into homes, airplanes, and client sites makes it difficult to use hours worked as a measure, and that criterion never had much to do with the quality of knowledge produced.

[6]The use of Business Process Management approaches in collaborative work settings is explored in Kemsley (2014).

Quality is perhaps the greatest problem in measuring knowledge work. Why is one research paper, one advertising slogan, or one new chemical compound better than another? If you cannot easily measure the quality of knowledge work, it makes it difficult to determine who does it well, and to what degree interventions have improved it. Many organizations tend to fall back on measuring the volume of knowledge outputs produced – lines of programming code, for example – simply because it is possible to measure them. But without some measure of quality, the improvement of knowledge work is unlikely to succeed.

It is possible to measure the quality of knowledge work, albeit with a subjective method. It involves determining who is a relevant peer group for the particular work involved, and asking them what they think of it. This technique has often been used, for example, in evaluating professors for promotion and tenure. A jury of peers – usually from within and outside the professor's school – is consulted, and the quality of their published work assessed. Similarly, student evaluations are used to assess the quality of teaching. Any problems with lack of objectivity are remedied in the volume and diversity of responses. In the same fashion, a few organizations ask for multiple peer evaluations in annual performance reviews and promotion decisions. Some knowledge management applications ask each user of the system to rate the quality of the knowledge found. Thus, there are means of assessing quality, although the peer group and the assessment approach will vary by the context.

There does not seem to be, however, a universal measure for the quality or quantity of knowledge work outputs. What matters is high-quality outputs per unit of time and cost, and the specific outputs vary widely across knowledge worker types. A computer programmer produces lines of code; a physician produces well people; a scientist produces discoveries and research. The only way we can determine whether a particular intervention improves knowledge work performance is to assess the quantity and quality of the outputs produced by those workers. Universal measures are pretty much useless for this purpose.

Therefore, the appropriate output (and sometimes input) measures for knowledge work will vary by the industry, process, and job. In improving knowledge worker performance, it is important to determine what measures make sense for the particular type of work being addressed. Organizations need to begin to employ a broad array of inputs and outputs, some of which are internal to the knowledge worker's mind. One input might involve the information and knowledge that a knowledge worker consulted in making a decision or taking an action (a particularly important criterion for managers). ABB, the global electrical and engineering firm, uses this factor as one of many in assessing managerial performance. Another input could be the process that a knowledge worker follows in producing knowledge work. The self-reported allocation of the knowledge worker's time and attention is a third possible input.[7]

[7]For an example of how to assess self-reported attention allocation, see Davenport and Beck (2002).

Outputs could include the volume of knowledge produced, the quality of the decisions or actions taken on the basis of knowledge, and the impact of the knowledge produced (as judged by others). In the consulting industry, some consultants are already evaluated in part on the knowledge they bring to the firm and the impact it has on clients – in addition to the usual measures of chargeability and consulting projects sold.

Some knowledge work processes already employ well-defined measures. IT is certainly one of the more measured knowledge work domains. IT measurement is relatively advanced in both programming and in IT processes and capabilities. In programming, some organizations have measured for decades the production of either lines of code or function points, and various researchers have analyzed the considerable variance in productivity. These measures are not perfect, but they have allowed IT organizations to begin to understand differences across groups and individuals – something that lawyers, doctors, and managers cannot measure nearly as well.

The other primary domain of measurement is the assessment of IT processes, particularly software engineering (but also software acquisition, people management, and the development of software-intensive products). Thanks to the Software Engineering Institute and researcher Watts Humphrey, we have an international standard for the quality of software engineering: the Capability Maturity Models (Software Engineering Institute 1995). Thousands of organizations have been assessed along these five-level models. The Software Engineering Institute has developed a more general approach to assessing capability maturity (called CMMI – Capability Maturity Model Integration), but thus far it has largely been applied to software-related processes only (Crissis et al. 2003). Unfortunately, there is no similar global standard for other forms of knowledge work, other than perhaps the ISO 9000 family of standards for manufacturing quality.

6.4 Positive Deviance

Once measures have been developed for knowledge work, there are other approaches that can take advantage of them. One is called positive deviance, defined by Wikipedia as:

> Positive Deviance (PD) is an approach to personal, organizational and cultural change based on the idea that every community or group of people performing a similar function has certain individuals (the "Positive Deviants") whose special attitudes, practices/strategies/behaviors enable them to function more effectively than others with the exact same resources and conditions. Because Positive Deviants derive their extraordinary capabilities from the identical environmental conditions as those around them, but are not constrained by conventional wisdoms, Positive Deviants standards for attitudes, thinking and behavior are readily accepted as the foundation for profound organizational and cultural change (Wikipedia 2009).

Positive deviance-based approaches have been employed in health care (for example, to reduce infection from antibiotic-resistant bacteria) and international development. To use it for knowledge work improvement, different knowledge workers within an organization would be measured on key metrics. Those individuals or groups that score relatively well are publicized, and their approaches investigated. They would become examples for less successful knowledge workers. Because humans are often competitive and want to improve, they often adopt the approaches used by their most successful peers.

6.5 Knowledge Management-Based Interventions

Since knowledge workers employ knowledge as a primary aspect of their jobs, it is natural that organizations would try to improve the work with knowledge management, or systematic attempts to improve the distribution and utilization of knowledge. However, most implementations of knowledge management within organizations do not employ a process-based approach. Instead, they typically involve adding knowledge management activities on top of existing work activity.

In a few cases, however, organizations have attempted to use knowledge management approaches to make knowledge available at the time of need in the context of the work process. This is similar to the idea of "performance support," which specified that learning would be delivered in real time as task performance required it (Gery 1991). One successful example of applying knowledge to the work process is at healthcare provider Partners HealthCare, where knowledge of appropriate therapies is made available to physicians as they input online orders for patients (Davenport and Glaser 2002). The system and the process have led to many benefits, including a 55% reduction in adverse drug events.

In such situations knowledge management can be a very effective way to improve knowledge work processes, but it is more difficult to implement than "traditional" knowledge management. It requires focusing on and supporting a particular work process, as opposed to an entire organization. It also may require considerable customization and integration of information technology tools. This is presumably the reason why more organizations do not implement knowledge management in a process context.

6.6 Outsourcing Knowledge Work

Outsourcing of business processes began for most organizations with structured, repetitive activities with high labor content, such as routine IT development, a call center, or an accounting back office. But today, many more intellectual and less structured activities are being outsourced. Back-office work is being supplanted by "knowledge process outsourcing" (KPO) of various types.

This transition began quietly more than a decade ago at GE's captive offshore center in India. GE Capital set up the center to do back-office work. But managers began to notice that they could get help with decision algorithms from their Indian employees. Soon the Indian operation was the primary provider of analytical tools for credit and risk analysis. When GE spun out its captive offshore group in 2005, the resulting company, Genpact, began to take on KPO work for other clients in addition to GE. And GE eventually established a captive (offshore but not outsourced) R&D center in India that takes on the thorniest problems it encounters in its global operations.

Today, several offshore firms in addition to Genpact specialize in various forms of decision analysis. Organizations such as E-Valueserve, Mu Sigma, and MarketRX (now owned by Cognizant) are helping some of the largest US-based firms with their knowledge-based processes. They are helping a major retailer, for example, determine where to build their next stores. They are helping a major pharmaceutical firm decide which salespeople are most effective, and which drugs are passing their clinical trials. They are helping a major insurance company decide what price to charge different customers for automobile insurance. They are helping a major office products firm decide which promotions and products to offer to which customers. They are taking on a wide variety of product development activities for IT and other firms. Even larger offshore outsourcers that previously specialized in IT – such as Wipro, Infosys, and Satyam – have decided that KPO is a future growth area. With their scale and marketing budgets, as well as their orientation to process improvement, we will undoubtedly see substantial offshore KPO in the future.

Companies working with offshore decision outsourcers report great success in improving their decision processes and results, but they warn that the structure of the projects is critical. The result of a decision analysis is not useful unless it is implemented, and offshore analysts cannot easily influence executives to adopt the results. Therefore, the clients say, it is important to have at least one of their own employees on the analysis team. It is that person's job to ensure that the analysis is consistent with the decisions the organization wants to make, and to communicate the results to responsible executives. They also report that it is valuable to have at least one representative of the offshore firm working onshore at the client site. That person typically has responsibility for communicating and coordinating between the offshore team and the client.

With the shortage of knowledge workers in the US and Western Europe, and the ready supply of them in India, Eastern Europe, and China, it is perhaps not surprising that organizations are now outsourcing not only hands, but also brains. Outsourcing knowledge work can be just as effective an intervention as improving a process internally, for example.

7 Summary

This chapter has addressed process-oriented approaches to improving knowledge work. The different process techniques include:

- Segmentation of knowledge work into its more and less structured components;
- Differentiation by types of knowledge workers by level of integration and expertise, with different process-oriented interventions for each type;

- Different process interventions for knowledge creation, distribution, and application;
- Distinction between a process orientation and a practice orientation;
- The application of participative, incremental, and continuous process management approaches;
- The use of "agile" process methods;
- Process measurement as a tool for improvement;
- "Positive deviance" approaches to improvement;
- Knowledge management applied in a process context;
- Outsourcing of knowledge work processes.

The breadth of potential approaches to knowledge work improvement confirms that taking a traditional, engineering-oriented process approach is not the only or even the best way to improve a knowledge worker's performance. Any engineering perspective on processes has to be balanced against the day-to-day practice of knowledge workers, and the "softer" means of intervening into knowledge work.

In an ideal situation, knowledge work processes can create a climate in which innovation and discipline coexist. Knowledge workers are often passionate about their ideas, and would not abandon them easily. Yet, it is sometimes necessary to kill some knowledge work initiatives in order to free up resources for new ones. Managers in pharmaceutical firms, for example, have noted that a key aspect of a strong drug development program is the ability to cancel projects that do not meet success criteria. But cancellation should be the result of a process, not a matter of an individual's taste.

Kao Corporation, Japan's largest consumer products firm, is an example of an organization with both a strong orientation to knowledge and learning, and a sense of process-oriented discipline when necessary. Kao's CEO describes the company as an "educational institution," and it was one of the earliest adopters of knowledge management in Japan. Kao's researchers have a high degree of autonomy in the research they pursue, at least for Japanese firms. But Kao also has discipline. It has well-structured continuous process improvement programs, even in the R&D function. It also kills undesirable products and projects when necessary. The company had entered the floppy disk business and had become the world's second largest producer, but by the late 1990s it became clear that the business was fully commoditized. Most large Japanese firms are slow to restructure, but Kao first closed down half and then all of the business. 1998 was the first year in seventeen that Kao had not grown profits, but it was already back on the profit growth track by 1999 – and it is continued on that track since then.

Organizations like Kao take a process approach to knowledge work because it is one of the most successful and time-honored approaches to business improvement – dating back at least as far as Frederick Taylor at the dawn of the twentieth century. But a process orientation would not be successful without modifications and supplementary approaches that equip it for the unique attributes of knowledge work and workers.

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The Scope and Evolution of Business Process Management

Paul Harmon

Abstract Business Process Management describes a broad movement toward improving how business people think about and manage their businesses. There are many different approaches to business process change and this article explores the three most important approaches. The oldest tradition is work simplification and quality control which is currently represented by Six Sigma and Lean. A second tradition is a management tradition driven by teachers and consultants like Porter, Rummler and Hammer. The third tradition is driven by Information Technologists and focuses on process automation of all kinds. Each tradition has its heroes and its own vocabulary and each emphasizes some practices over others. There is a growing emphasis on combining the various traditions in a comprehensive approach.

1 Introduction

Business Process Management or BPM, broadly speaking, is part of a tradition that is now several decades old that aims at improving the way business people think about and manage their businesses. Its particular manifestations, whether they are termed "work simplification," "six sigma," "business process reengineering," or "business process management," may come and go, but the underlying impulse, to shift the way managers and employees think about the organization of business, will continue to grow and prosper.

This paper will provide a very broad survey of the business process movement. Anyone who tries to promote business process change in an actual organization will soon realize that there are many different business process traditions and that individuals from the different traditions propose different approaches to business process change. If we are to move beyond a narrow focus

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on one tradition or technology, we need a comprehensive understanding of where we have been and where we are today, and we need a vision of how we might move forward.

We will begin with a brief overview of the past and of the three business process traditions that have created the context for today's interest in BPM. Then we will turn to a brief survey of some of the major concerns that process practitioners are focused on today and that will probably impact most corporate BPM efforts in the near future.

2 The Three Business Process Traditions

The place to begin is with an overview of the world of business process change technologies and methodologies. In essence, there are three major process traditions: the management tradition, the quality control tradition, and the IT tradition. Too often individuals who come from one tradition are inclined to ignore or depreciate the other approaches, feeling that their approach is sufficient or superior. Today, however, the tendency is for three traditions to merging into a more comprehensive BPM tradition.

One could easily argue that each of the three traditions has roots that go right back to ancient times. Managers have always tried to make workers more productive, there have always been efforts to simplify processes and to control the quality of outputs, and, if IT is regarded as an instance of technology, then people have been trying to use technologies of one kind or another ever since the first human picked up a stick to use as a spear or a lever. All three traditions got a huge boost from the Industrial Revolution which started to change manufacturing at the end of the eighteenth century. Our concern here, however, is not with the ancient roots of these traditions but the recent developments in each field and the fact that practitioners in one field often choose to ignore the efforts of those working in other traditions.

We'll begin by considering each of the traditions pictured in Fig. 1 in isolation, and then consider how companies are using and integrating the various business process change technologies today.

3 The Work Simplification\Industrial Engineering\Quality Control Tradition

In Fig. 1 we pictured the Quality Control tradition as a continuation of the Work Simplification and the Industrial Engineering traditions. The modern roots of quality control and process improvement, in the United States, at least, date from the publication, by Frederick Winslow Taylor, of *Principles of Scientific*

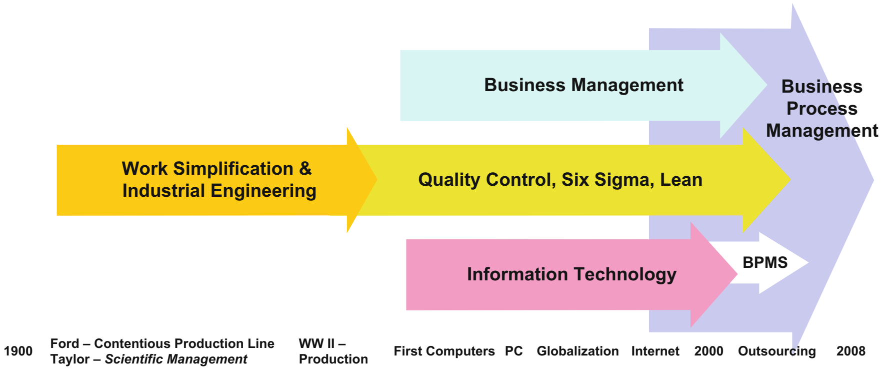


Fig. 1 An overview of approaches to business process change (BPTrends Associates. © 2013)

Management, in 1911 (Taylor 1911). Taylor described a set of key ideas he believed good managers should use to improve their businesses. He argued for work simplification, for time studies, for systematic experimentation to identify the best way of performing a task, and for control systems that measured and rewarded output. Taylor's book became an international best-seller and has influenced many in the process movement. Shigeo Shingo, one of the co-developers of the Toyota Production System, describes how he first read a Japanese translation of Taylor in 1924 and the book itself in 1931 and credits it for setting the course of his work life (Shingo 1983).

One must keep in mind, of course, the Taylor wrote immediately after Henry Ford introduced his moving production line and revolutionized how managers thought about production. The first internal-combustion automobiles were produced by Karl Benz and Gottlieb Daimler in Germany in 1885. In the decades that followed, some 50 entrepreneurs in Europe and North America set up companies to build cars. In each case, the companies built cars by hand, incorporating improvements with each model. Henry Ford was one among many who tried his hand at building cars in this manner (McGraw 1997).

In 1903, however, Henry Ford started his third company, the Ford Motor Company, and tried a new approach to automobile manufacturing. First, he designed a car that would be of high quality, not too expensive, and easy to manufacture. Next he organized a moving production line. In essence, workmen began assembling a new automobile at one end of the factory building and completed the assembly as it reached the far end of the plant. Workers at each point along the production line had one specific task to do. One group moved the chassis into place, another welded on the side panels, and still another group lowered the engine into place when each car reached their station. In other words, Henry Ford conceptualized the development of an automobile as a single process and designed and sequenced each activity in the process to assure that the entire process ran smoothly and efficiently. Clearly Ford had thought deeply about the way cars were assembled in his earlier plants and had a very clear idea of how he could improve the process.

By organizing the process as he did, Henry Ford was able to significantly reduce the price of building automobiles. As a result, he was able to sell cars for such a modest price that he made it possible for every middle-class American to own a car. At the same time, as a direct result of the increased productivity of the assembly process, Ford was able to pay his workers more than any other auto assembly workers. Within a few years, Ford's new approach had revolutionized the auto industry, and it soon led to changes in almost every other manufacturing process as well. This success had managers throughout the world scrambling to learn about Ford's innovations and set the stage for the tremendous popularity of Taylor's book which seemed to explain what lay behind Ford's achievement.

Throughout the first half of the twentieth century, engineers worked to apply Taylor's ideas, analyzing processes, measuring and applying statistical checks whenever they could. Ben Graham, in his book on *Detail Process Charting*, describes the Work Simplification movement during those years, and the annual Work Simplification conferences, sponsored by the American Society of Mechanical Engineers (ASME), that were held in Lake Placid, New York (Graham 2004). These conferences, that lasted into 1960s, were initially stimulated by a 1911 conference at on Scientific Management, held at Dartmouth College, and attended by Taylor and the various individuals who were to dominate process work in North America during the first half of the twentieth century.

The American Society for Quality (ASQ) was established in 1946 and the Work Simplification movement gradually transitioned into the Quality Control movement. The Institute of Industrial Engineers (IIE) was founded in 1948. In 1951, *Juran's Quality Control Handbook* appeared for the first time and this magisterial book has become established at the encyclopedic source of information about both the quality control and the industrial engineering movements (Juran 1951)

In the 1980s, when US auto companies began to lose significant market share to the Japanese, many began to ask what the Japanese were doing better. The popular answer was that the Japanese had embraced an emphasis on Quality Control that they learned, ironically, from Edwards Deming, a quality guru sent to Japan by the US government in the aftermath of World War II. (Deming's classic book is *Out of the Crisis*, published in 1982.) In fact, of course the story is more complex, and includes the work of native Japanese quality experts, like Shigeo Shingo and Taiichi Ohno, who were working to improve production quality well before World War II, and who joined, in the post-war period to create the *Toyota Production System*, and thereby became the fathers of Lean (Shingo 1983; Ohno 1978). (The work of Shingo and Ohno work was popularized in the US by James Womack, Daniel Jones and Daniel Roos in their book *The Machine That Changed the World: The story of Lean Production*, 1991. This book was a commissioned study of what Japanese auto manufacturing companies were doing and introduced "lean" into the process vocabulary.)

3.1 TQM, Lean and Six Sigma

In the 1970s the most popular quality control methodology was termed Total Quality Management (TQM), but in the late-1980s it began to be superseded by Six Sigma – an approach developed at Motorola (Ramias 2005; Barney and McCarty 2003). Six Sigma combined process analysis with statistical quality control techniques, and a program of organizational rewards and emerged as a popular approach to continuous process improvement. In 2001 the ASQ established a SIG for Six Sigma and began training black belts. Since then the quality movement has gradually been superseded, at least in the US, by the current focus on Lean and Six Sigma.

Many readers may associate Six Sigma and Lean with specific techniques, like DMAIC, Just-In-Time (JIT) delivery, or the Seven Types of Waste, but, in fact, they are just as well known for their emphasis on company-wide training efforts designed to make every employee responsible for process quality. One of the most popular executives in the US, Jack Welsh, who was CEO of General Electric when his company embraced Six Sigma, not only mandated a company-wide Six Sigma effort, but made 40 % of every executive's bonus dependent on Six Sigma results. Welch went on to claim it was the most important thing he did while he was CEO of GE. In a similar way, Lean, in its original implementation as the Toyota Production System, is a company-wide program embraced with an almost religious zeal by the CEO and by all Toyota's managers and employees. Of all the approaches to process improvement, Lean and Six Sigma come closest, at their best, in implementing an organizational transformation that embraces process throughout the organization.

An overview of the recent history of the quality control tradition is illustrated in Fig. 2. Throughout most of the 1990s, Lean and Six Sigma were offered as independent methodologies, but starting in this decade, companies have begun to combine the two methodologies and tend, increasingly, to refer to the approach as Lean Six Sigma.

3.2 Capability Maturity Model

An interesting example of a more specialized development in the Quality Control tradition is the development of the Capability Maturity Model (CMM) at the Software Engineering Institute (SEI) at Carnegie Mellon University. In the early 1990s, the US Defense of Department (DoD) was concerned about the quality of the software applications being delivered, and the fact that, in many cases, the software applications were incomplete and way over budget. In essence, the DoD asked Watts Humphrey and SEI to develop a way of evaluating software organizations to determine which were likely to deliver what they promised on time and within

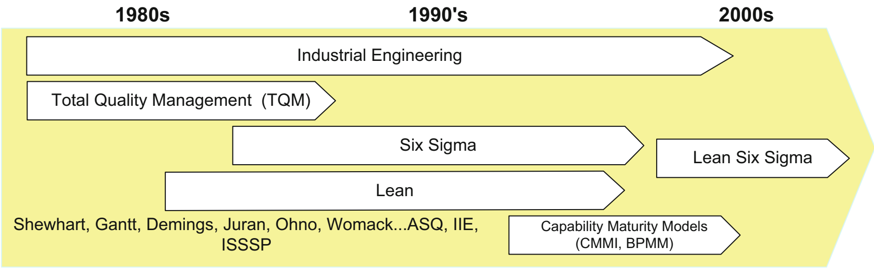


Fig. 2 The quality control tradition (BPTrends Associates. © 2013)

budget. Humphrey's and his colleagues at SEI developed a model that assumed that organizations that didn't understand their processes and that had no data about what succeeded or failed were unlike to deliver as promised (Paulk et al. 1995). They studied software shops and defined a series of steps organizations went through as they become more sophisticated in managing the software process. In essence, the five steps or levels are:

1. **Initial** – Processes aren't defined.
2. **Repeatable** – Basic departmental processes are defined and are repeated more or less consistently.
3. **Defined** – The organization, as a whole, knows how all their processes work together and can perform them consistently.
4. **Managed** – Managers consistently capture data on their processes and use that data to keep processes on track.
5. **Optimizing** – Managers and team members continuously work to improve their processes.

Level 5, as described by CMM, is nothing less that the company-wide embrace of process quality that we see at Toyota and at GE.

Once CMM was established, SEI proceeded to gathered large amounts of information on software organizations and begin to certify organizations as being level 1, 2, etc. and the DoD began to require level 3, 4 or 5 for their software contracts. The fact that several Indian software firms were able to establish themselves as CMM Level 5 organizations is often credited with the recent, widespread movement to outsource software development to Indian companies.

Since the original SEI CMM approach was defined in 1995, it has gone through many changes. At some point there were several different models, and, recently, SEI has made an effort to pull all of the different approaches back together and have called the new version CMMI – Capability Maturity Model Integrated. At the same time, SEI has generalized the model so that CMMI extends beyond software development and can be used to describe entire companies and their overall process maturity (Chrissis et al. 2007). We will consider some new developments in this approach, later, but suffice to say here that CMMI is very much in the Quality

Control tradition with it emphasis on output standards and statistical measures of quality.

If one considers all of the individuals working in companies who are focused on quality control, in all its variations like Lean and Six Sigma, they surely constitute the largest body of practitioners working for process improvement today.

4 The Management Tradition

At this point, we'll leave the Quality Control tradition, whose practitioners have mostly been engineers and quality control specialists, and turn to the management tradition. As with the quality control tradition, it would be easy to trace the Management Tradition to Ford and Taylor. And, as we have already suggested, there have always been executives who have been concerned with improving how their organizations functioned. By the mid-twentieth century however, most US managers were trained at business schools that didn't emphasize a process approach. Most business schools are organized along functional lines, and consider Marketing, Strategy, Finance, and Operations as separate disciplines. More important, operations have not enjoyed as much attention at business schools in the past few decades as disciplines like finance and marketing..

Joseph M. Juran, in an article on the United States in his *Quality Control Handbook*, argues that the US emerged from World War II with its production capacity in good condition while the rest of the world was in dire need of manufactured goods of all kinds (Juran 1951). Thus, during the 1950s and 1960s US companies focused on producing large quantities of goods to fulfill the demand of consumers who weren't very concerned about quality. Having a CEO who knew about finance or marketing was often considered more important than having a CEO who knew about operations. It was only in the 1980s, when the rest of the world had caught up with the US and began to offer superior products for less cost that things began to change. As the US automakers began to lose market share to quality European and Japanese cars in the 1980s, US mangers began to refocus on operations and began to search for ways to reduce prices and improve production quality. At that point, they rediscovered, in Japan, the emphasis on process and quality that had been created in the US in the first half of the twentieth century.

Unlike the quality control tradition, however, that focuses on the quality and the production of products; the management tradition has focused on the overall performance of the firm. The emphasis is on aligning strategy with the means of realizing that strategy, and on organizing and managing employees to achieve corporate goals. Equally, the management tradition stresses the use of innovation to radically change the nature of the business or to give the business a significant competitive advantage.

4.1 Geary Rummler

The most important figure in the management tradition in the years since World War II, has been Geary Rummler, who began his career at the University of Michigan, at the very center of the US auto industry. Rummler derives his methodology from both a concern with organizations as systems and combines that with a focus on how we train, manage, and motivate employee performance. He began teaching courses at the University of Michigan in the 1960s where he emphasized the use of organization diagrams, process flowcharts to model business processes, and task analysis of jobs to determine why some employees perform better than others. Later, Rummler joined with Alan Brache to create Rummler-Brache, a company that trained large numbers of process practitioners in the 1980s and early 1990s and co-authored, with Alan Brache, one of the real classics of our field – *Improving Performance: How to Manage the White Space on the Organization Chart* (Rummler and Brache 1990). Rummler always emphasized the need to improve corporate performance, and argued that process redesign was the best way to do that. He then proceeded to argue that improving managerial and employee job performance was the key to improved processes.

Figure 3 illustrates Rummler's approach which integrates three levels of analysis and concerns with measures, design and implementation and management. This diagram suggests the broader concerns that the management tradition in process has always embraced. The focus is on process and on all the elements in the business environment that support or impede good process performance.

A good example of this is illustrated in Fig. 4, another diagram that Rummler frequently uses, that illustrates the role of the process manager. Where someone in the work simplification tradition might be inclined to look at the steps in a procedure and at how employees perform, Rummler is just as likely to examine the performance of the process manager and ask if the manager has provided the needed resources, is monitoring the process, and is providing the feedback and incentives needed to motivate superior employee performance.

	Goals & Measures	**Design & Implementation**	**Management**
Organizational Level	Organizational Goals and Measures of Organizational Success	Organizational Design and Implementation	Organizational Management
Process Level	Process Goals and Measures of Process Success	Process Design and Implementation	Process Management
Activity or Performance Level	Activity Goals and Measures of Activity Success	Activity Design and Implementation	Activity Management

Fig. 3 A performance framework (Modified after a figure in Rummler and Brache, *Improving Performance*.)

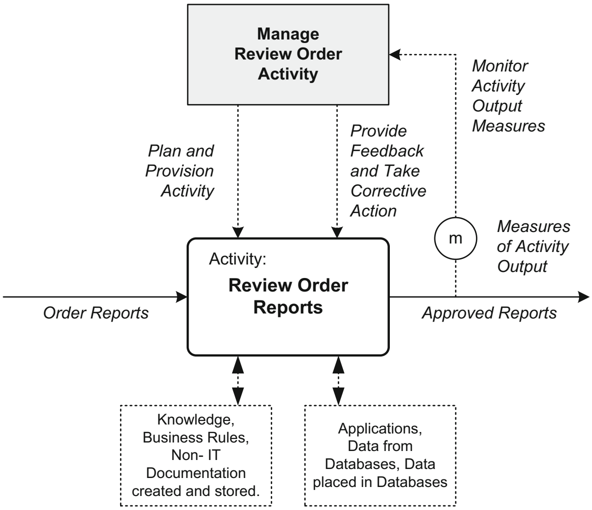


Fig. 4 Each process or activity must be managed (Modified after a figure in Rummler and Brache, *Improving Performance*)

Unlike the work simplification and quality control literature that was primarily read by engineers and quality control experts, Rummler's work has always been read by business managers and human resource experts.

4.2 Michael Porter

The second important guru in the Management tradition is Harvard Business School professor Michael Porter. Porter was already established as a leading business strategy theorist, but in his 1985 book, *Competitive Advantage*, he moved beyond strategic concepts, as they had been described until then, and argued that strategy was intimately linked with how companies organized their activities into value chains, which were, in turn, the basis for a company's competitive advantage (Porter 1985).

Figure 5 provides an overview of a value chain as described Michael Porter described it in *Competitive Advantage*.

A Value Chain supports a product line, a market, and its customers. If your company produces jeeps, then you have a Value Chain for jeeps. If you company makes loans, then you have a Value Chain for loans. A single company can have more than one value chain. Large international organizations typically have from 5 to 10 value chains. In essence, value chains are the ultimate processes that define a company. All other processes are defined by relating them to the value chain.

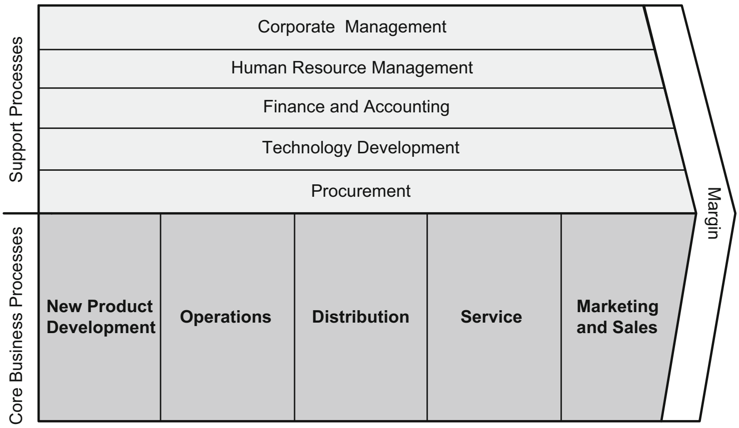


Fig. 5 Michael Porter's value chain

Put another way, a single value chain can be decomposed into major operational process like Market, Sell, Produce, and Deliver and associated management support processes like Plan, Finance, HR and IT. In fact, it was Porter's value chain concept that emphasized the distinction between core and support processes. The value chain has been the organizing principle that has let organizations define and arrange their processes and structure their process change efforts during the past two decades.

As Porter defines it, a competitive advantage refers to a situation in which one company manages to dominate an industry for a sustained period of time. An obvious example, in our time, is Wal-Mart, a company that completely dominates retail sales in the US and seems likely to continue to do so for the foreseeable future. "Ultimately," Porter concludes, "all differences between companies in cost or price derive from the hundreds of activities required to create, produce, sell, and deliver their products or services such as calling on customers, assembling final products, and training employees..." In other words, "activities... are the basic units of competitive advantage." This conclusion is closely related to Porter's analysis of a value chain. A value chain consists of all the activities necessary to produce and sell a product or service. Today we would probably use the word "processes" rather than "activity," but the point remains the same. Companies succeed because they understand what their customers will buy and proceed to generate the product or service their customers want by means of a set of activities that create, produce, sell and deliver the product or service.

So far the conclusion seems like a rather obvious conclusion, but Porter goes further. He suggests that companies rely on one of two approaches when they seek to organize and improve their activities or processes. They either rely on an approach which Porter terms "operational effectiveness" or they rely on "strategic positioning." "Operational effectiveness," as Porter uses the term, means performing similar activities better than rivals perform them. In essence, this is the "best practices" approach we hear so much about. Every company looks about, determines what appears to be the best way of accomplishing a given task and then seeks to implement that process in their organization. Unfortunately, according to Porter, this isn't an effective strategy. The problem is that everyone else is also trying to implement the same best practices. Thus, everyone involved in this approach gets stuck on a treadmill, moving faster all the time, while barely managing to keep up with their competitors. Best practices don't give a company a competitive edge – they are too easy to copy. Everyone who has observed companies investing in software systems that don't improve productivity or price but just maintain parity with one's competitors understands this. Worse, this approach drives profits down because more and more money is consumed in the effort to copy the best practices of competitors. If every company is relying on the same processes then no individual company is in a position to offer customers something special for which they can charge a premium. Everyone is simply engaged in an increasingly desperate struggle to be the low cost producer, and everyone is trying to get there by copying each others best practices while their margins continue to shrink. As Porter sums it up: "Few companies have competed successfully on the basis of operational effectiveness over an extended period, and staying ahead of rivals gets harder every day."

The alternative is to focus on evolving a unique strategic position and then tailoring the company's value chain to execute that unique strategy. "Strategic positioning," Porter explains, "means performing different activities from rivals' or performing similar activities in different ways." He goes on to say that "While operational effectiveness is about achieving excellence in individual activities, or functions, strategy is about combining activities." Indeed, Porter insists that those who take strategy seriously need to have lots of discipline, because they have to reject all kinds of options to stay focused on their strategy.

Rounding out his argument, Porter concludes "Competitive advantage grows out of the entire system of activities. The fit among activities substantially reduces cost or increases differentiation." He goes on to warn that "Achieving fit is difficult because it requires the integration of decisions and actions across many independent subunits." Obviously we are just providing the barest summary of Porter's argument. In essence, however, it is a very strong argument for defining a goal and then shaping and integrating a value chain to assure that all the processes in the value chain work together to achieve the goal.

The importance of this approach, according to Porter, is derived from the fact that "Positions built on systems of activities are far more sustainable than those built on individual activities." In other words, while rivals can usually see when you have improved a specific activity, and duplicate it, they will have a much harder time figuring out exactly how you have integrated all your processes. They will have an even harder time duplicating the management discipline required to keep the integrated whole functioning smoothly.

Porter's work on strategy and value chains assured that most modern discussion of business strategy are also discussions of how value chains or processes will be organized. This, in turn, has led to a major concern with how a company aligns its

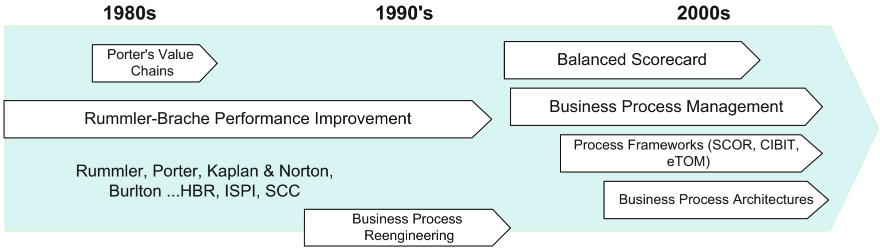


Fig. 6 The management tradition

strategic goals with its specific processes and many of the current concerns we discuss in the following pages represent efforts to address this issue.

Figure 6 pictures Rummler, Porter and some of the other major trends in the management tradition.

4.3 *Balanced Scorecard*

One methodology very much in the management tradition is the Balanced Scorecard methodology developed by Robert S. Kaplan and David P. Norton (1996). Kaplan and Norton began by developing an approach to performance measurement that emphasized a scorecard that considers a variety of different metrics of success. At the same time, the Scorecard methodology proposed a way of aligning departmental measures and managerial performance evaluations in hierarchies that could systemize all of the measures undertaken in an organization. Later they linked the scorecard with a model of the firm that stressed that people make processes work, that processes generated happy customers, and that happy customers generated financial results (Kaplan and Norton 2004). In other words, Kaplan and Norton have created a model that begins with strategy, links that to process and people, and then, in turn, links that to measures that determine if the operations are successfully implementing the strategy.

In its initial use, the Balanced Scorecard methodology was often used by functional organizations, but there are now a number of new approaches that tie the scorecard measures directly to value chains and business processes, and process people are increasingly finding the scorecard approach a systematic way to align process measures from specific activities to strategic goals.

4.4 *Business Process Reengineering*

One can argue about where the Business Process Reengineering (BPR) movement should be placed. Some would place it in the management tradition because it motivated lots of senior executives to rethink their business strategies.

The emphasis in BPR on value chains certainly derives from Porter. Others would place it in the IT tradition because it emphasized using IT to redefine work processes and automate them wherever possible. It probably sits on line between the two traditions, and we'll consider in more detail under the IT tradition.

5 The Information Technology Tradition

The third tradition involves the use of computers and software applications to automate work processes. This movement began in the late 1960s and grew rapidly in the 1970s with an emphasis on automating back office operations like book keeping and record keeping and has progressed to the automation of a wide variety of jobs, either by doing the work with computers, or by providing desktop computers to assist humans in performing their work.

When your author began to work on process redesign with Geary Rummler, in the late 1960s, we never considered automation. It was simply too specialized. Instead, all of our engagements involved straightening out the flow of the process and then working to improve how the managers and employees actually implemented the process. That continued to be the case through the early part of the 1970s, but began to change in the late 1970s as more and more core processes, at production facilities and in document processing operations, began to be automated. By the early 1980s we were working nearly full time on expert system problems and focused on how we could automate the decision making tasks of human experts, and had realized that, eventually, nearly every process in every organization would either be automated, or performed by human's who relied on access to computers and information systems.

We will not attempt to review the rapid evolution of IT systems, from mainframes to minis to PCs, or the way IT moved from the back office to the front office. Suffice to say that, for those of us who lived through it, computers seemed to come from nowhere and within two short decades, completely changed the way we think about the work and the nature of business. Today, it is hard to remember what the world was like without computer systems. And that it all happened in about 40 years. Perhaps the most important change, to date, occurred in 1995 when the Internet and the Web began to radically alter the way customers interacted with companies. In about 2 years we transitioned from thinking about computers as tools for automating internal business processes to thinking of them as a communication media that facilitated radically new business models. The Internet spread computer literacy throughout the entire population of developed countries and has forced every company to reconsider how its business works. And it is now driving the rapid and extensive outsourcing of processes and the worldwide integration of business activities.

Figure 7 provides an overview of the IT Tradition. It is the youngest, and also the most complex tradition to describe in a brief way. Prior to the beginning of the 1990s, there was lots of work that focused on automating processes, but it was

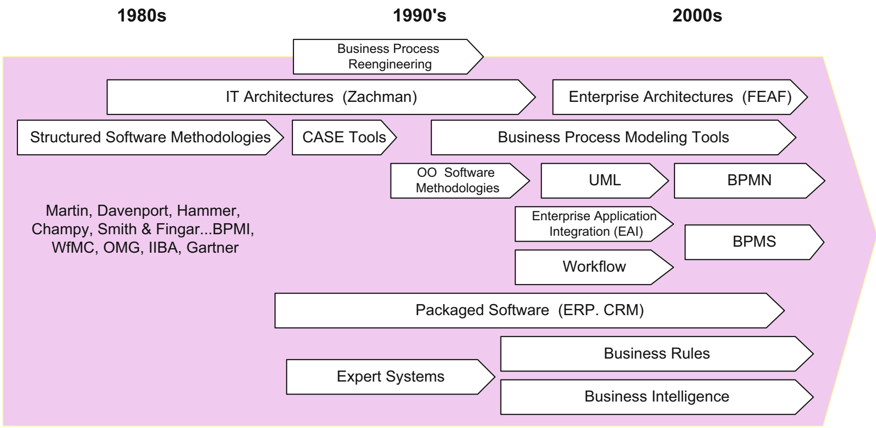


Fig. 7 The information technology tradition

rarely described as process work, but was instead referred to as software automation. As it proceeded jobs were changed or eliminated and companies became more dependent on processes, but in spite of lots of arguments about how IT supported business, IT largely operated independently of the main business and conceptualized itself as a service.

5.1 Business Process Reengineering

That changed at the beginning of the 1990s with Business Process Reengineering (BPR), which was kicked off, more or less simultaneously, in 1990, by two articles: Michael Hammer's "Reengineering Work: Don't Automate, Obliterate" (*Harvard Business Review*, July/August 1990) and Thomas Davenport and James Short's "The New Industrial Engineering: Information Technology and Business Process Redesign" (*Sloan Management Review*, Summer 1990). Later, in 1993, Davenport wrote a book, *Process Innovation: Reengineering Work through Information Technology*, and Michael Hammer joined with James Champy to write *Reengineering the Corporation: A Manifesto for Business Revolution* (Davenport 1993; Hammer and Champy 1993).

Champy, Davenport, and Hammer insisted that companies must think in terms of comprehensive processes, similar to Porter's value chains and Rummler's Organization Level. If a company focused only on new product development, for example, the company might improve the new product development subprocess, but it might not improve the overall value chain. Worse, one might improve new product development process at the expense of the overall value chain. If, for example, new process development instituted a system of checks to assure higher-quality documents, it might produce superior reports, but take longer to produce them, delaying marketing and manufacturing's ability to respond to sudden changes in the marketplace. Or the new reports might be organized in such a way that they made better sense to the new process development engineers, but became much harder for marketing or manufacturing readers to understand. In this sense, Champy, Davenport, and Hammer were very much in the Management Tradition.

At the same time, however, these BPR gurus argued that the major force driving changes in business was IT. They provided numerous examples of companies that had changing business processes in an incremental manner, adding automation to a process in a way that only contributed an insignificant improvement. Then they considered examples in which companies had entirely reconceptualized their processes, using the latest IT techniques to allow the process to function in a radically new way. In hindsight, BPR began our current era, and starting at that point, business people began to accept that IT was not simply a support process that managed data, but a radical way of transforming the way processes were done, and henceforth, an integral part of every business process.

BPR has received mixed reviews. Hammer, especially, often urged companies to attempt more than they reasonably could. Thus, for example, several companies tried to use existing technologies to pass information about their organizations and ended up with costly failures. Keep in mind these experiments were taking place in 1990–1995, before most people knew anything about the Internet. Applications that were costly and unlikely to succeed in that period, when infrastructures and communication networks were all proprietary became simple to install once companies adopted the Internet and learned to use email and web browsers. Today, even though many might suggest that BPR was a failure, its prescriptions have largely been implemented. Whole industries, like book and music retailers and newspapers are rapidly going out of business while customers now use online services to identify and acquire books, download music and provide the daily news. Many organizations have eliminated sales organizations and retail stores and interface with their customers online. And processes that were formerly organized separately are now all available online, allowing customers to rapidly move from information gathering, to pricing, to purchasing.

Much more important, for our purposes, is the change in attitude on the part of today's business executives. Almost every executive today uses a computer and is familiar with the rapidity with which software is changing what can be done. Video stores have been largely replaced by services that deliver movies via mail, directly to customers. But the very companies that have been created to deliver movies by mail are aware that in only a few years movies will be downloaded from servers and their existing business model will be obsolete. In other words, today's executives realize that there is no sharp line between the company's business model and what the latest information technology will facilitate. IT is no longer a service – it has become the essence of the company's strategy. Companies no longer worry about reengineering major processes and are more likely to consider getting out of an entire line of business and jumping into an entirely new line of business to take advantage of an emerging development in information or communication technology.

5.2 Enterprise Resource Planning Applications

By the late 1990s, most process practitioners would have claimed to have abandoned BPR, and were focusing, instead on more modest process redesign projects. Davenport wrote *Mission Critical*, a book that suggested that Enterprise Resource Planning (ERP) applications could solve lots of process problems, and by the end of the decade most large companies had major ERP installation projects underway (Davenport 2000). ERP solved some problems and created others. Meanwhile, workflow applications also came into the own in the late 1990s, helping to automate lots of document processing operations (van der Aalst and van Hee 2000).

5.3 CASE and Process Modeling Tools

The interest in Computer Aided Software Engineering (CASE) tools, originally created in the 1980s to help software engineers create software from the diagrams created by software developers using structured methodologies, declined, rapidly in the early 1990s as companies embraced minis, PCs and a variety on non-COBOL development languages and new object-oriented development methodologies (McClure 1989). The CASE vendors survived, however, by redesigning their tools and repositioning themselves as business process modeling tools. Thus, as companies embraced BPR in the mid-1990s they did it, in part, by teaching business people to use modeling tools to better understand their processes (Scheer 1994).

5.4 Expert Systems and Business Rules

In a similar way, software developed to support Expert Systems development in the 1980s morphed into business rule tools in the 1990s. The expert systems movement failed, not because it was impossible to capture the rules that human experts used to analyze and solve complex problems, but because it was impossible to maintain the expert systems once they were developed. To capture the rules used by a physician to diagnose a complex problem required tens of thousands of rules. Moreover the knowledge kept changing and physicians needed to keep reading and attending conferences to stay up-to-date (Harmon and King 1985; Harmon and Hall 1993). As the interest in expert systems faded, however, others noticed that small systems designed to help mid-level employees perform tasks were much more successful. Even more successful were systems designed to see that policies were accurately implemented throughout the organizations (Ross 2003). Gradually, companies in industries like insurance and banking established business rule groups to develop and maintain systems that enforced policies implemented in their business processes. Processes analysis and business rule analysis have not yet fully merged, but everyone now realizes that they are two sides of the same coin. As a process is executed, decisions are made. Many of those decisions can be described in terms of business rules. By the same token, no one wants to deal with huge rule bases, and process models provide an ideal way to structure where and how business rules will be used.

In the near future business rules will be reconceptualized as one type of decision, and the emphasis will shift to analyzing and managing decisions that occur in processes. The OMG is working on a Decision Management Notation (DMN), and the rules field increasingly reflects ideas derived from David Taylor (Taylor and Raden 2007) and from Barbara von Halle and Larry Goldberg (2010). At the same time Decision Management and the use of Analytics seems likely to be combined (Davenport et al. 2010).

5.5 *Process and the Interface Between Business and IT*

Stepping back from all the specific software initiatives, there is a new spirit in IT. Executives are more aware than ever of the strategic value of computer and software technologies and seek to create ways to assure that their organizations remain current. IT is aware that business executives often perceive that IT is focused on technologies rather than on business solutions. Both executives and IT managers hope that a focus on process will provide a common meeting ground. Business executives can focus on creating business models and processes that take advantage of the emerging opportunities in the market. At the same time, IT architects can focus on business processes and explain their new initiatives in terms of improvements they can make in specific processes. If business process management platforms can be created to facilitate this discussion, that will be very useful. But even without software platforms, process seems destined to play a growing role in future discussions between business and IT managers.

One key to assuring that the process-focused discussions that business and IT managers engage in are useful is to assure that both business and IT managers begin with a common, comprehensive understanding of process. A discussion of only those processes that can be automated with today’s techniques is too limited to facilitate discussions that can help business executives. Business executives are just as concerned with customer and employee issues as they are with automation issues. While it is impossible, today, to think of undertaking a major business process redesign project without considering what information technology can do to improve the process, it is equally impossible to think about a major redesign that doesn’t call for major changes in how employees perform their jobs. Employees and the management of employees are just as important as information technology and business managers need, more than ever, an integrated, holistic approach to the management of process change.

6 Business Process Change Today and Tomorrow

While many individuals continue to work largely within one of the three traditions we just described, a growing number are struggling to create a new synthesis, which is increasingly referred to as Business Process Management (BPM) and which, at its best, embraces all three traditions.

To organize our discussion of some of the more important efforts under way today, it is useful to have some general framework. The one we are most familiar with describes corporate business process change efforts in terms of levels. Some organizations are only focused on one level. Organizations with a CMM maturity of 2.5 are focused mainly on the Business Process Level. Increasingly, however, as organizations become more mature in managing their processes, they are working on all levels, simultaneously. At the Enterprise Level organizations seek to organize their processes across the entire enterprise, aligning processes with strategies and defining process governance and measurement systems for the entire organization. At the Process Level, organizations are exploring a wide variety of new approaches to process analysis and redesign, and at the Implementation level, new technologies are evolving to support process work. Some of the initiatives at each level can be associated with specific traditions, but, increasingly, as companies seek an integrated approach to process, we are witnessing the evolution of approaches at each level that combine elements of more than one tradition. We will organize the discussion that follows around the current initiatives on these three levels. (See Fig. 8.)

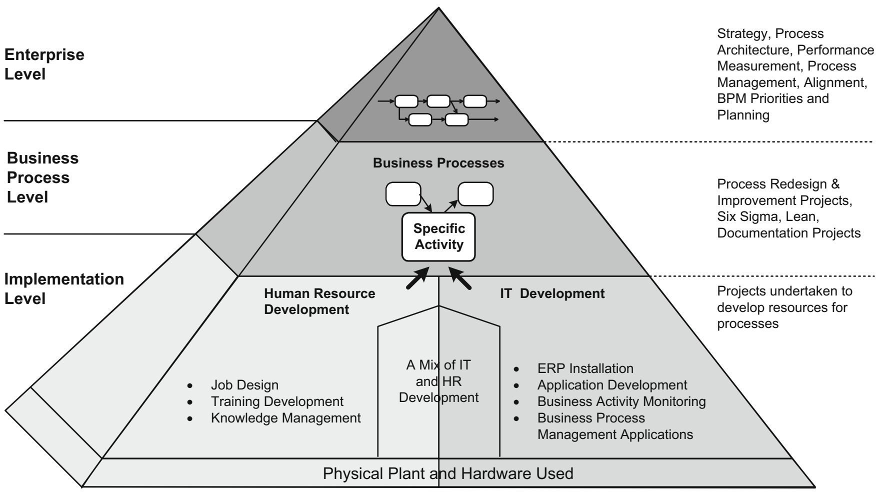


Fig. 8 The business process trends pyramid

7 Enterprise Level Initiatives

Enterprise Level initiatives are focused on strategy, architecture, process governance and on process measurement systems. As companies become more mature in their use of processes and increasingly try to integrate around business processes they continue to place more emphasis on enterprise level initiatives.

7.1 Business Architecture

Enterprise Architecture has always been a concern of those in IT. The focus has traditionally been on identifying how all of the software technologies, applications and infrastructure elements fit together. The leading IT approach to enterprise architecture development was defined by John Zachman (1987), and is usually termed the Zachman Framework. It's an approach that is very oriented towards classifying elements and storing them in a database. The Zachman Framework mentions processes, but process concerns are simply not a major focus of the Zachman Framework.

Beginning in the early years of this decade, however, Enterprise Architecture began to take on a different meaning, and was increasingly used to not only define IT elements, but to show how the IT elements supported business processes. In effect, senior IT managers have begun to redefine their jobs and consider that they are not so much service providers as business managers who are responsible for using new technology to improve the companies business processes. IT managers who used to try to sell new technologies are now more likely to work with other business managers to see how business processes can be improved. This reflects the fact that IT no longer consists of applications running on mainframes in a special location, but, with the advent of the PC, the Internet, and email, is now integrated throughout every process in the organization. This, in turn, has led those involved in architectural efforts to embrace a broader, more process-oriented view of an enterprise architecture. In fact, the tendency has been to shift from speaking of enterprise to either speaking of Business Architecture or of Business Process Architecture. In essence, the Business Architecture defines how the business is organized to achieve its goals. Then, IT and other groups align their architectures to support the business architecture. At the same time, processes are increasingly aligned with corporate strategies and performance measures to generate architectural models that emphasize alignment and facilitate the rapid identification of related elements when strategic and process change is required (Harmon 2007).

In the US, Enterprise Architecture work has been strongly influenced by recent government laws that require government departments to have and use Enterprise Architectures to justify new initiatives. Although some of these architectures are more traditional IT architectures, increasingly they are modeled on the US

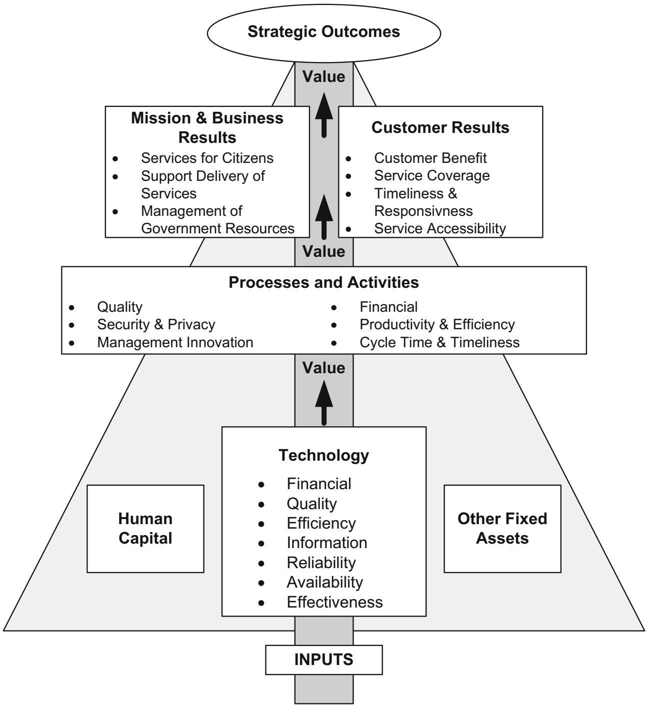


Fig. 9 An overview of the US government's Federal Enterprise Architecture Framework

government's Federal Enterprise Architecture Framework (FEAF) and rely on a layered, hierarchical model that emphasizes the alignment of strategy, missions and customer results, and business processes with human and IT resources. (See Fig. 9.) (www.gov.cio/Documents/fedarch1.pdf)

The emphasis on process-focused ways of conceptualizing an enterprise architecture have, in turn, led architects to explore ways of representing value chains and high level processes. Today, there is a lot of emphasis on creating a Business Process Architecture and not too much agreement on exactly how to do it.

7.2 Value Chains and Value Networks

For the last 20 years the organizing principle that most business process architects have relied upon has been the Value Chain. Michael Hammer relied heavily on the concept in *Reengineering the Corporation* which he published in 1993. He urged companies to begin their process work by identifying their value chains and then, as needed, to reengineer each value chain.

In the last decade, however, the value chain has come under attack in academic circles. Those who dislike the value chain approach argue that it is too rigid; that is was developed when most companies emphasized manufacturing operations and focused on making large-scale processes as efficient as possible. In other words, they argue that the idea of the value chain is another artifact of the over emphasis on mass production. As companies become more agile and respond to customers in more creative ways, they argue, companies need a more flexible way of representing the relationships among their business processes.

Value Nets. Most of those who oppose the Value Chain approach support an alternative model that is usually termed a Value Net. There have been several books published on Value Nets. The book that is most cited is David Bovet and Joseph Martha's *Value Nets: Breaking the Supply Chain to Unlock Hidden Profits* (Wiley 2000). Recently, IBM's Global Services group has begun to suggest that companies develop Component Business Models (CBM), which IBM claims it derives from a Value Nets approach. IBM's Component Business Models offer a very specific and practical approach to organizing a Business Process Architecture, and thus they move the discussion of whether one should emphasize a Value Chain or a Value Net out of the academic arena and make it an issue that business process architects and practitioners will need to consider.

Clearly IBM has thought quite a bit about its Component Business Model approach. Two IBM publications trace the evolution of CBM. The first is a paper by Luba Cherbakov, George Galambos, Ray Harishankar, Shankar Kalyana and Guy Rockham entitled "Impact of Service Orientation at the Business Level." This appeared in the *IBM Systems Journal* in April 2005. It clearly lays out the Component Business Model, but seems to suggest that the CBM can be derived from the Value Chain, which seems to come first. The method has apparently evolved since then. In a white paper, *Component Business models: Making Specialization Real*, issued by IBM Institute for Business Value in August 2005, and authored by George Pohle, Peter Korsten and Shanker Ramamurthy, IBM suggests that a CBM can be developed without reference to a value chain. Recent practice seems to rely grouping similar processes based on interviews and statistics. In either case, the result on an IBM CBM effort is a diagram like the one pictured in Fig. 10.

An IBM CBM architecture starts by grouping processes into broad categories, which it terms Business Competency Domains. The domains vary from company to company and seem to be an informal way to organize the specific company's large-scale processes. Typical domains include Managing Customers, Supply Chain and Administration. IBM subdivides those categories into three fixed Accountability Levels: Strategy, Tactics, and Operations to form the basic CBM matrix. Both Strategy and Tactics level processes tend to be management processes. Operations level processes include both core and support processes.

No explicit relationships between the Business Components placed within the matrix are indicated. In other words, if we imagine a company with two value chains, each of which had an inventory process, both inventory processes would be merged here into a single generic Inventory process. Thus, an IBM CBM classifies a set of business processes (i.e. components) but does not suggest how they combine to provide specific value to particular customers. The whole point of the IBM CBM

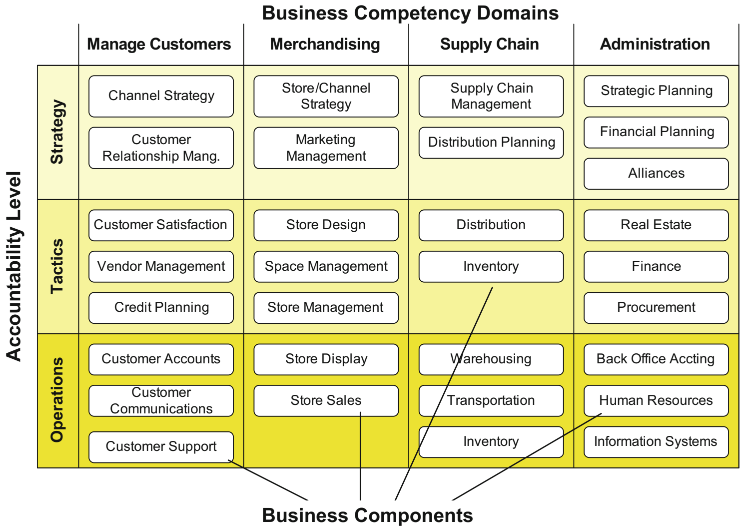


Fig. 10 IBM's Component Business Model

is to avoid showing specific chains of business processes in order to emphasize common, standard processes that are independent of any specific chain.

Reading the Value Net literature, one could easily conclude that Value Nets are primarily being used by consulting companies that are primarily focused on how to assemble unique processes to support one-of-a-kind engagements. The Value Net is just the shelf they keep their skill and knowledge on before they will assemble it in any way necessary to satisfy a given client.

On the other hand, we have encountered clients who increasingly focus on their management competencies and put less emphasis on their core or operational processes. This is often the case when companies outsource manufacturing to China and rely on distributors to market to customers. The traditional core capabilities of these companies have become commodities. Increasingly their new core competencies consist of designing new products and assembling the capital and organizing the overall supply chain needed to bring new products or services to market. In other words, the core competencies of virtual companies are tactical and strategic management processes. For these companies, value nets seem to place more emphasis on the management processes and less on the traditional operational processes.

In a similar way, many companies are focused on building Service Oriented Architectures and want to have a way of thinking of alternative services that can be used in any given process. Other companies are interested in simplifying their ERP systems, and want to standardize similar processes throughout the company to facilitate shifting to a single instance of ERP. And, finally, value net approaches often seem to provide a better way of describing business process frameworks like SCOR and VRM. Suffice to say there are lots of groups that are deemphasizing value chains and focusing, instead, on sets of business processes that can be integrated on an ad hoc basis.

Tight Integration and Efficiency versus Flexibility. Recall that Michael Porter argued that a company should work hard to integrate a value chain. Porter (1996) his primary concern was not efficiency, as such, but the fact that a tightly integrated value chain that focused on executing a specific strategy was much more difficult for a competitor to copy. In other words, you optimize a value chain to not only assure efficiency but to implement a strategy in a manner that gives you a competitive advantage that competitors find it difficult to duplicate. The alternative, which Porter terms "operational effectiveness," tries to make each individual process as efficient as possible, while ignoring the integration of the processes.

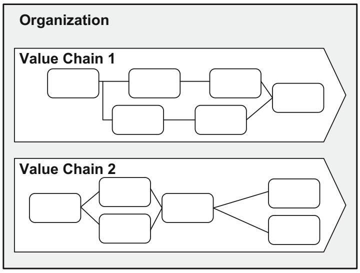
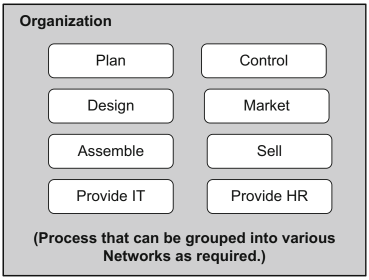
The Value Net theorists and IBM's CBM approach argue that few companies, today, have the time to integrate and refine their value chains. New technologies and new customer demands keep coming faster and product lifecycles keep getting shorter. Thus, they argue, that companies should conceptualize their organizations as a set of competencies, and to refine the business processes that embody each of the competencies. Then, as specific and unique challenges arise the companies are well positioned to combine these competency-based processes, as needed, to create the large-scale processes they need to satisfy ad hoc customer needs. Obviously IBM's approach is very much in the spirit of the Service Oriented Architecture (SOA) that increasingly thinks of processes as assemblages created as needed. It's also very much in line with efforts underway at companies that seek to standardize business processes throughout the company in order to support a single instance (or at least a few instances) of ERP throughout the company.

A tightly integrated value chain can usually produce outputs for the minimum price in the fastest possible time. A flexible value net, assembled quickly, probably can't produce outputs as efficiently or as cheaply. On the other hand, it can be hard to change a tightly integrated value chain, although it can be done if one designs variation in from the start. In either case efficiency and success will depend on anticipating the right scope and size of the business components one creates. Too large and they won't snap together to handle the various and changing demands one faces. Too small and one faces too many hassles when one seeks to assemble them for a specific purpose.

Table 1 pictures the two approaches and compares some of the obvious advantages and disadvantages of the two approaches.

The authors who have written about Value Nets have tended to be both defensive and over enthusiastic. They suggest that there is a sharp either-or difference between the two approaches and that everyone will want to shift to the "more modern" value net approach. In reality, we suspect, most large companies will want both. Most large companies have at least some large-scale processes that are done over-and-over. Success in these operations requires efficiency and tight integration. It makes sense to model those processes as value chains and to work hard to make those processes as efficient as possible. In these cases, competitive advantage will clearly reside with tightly integrated processes that support a high quality, low cost strategy. At the same time, most large companies also have large-scale processes

Table 1 Advantages and disadvantages of value chains and value nets

Value chain	Value net (CBM)
	
Advantages • Defines an actual process undertaken by the organization • Identifies customer • Shows specific relationships between internal sub-processes • Allows you to measure results of chain and use that measure to evaluate the results of the internal processes that make up the value chain	**Advantages** • Defines all processes company has that could be used to assemble a new value chain • Identifies all processes that company supports that have competencies and that take similar inputs and make similar outputs.
Disadvantages • Defines a specific way in which processes fit together • May use similar processes in more than one value chain without identifying that fact	**Disadvantages** • Does not identify specific process • Does not identify customer • Does now show relationships between business processes

that change rapidly and that generate highly tailored outputs. It may not make sense to model those processes as value chains, or to spend too much time trying to integrate all the subprocesses. In this cases competitive advantage will lie with a strategy that emphasizes flexibility.

Overall, however, the business process architects job is not becoming easier. Companies will increasingly need to rely on a variety of different approaches to organize their business process architectures.

7.3 *Business Process Frameworks*

Business Process Frameworks (also called Operation Reference Frameworks) are one of the most exciting developments in process work in the past decade. Frameworks provide a quick way for a company to establish a high-level process architecture, complete with core, management and support processes, and with measures to use in evaluating performance. The use of process frameworks were driven, initially, by the growing interdependency of company supply chains, by

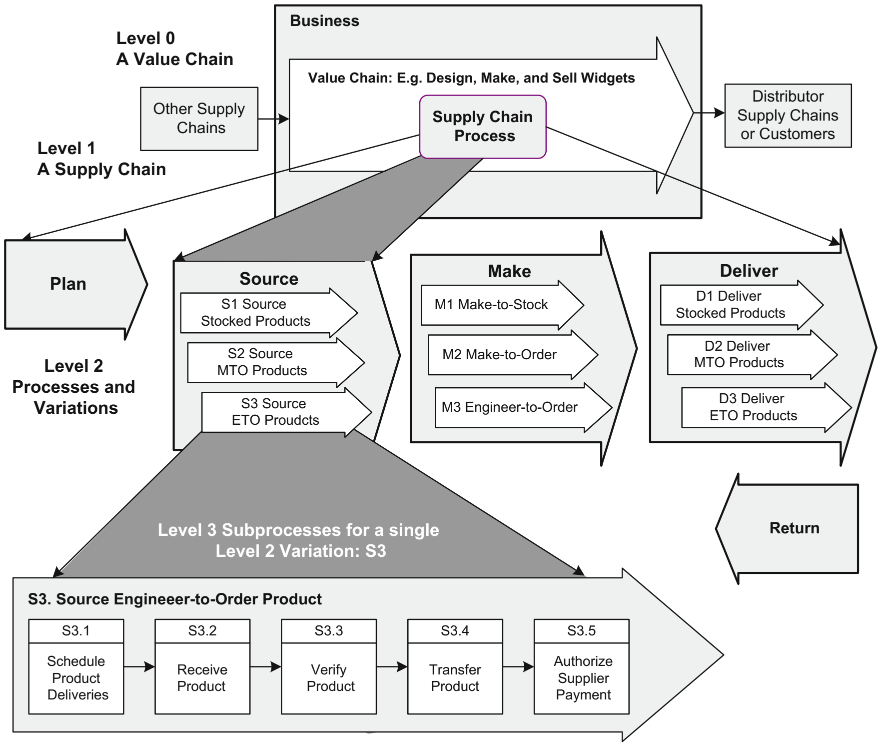


Fig. 11 The three levels of a SCOR architecture

outsourcing, and by a heightened need for a standard vocabulary to facilitate communication between companies that are trying to coordinate how their respective processes can work together. As more companies have decided to create formal business process architectures, however, frameworks have become popular as templates that can be used to help a company quickly create a business architecture.

7.3.1 The Supply Chain Council's SCOR Framework

The Supply Chain Council's SCOR Framework is undoubtedly the best known example of a business process framework. The Supply Chain Council (SCC) was established as a nonprofit consortium in 1996. Today, it is a worldwide organization with over 700 members. The Council conducts meetings that allow companies to gather together to discuss supply chain problems and opportunities. In addition, it has been working on a standard supply chain framework or reference model (Bolstorff and Rosenbaum 2007; Poluha 2007).

SCOR is comprised of three levels, as illustrated in Fig. 11. The SCOR Reference Manual defines each level 2 and level 3 subprocess and also indicates what

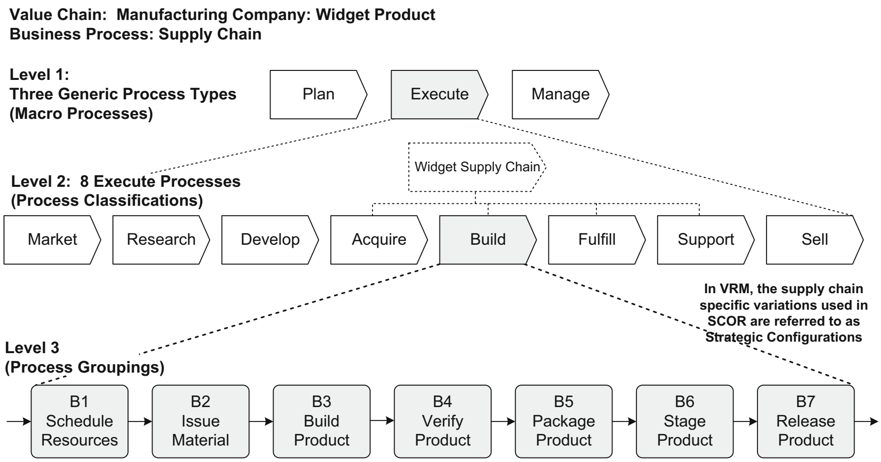


Fig. 12 The Value-Chain Group's VRM framework

planning and support processes are typically linked to each of process or subprocess. The SCC does not define a fourth level, leaving the specification of level four activities to individual companies. In other words, SCOR defines a supply chain architecture and all of the high-level processes and leaves the technical implementation of the level 3 processes to the individual members.

In a similar way, the SCOR Reference Manual defines metrics for each of the processes in the SCOR framework. Thus, using SCOR a company can quickly characterize its supply chain architecture and choose metrics appropriate to their industry and strategy. Several organizations that track benchmarks are working with the Supply Chain Council and can provide generic benchmarks for SCOR measures for specific industries. Thus a company cannot only create an architecture but also obtain information to determine where their existing processes are superior or deficient.

7.3.2 Other Business Frameworks

The Value-Chain Group has created its own model, the Value Reference Model or VRM, which is similar to SCOR, but more comprehensive and, in some ways, better integrated. Figure 12 illustrates the VRM architecture.

Although Fig. 12 does not show any details, VRM defines an extensive set of Planning and Managing processes. If we wanted to analyze *B4:Verify Product* in some detail we would not only want to look at the relationships between B3-B4-B5, but we would also look at relationships between B4 and other core processes but also with a variety of planning and managing processes. Consider Fig. 13 which shows some of the basic Level 3 processes that link to B4. Then imagine that each of those processes had four or five inputs and four or five outputs. Thus, the high

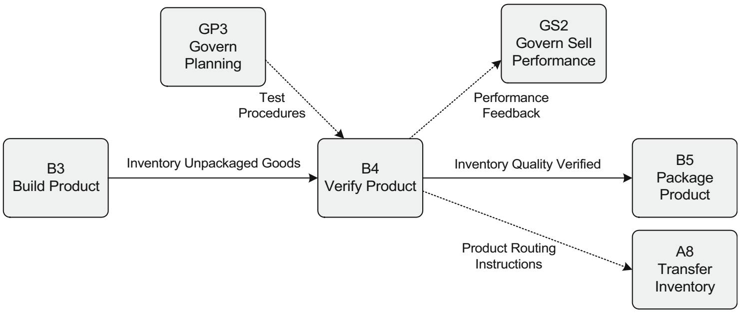


Fig. 13 Processes linked to B4 in the VRM framework

level processes we find in Frameworks and Business Process Architectures, in general, are often simply nodes in a complex network of relationships and hard to represent in traditional flow diagrams. We'll consider the implementations of this in a moment.

Another effort to define a complete value chain framework was undertaken by the TeleManagement Forum, a consortium of telecom companies. Their framework is highly tailored to the needs of telecom companies. Thus, it can't be used by non-telecoms, but it does provide a comprehensive approach for telecom companies.

In addition to SCOR, VRM and eTOM, there are a number of other initiatives underway to create business process frameworks. AQPC offers a framework that incorporates elements of SCOR. ITIL and COBIT are more specialized frameworks that can be used by IT departments. The insurance industry consortium, ACORD, is working on a framework for the insurance industry, the OMG's Finance Task Force is working on a framework for finance companies and there are probably others we haven't heard of yet.

All of these framework efforts not only provide companies with an easy way to create a process architecture, but they focus everyone on the various issues involved in the creation and maintenance of a process architecture. There is already talk about how to best model frameworks and there are software tools being developed to help companies use the various frameworks. ISSSP has a SIG focused on how to integrate SCOR models with Six Sigma development efforts and similar initiatives will undoubtedly appear in the next few years. Once companies accept the idea that they don't need to create their own process architecture from scratch, many different aspects of process work will gradually change.

7.4 Roger Burlton, Process Scope, and Value Chain Diagrams

Roger Burlton, a well-known process consultant, is also very much in the management tradition and his book, *Business Process Management*, published in 2001, is, as far as we know, the first book to use the term *BPM* in its modern sense

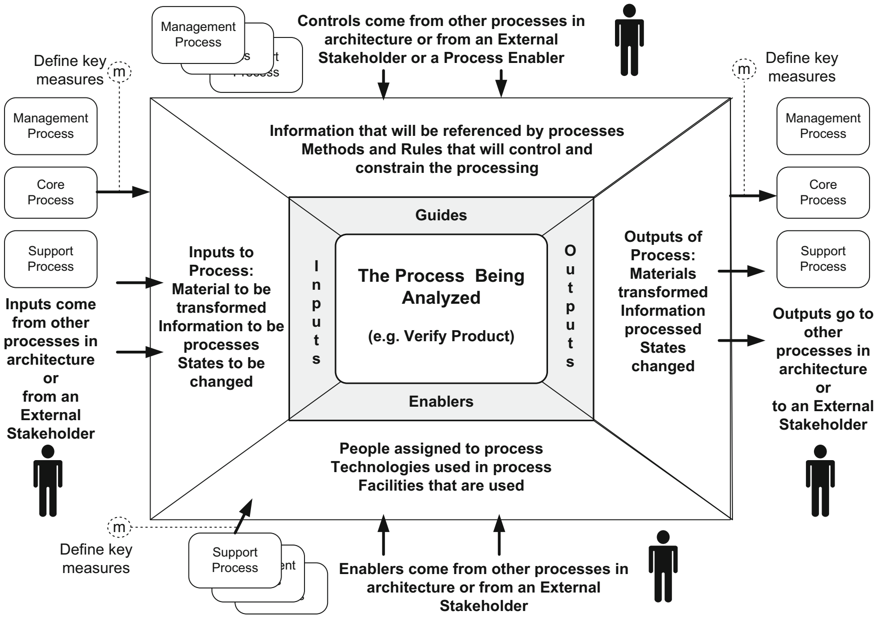


Fig. 14 Burlton's Process Scope Diagram

(Burlton 2001). As with all those working in the management tradition, Burlton emphasizes the need to align organizations from the top, down, to assure that processes are measured and can be shown to support customers and strategic goals. Similarly, he puts as much emphasis on the management and the way employees implement the processes as on the formal organization of the processes themselves.

Just as Rummler is associated with process flow diagrams (Rummler-Brache Diagrams) that include swimlanes and a top line for the customers of the process, Burlton is associated with Process Scope Diagrams or IGOEs (Inputs, Guides, Outputs and Enablers). (See Fig. 14.)

Scope diagrams represent an extension of an earlier type of diagram found in a US Air Force methodology – IDEF – but extended by Burlton and others to support high-level process analysis work. IGOE diagrams are particularly useful for analyzing the problems associated with the types of processes you find in process architectures and in frameworks like SCOR and VRM – processes that linked, in complex ways, to a variety of other core, management, and support processes. They are also useful for emphasizing the role of policies and rules and management and employee issues that are largely ignored in traditional flow diagrams.

The process-in-scope is placed in the middle box. Inputs and outputs are then examined. The sources of the inputs and those who receive the outputs are also identified. Then, in addition, one looks at Guides – information that controls the execution of the process, including business rules and management policies – and we look at what Enables the process, including employees, data from IT applications and the physical layout of the work environment. As we define the flows into and out of the process-in-scope, we look for problems and we also begin to define how we will measure the effectiveness of the process and where the problems seem to reside.

As companies begin to work with process architectures, they will need ways to focus on specific processes and examine all of the relationships between a given high level processes and all of the other processes associated with it. Rummler-Brache process flow diagrams have evolved into BPMN diagrams. We wouldn't be surprised to find that Burlton's IGOE diagrams, or something very similar, will evolve into a new standard type of diagram that those interested in process architectures sand frameworks will use to document, analyze and model high level business processes. Some authors have begun to refer to this type of diagram as a value chain diagram.

7.5 Process Maturity Models

CMM, and CMMI remain the most popular descriptions of process maturity, but they are increasingly seen as too oriented towards the concerns of groups like the US Department of Defense, that uses this approach to evaluate contractors. In the past few years we have seen several effort aimed at producing maturity models that are more aligned with the concerns of business process architects.

One effort, the Business Process Maturity Model was developed by Bill Curtis and Charles Weber, researchers who had formerly worked with SEI. Their effort resulted in a process-oriented maturity standard, BPMM, that has been adopted by the OMG. (www.omg.org Search BPMM)

Another effort has been led by Dr. Michael Rosemann and Tonia de Bruin at the Business Process Management Research Group at Queensland University of Technology, in Australia has been undertaken in conjunction with a related effort which is being led by Tom Davenport and Brad Powers at Babson College (Rosemann 2007). This group has been developing a Holistic Model for BPM Maturity. In essence, this work has extended the CMM model to three dimensions and seeks to coordinate a wider range of variables in their characterizations of maturity. This model has been derived from a comprehensive study of related literature in the areas of maturity models and critical success factors of Business Process Management. The model has been applied in a number of case studies and the findings from these case studies motivated further revisions. Rather than simply analyze existing process efforts, the maturity model developed by Rosemann and others has proven useful in helping companies develop their BPM strategies and create roadmaps to guide their ongoing process efforts.

All of these efforts, and undoubtedly others we don't know about, seek to provide tools that companies can use to characterize how they currently manage processes and suggestions about what steps companies can take to improve their performance. The costs for the user range from a few thousand dollars for a "quickie" evaluation by an individual consultant, to over $100,000 for a very detailed assessment by a certified team. Maturity modeling isn't the right approach for everyone, but many companies have found these assessments can serve as a way to rally their organization and focus everyone's attention on a specific process management improvement effort. Others use assessments to establish milestones and then re-evaluate in subsequent years to determine their improvement and maintain their focus. It's a tool that many companies have found very useful and we will undoubtedly witness more work in this domain in the near future.

7.6 Integrated Process Measurement Systems

Most business process practitioners have struggled to define systematic process measurement systems. It's relatively easy to define measures that can be used to determine if a specific process is functioning efficiently. It's much harder to determine if a given process is contributed to customer happiness or company success. What's needed is a way of systematically aligning company goals with process goals. At the moment the approach that is attracting the most attention is a variation on the Balanced Scorecard system popularized by Kaplan and Norton. Today there are a variety of scorecards, including Six Sigma Scorecards and SCORcards (Gupta 2004; Bolstorff and Rosenbaum 2007; Poluha 2007). The real challenge, however, is not to come up with a scorecard on which to record a variety of measures, but to create a system that aligns the measures from the top to the bottom of the organization.

Most scorecards developed by those working in the Balanced Scorecard tradition have tended to align functional or departmental measures rather than process measures. Using such a system, one begins by creating an Organization Scorecard. Then each division or department creates its own variation on the Organization Scorecard, showing how the division or department will measure its contribution the organizational effort. Similarly, each department or group in each division creates its own scorecard to show how it will support the divisional effort. Once the scorecards are complete and aligned, the scorecards are used to evaluate the divisional, departmental and group managers responsible for the respective business units. A wide variety of organizations currently use some slight variation on this approach.

Imagine tailoring the scorecard approach for a company that is serious about measuring the performance of its processes. In effect we begin with an organizational scorecard, then create scorecards for each value chain, and then for each major process and each subprocess, etc. A few organizations have experimented with this approach.

Most organizations that embrace process management in a significant way, however, also maintain a functional structure and end up with a matrix pattern, with some managers responsible for processes and others for functional units. This

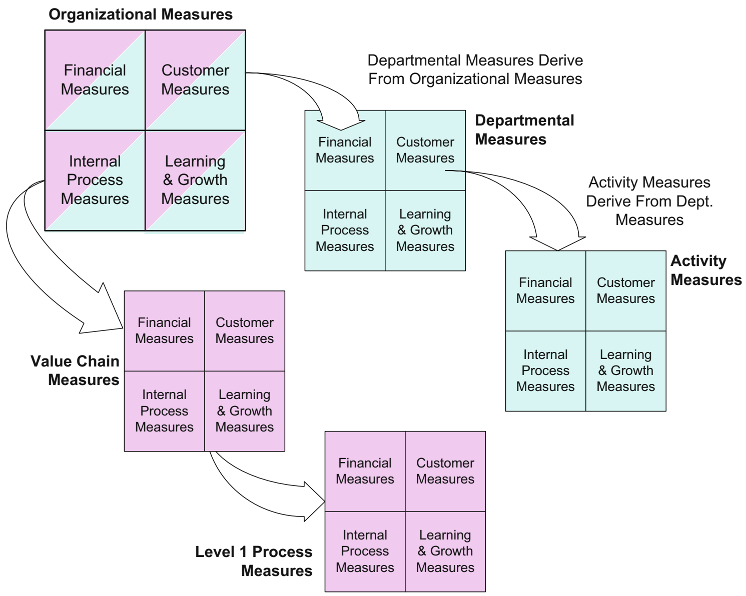


Fig. 15 A dual scorecard system for a company with both functional and process managers

requires a dual set of scorecards, as illustrated in Fig. 15. In this case one divides the organizational goals between goals that will be the responsibility of a functional manager and others that will be the responsibility of a value chain manager and then proceed to decompose each independently. Done with care this can provide an organization with interesting insights into which of its goals are really dependent on processes and which are independent of process considerations.

Aligning process measurement systems via scorecard hierarchies is relatively new and there is a lot of experimentation going on to determine the most efficient ways to create and manage these systems (Gupta 2004; Smith 2007).

7.7 Managing Culture Change and Organizational Transformations

In additional to the more or less technical concerns, companies are very interested in tools and techniques that facilitate large scale changes in their organizations. Many companies have launched programs to make managers and employees more conscious of the importance of quality or of processes. Many others have launched programs to achieve some more strategic culture change – sometimes called organization transformation – as when a company tries to change from a technical to a customer focused orientation, or from being manufacturing-oriented to being service-oriented.

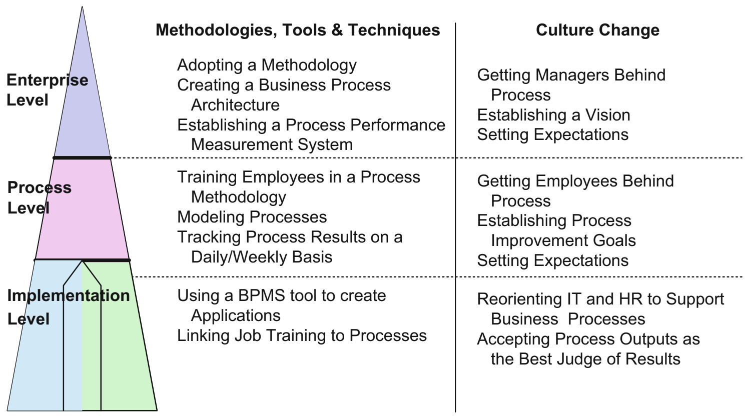


Fig. 16 Tools and techniques versus culture change activities

Anyone who wants a trivial example of this need only look at the HP-Compaq merger. HP was well know as an engineering oriented company that toward operational excellence and wasn't very good at marketing. Compaq was very much a marketing company. In the heady early days of the merger executives speculated that the new HP would be able to combine the best of both. When the merger initially took place the executive team was balanced between Compaq and HP executives. Two years later there were only one or two Compaq executives still on the executive team. To those who observed the merger at close range it was obvious that the old HP engineering culture had rejected the marketing positioning that was represented by Compaq.

Figure 16 suggests some of the culture change activities that occur and contrasts culture change with concerns about more traditional process methodologies, tools and techniques. Popular books on organizational transformation or culture change often offer platitudes. Undoubtedly it is important to communicate with everyone and meet together and maybe even share a rock climbing experience. Beyond that, however, anyone who has really tried to transform a company knows that it requires a major top-down effort and a very forceful senior executive to drive the changes and a well-structured plan to drive the effort. Organization transformation is about politics and motivation, as well as communication.

We've visited several companies and been told by senior executives that they intend to reorient their companies, to make them more process centric. If all they mean is that they intend to analyze their processes more effectively and begin to gather data on their processes that will support better decisions, then we are usually reasonably confident they can succeed. If, on the other hand they are really talking about an major organizational transformation and they want to create a company, like Toyota's automotive business, in which every manager and employee obsesses about process and quality, then we are usually much less sanguine about their prospects. Put a little differently, organizational transformation is very hard.

The best cultural change stories we know of come from the Six Sigma community. Six Sigma has often been introduced and strongly supported by the CEO of the company. One thinks of Jack Welsh, at GE, who made a significant portion of every senior executive's bonus dependent on getting results with Six Sigma. Under those circumstances organizational transformation is much more likely.

Consider, however, the situation discussed by *BusinessWeek* in its June 11, 2007 issue. The cover story was on 3M and described how 3M hired James McNerney as CEO in 2000. McNerney had previously worked for Jack Welch at GE and promised, when hired, to use Six Sigma at 3M to make the organization for process focused. 3M's stock was down – it had stayed nearly flat during the hyperactive late 1990s – and most outside analysts thought that 3M was overstaffed. McNerney introduced Six Sigma after laying off 11 % of the workforce (8,000 people). Thousands of 3M staffers were trained as Black Belts and many more received Green Belt training. The company embraced both DMAIC and Design for Six Sigma and began to improve its processes with a vengeance.

McNerney slashed capital expenditures by 22 % from $980 million to $763 million in his first year and was down to $677 by 2003. Operating margins went from 17 % in 2001 to 23 % in 2005. As a percentage of sales, capital expenditures dropped from 6.1 % in 2001 to 3.7 % in 2003. Profits under McNerney grew by 22 % a year.

After four and a half years McNerney left 3M to become the new CEO of Boeing. Given the training and the good results, one might have thought that 3M, a company previously famous for its product innovation focus, might have transitioned to a more process or operationally oriented culture. In fact, according to *BusinessWeek*, McNerney's successor at 3M, George Buckley, immediately began to dial back the Six Sigma effort. The major complaint among the 3M people, was that "innovation" was down. 3M had always been a company that promoted innovation. It's where Thinsulate and Post-Its were invented. The company had historically prided itself on the fact that, at any one time, at least 33 % of its products sales came from products released in the past 5 years. By the time McNerney left the percentage of sales from products released during the past 5 years was down to 25 %. Those who complained argued that Six Sigma is somehow incompatible with innovation. Given growth of 22 % a year and operating margins that grew from 17 % to 23 %, one might have thought that 3M had made a reasonable transition to be better balanced culture. At this point, however, it seems likely that 3M will reject the effort at organizational transformation and shift back to the norms of its earlier product focused, innovation-oriented culture.

As we suggested: culture change is hard. It takes a massive, sustained effort, and even then it often fails. Clearly anyone interested in process change is going to want to pay close attention to developments in this area in the years ahead.

8 Process Level Initiatives

Process Level Initiatives focus on projects that seek to create, redesign or improve specific business processes. At this level, companies are interested in methodologies and tools that they can use to undertake business change projects.

8.1 The Emphasis on Innovation

Suddenly *Innovation* is a very hot term. It's recently replaced *Agile* and *Excellence* as the accolade of choice in the business press. It might even replace *BPM* as a popular way to describe process initiatives. *Merriam Webster's Collegiate Dictionary* suggests that *Innovation* involves: (1) introducing something new, which can be (2) an idea, a method, or a device. The *Oxford English Dictionary* suggests the word is derived from Latin, where it referred to the introduction of novelty and that it was first used in English, in something like its current meaning, in 1,297. Clearly we are not talking about a new concept here. Equally clearly, businesses have always tried to be innovative. An entrepreneur creates something new when he starts a new business and a manager is innovative when he introduces a new process. Marketing is innovative when they introduce a new ad campaign that gets a lot of attention and New Product Development innovates when they use new technology to create a new product or service.

If we focus more narrowly on innovation in the context of process change, we can divide the recent literature, very roughly, into three broad piles. One school stresses creativity and focuses on brainstorming and a variety of related techniques that can help teams of people think of alternative ways of accomplishing a task. This school might be summed up as the creative thinking school.

A second school derives from the work of Genrich Altshuller, a Russian theorist who has created a systematic or "engineering" approach – called TRIZ – which can be used to examine problems and generate new possibilities. TRIZ is a Russian acronym that means something like the theory of inventive problem solving, and it was originally developed in conjunction with work on patent analysis (Altshuller 1984). Most of the early interest in TRIZ, in the US, was generated by Six Sigma practitioners who adopted TRIZ for use with Six Sigma improvement efforts (Silverstein et al. 2005). Recently, Howard Smith has written a wonderful series of columns for BPTrends in which he has shown how TRIZ can be used in conjunction with process redesign (Smith 2007).

The third major use of the term *Innovation* is being driven by Michael Hammer, who has written on the importance of innovation (Hammer 2004). Hammer contrasts *Innovation* with *Improvement* and suggests that there are times when you simply want to improve existing processes and then there are other times when you want to innovate and completely change the way you do business. In other words, Hammer is simply using *Innovation* as a synonym for *reengineering*.

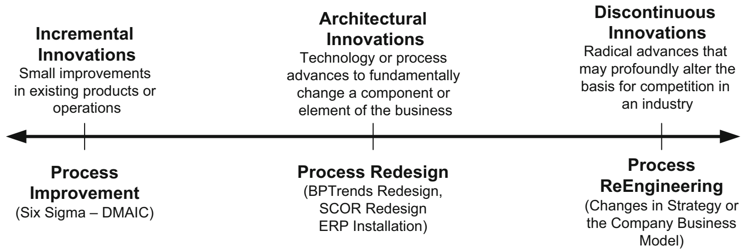


Fig. 17 The O'Reilly-Tushman innovation continuum

We've heard people argue that innovation distinguishes between process improvement and process redesign. Hammer seems to suggest that innovation distinguishes between reengineering and either redesign or improvement. We don't think either distinction is very useful. Let's face it: almost everyone is engaged in introducing new ideas, new methods, and new devices. Some are "newer" than others, no doubt, but everyone is looking for new ways to get things done. Clearly if we are going to make sense out of *Innovation* we are going to need a continuum. The best continuum that we have found is provided by Charles A. O'Reilly III and Michael L. Tushman. O'Reilly and Tushman review a wide variety of different examples of innovation and end up proposing the continuum pictured in Fig. 17 (O'Reilly and Tushman 2004).

In the area above the bold arrow in Fig. 18 we describe the three categories that O'Reilly and Tushman use to map the various examples of innovation they studied. Below the bold arrow we have listed the three general approaches to process change. Obviously Fig. 17 is a continuum and there are all kinds of instances that would lie on the line between Incremental Innovations and Discontinuous Innovations, but at least this figure suggests why all kinds of people will be using the term *Innovation* to mean different things. Once you realize that innovation is usually just a synonym for process or product change and accept that there is a whole continuum of possibilities, then the trick, for a given company, becomes a matter of getting the mix right.

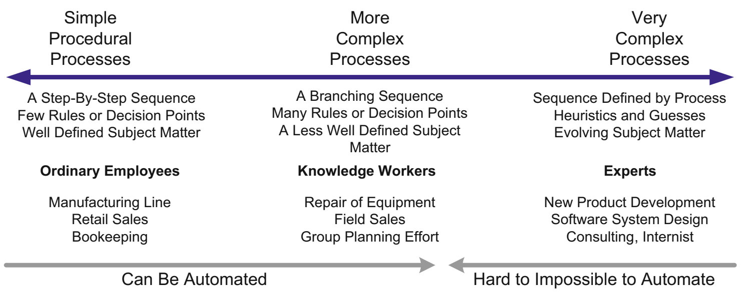


Fig. 18 A process complexity continuum

Everyone is going to hear a lot more about innovation in the years ahead (Seidel and Rosemann 2008). Getting a good idea of what's involved, and focusing on what's important, and what can be used at your company today is important. Similarly, every reader should understand that there will be a lot of nonsense peddled in the name of innovation and should try to avoid getting carried away by either narrow definitions or by the spurious correlations that always seem to accompany any hot new business jargon. The bottomline, however, is that if management wants to talk about innovation, then processes practitioners should be prepared to say, we can make innovation happen.

8.2 Analyzing and Modeling Complex Processes

Another area of process work that is receiving a lot of attention involves the analysis and modeling of complex processes. There are different ways of describing complex processes. Some emphasize that they are unique – as when an engineering firm creates a process to create a unique product. Some industries refer to them as Cases. Keith Harrison-Broninski has written extensively about them and has emphasized that collaborative processes that require people to network to find unique solutions (Harrison-Broninski 2005). We sometimes think of them as expert systems – processes that would require tens of thousands of rules if one were to try to describe the decision processes involved. The OMG has recently issued a request for information about what it terms Dynamic Business Processes. However you describe them, we all recognize that there are processes and activities that are very difficult to analyze or describe.

It's easy enough to describe complex processes a very high level, of course, you simply create a box called “Design Software Architecture,” “Manage Marketing,” or “Write Business Plan.” As you begin to drill down, however, you realize just how little we know about how these activities are actually done. These are processes that – given current technologies – are impossible to automate in a cost-effective manner. In other words, complex processes challenge our ability to define the specific procedures involved.

Figure 18 suggests a continuum from simple to very complex processes. Manufacturing production line processes were easy because they involved watching what people do. Many service processes are more complex, but can still be define without too much difficulty. At the other extreme from procedures, however, there are complex or dynamic processes. Most companies don't focus on defining the jobs, but concentrate, instead, on hiring people who have already proven they can perform the activities.

As we already suggested, expert systems developers were focused on this type of process in the late 1980s. The expert systems effort failed to create useful applications, in even narrowly prescribed domains (e.g. Meningitis Analysis), not because they couldn't capture the thousands of rules a human expert used, but because they couldn't maintain the rule bases. A human expert is always learning and changing his or her rules as the environment changes and knowledge evolves. Using existing techniques, an expert system is out of date the day after its completed.

We recently looked at a BPMS tool, the EMC Documentum BPM Suite, that has introduced a way of dealing, indirectly, with some of the more complex collaborative activities process modelers encounter. In essence, a developer creates a special type of activity, which the EMC product calls an "e-room." When an input is made to an instance of the activity when the process is being executed, several employees associated with the activity are notified and can create a web dialog which focuses on creating the desired output. If we were to define some of the activities that make up an e-room process, we would find activities like: Name project, identify who should be involved, send emails inviting people to e-meeting, define steps in project, define roles for team members in project, etc. In effect, the BPMS product avoids the problem of analyzing the activity and simply recognizes that people will need to collaborate to arrive at a solution, and then provides groupware to facilitate their collaboration.

Another approach to complex process analysis is termed Cognitive Task Analysis (Crandall et al. 2006). When we first started analyzing human performance problems, in the late 1960s, the techniques we used were generally termed "behavioral task analysis." This term reflected the dominant trend in psychology in the late 1960s – behaviorism – which stressed observation of overt activity. By the late 1970s, however, most academic psychologists had returned to the study of cognition. Using new techniques, derived primarily from work with computers, psychologists began to conceptualize human performers as information processing systems, and ask questions about the nature of human cognitive processing. The new cognitive psychology put its emphasis on observation and was at least a rigorous as behaviorism. An early classic of cognitive task analysis was Allen Newell and Herbert A. Simon's *Human Problem Solving*. In *Human Problem Solving* Newell and Simon analyzed a variety of human cognitive tasks, including cryptarithmetic, logic, and chess playing and reached a variety of interesting conclusions that formed the basis for several decades of work in both cognitive psychology and artificial intelligence (Newell and Simon 1972). Indeed, it could be argued that their work led directly to expert systems and, more recently to Cognitive Task Analysis. The key point to make here, however, is that psychologists and computer scientists spent several years, in the early 1980s developing techniques to capture human expertise and embed expert knowledge in software systems.

The work in cognitive psychology led to the development of expert systems. They have not provide very useful, but the same techniques are now being used in business rules analysis efforts and in cognitive task analysis, which relies on many of the techniques used in expert systems design. Object models are constructed to describe the concepts and knowledge structures used by the human decision makers and rules are written to describe specific decisions.

The emphasis today, however, is on avoiding expert activities and focusing on the tasks undertaken by knowledge workers. While a true expert, an engineer who could design an M1 Battle Tank, might have models with many hundreds of objects and use ten or twenty thousand rules, the soldiers who diagnose M1 Battle Tank problems in the field might only require a hundred objects and a thousand rules.

The trend, in other words, is to ignore true expertise, which is too hard to analyze or maintain – given our current techniques – and to focus on analyzing the knowledge that knowledge workers bring to bear on their more circumscribed but still demanding tasks. The work of knowledge workers is, of course, very important and valuable, and if we can capture significant portions of it, we can share it, and use it to design processes that can contribute significantly to the value of our organizations. To date, cognitive task analysis has proven very expensive, and is largely confined to complex tasks required by institutions, like military organizations, that need to train large numbers of new recruits to operate very complex equipment in a very short period of time. As more is learned, however, we can hope that new tools and techniques will make it easier to analyze and then automate the more complex tasks in most organizations.

The line between what can be analyzed and automated will keep moving in the decade ahead. The successful process practitioner will want to stay abreast of where the line is at any point in time to assure that the processes he or she chooses to analyze and automate are within the means available at that point in time.

9 Implementation Level Initiatives

The development of specific solutions to business process problems usually occurs on the implementation level. If a process is changed it usually implies that software will have to be developed or changed. Similarly, job descriptions and training programs require changes. In extreme cases, offices will need to be changed to different locations in different countries to support the new processes. Just as there are challenges, methodologies and techniques that are used at the process level, there are other methodologies and techniques that are appropriate to the implementation level.

9.1 Business Process Management Systems (BPMS)

A major change has occurred in this decade. Business people have realized that IT is no longer a support service but an integral element in the company's strategy. IT managers, for their part, have decided to stop focusing on technology and support, as such, and to focus, instead, on how they help implement business processes. In essence, the description of the goals and workings of business processes has emerged as the common language that both business executives and IT managers speak. This reorientation, has, in turn, led to a sweeping reconsideration of how IT supports business managers and to the development of integrated packages of business process management software suites. Software tools that, a decade ago, would have been described as workflow, business intelligence, rules engines, or enterprise application integration tools and now being integrated together and spoken of as BPMS products (Khan 2004).

No one, today, is exactly sure what BPMS means or how BPMS products will evolve. It's a complex software market, made up, as it is of vendors who would formerly have said they were in different niches (BI, EAI, Rules, Modeling, CASE), and who are now trying to determine exactly how they work with others to generate a common Business Process Management Software platform. Many users don't discriminate between modeling tools, like ARIS and Casewise, and BPMS suites like webMethods or webSphere and applications suites with some BPMS capabilities, like BizTalk and NetWeaver. Perhaps its not important to do so at this time, as all are rapidly evolving and each will change as the functionality desired by users, after they have had a change to experiment with the various products, becomes clearer.

In 2003, Howard Smith and Peter Fingar wrote *Business Process Management* as a clarion call for companies to develop and use BPMS products to automate and manage their business processes. Smith and Fingar envisioned a world in which business managers would be able to glance at computer screens and see how their business processes were performing, and then, as needed, modify their processes to respond better to the evolving business situation. In other words, BPMS was to be a new type of software – a layer of software that sat on top of other software and managed all the people and software elements required to control major business processes. It is worth stepping back and asking to what degree that vision has been realized.

With a few exceptions, the BPMS software market has not evolved from scratch. Instead, the BPMS vendors were already in existence, offering workflow, documentation, rules engines, enterprise application integration (EAI), business intelligence (BI), or even ERP applications. Vendors from each of these older software domains have rushed to modify and expand their software products to incorporate capabilities associated with an evolving idea of what a BPMS product might include. Thus, workflow vendors have added EAI and vice versa. Most vendors have added a rule capability and incorporated BI (zur Muehlen 2004).

There has been a lot of consolidation as the various vendors have acquired each other to assemble the right set of capabilities. For all that effort, there is still, as of 2008, a very vigorous BPMS market with at least 15 vendors fighting for market share. At this point the platform vendors – like IBM, Oracle, SAP, and Software AG – seem to be doing best with process automation projects that are essentially EAI projects. The smaller vendors who are more focused on workflow, however, taken together, still constitute about half the market. And this, in turn, suggests the current immaturity of the 2008 BPMS market. In part, vendors have focused on what they know best. Vendors from an EAI background have focused on automating processes that primarily involve software systems. Vendors from a workflow background have focused on automating processes with lots of human interaction. And that, in turn, means that both are working on relatively small scale processes, or only working on one part of larger business processes.

We are still looking for good case studies that describe large-scale business processes whose managers now monitor and control those processes using BPMS suites. Most “BPMS” products, to date, are, in fact, workflow or EAI projects that could have been done in 2000. They are done by IT and IT manages them. This isn’t to say that they aren’t important automation projects and that business managers aren’t happy to have them in place, but we are only beginning to realize the goal proposed by Smith and Fingar – to create overarching process management systems that business managers can own and control (Smith and Fingar 2003).

If there is a major difference between today’s “BPMS” applications and EAI or workflow applications that would have been build in 2000, it lays in the fact that today’s EAI and workflow systems are built to take advantage of the Internet and, increasingly, a Service Oriented Architecture (SOA). Elementary SOA projects can be done without reference to BPM, but sophisticated SOA projects, to be of value to the company, must be integrated with a deep understanding of the organization’s business processes. Indeed, it is the emphasis on SOA, and the role that SOA infrastructure plays in the thinking of the leading platform vendors, that explains their growing support for BPM and BPMS.

The new emphasis on BPMS and SOA, as the two sides of the same coin, is a mixed blessing for the BPM community. It has attracted the interest of the platform vendors and driven their commitment. At the same time, it has led them to emphasize the more technical aspects of BPMS and make discussions of BPMS sound more and more like discussions of enterprise integration. BPM and BPMS need not get lost when the discussion turns to SOA, but they often do (Inaganti 2007). Or, more correctly, they get relegated to a very secondary role. Like too many IT discussions in the past, SOA developers are inclined to simply ask the business people for “their requirements” and then move on to the serious and complex work involved in creating the infrastructure environment.

None of this is final, of course. We are at an early stage in the development of the BPMS market. Some vendors will go off track and focus too much on SOA and thereby confine themselves to selling products to IT developers. Others, however, still have the vision that motivated Smith and Fingar and others of us and will continue to work on BPMS products that subsume technology to an interface that can support business managers as they interact with the business processes that do the work in their organizations. Large-scale business processes invariably involve a mix of software systems and people and true BPMS products must evolve to support both if they are to really help business managers to manage the processes and their companies.

9.2 *Standards and Certification*

Because BPMS is dependent on the Internet and various Internet protocols (e.g. UDDI, XML) there have been a variety of efforts to generate software standards that would support BPMS development. BPEL, being standardized by Oasis and BPMN, an OMG standard are good examples.

At the same time, a variety of different organizations are working to formalize the knowledge and the competencies needed by business process professionals. There is a certification program at ASQ. The ABPMP has just released a draft Body of Knowledge (BOK) for BPM. The OMG is working on a set of certification exams for the various process standards it supports, and the IIBA has just released an updated BOK for Process Analysts that incorporates more business process ideas.

Certification and standards always take time to develop and are hard to do when a body of practice is evolving as rapidly as BPM is today, but these efforts will undoubtedly bear fruit at some point in the future.

9.3 Other Implementation Concerns

The other major area of implementation activity concerns techniques for redesign jobs and training and motivating employees and managers to implement and support changing processes. We won't consider human performance change further at this point, having already discussed Haskett's work when we considered the process level. Suffice to say that automation and employee empowerment continue to evolve together and each needs the attention of anyone seeking to change processes within an organization.

10 Towards a Comprehensive BPM

We have tried to give readers a feel for the breadth and scope of today's Business Process Management efforts. In reviewing so many different domains and techniques we have undoubtedly misrepresented some of the details. Our goal, however, was not a definitive history, but, instead, a survey that would suggest how much needs to be integrated and coordinated by any company that would organize and manage a comprehensive BPM effort.

This survey has undoubtedly missed a number of important concerns. We have, however, highlighted some of the key issues that we think will increasingly concern business process practitioners in the near future. These concerns include:

Enterprise Level Concerns

- Enterprise Architecture
- Value Chains and Value Networks
- Business Process Frameworks
- Value Chain Diagrams
- Process Maturity Models
- Integrated Process Measurement Systems
- Managing Culture Change

Process Level Concerns

- Innovation
- Analyzing and Modeling Service Processes
- Analyzing and Modeling Complex Processes

Implementation Level Concerns

- Business Process Management Systems (BPMS)
- Standards and Certification

One could easily argue that any one of these topics could be repositioned at a different level. Similarly, though some topics seem more the concern of one tradition than another, all are being discussed by practitioners from each tradition and some already benefit from efforts that draw on practitioners from each of the major process traditions. In other words, they are emerging as the common concerns of Business Process Management.

While our list may be incomplete and while the names may change, we are confident, that the idea of process, and technologies and methodologies to manage and improve processes, will continue to grow in importance. We even expect to see process courses showing up at the better business schools in the course of the next decade.

What we want to urge, here, is the creation of a Business Process Management discipline that embraces all of the various approaches we have discussed. The world is changing very fast and will change even faster in the near future. The very nature of business models and processes will continue to change rapidly as outsourcing and information systems continue to change the way we organize to create value for customers. Change and business process are two sides of the same coin. Process concepts and technologies are the best way to organize businesses to adopt to change. But the use of process concepts and techniques won't be nearly as effective if different groups continue to approach process problems from their respective silos. We need an integrated, comprehensive process discipline and process mangers and practitioners who can integrate all of the concepts we have considered, and others besides. It isn't sufficient to provide process monitoring technology and not concern yourself with what employees must do to help the organization succeed. It isn't sufficient to focus on managing day-to-day processes without concerning yourself with technologies that will soon render your current approach inadequate. It isn't sufficient to improve specific processes without a clear idea of how the specific process contributes to other processes, or supports the goals of the value chain or results in a great customer experience.

Ultimately, process practitioners must not be so concerned with decomposing and analyzing, although those skills are very important, but the process practitioner must be a holist who works to synthesize and assure that the performance of the whole organization is optimized to achieve its strategic goals.

There are too many commonplace organizations in the world today. There is an oversupply of productive capacity. And, at the same time there are people who are not being served well, or at all. We need to create the next generation of global organizations that will draw on resources and people from throughout the world to produce products they can tailor and deliver anywhere in the world at prices everyone can afford. At the same time we need to create the techniques and technologies that will allow individuals and small companies to flourish in the niches in between the corporate giants. These are the challenges we face and they will call for a new generation of more sophisticated process practitioners who can integrate everything we know to accomplish these tasks.

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A Framework for Defining and Designing the Structure of Work

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Abstract This chapter describes a framework for modeling the business architecture layer of enterprise architecture. We subscribe to the definition of enterprise architecture provided by Ken Orr, who identifies business architecture as the top layer of four linked architectures in an enterprise architecture. This chapter describes a value creation architecture consisting of the business architecture, the management system architecture, the technology performance architecture, and the human performance architecture.

1 Introduction

We do not need to belabor the potential value to an organization of modeling its business and technologies in an enterprise architecture (EA) framework (see Fig. 1 for typical EA framework layers), but here are a couple of expert opinions on the subject.

Paul Harmon, founder and executive editor of BPTrends, has written, "Most people who use the term 'enterprise architecture' today, are probably from the IT world, and they tend to use the term as (an overview of how all the various IT models and resources in the organization work together). Depending on the individual, they might insist that their concept of an enterprise architecture includes business process elements and even strategy elements, but if you look at their actual models and their practices, you will see that they chiefly look at processes as a source of system requirements that can drive software development" (Harmon 2004, 2014).

Dave Ritter, co-founder and vice president of Proforma, said, "Enterprise Architecture is often touted as one of the tools needed to bridge the gap between the business and IT [...]. Successful alignment of business and IT will maximize enterprise performance. This will only be achieved by organizations that understand

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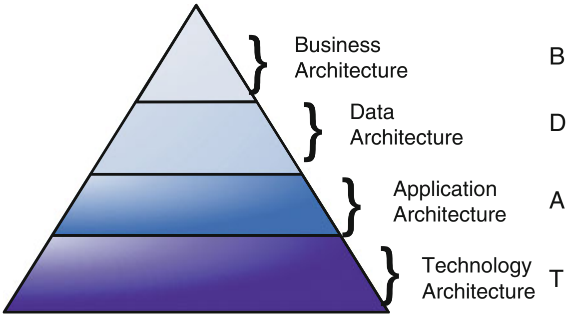

Fig. 1 Typical layers of an enterprise architecture

how to develop and maintain an accurate model of their companies' business and strategy architectures and provide value to the business through their introduction of automation solutions." (Ritter 2004).

However, even though there is value to organizations in having a complete, accurate EA, problems abound. Ritter points out, "Despite the fact that Enterprise Architecture concepts have been around since the early 1980s, their critical mission of defining and linking Business, Systems, and Technology Architectures is rarely achieved. Enterprise Architecture projects are all too often reduced to nothing more than elaborate exercises to inventory systems and technologies, with little or no effort put into documenting and analyzing their companies' strategic direction and business processes – the very strategic direction and business processes which should be the driving force for IT initiatives".

In our view, these problems with EA exist for several reasons:

First, EAs are typically built by IT people. IT is disadvantaged in its efforts to depict the business aspects of an EA without the participation of other members of the organization. The result is inevitably an EA model skewed to IT interests.

Second, there is not enough structure available in any of the models of EA we have seen that would aid someone interested in building a sufficiently complete picture of the BA layer. While business processes are typically identified as the contents of the BA layer, the labeling, organizing, and relating of the processes are done in a rudimentary fashion, leading some business people to say, "So what?" Besides, there is more to the BA view than processes.

Third, there is insufficient recognition in the EA models we have reviewed that the purpose of all this modeling is to show how work is (or should be) performed. The emphasis is on linkages between systems and applications, and sometimes to processes, but without enough clarity about who does the work, and how the work is actually being performed. The critical focus of an EA should be on how work gets done, who (both human and technology) is performing the work, and how performance is managed. If an EA does not make accomplishment and management of work quite clear, it ends up being little more than, in Harmon's words, "processes as a source of system requirements that can drive software development".

Fourth, EA models need to (but generally do not) recognize the basic premises of the organization as a system, namely that:

- All organizations are systems that exist to produce valued outputs (desired products or services to customers and economic returns to stakeholders);
- All organizations need to be adaptive systems existing inside a larger Super-System, and in order to succeed over the long term, organizations need to continuously adapt to the changes in their Super-System. The Super-System is the ultimate reality and performance context for every organization. Bluntly put, any organization must adapt to its Super-System or die.

Any EA model that does not recognize or provide clarity about the organization as a system will fall short in providing clarity or direction. So our approach is based upon the concept of the organization as a system, starting from the outside (i.e., the Super-System) and then drilling into the organization level by level.

2 The Value Creation Hierarchy

Our view starts via a view we call the Value Creation Hierarchy (VCH). Every organization exists in order to create something (goods, services) of value to a market, and in order to create and deliver that value, it needs an internal system of processes and resources to make good on its promises.

Fig. 2 shows a Hierarchy consisting of five levels. The VCH is a top-to-bottom framework for organizing work in a way that meets the following criteria:

- Value is created and delivered to the market
- The work of value creation and delivery can be effectively and efficiently performed
- The work can be effectively managed
- Whenever practical, the work is organized in a way that gives the business a competitive advantage

2.1 Enterprise Level

At the top level is the entire organization as a system, with the organization's business units operating as the engines that create, sell, and deliver value, and generate revenue for the enterprise. The enterprise is depicted in the context of its marketplace, its resources and competitors, and the general environment in which the organization must operate. Most of the time, people are not referring to this topmost level when they talk about processes, but what this model suggests is that every organization is in fact a giant processing system, and all of its individual processes are contained somewhere in this system.

2.2 Value Creation Level

The next level is a depiction of the organization's Value Creation System (VCS), which is the means by which the organization creates, sells, and delivers products

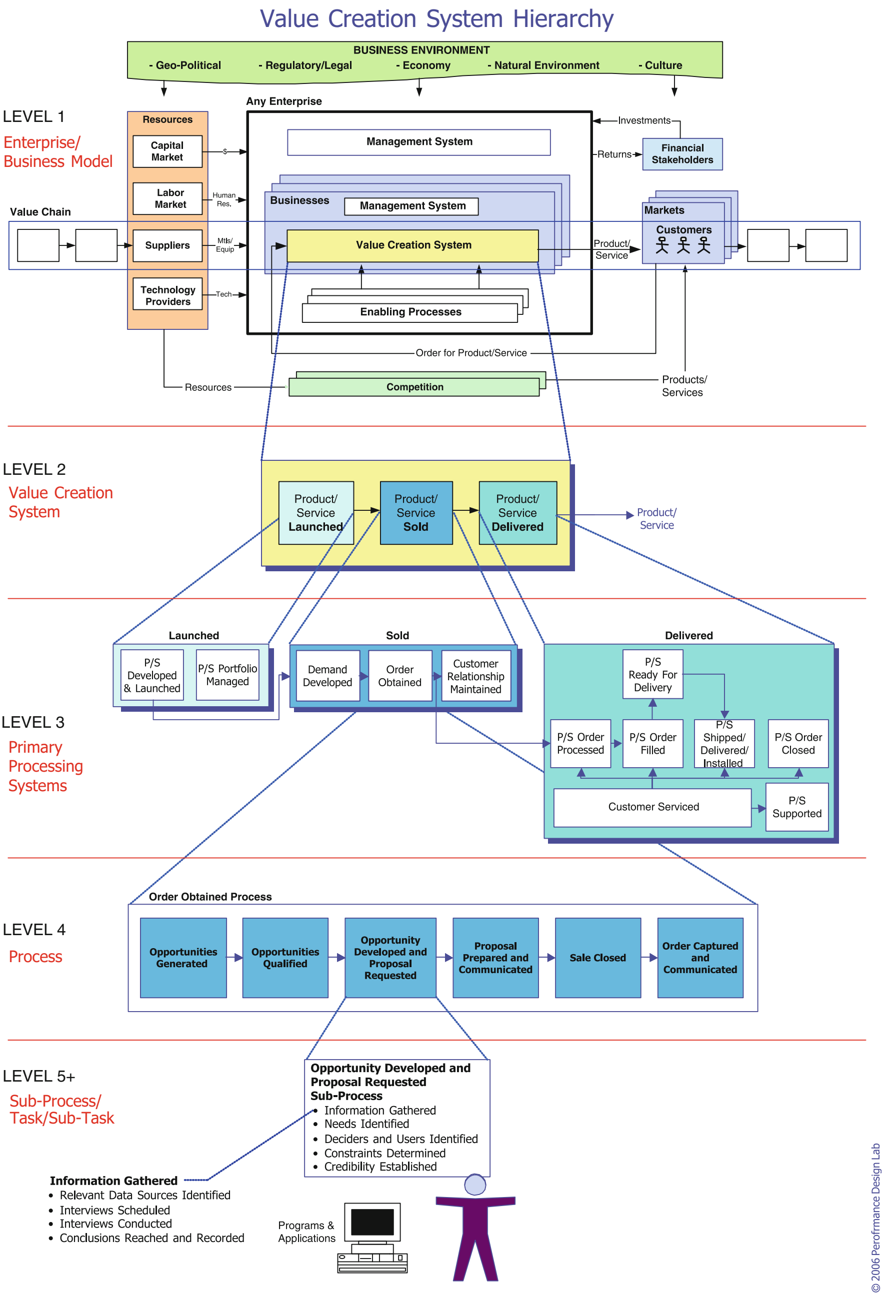

Fig. 2 Value creation hierarchy

and services of value to the marketplace. The value-creation level is kind of a mega-process view, and in a large, complex company, there may be a different VCS for different products and services. Sometimes people who talk about process do mean the entire Value Creation System, and quite often, improvement is needed at this level, when parts of the VCS are misaligned or missing.

2.3 Processing Sub-Systems Level

The third level then divides the components of the VCS into three general types of processes, what we call the Launched, Sold, and Delivered processing sub-systems. Launched includes those processes – such as research, product development, and product extensions – whose purpose is to create and make available new products and services. Sold includes those processes that are aimed at marketing and selling the goods and services. Delivered includes those many processes that get the products and services to customers and provide ongoing support. At this level, we are still talking about multiple sets, or bundles, of processes, which we call Processing Sub-Systems.

2.4 Process Level

It is at the fourth level that we reach the individual process level, and it may be one of those processes contained inside Launched, Sold, or Delivered. Often, this is the level of process that people mean when they talk about "end-to-end" processes, because these processes typically begin with a market or customer input (e.g., an order, a product idea) and end with an output that either goes to the customer or becomes an input to another stage of the value chain. For example, the output of the product development process in Launched is a new product that now can be marketed and sold by those employees who participate in the Sold processes. The other processes to be found at this level are management processes and supporting processes (for example, the hiring process or the information system development process).

2.5 Subprocess/Task/Subtask Level

The fifth level then decomposes a given process into subprocesses and tasks. It is at this level that the performer (whether human or technology or a combination) becomes visible. The final level goes into even greater detail, delving into substeps and procedures. Sometimes, people who use the word "process" are actually talking about this level, because from their vantage point, what they do is a whole process, although from the VCH view, they are well down in the weeds within a single subprocess or even a single task.

3 Business Architecture

The VCH can be used to derive the Business Architecture (BA) for a given organization. Corresponding to each level of the Hierarchy are one or more diagrams that depict elements of that level and their interrelationships. Fig. 3 depicts a generic BA.

3.1 Super-System Map

Corresponding to the super-system level of the VCH is a Super-System Map (Fig. 4), which displays specific information about a given organization. There is information about the external variables that affect the organization (i.e., the markets and customers, competitors, resources, and general environmental factors). Inside the organizational box is a high-level depiction of the organization's lines and major organizational units. Outputs from the organization (i.e., its products and services) are depicted.

3.2 Cross-Functional Value Creation System Map

Corresponding to the value chain level of the VCH is a Cross-Functional Value Creation System Map (Fig. 5), which depicts the organization's value-creation processes and the organizational players who participate in those processes. This level is a very high-level view of the organization way of doing business (i.e., its business model) and delivering value to its customers.

3.3 Business Process Architecture Framework

The tool for displaying the Primary Processing Systems of an organization is called a Business Process Architecture (BPA) framework (Fig. 6). This diagram shows all of the significant processes (i.e., value creation processes, management processes, and supporting processes) of the organization and their systematic interrelationships.

The BPA Framework provides executives and employees with a common view of all the major processes of the business – on one page. The document is a concise summary of the value-adding work that must be performed and managed to provide value to customers – the operative word being *work*. The picture is a work-centric picture and does not reflect who does the work – so the primary focus of dialog, troubleshooting, and decision making stays on the work and on the creation and delivery of value.

3.4 BPA Detail Chart

The BPA Detail Chart (Fig. 7) is a tool that bridges the multiple processes shown in a BPA and the details required to depict a single cross-functional process.

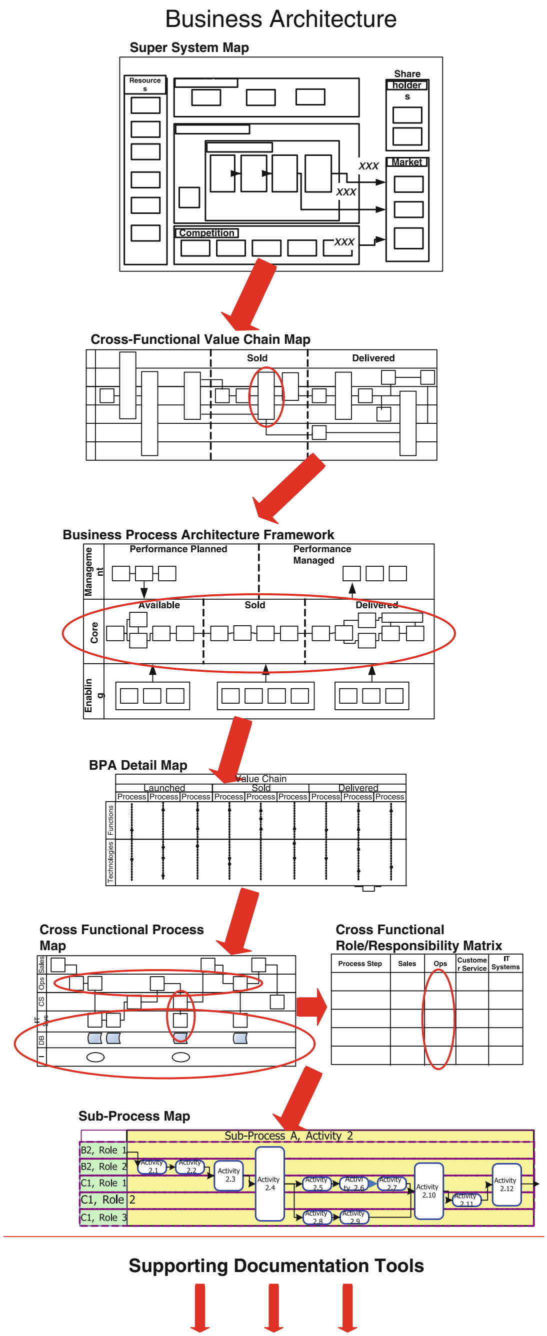

Fig. 3 Business architecture

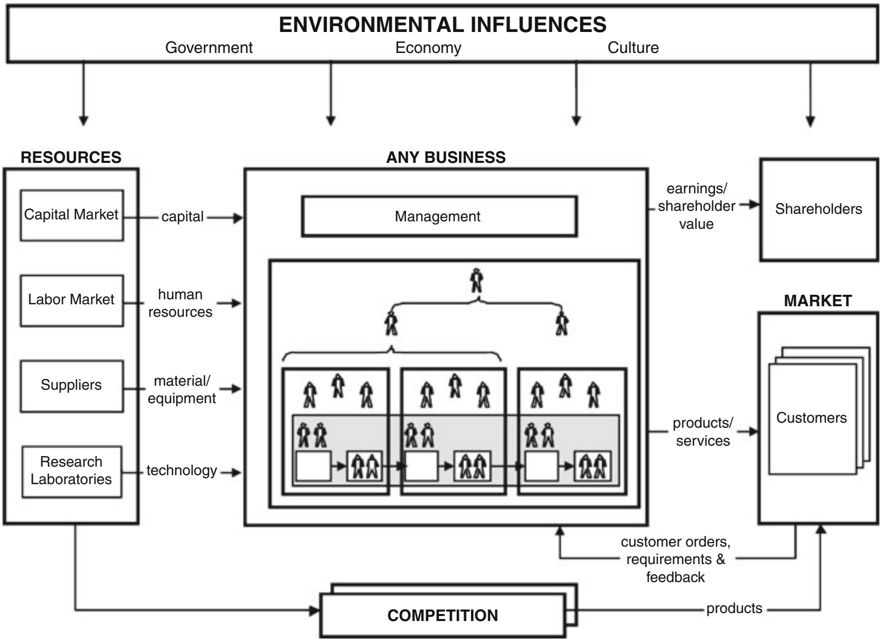

Fig. 4 Super-system map template

The BPA Detail Map is a device for identifying all processes in a given VCS, participants in those processes, and enabling technologies in a given section of an organization's BPA (such as in its Launched processes) or it may be applied to identify only certain processes (and corresponding participants and technologies) relevant to a given business issue or proposed change (for example, a new way to go to market, which would affect multiple processes in the Sold area of the BPA. The processes included in a given BPA Detail Chart can include not only primary, value-adding processes but also support and management processes.

3.5 Cross-Functional Business Process Map

Below the level of the BPA are the individual processes, which are captured using the classic "swimlane" format popularized by Geary Rummler and used today by virtually all process flowcharting practitioners and imbedded in BPM software (Fig. 8). The format enables the process map to provide rich detail about the tasks performed in a given process and who participates in the process. The map can also show how technology is employed in executing the tasks, and may show how various systems and applications interact with each other in performing various subtasks. In addition, maps may contain other information such as time consumption, metrics, resources, etc.

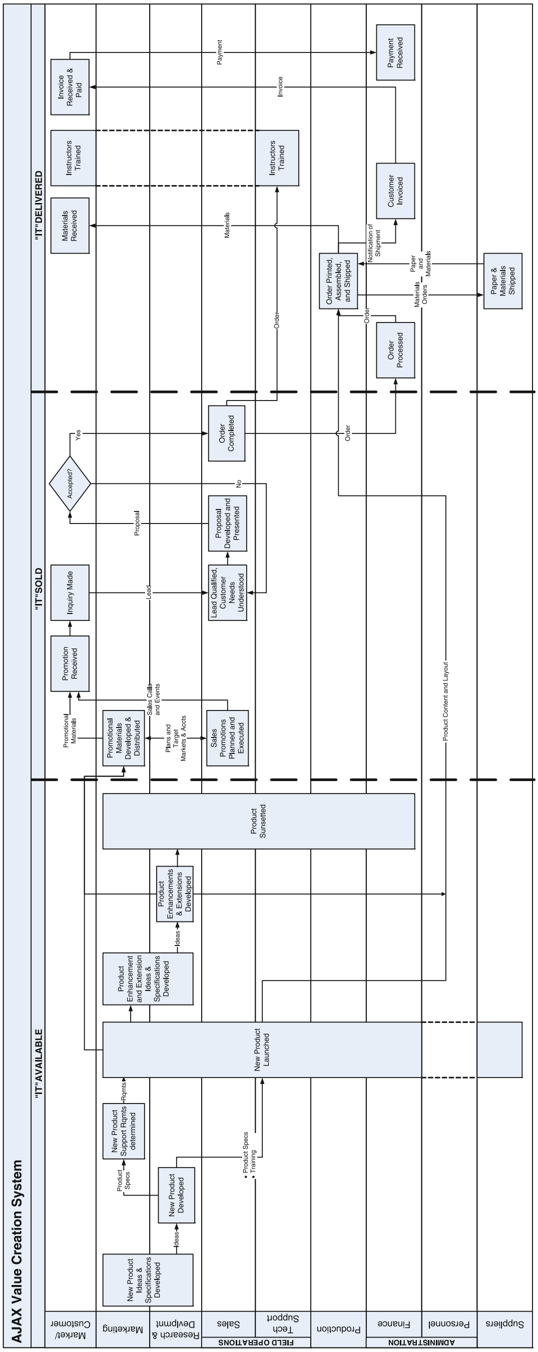

Fig. 5 Cross-functional value creation system map

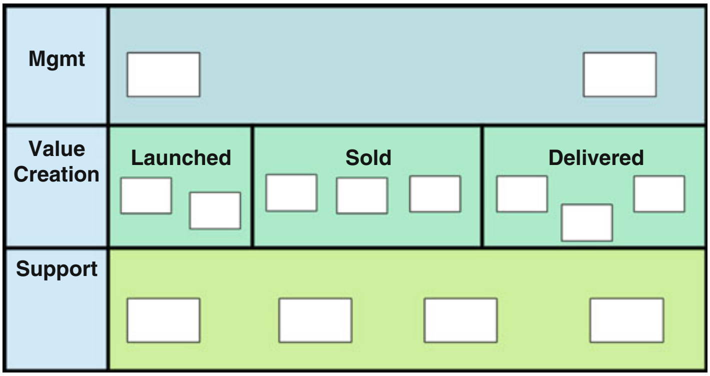

Fig. 6 Business process architecture framework

Corresponding to the cross-functional process map is a cross-functional Role-Responsibility Matrix, which provides even more detail about how the tasks contained in the process are being performed.

3.6 Subprocess Maps

If it is useful to delve into even greater process detail, a subprocess map can be used to decompose a single task and, using the same swimlane format, show the subtasks, performers, technologies, and sequence.

Below this level are any number of other tools that could be applied in either analyzing existing processes or designing new ones. For example, if the purpose is to identify where controls exist in a process in order to meet the compliance requirements of the Sarbanes–Oxley Act, subprocess maps can be applied to this purpose, providing a picture of exactly where various controls exist in a given process.

In summary, the BA is derived from the Value Creation Hierarchy. As shown in Fig. 9, each component of the BA corresponds to a level of the VCH. In our view, a complete BA constitutes a completely mapped set of all of these components, whether it is intended as a BA of the current state or it is a future-state BA.

This then constitutes our view of one important dimension that should be contained in a complete BA: a vertical depiction of how a business creates and delivers value through its complex hierarchy of processes.

4 Value Creation Management System

An EA model should show not only how work gets done in an organization but also how performance is managed. At the Performance Design Lab (PDL), we have long argued that to be effective any organization needs to have a well-designed

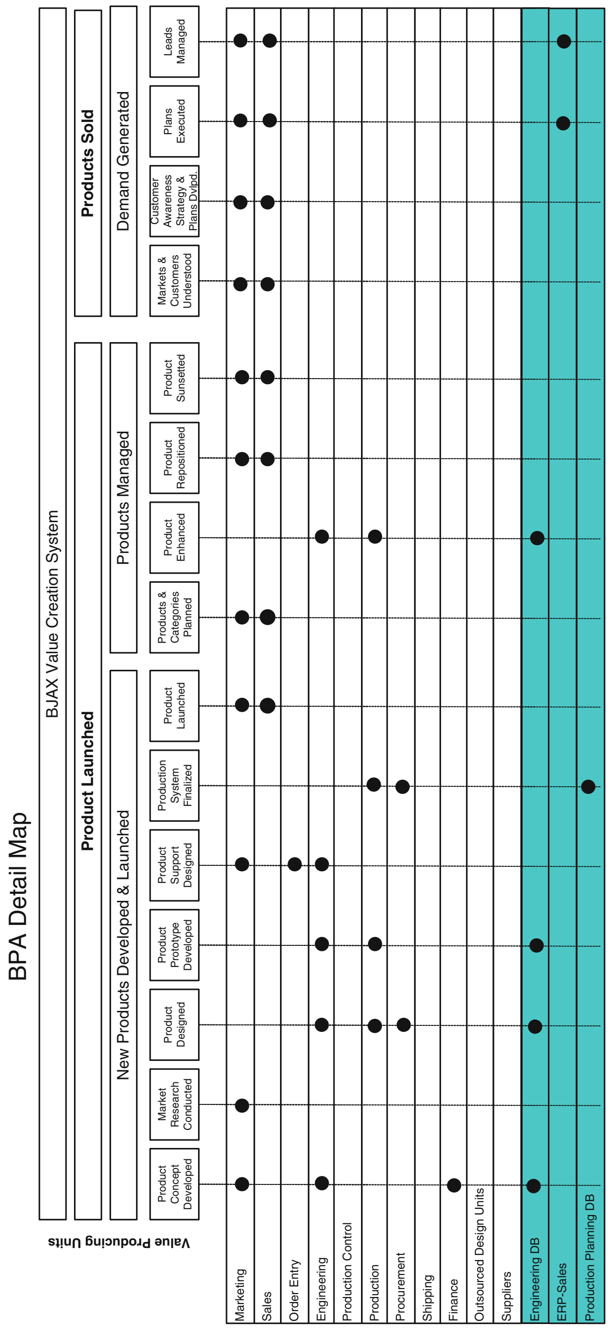

Fig. 7 BPA detail chart

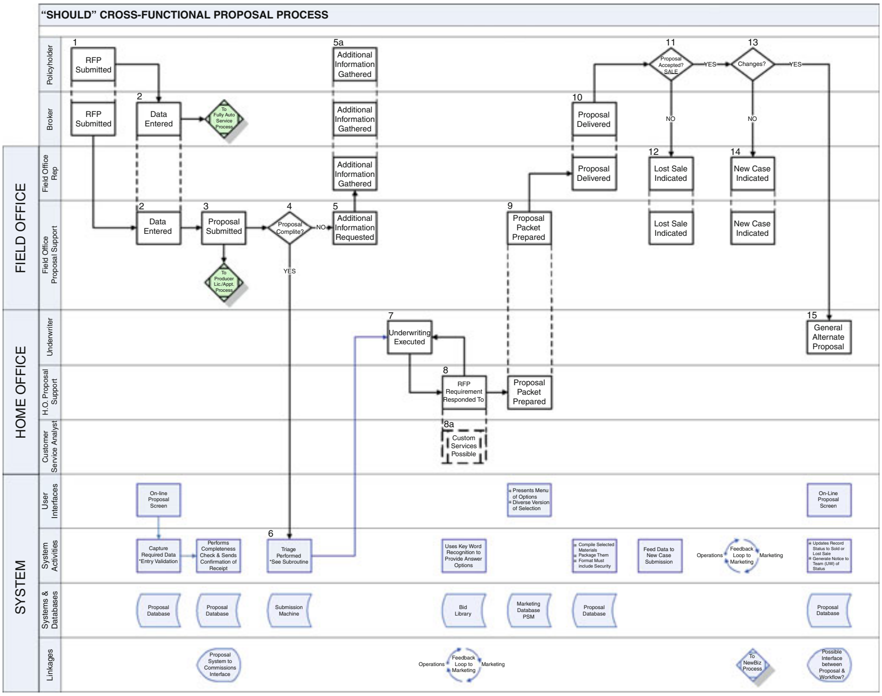

Fig. 8 Cross functional process map

management system. We have a framework for reviewing the management system of an organization.

We know that desired performance/results are a function of the three components shown in Fig. 10:

1. *Performance planned* – goals and plans (including necessary resources and processes to achieve the goals) are set and communicated to the "performer".
2. *Performance executed* – the "performer" (which can be an individual, a process, or an organization entity – e.g., a company division, plant, or department) delivers the desired performance/results prescribed in the goals and plans.
3. *Performance managed* – actual performance is monitored against the goals and plans and if a negative deviation is detected, there may be a "change" signal sent to the performer. The bottom-line of Performance Managed is closing any gaps between Plan and actual.
   (a) The "performer" to change their execution in some way (e.g., better scheduling of staff) and/or
   (b) The Performance Planned component to do some combination of the following:

   – Alter the Goals
   – Modify the Strategy to achieve those Goals

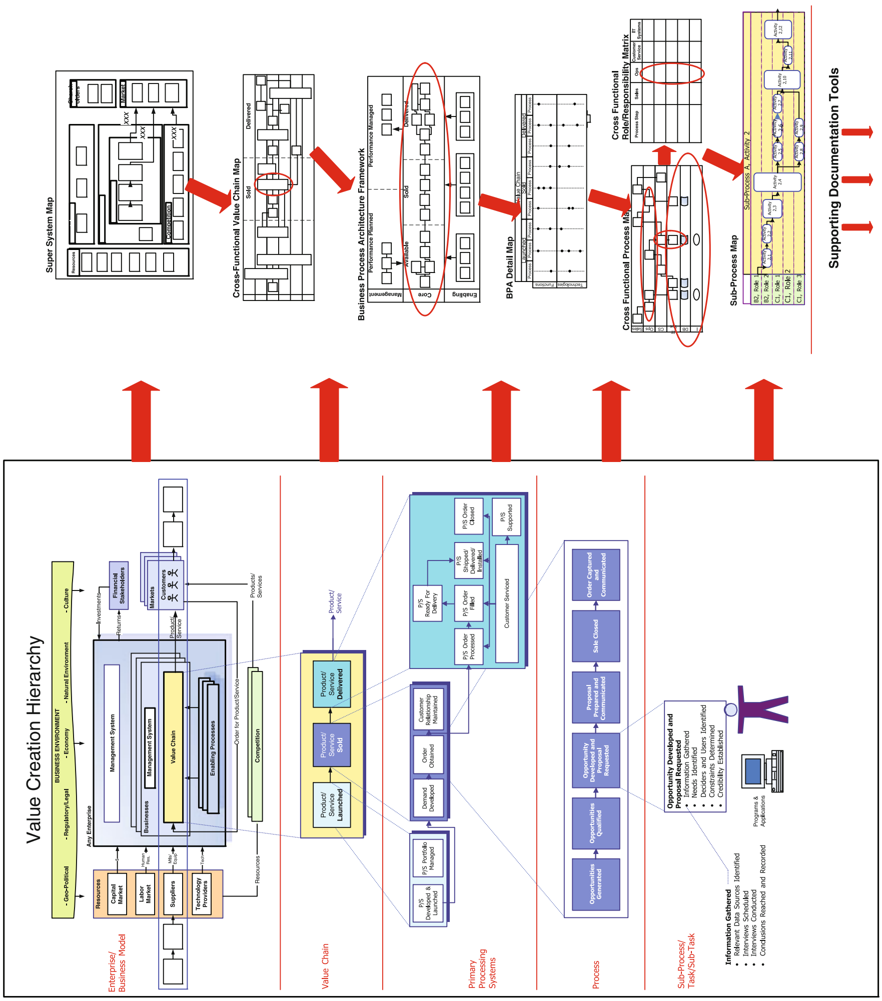

Fig. 9 Value creation hierarchy and corresponding business architecture

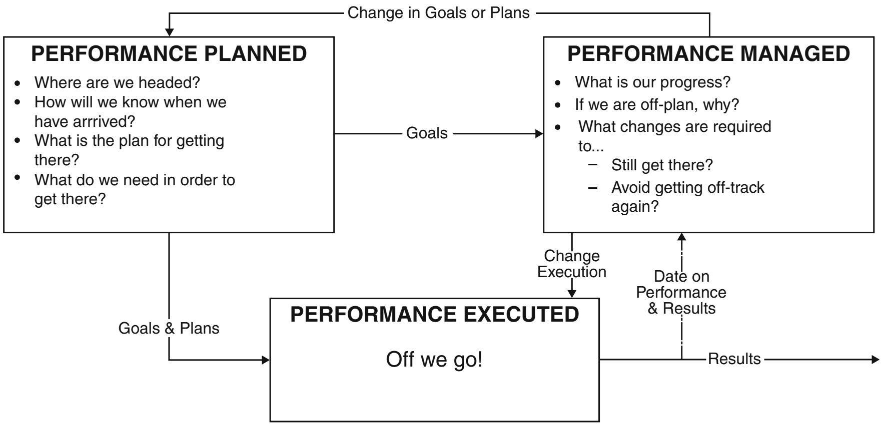

Fig. 10 Management model

– Modify the Operating Plan and Budget to better support the Strategy including: (a) The allocation of resources, (b) The Organization design, (c) Process requirements, and (d) Policies

Put another way,

- Performance Planned = (equals) "Plan"
- Performance Executed = "Actual"
- Performance Managed = Action to close the gap between "plan" and "actual".

"Performance Executed" (PE), the individual, process, or entity that performs the work, is always a very visible component of this fundamental performance system. On the other hand, the "Performance Planned" (PP) and "Performance Managed" (PM) components, which constitute the "brains" or intelligence of the performance system tend to be invisible and flawed. This PP/PM combination (which we refer to as the Performance Planned and Managed System [PPMS]) is what makes it possible for the performance system to adapt to external changes and react to execution failures. It is the mechanism whereby the performance system is both an effective processing system and an adaptive (learning) system.

Figure 11 provides more details about the functioning of the Performance Planned and Performance Managed components. An extra detail from the earlier diagram to point out is that in addition to providing Goals (direction) and Plans to Performance Executed, the Performance Planned component also makes available the necessary structure, processes, policies, and resources (financial and other) to achieve said goals.

You might think of the PPMS as a sophisticated guidance/control mechanism – a "management chip," if you will – whose goal it is to optimize the Performance Executed component and produce the desired results. A *management system* for an organization is a collection of these "management chips," inserted at key junctures in the organization, and *linked* as shown in Fig. 12.

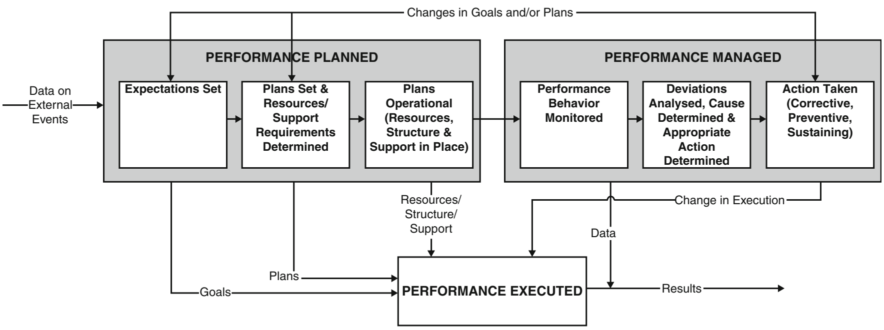

Fig. 11 Management model details

The diagram in Fig. 12 (a variation of Fig. 11, the preceding diagram) is a powerful template for both "troubleshooting" an existing management system and designing a new management system.

5 Management System Architecture

Corresponding to the Management System Hierarchy is a set of tools that collectively can be used to design and organize the management system (see Fig. 13). Just as with the BA, these tools can be used to define and analyze an organization's current state ("is") or future state ("should"). The Management System components

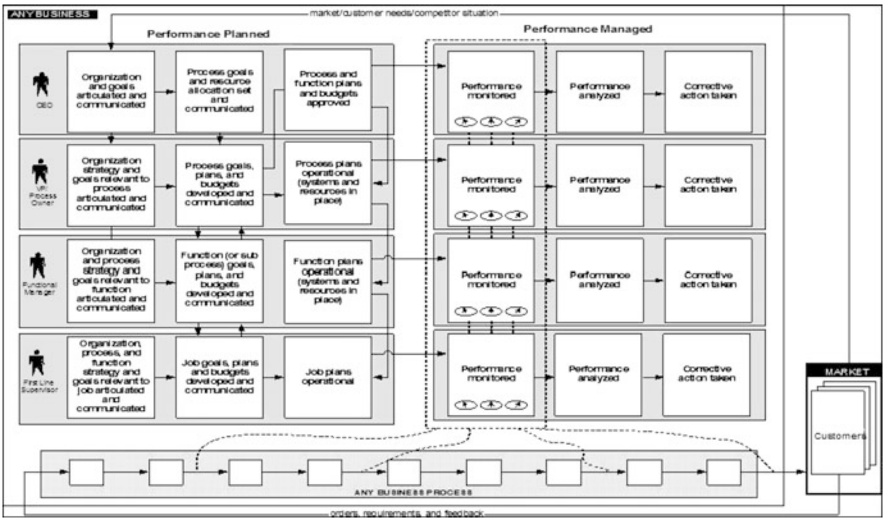

Fig. 12 Performance planned and managed hierarchy

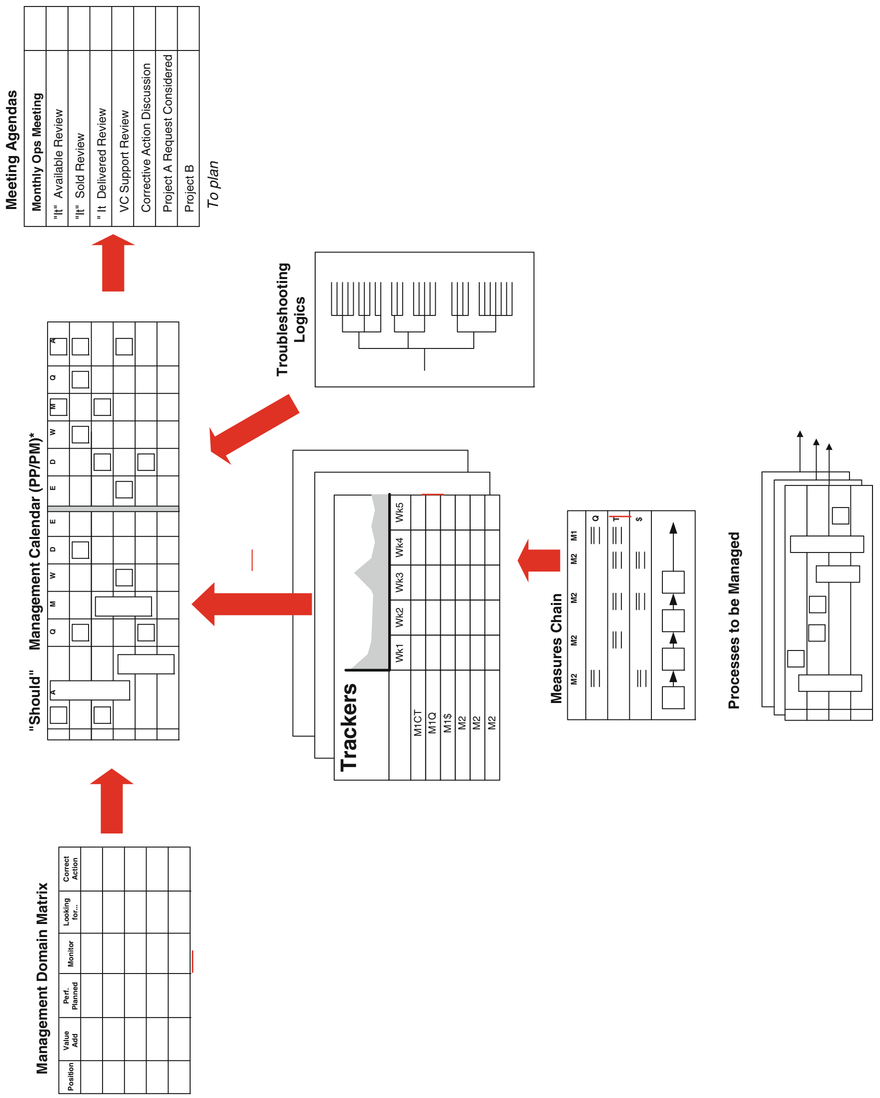

Fig. 13 Management system architecture

are anchored by the processes to be managed. Starting from the bottom, the components are arranged in rough order of their development when building a management system.

5.1 Measures Chain

For each process in the BA, a Measures Chain identifies what critical dimensions of performance and measures are applicable, and where in the process the performance data should be monitored. The way a Measures Chain is developed is to start at the right, with the requirements of customers and stakeholders and translate them into dimensions of performance such as timeliness, quality, and price, and applied to the process. For example, if the timeliness requirement is to deliver a product within 30 days, the requirements on the whole process might be 25 days (assuming 5 days for shipping), and then those 25 days are allocated appropriately to the subprocesses based on the worked required. The result is a set of measures for a given process. When Measures Chains are created for all the key processes in an organization's BPA, the management team has a powerful means of monitoring and controlling process performance across the organization.

5.2 Performance Trackers

Performance Trackers are tools for collecting and displaying performance data. The trackers are derived from the performance measures required by the Measures Chains. Typically, a tracker shows the trends in performance for a given measure, such as cost, timeliness, or quality. A hierarchy of trackers corresponding to the management levels contained in the Management Domain Matrix and covering all the key processes in the BPA results in a comprehensive "dashboard" for viewing and management organization-wide performance.

5.3 Troubleshooting Logic Diagrams

Much of the management work required to manage the organization as a system is diagnosing and acting upon performance feedback with the appropriate corrective action, which might be to provide coaching, better training or feedback, different tools or methods, etc. Troubleshooting tools are intended to help managers assess data, make the right conclusions, and choose the right actions.

5.4 Management Calendar

The central tool is the Management Calendar, which provides a road map and timeline for a total Performance Planned and Managed System (PPMS) for any organization. It prescribes the key points of interaction between key management roles (the vertical axis) at specific points in time (across the top of the chart, from Annual to Weekly/Daily). As the Management Architecture shows, the metrics used by management are derived from Measures Chains for each key process, and the levels of management are defined in the Management Domain Matrix.

5.5 Management Domain Matrix

This tool identifies each level of management, specifies the mission and value of each role, and the responsibilities for performance management of each role. How these responsibilities are carried out can be seen in the Management Calendar, where each manager participates in planning and management activities appropriate to their level.

5.6 Meeting Agendas

In most organizations, the best arena for managing the organization as a system are in those regular meetings where management teams plan and make decisions. The Management Calendar is typically built according to the schedule of management meetings. This final tool is a set of meeting agendas that aid management teams in optimizing and leading the organization.

For example, the Management Calendar for our fictitious organization includes a monthly Performance Managed meeting to emphasize that Functions exist to support Primary processes, which in turn meet customer and organization requirements. It works like this.

The executive team of the president and all vice-presidents meets every month for a review of operations and performance against goals. It is usually a 4-h meeting, chaired by the president. The first 30 min of the meeting is a quick briefing on performance against corporate goals for the month and year-to-date, including financials, sales performance, and customer satisfaction data. The next segment of the meeting, usually an hour and a half, is a review of Process performance against goals. The Process Management Team Chair (also a functional VP on the executive team) for each Primary Process reports on how their Process has performed against the goals for the period. The Chair/VP is also expected to comment on any issues regarding "suboptimization" of their process by any function. On a rotational basis, each month the performance of one of the Support Processes is reviewed in a similar manner. The president is a big advocate of "functions exist to support processes" and listens carefully during this segment of the meeting for indications that this is not the case.

In the final hour-and-a-half segment of the meeting, the focus shifts to a review of each major function in the company. Each VP gives a brief summary of their function's performance against their monthly goals and raises any issues they are having or anticipate having supporting any of the Primary Processes. The president is quick to ask questions if he senses a function is failing to support one of the Processes as required. If such a problem is identified, the president leads a positive "problem-solving" discussion of "why" the problem exists and what must be done (by all VP's, not just that function VP) to correct the problem, prevent the problem happening again, and recover from the problem.

The whole idea of the Management System is to make complex organizations more manageable. A company has hundreds of individuals in hundreds of jobs performing thousands of more or less related activities aimed at meeting ever changing customer requirements or expectations. It is a major management challenge to provide direction for such a complex organism. The alternative is to view the company as a processing system that delivers valued products to customers through a handful of critical processes – basically three Primary Processes and several Support Processes. With this processing system view of organizations, the primary management task for executives and managers becomes twofold:

- First, assure that the internal processing system is aligned with the external "Super-System" requirements and reality. For example, if customers expect to receive their orders in 5 days (because that is what your competition does), then you need to be sure that "5 days" is the standard for delivery of the Order Fulfillment Process. Likewise with expectations for new product development, customer service, etc.
- Secondly, assure that the internal processing system is efficient and effective in meeting organization goals and customer requirements. That is, if you set an order fulfillment standard of 5 days, your job as a management team is to see that the Order Fulfillment Process can meet that standard. You must see that the process is appropriately designed and resourced to consistently meet that customer-driven performance goal.

6 Bridge to Enabling Architectures

Now we are in position to bridge between the BA and other architectures. We want to specify performance and performers. We will define the "performer" as:

- A human being executing tasks with no use of an enabling information technology (i.e., the human performer performs a manual task without any use of a computer);
- Or a human using a supporting technology (e.g., the human performer uses a computer to process information, access data, perform analysis, etc.);

- Or a technology acting as a performer (e.g., a system sends information to another system)

Each of the above options describes a performance situation in which the task is executed in a particular manner, and our process maps should make clear which performance situations are required in the process. In turn the maps become the basis for defining what kinds of technologies are needed and what knowledge and skills the human performers must possess in order to perform the processes as they have been designed.

6.1 Technology Performance Architecture

The jumping off point for defining the enabling technologies are the process maps described earlier in the BA. Taken together, the maps for all the affected processes contain the specifications for what technologies are going to be needed. Figure 14 shows the elements of the Technology Performance Architecture.

One key element of the Technology Performance Architecture is the Use Case. A Use Case is developed for each instance in each process where a human performer uses technology to execute a task. For a change of significant magnitude, affecting multiple processes, there may be dozens of Use Cases developed. Each Use Case is a specific requirement for a specific item of technology to be designed, purchased, or modified to meet process needs.

At times, the use of a technology may be so complex that it cannot be adequately captured in a process map or use case document. What may be more revealing are “drilldowns” that show how the performance will happen. For example, a process may require very different actions depending on whether a customer is new; existing; existing but with a late-payment history; existing but with no credit, etc. Such complicated algorithms might be diagramed using tools such as if-then scenarios or other techniques that work better than process maps.

Another element of the Technology Performance Architecture is the Technology Enabler Chart, which is a compilation of all the technologies embedded in the various processes identified in the BA. When developed in the context of an improvement effort, the Technology Enabler Chart also specifies the current state of each required technology, some of which may be existing and others brand-new. This list amounts to “marching orders” for the IT organization, as it lists all of the requirements of all the processes needed to support the business.

From the Technology Enabler Chart, all of the requirements can be and appropriately distributed into three categories of IT technologies that link to the three classic IT architectures (data architecture, applications architecture, and technical architecture) listed in most EA models.

In addition, the Technology Performance Architecture contains some other elements not generally found in EA models:

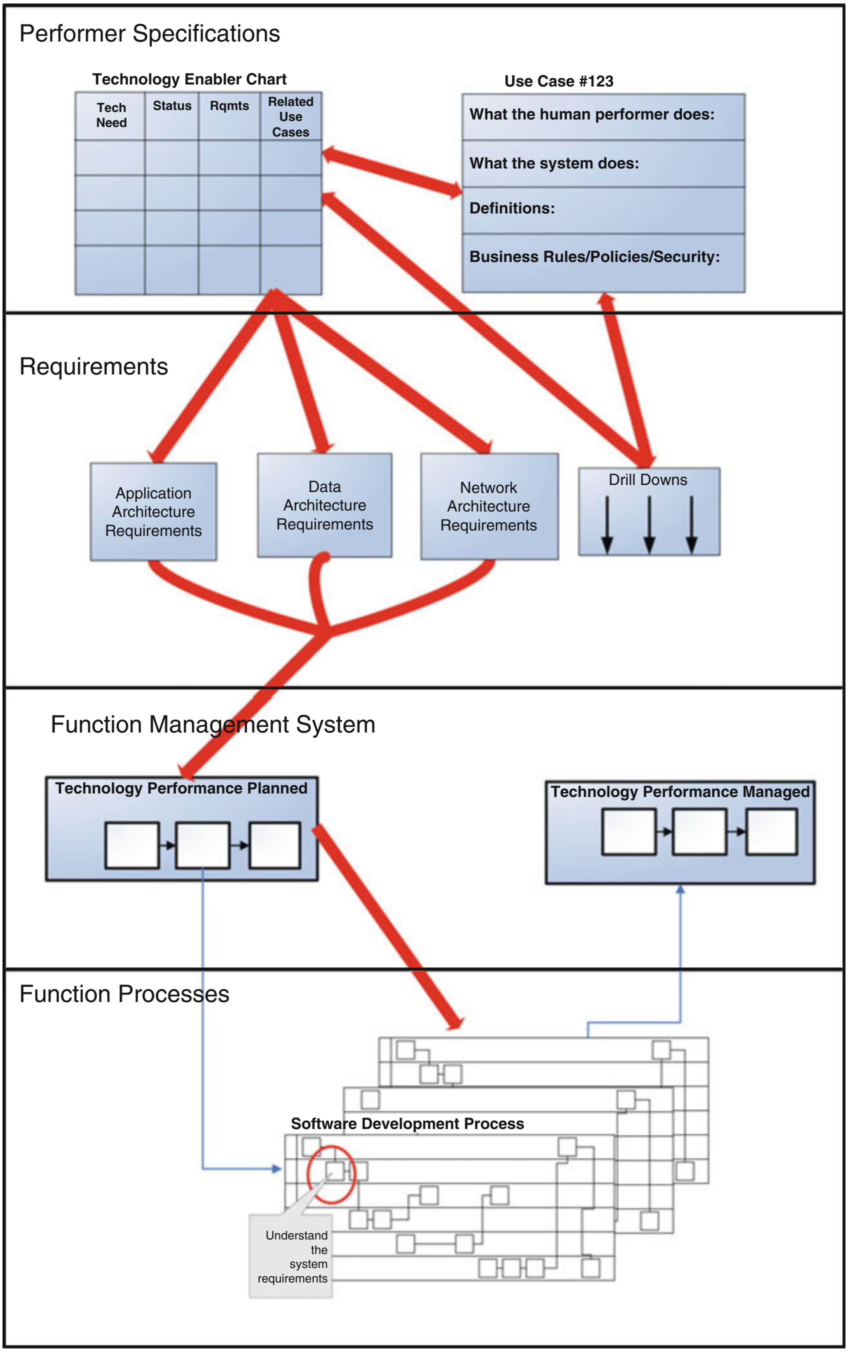

Fig. 14 The technology performance architecture

- We have included the IT organization's own processes, since these are the processes that produce the technologies needed by the business. How well these processes are designed, executed, and managed are key to success.
- We have also included the IT function's management system, which should be a mirror of the enterprise management system and driven by it. The goals and needs of the enterprise should be received by this system and then translated into specific objectives and projects for the IT function's processes.

6.2 Human Performance Architecture

This architecture is derived from the BA as well, with a focus on the human performers who execute the processes (see Fig. 15 for the Human Performance Architecture). The tools in this architecture specify what the human performers will have to be able to do to execute the BA processes as intended. The path down from the BA leads to two tools that provide more details and insight into human performance of the targeted processes.

The function role–responsibility matrices identify each job that participates in the affected processes and how the performers in those jobs will do their work.

Then for each affected job we develop a complete Job Model that specifies the job accomplishments, measures, performance goals, and knowledge/skill requirements.

With the Job Models completed, we can check them against the Use Cases to see if they match, and make appropriate adjustments if they do not. For example, perhaps the use cases specify that order entry clerks are going to be using supply chain analytics software, yet the Job Models make no reference to the skills it would take to use such software.

Then, as we did with the Technology Performance Architecture, we now distribute the requirements into several buckets (knowledge and skills, staffing, and performance management) and link them to the HR function's processes that deal with those areas. For example, in order to execute some of the processes in the BA, we may have to train people, or maybe we will hire from outside, which impacts the staffing process.

7 The Complete VCA

Now, with these enabling architectures defined, we have produced what we would consider to be a complete EA, or what we prefer to call a Value Creation Architecture (VCA). It consists of the Business Architecture, the Management System Architecture, the Technology Performance Architecture, and the Human Performance Architecture.

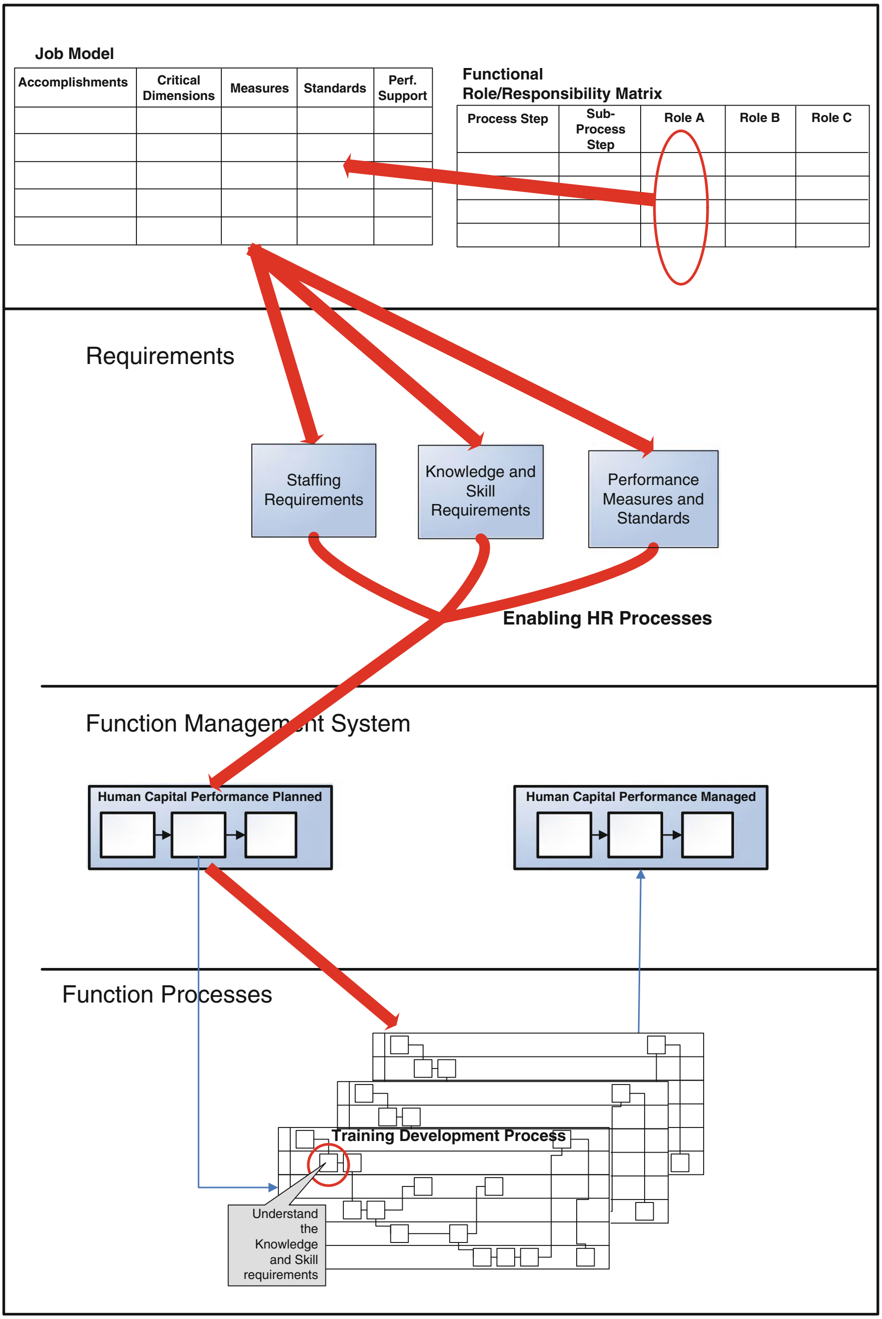

Fig. 15 The human performance architecture

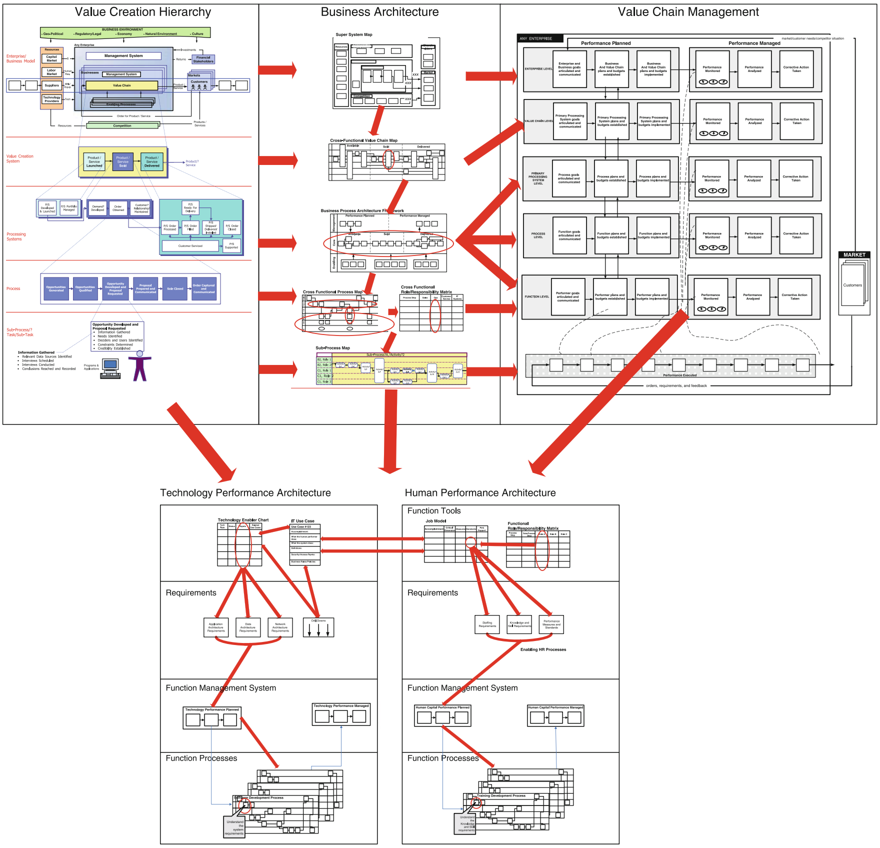

Fig. 16 Whole value creation architecture

This unifying architecture (see Fig. 16) will be constantly affected by changes large and small, but an organization that has developed a complete and accurate VCA like this one is capable of accommodating even large changes much more rapidly than an organization that has not defined its VCA.

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The Six Core Elements of Business Process Management

Michael Rosemann and Jan vom Brocke

Abstract The previous chapters gave an insightful introduction into the various facets of Business Process Management. We now share a rich understanding of the essential ideas behind designing, managing and changing processes for a variety of organizational purposes. We have also learned about the streams of research and development that have influenced contemporary BPM. As a result of more than two decades of inter-disciplinary research and a plethora of diverse BPM initiatives in corporations of all sizes and across all industries, BPM has become a holistic management discipline. Consequently, it requires that a number of complementary elements needs to be addressed for its successful und sustainable deployment. This chapter introduces a consolidating framework that provides structure and decomposes BPM into six essential elements. Drawing from research in the field of maturity models and its application in a number of organizations all over the globe, we suggest the following six core elements of BPM: strategic alignment, governance, methods, information technology, people, and culture. These six elements serve as the core structure for this BPM Handbook.

1 Why Looking for BPM Core Elements?

Despite the fact that BPM has disappeared as the top issue for CIOs (Gartner 2010), the interest in process-aware management and supporting methods and technologies remains very high (Gartner 2013). BPM is nowadays seen as being beyond the stage of inflated hype and the related expectations have become more realistic. Overall there is a much more matured understanding of how to approach BPM as a program of work or on a project-by-project base (vom Brocke et al. 2014). Nevertheless, new expectations are continuously being fuelled with emerging BPM

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solutions such as process mining, social BPM or cloud BPM. In this regard, BPM has increasingly been recognized a driver for innovation in a digital world (vom Brocke and Schmiedel 2014).

This context demands a robust frame of reference that helps decomposing the complexity of a holistic approach such as Business Process Management and allows accommodating new BPM capabilities. A framework highlighting essential building blocks of BPM can particularly serve the following purposes:

- *Project and Program Management*: How can all relevant issues within a BPM approach be safeguarded? When implementing a BPM initiative, either as a project or as a program, is it essential to individually adjust the scope and have different BPM flavors in different areas of the organization? What competencies are relevant? What approach fits best with the culture and strategic imperatives of the organization? How can BPM be best tailored to the specific corporate context? Michael Hammer has pointed in his previous chapter to the significance of appropriately motivated and skilled employees for the overall success of BPM. What might be further BPM elements of significance? In order to find answers to these questions, a framework articulating the core elements of BPM provides invaluable advice.
- *Vendor Management*: How can service and product offerings in the field of BPM be evaluated in terms of their overall contribution to successful BPM? What portfolio of solutions is required to address the key issues of BPM, and to what extent do these solutions need to be sourced from outside the organization? There is, for example, a large list of providers of process-aware information systems, process change experts, BPM training providers, and a variety of BPM consulting services. How can it be guaranteed that these offerings cover the required capabilities? In fact, the vast number of BPM offerings does not meet the requirements as distilled in this Handbook; see for example, Hammer (2014), Davenport (2014), Harmon (2014), and Rummler and Ramias (2014). It is also for the purpose of BPM make-or-buy decisions and the overall management of vendors and advisors that a framework structuring core elements of BPM is highly needed.
- *Complexity Management*: How can the complexity that results from the holistic and comprehensive nature of BPM be decomposed so that it becomes manageable? How can a number of coexisting BPM initiatives within one organization be synchronized? An overarching picture of BPM is needed in order to provide orientation for these initiatives. Following a "divide-and-conquer" approach, a shared understanding of the core elements can help to focus on special factors of BPM. For each element, a specific analysis could be carried out involving experts from the various fields. Such an assessment should be conducted by experts with the required technical, business and socio-cultural skills and knowledge.
- *Standards Management*: What elements of BPM need to be standardized across the organization? What BPM elements need to be mandated for every BPM initiative? What BPM elements can be configured individually within each

initiative? A comprehensive framework allows an element-by-element decision for the degrees of standardization that are required. For example, it might be decided that a company-wide process model repository will be "enforced" on all BPM initiatives, while performance management and cultural change will be decentralized activities.

- *Strategy Management*: What is the BPM strategy of the organization? How does this strategy materialize in a BPM roadmap? How will the naturally limited attention of all involved stakeholders be distributed across the various BPM elements? How do we measure progression in a BPM initiative ("BPM audit")?

A BPM framework that clearly outlines the different elements of BPM has the potential to become an essential tool for such strategy and road-mapping challenges as it facilitates the task of allocating priorities and timeframes to the progression of the various BPM elements.

Based on this demand for a BPM framework that can be used for project and program management, vendor management, complexity management, standards management, and strategy management, we propose a framework that can guide BPM decision makers in all of these challenges. In the following section, we outline how we identified these elements. We then introduce the six core elements by first giving an overview and second presenting each element and its subcomponents in more detail.

2 How to Identify Core Elements of BPM?

The framework to be identified has to comprehensively structure those elements of BPM that need to be addressed when following a holistic understanding of BPM, i. e., BPM as an organizational capability and not just as the execution of the tasks along an individual process lifecycle (identify, model, analyze, improve, implement, execute, monitor, and change). This requires an organization-wide perspective and the identification of the core capability areas that are relevant for successful BPM. We, thus, base our work on BPM maturity models that have been subject to former research (Roeglinger et al. 2012; van Looy 2014).

Recently, a number of models to decompose and measure the maturity of Business Process Management have been proposed as shown in Fig. 1.

The basis for the greater part of these maturity models has been the *Capability Maturity Model* (CMM) developed by the Software Engineering Institute at Carnegie Mellon University, Pittsburgh, PA. This model was originally developed in order to assess the maturity of software development processes and is based on the concept of immature and mature software organizations. The basis for applying the model is confirmed by Paulk et al. (1993) who stated that improved maturity results "*in an increase in the process capability of the organization*". CMM introduces the concept of five maturity levels defined by special requirements that are cumulative.

Model	Subject	Source
Process Condition Model	Effectiveness and efficiency measurement to rate a process' condition	DeToro and McCabe (1997)
Strategic Alignment Maturity Model	Maturity of strategic alignment	Luftman (2003)
BPR Maturity Model	Business Process Re-engineering Programmes	Maull et al. (2003)
Harmon's BPM Maturity Model	BPM maturity model based on the CMM	Harmon (2003, 2004)
Rummler-Brache Group's Process Maturity Model	Success factors for managing key business processes	Rummler-Brache (2004)
OMG's BPM Maturity Model	Practices applied to the management of discrete processes	Curtis et al., (2004); OMG (2008)
Rosemann and de Bruin's BPM Maturity Model	Maturity of Business Process Management capabilities	Rosemann; de Bruin (2005); de Bruin (2009)
Capability Maturity Model Integration (CMMI)	Maturity of software development processes	SEI (2006a, 2006b)
Hammer's BPM Maturity Model (Process Audit)	Defining process and enterprise competencies	Hammer (2007)

Fig. 1 Selected maturity models in BPM

Among others, Harmon (2004) developed a BPM maturity model based on the CMM (Harmon 2003). In a similar way, Fisher (2004) combines five "levels of change" with five states of maturity. Smith and Fingar (2004) argue that a CMM-based maturity model, which postulates well-organized and repeatable processes, cannot capture the need for business process innovation. Further, BPM maturity models have been designed by the Business Process Management Group (BPMG) and the TeraQuest/Borland Software (Curtis et al. 2004) that is now supported by the OMG (2008).

Curtis and Alden (2006) take a prescriptive approach to process management. This model combines a number of process areas by either applying a staged or a continuous approach. Progress through the stages is dependent on all requirements of preceding and completed stages. Some discretion is allowed at lower stages using the continuous approach but it largely evolves around the order in which the process areas are addressed. Hammer (2007), likewise, adopts a prescriptive approach (the "Process Audit") defining a number of process and enterprise competencies. Hammer also demands that all aspects of a stage are to be completed before progressing to higher stages of maturity.

One shortcoming of the universalistic approaches adopted by Curtis and Alden (2006) and Hammer (2007) is that they seem to be more appropriate for relatively narrow domains and do not capture various aspects of an organization sufficiently (Sabherwal et al. 2001). A further critique of these BPM maturity models has been the simplifying focus, the limited reliability in the assessment, and the lack of actual (and documented) applications of these models leading to limited empirical validations.

A proposal to divide organizations into groups with regard to their grade and progression of BPM implementation was made by Pritchard and Armistead (1999). The Rummler–Brache Group commissioned a study, which used ten success factors gaging how well an organization manages its key business processes (Rummler-Brache Group 2004). The results have been consolidated in a Process Performance Index. Pritchard and Armistead (1999) provide a proposal for how to divide organizations into groups depending on their grade and progression of BPM implementation.

In an attempt to define maturity of BPR programs, Maull et al. (2003) encountered problems in that they could not use objective measures. They define BPM by using two dimensions, an objective measure (time, team size, etc.) and a "weighting for readiness to change" (Maull et al. 2003). This approach, however, turned out to be too complex for measurement. Therefore, they chose a phenomenological approach assessing the organization's perception of their maturity, using objective measures as a guideline. Another example of how to define maturity (or in their case "process condition") is provided by DeToro and McCabe (1997), who used two dimensions (effectiveness and efficiency) to rate a process' condition. These models show that a clear distinction should be made between process maturity models ("How advanced are our processes?") and Business Process Management maturity models ("How advanced is the organization in managing its business processes?").

In addition to these dedicated process and BPM maturity models, a number of models have been proposed that study and structure the maturity of single elements of BPM. An example is Luftman's (2003) maturity model for strategic alignment which serves as a foundation of Strategic Alignment in BPM (Luftman 2014).

As our base for identifying the core elements of BPM, we have used Rosemann and de Bruin's (2005) BPM maturity model (de Bruin 2009). This BPM maturity model was selected for a number of reasons:

- First, it was developed on the contemporary understanding of BPM as a holistic management approach.
- Second, it is based on a sound academic development process. Starting with an in-depth and comprehensive literature review, the experiences and preliminary versions of three previous BPM maturity models have been consolidated. The model has been validated, refined, and specified through a series of international

Delphi studies involving global BPM thought leaders (de Bruin and Rosemann 2007). A number of detailed case studies in various industries further contributed to the validation and deeper understanding of the model (de Bruin 2009).

- Third, the model distinguishes factors and capability areas on two levels of abstraction. This hierarchical structure allows different types of granularity in the analysis. As a result, definitions of the factors and capability areas are available and provide a basis for consistent interpretation (Rosemann et al. 2006; de Bruin 2009).
- Fourth and finally, the model has been applied within a number of organizations by means of documented case studies including embedded surveys and workshops (Rosemann and de Bruin 2004; Rosemann et al. 2004; de Bruin and Rosemann 2006; de Bruin 2009). Hence, the core elements have been validated and proven to be of practical relevance in real life projects.

Using this maturity model to identify the six core elements of BPM, we do not explicitly elaborate on the maturity assessment process and the various maturity stages of this model. Rather we take a static view and discuss the six capability areas as core elements of BPM.

3 Introducing the Six Core Elements of BPM

3.1 Overview

The consolidation of related literature, the merger of three existing BPM maturity models, the subsequent international Delphi studies and the case studies led to a set of well-defined factors that together constitute a holistic understanding of BPM (de Bruin 2009). Each of the six core elements represents a critical success factor for Business Process Management. Therefore, each element, sooner or later, needs to be considered by organizations striving for success with BPM. For each of these six factors, the consensus finding Delphi studies (de Bruin and Rosemann 2007) provided a further level of detail, the so called *Capability Areas*. Both factors and capability areas are displayed in Fig. 2.

Our model distinguishes six core elements critical to BPM. These are strategic alignment, governance, methods, information technology, people, and culture.

- *Strategic Alignment*: BPM needs to be aligned with the overall strategy of an organization. Strategic alignment (or synchronization) is defined as the tight linkage of organizational priorities and enterprise processes enabling continual and effective action to improve business performance. Processes have to be designed, executed, managed, and measured according to strategic priorities and specific strategic situations (e.g., stage of a product lifecycle, position in a

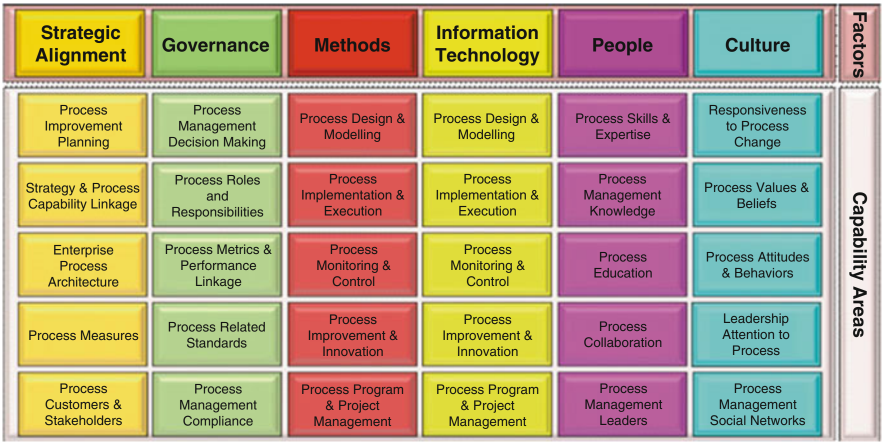

Fig. 2 The six core elements of BPM

strategic portfolio; Burlton 2014). In return, specific process capabilities (e.g., competitive advantage in terms of time to execute or change a process) may offer opportunities to inform the strategy design leading to process-enabled strategies.

- *Governance*: BPM governance establishes appropriate and transparent accountability in terms of roles and responsibilities for different levels of BPM, including portfolio, program, project, and operations (Spanyi 2014). A further focus is on the design of decision-making and reward processes to guide process-related actions.
- *Methods*: Methods in the context of BPM are defined as the set of tools and techniques that support and enable activities along the process lifecycle and within enterprise-wide BPM initiatives. Examples are methods that facilitate process modeling or process analysis and process improvement techniques (Dumas et al. 2013). Six Sigma is an example for a BPM approach that has at its core a set of integrated BPM methods (Conger 2014).
- *Information Technology*: IT-based solutions are of significance for BPM initiatives. With a traditional focus on process analysis (e.g., statistical process control) and process modeling support, BPM-related IT solutions increasingly manifest themselves in the form of process-aware information systems (PAIS) (Dumas et al. 2005). Process-awareness means that the software has an explicit understanding of the process that needs to be executed. Such process awareness could be the result of input in the form of process models or could be more implicitly embedded in the form of hard-coded processes (like in traditional banking or insurance applications).
- *People*: People as a core element of BPM is defined as individuals and groups who continually enhance and apply their process and process management skills

and knowledge in order to improve business performance. Consequently, this factor captures the BPM capabilities that are reflected in the human capital of an organization and its ecosystem.

- Culture: Culture incorporates the collective values of a group of people (Schein 2004) and comparative case studies clearly demonstrate the strong impact of culture on the success of BPM (de Bruin 2009). Culture is about creating a facilitating environment that complements the various BPM initiatives. Research has identified specific organizational values supportive for BPM as well as methods to measure and further develop a BPM-supportive organizational culture (Schmiedel et al. 2013). However, it needs to be recognized that the impact of culture-related activities tends to have a much longer time horizon than activities related to any of the other five factors.

The six identified factors in this BPM maturity model are heavily grounded in literature. A sample summary of literature supporting these factors is shown in Fig. 3.

In the following, we will elaborate on the capability areas that further decompose each of these six factors. Here, we particularly draw from the results of a set of international Delphi Studies that involved BPM experts from the US, Australasia, and Europe (de Bruin and Rosemann 2007). We can only provide a brief overview about each of the six factors in the following sections and refer to the chapters in this Handbook for deeper insights per factor.

Factor	Source
Strategic Alignment	Elzinga et al., 1995; Hammer, 2001; Hung, 2006; Jarrar et al., 2000; Pritchard and Armistead, 1999; Puah K.Y. and Tang K.H, 2000; Zairi, 1997; Zairi and Sinclair, 1995
Government	Braganza and Lambert, 2000; Gulledge and Sommer, 2002; Harmon, 2005; Jarrar et al., 2000; Pritchard and Armistead, 1999
Methods	Adesola and Baines, 2005; Harrington, 1991; Kettinger et al. 1997; Pritchard and Armistead, 1999; Zairi, 1997
Information Technology	Gulledge and Sommer, 2002; Hammer and Champy, 1993; McDaniel, 2001
People	Elzinga et al., 1995; Hung, 2006; Llewellyn and Armistead, 2000; Pritchard and Armistead, 1999; Zairi and Sinclair, 1995; Zairi, 1997
Culture	Elzinga et al., 1995; Llewellyn and Armistead, 2000; Pritchard and Armistead, 1999; Spanyi, 2003, Zairi, 1997; Zairi and Sinclair, 1995

Fig. 3 The six BPM core elements in the literature

3.2 Strategic Alignment

Strategic alignment is defined as the tight linkage of organizational priorities and enterprise processes enabling continual and effective action to improve business performance. Five distinct capability areas have been identified as part of an assessment of strategic alignment in BPM.

- A strategy-driven *process improvement plan* captures the organization's overall approach towards BPM. The process improvement plan should be directly derived from the organization's strategy, and outline how process improvement initiatives are going to meet strategically prioritized goals. This allows a clear articulation of the corporate benefits of BPM initiatives. The process improvement plan also provides information related to how the BPM initiative relates to underlying projects such as the implementation of an Enterprise System.
- A core element of strategic alignment, in the context of BPM, is the bidirectional *linkage between strategy and business processes*. Do the business processes directly contribute to the strategy? Do organizational strategies explicitly incorporate process capabilities? By way of example, do we know which processes are impacted by a change of the strategy? Which processes could become a bottleneck in the execution of the strategy? Is the strategy designed and continually reviewed in light of current and emerging process capabilities? How should scarce resources be allocated to competing processes? Which processes are core to the organization and should be executed in-house (core competency)? Which processes are candidates for process outsourcing or off-shoring (Bhat et al. 2014)? Common methodologies such as Strategy Maps (Kaplan and Norton 2004) play an important role in linking strategy and process design.
- *An enterprise process architecture* is the highest level abstraction of the actual hierarchy of value-driven and enabling business processes (Aitken et al. 2014; Spanyi 2014). A well-defined enterprise process architecture clearly depicts which major business processes exist, describes the industry-/company-specific value chain, and captures the enabling processes that support this value chain, for example, finance, human capital management, or IT services. A well-designed process architecture provides a high level visualization from a process view and complements, and not replicates, organizational structures. In addition, it serves as the main process landscape and provides a starting point for more detailed process analyses and models. Reference models (vom Brocke 2006) can provide domain-oriented knowledge for deriving a company-specific process architecture (Houy 2014).
- In order to be able to evaluate actual process performance, it is important to have a clear and shared understanding of *process outputs* and related key performance indicators (KPIs). A hierarchy of cascading, process-oriented, and cost-effectively measured KPIs provides a valuable source for the translation of strategic objectives to process-specific goals and facilitates effective process control. Relevant KPIs can differ in their nature, including financial, quantitative, qualitative, or time-based data, and will be dependent on the strategic

drivers for the specific enterprise process (vom Brocke et al. 2014; Franz et al. 2011). As far as possible, such KPIs should be standardized across the various processes and in particular across the different process variants (e.g., in different countries). Only such a process performance standardization allows consistent cross-process performance analysis (e.g., what processes can explain a drop in the overall customer satisfaction?). Often equally important, but more difficult to measure, are those KPIs related to characteristics of an entire process, such as flexibility, reliability or compliance.

- Strategies are typically closely linked to individuals and influential stakeholder groups. Thus, a strategic assessment of BPM has to evaluate the actual priorities of *key customers and other stakeholders such as senior management, shareholders, government bodies, etc*. For example, it can be observed that a change of a CEO often will have significant impact on the popularity (or not) of BPM even if the official strategy remains the same. The consideration of stakeholders also includes an investigation of how well processes with touch-points ("moments of truth") to external parties are managed, how well external viewpoints have been considered in the process design, and what influence external stakeholders have on the process design. Such a view can go so far that organizations consciously design processes the way they are perceived by their business partners, and then start to position their services in these processes.

3.3 Governance

BPM governance is dedicated to appropriate and transparent accountability in terms of roles and responsibilities for different levels of BPM (portfolio, program, project, and operations). Furthermore, it is tasked with the design of decision-making and reward processes to guide process-related actions.

- The clear definition and consistent execution of related BPM *decision-making processes* that guide actions in both anticipated and unanticipated circumstances is a critical challenge for BPM governance (Markus and Jacobson 2014). In addition to *who* can make *which* decision, the speed of decision-making and the ability to influence resource allocation and organizational responses to process change is important. This requires alignment with related governance processes such as IT change management or Business Continuity Management.
- A core element of BPM governance is the definition of *process roles and responsibilities*. This covers the entire range of BPM-related roles, from business process analysts to process owners up to potential chief process officers (CPO). It also encompasses all related committees and involved decision boards, such as Process Councils and Process Steering Committees (Spanyi 2014). The duties and responsibilities of each role need to be clearly specified, and precise reporting structures must be defined.

- Processes must exist to ensure the direct linkage of process performance with strategic goals. While the actual process output is measured and evaluated as part of the factor strategic alignment, accountabilities and the process for *collecting the required metrics* and linking them to performance criteria is regarded as being a part of BPM governance (Scheer and Hoffmann 2014).
- *Process management standards* must be well-defined and documented. This includes among others the coordination of process management initiatives across the organization, and guidelines for the establishment and management process measures, issue resolution, reward, and remuneration structures.
- *Process management controls* as part of BPM governance cover regular review cycles to maintain the quality and currency of process management principles (e. g., "process reuse before process development; "exception-based process execution"). Finding the right level of standardizing these principles is a major success factor of BPM initiatives (Tregear 2014). Appropriate compliance management forms another key component of process management controls (Spanyi 2014).

3.4 Methods

Methods, in the context of BPM, have been defined as the tools and techniques that support and enable consistent activities on all levels of BPM (portfolio, program, project, and operations). Distinct methods can be applied to major, discrete stages of the process lifecycle. This characteristic, which is unique to the "methods" and "information technology" factors, has resulted in capability areas that reflect the process lifecycle stages rather than specific capabilities of BPM methods or information technology. An advantage of associating the method capability with a specific process lifecycle stage is that a method can be assessed with regards to a specific purpose. For example, it is possible to assess the specific methods used for designing processes as distinct from those used for improving processes. Therefore, the methods dimension focuses on the specific needs of each process lifecycle, and considers elements such as the integration of process lifecycle methods with each other and with other management methods, the support for methods provided by information technology, and the sophistication, suitability, accessibility, and actual usage of methods within each stage.

- *Process design and modeling* is related to the methods used to identify and conceptualize current (as-is) business processes and future (to-be) processes. The core of such methods is not only to process modeling techniques but also to process analysis methods (Dumas et al. 2013; Sharp and McDermott 2009).
- *Process implementation and execution* covers the next stages in the lifecycle. Related methods help to transform process models into executable business process specifications. Methods related to the communication of these models and escalation methods facilitate the process execution.

- The *process control and measurement* stage of the process lifecycle is related to methods that provide guidance for the collection and consolidation of process-related data. These data can be related to process control (e.g., risks), or could be process performance measures (e.g., time, cost, and quality).
- The *process improvement and innovation* stage includes all methods which facilitate the development of improved business processes. This includes approaches that support the activities of process enhancement (e.g., re-sequencing steps in a process), process innovation (e.g., design-led process innovation techniques), process utilization (better use of existing resources such as people, data, or systems), and process derivation (reference models, benchmarking, etc.).
- The assessment component *process project management and program management* evaluates the methods that are used for the overall enterprise-wide management of BPM and for specific BPM projects. The latter requires a sound integration of BPM methods with specific project management approaches (e.g., PMBOK, PRINCE 2).

3.5 Information Technology

Information technology (IT) refers to the software, hardware, and information systems that enable and support process activities. As indicated, the assessment of IT as one of the BPM core elements is structured in a similar way to that of BPM methods, and also refers to the process lifecycle stages. Similar to the methods dimension, the IT components focus on the specific needs of each process lifecycle stage and are evaluated from viewpoints such as customizability, appropriateness of automation, and integration with complementary IT solutions (e.g., social computing, mobile application, cloud computing, business rules engines). An overview of IT solutions for BPM is provided by Sidorova et al. (2014). Further evaluation criteria capture the sophistication, suitability, accessibility, and usage of such IT within each stage.

- *IT solutions for process design and modeling* cover the (semi-)automated support that enables derivation of process models from log files (process mining) (van der Aalst 2011), and tool-support for business process modeling and analysis (e.g., process animation, process simulation) (van der Aalst 2014).
- *IT-enabled process implementation and execution* focuses on the automated transformation of process models into executable specifications and the subsequent workflow-based process execution, (Ouyang et al. 2014). This also includes related solutions such as business rules engines or case management systems. This entire category of software is often labeled “process-aware information systems” (Dumas et al. 2005). Recent increases in the information processing capacity of PAIS, for example through in-memory-databases

(Plattner and Krüger 2014), enable new principles of process design, including context-aware and real-time process management (vom Brocke et al. 2013).

- *Process control and measurement* solutions facilitate (semi-)automated process escalation management, exception handling, performance visualization (e.g., dashboards), and process controlling. There is a high demand for these type of solutions to be integrated in the corporate landscape (e.g., via Balanced Scorecard systems).
- Tools for *process improvement and innovation* provide (semi-)automated support for the generation of improved business processes. These could be solutions that provide agile (i.e., self-learning) tools that continuously adjust business processes based on contextual changes.
- *Process project management and program management* tools facilitate the overall management of different types of BPM initiatives. They provide among others decision support systems for process owners.

3.6 People

While the information technology factor covered IT-related resources, the factor "people" comprises human resources. This factor is defined as the individuals and groups who continually enhance and apply their process and process management skills and knowledge to improve business performance.

- *Process skills and expertise* is concentrated on the comprehensiveness and depth of the capabilities of the involved stakeholders in light of the specific requirements of a process. This is an important capability area for process owners and all stakeholders involved in the management and operations of a process. Apart from technical and methodological skills, social and communicative skills are key to the skillset of successful BPM professionals (Bergener et al. 2012).
- *Process management knowledge* consolidates the explicit and tacit knowledge about BPM principles and practices. It evaluates the level of understanding of BPM, including the knowledge of process management methods and information technology, and the impact these have on business process outcomes (Karagiannis and Woitsch 2014). In particular, business process analysts and the extent to which they can apply their process management knowledge to a variety of processes are assessed within this capability area.
- *Process education and learning* measures the commitment of the organization to the ongoing development and maintenance of the relevant process and process management skills and knowledge. The assessment covers the existence, extent, appropriateness, scope of roll-out, and actual success (as measured by the level of learning) of BPM education programs. Further items are devoted to the qualification of the BPM educators and BPM certification programs.
- *Process collaboration and communication* considers the ways in which individuals and groups work together in order to achieve desired process outcomes.

This includes the related evaluation of the communication patterns between process stakeholders, and the manner in which related process knowledge is discovered, explored, and disseminated.

- The final “people” capability area is dedicated to *process management leaders*. The assessment according to this element evaluates the willingness to lead, take responsibility, and be accountable for business processes. Among others, this capability area also captures the degree to which desired process leadership skills and management styles are actually practiced.

3.7 Culture

Culture, the sixth and final BPM core element, refers to the collective values and beliefs that shape process-related attitudes and behavior to improve business performance. Despite its proven relevance, culture has been under-researched in BPM over years (vom Brocke and Sinnl 2011). Only more recently, significant progress has been made in understanding the role of culture in BPM. Specific values have been identified, that are essential for meeting BPM objectives, namely the CERT values customer-orientation, excellence, responsibility and teamwork (Schmiedel et al. 2013). Measurement instruments are available to evaluate an organization’s cultural fitness according to these values and measures have been studied to further develop an organization’s culture accordingly (Schmiedel et al. 2014). Based on the maturity model, the following related capabilities have been identified:

- *Responsiveness to process change* is about the overall receptiveness of the organization to process change, the propensity of the organization to accept process change, and adaptation. It also includes the ability for process change to cross-functional boundaries seamlessly and for people to act in the best interest of the process.
- *Process values and beliefs* investigates the broad process thinking within the organization. For example, do members of the organization naturally see processes as the way things get done? Do “processes” play a prominent role in the corporate vision, mission, value statements? (vom Brocke et al. 2010). Furthermore, this capability area concentrates on the commonly held beliefs and values of the key BPM stakeholders. Among them is the longevity of BPM, expressed by the depth and breadth of the ongoing commitment to BPM.
- The *process attitudes and behavior* of those who are involved in and those who are affected by BPM form a further assessment item in the “culture” factor. This includes, among others, the willingness to question existing BPM practices in the light of potential process improvements. It also captures actual process-related behavior (e.g., willingness to comply with the process design or extent to which processes get priority over resources).

- *Leadership attention to process management* covers the level of commitment and attention to processes and process management shown by senior executives, the degree of attention paid to process on all levels, and the quality of process leadership. For example, do "processes" regularly appear as a term in presentations of the senior executives of the organization?
- Finally, *process management social networks* comprise the existence and influence of BPM communities of practice, the usage of social network techniques (e. g., Yammer), and the recognition and use of informal BPM networks.

4 Conclusion and Outlook

This chapter aimed at providing a brief overview of a framework for BPM comprising of six core elements. Each element represents a key success factor for implementing BPM in practice. We referred to a well-established and empirically validated BPM maturity model in order to identify the six core elements of BPM: strategic alignment, governance, methods, information technology, people, and culture.

These grounded elements provide the primary structure of the BPM Handbook at hand. The following chapters present contributions to each of these elements and have been provided by the most recognized thought leaders in these areas. While focusing on a specific element each contribution also considers relations to the other elements. We are presenting contributions from academics as well as case studies from practitioners. Some are more technical in nature, some more business oriented. Some look more at the behavioral side of BPM while others study the conceptual details of advanced methodologies. By proposing this structure, the reader may grasp what they consider most appropriate for their individual background. We trust that the discussion of these six core elements and the corresponding capability areas helps to make the holistic view on Business Process Management more tangible.

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Part II
Methods

In the tradition of BPM, the design of methods, tools, and process modeling methodologies has attracted a substantial amount of interest in the BPM community. This section covers the comprehensive set of rules and guidelines on how to proceed in the various stages of BPM, methods that often form the most tangible knowledge asset in BPM.

At least three levels of methods can be differentiated. First, process-specific individual techniques provide guidance for modeling, analyzing, animating, simulating, improving, or automating a process. A second class of methods covers the entire business process lifecycle, though often with differing levels of emphasis on the single lifecycle phases. Six Sigma and Lean Management are prominent representatives of this class of methodologies. Third, and most comprehensive in their scope, are the methods that guide the enterprise- wide roll-out of BPM as a corporate capability. It is characteristic of the current status of BPM that the body of knowledge on the first type of methods is rich, that a number of the second type of methods are widely used, though usually incomplete, and that representatives of the third type of BPM methodologies are still in their infancy. For all of these methodologies it is particularly important to consider the diverse contexts of BPM initiatives since any one-size-fits-all solution is likely to fail. The comprehensiveness of this section is a clear indicator of the large amount of activity and interest in this area, as well as the ongoing requirement to develop and consolidate BPM methodologies.

In the first chapter in this section, Sue Conger describes Six Sigma, one of the most popular business process lifecycle management methodologies, explains key techniques, gives examples, and positions Six Sigma in BPM. A core capability in the analysis and redesign of business processes is abstraction. In the second chapter in this section, Artem Polyvyanyy, Sergey Smirnov, and Mathias Weske present a process-model abstraction methodology that includes process-transformation rules helping users focus on the most significant parts of a process model in a specific modeling situation.

While there is no shortage of recommendations for modeling business processes, the discipline of process-model assessment has not matured to the same extent.

Hajo Reijers, Jan Mendling, and Jan Recker address this challenge in the third chapter of this section by proposing a framework for the holistic evaluation of business process models. One way to improve the quality of process models and subsequent process analyses is to use semantic building blocks. In the fourth chapter, Jörg Becker, Daniel Pfeiffer, Michael Räckers, Thorsten Falk, and Matthias Czerwonka introduce and apply PICTURE, a comparatively simple cost-effective process-modeling approach that reduces complexity. As part of the plethora of process-modeling techniques, first attempts toward standardization have emerged, the most prominent candidate among which is the business process modeling notation (BPMN). The fifth chapter, by Gustav Aagesen and John Krogstie, gives an overview of BPMN 2.0 and discusses its fitness for process analysis, including reports of practical experiences. A particular challenge in process modeling is the management of business-process variants, an issue that emerges in large-scale distributed modeling initiatives. The sixth chapter, by Manfred Reichert, Alena Hallerbach, and Thomas Bauer, discusses how such process variants can be configured and managed over the life-cycle of process models. The authors build on experience from a number of case studies in the automotive, healthcare, and public sector domains.

While an intra-organizational approach toward process modeling remains dominant, there is an increasing demand for inter-organizational modeling activities that appropriately conceptualize entire value networks. Two chapters are dedicated to this domain. The chapter by Alistair Barros introduces a process choreography modeling technique for various levels of abstraction, including the required refinement steps. In a comprehensive case study, Mikael Lind and Ulf Seigerroth use Intersport in the subsequent chapter to illustrate the real-word requirements of inter-organizational process design. Focusing on strategic alignment, the authors describe collaborative process modeling in this specific case.

Two chapters concentrate on advanced solutions that facilitate the design and analysis of business processes. Agnes Koschmider and Andreas Oberweis propose a recommendation-based editor for process modeling. Already widely used in many web-based applications, recommender systems have only just entered the world of business process modeling. In the tenth chapter, Wil van der Aalst discusses process simulation as one of the key quantitative process analysis techniques, providing a unique introduction to process simulation. Apart from the fundamentals of the topic, the chapter lists 15 risks (or potential pitfalls) of using simulation that will strongly influence future BPM research and practice.

This section closes with two case studies: Islay Davies and Michael Reeves report on the experiences of the Queensland Court of Justice as part of their process-management tool selection process, and Florian Johannsen, Susanne Leist, and Gregor Zellner report on their experience with implementation of Six Sigma at an automotive bank.

Six Sigma and Business Process Management

Sue Conger

Abstract Business process management lacks an integrated set of analysis methods for removing unneeded process steps, identifying inefficient or ineffective process steps, or simply determining which process steps to focus on for improvement. Often, tools and techniques from Six Sigma, an orientation to error-proofing that originated in the quality movement of the 1980s, are borrowed for those tasks. This chapter defines several Six Sigma techniques and shows through a case study how they can be used to improve deficient processes. Six Sigma combined with lean waste removal techniques can add significant value to a process improvement project.

1 Introduction

Organizations should constantly improve their functioning to remain competitive. Yet, problems develop in the translation of strategy to actual business processes, which accomplish some work (Kaplan and Norton 2001). Further, by improving business processes, the intellectual capital of workers increases through added understanding of their role in the organization and through removal of resource gaps (Herremans and Isaac 2004).

Business organizations are comprised of people who conduct daily business through process enactment. Organizations that do not manage their processes are less effective than those that do (Rummler and Brache 1995). Further, organizations that allocate information technologies to processes, but do not manage the process, are mostly wasting their money.

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As Dorgan and Dowdy (2004) demonstrated in their study of the intensity of IT deployment versus the intensity of process management, companies that neither actively manage processes nor invest in technology to support work return 0 % on any investments in either. Companies that invest in technology but do not manage their processes, in essence who throw technology at a situation, can return as much as 2 % on their investments. Companies that actively manage their business processes but have a low intensity of technology for supporting work can experience as much as 8 % gain from their investment. That is, simply managing business processes improves return on investment over blindly using technology. And, companies that both actively manage business processes and have a high intensity of technology support for work can experience as much as 20 % gain from their investment. Thus, the maximum gain accrues from intelligent process design followed by strategic, intelligent technology deployment to support those processes.

The first step in process management is to understand the processes, the work those processes accomplish, and how that work relates to the organization strategy (Rummler and Brache 1995). Any process, process step, or process product (e.g., document, email, data, or other product of a process step) that does not contribute to the organization strategy or its ability to meet its strategy is waste. Process value accrues to the extent that it fulfills some aspect of the organization's customer value proposition (Kaplan and Norton 2001). Thus, the overall goal of business process management (BPM) is to improve processes in optimizing customer value fulfillment (Hassan et al. 2012; Martinez et al. 2012; Rummler and Brache 1995).

BPM uses techniques to measure, analyze and improve processes, however, there is no single body of knowledge or techniques that apply to BPM. Lean Six Sigma provides useful techniques for BPM analysis and improvement (See also chapter by Paul Harmon).

1.1 Six Sigma

Modern quality programs have their roots in the 1950s in the U.S. and in Japan where Walter Shewhart and W. Edwards Deming popularized continuous process improvement as leading to quality production. Six Sigma is the practice of continuous improvement that follows methods developed at Motorola and is based on the notion that no more than 3.4 defects per million are acceptable (Motorola 2009). This means that a company fulfilling one million orders per year, and having only one error opportunity per order with 3-sigma correctness (99.95 %) will experience 66,738 errors versus a 6-sigma (99.9997 %) company, which would experience 3.4 errors. As engineered product complexity has increased (in telecommunications, for instance, the potential for over 50,000 errors per product are possible), without the type of quality management provided through Six Sigma tenets, virtually every product would experience defects.

The purpose of Six Sigma is to improve predictable quality of developed products and services through the removal of normally distributed errors. If error outcomes of a process are normally distributed, errors vary from the mean, or

1σ	690,000 per million opportunities (69% error rate)
2σ	308,000 per million opportunities (30.8%)
3σ	66,800 per million opportunities (6.7%)
4σ	6,210 per million opportunities (.62%)
5σ	230 per million opportunities (.02%)
6σ	3.4 per million opportunities (.00003%)

Fig. 1 Six sigma errors and error rates (iSixSigma Staff (2002))

average. A standard deviation, or sigma, is a measure of variance from the mean with equal areas on either side of the mean line. The error rates for sigma levels one through six are listed in Fig. 1 (σ is the Greek symbol for sigma). Six Sigma practice strives for 99.9997 % accuracy in the process.

Six Sigma can be combined with lean manufacturing tenets to error-proof and remove waste from processes (Martinez et al. 2012). The guiding principles of lean are not to make defects, accept defects, create variation, repeat mistakes, or build in defects (Ohno 1988). Lean Six Sigma combines lean manufacturing waste removal discipline with Six Sigma's defect prevention goal.

Six Sigma project life cycles are named DMAIC and DMADV, which translate to define – measure – analyze – improve – control and define – measure – analyze – design –verify, respectively. In general, DMAIC is the approach recommended for improving an existing process and DMADV is the approach recommended for new process design. But, these sets of methods are more similar than different and all activities tend to be done for all projects (Linderman et al. 2006). This paper focuses on the analyze-improve parts of the DMAIC life cycle. When applied to business processes and combined with lean tenets, Six Sigma is useful for eliminating unnecessary or inefficient steps from a process through the application of techniques such as process mapping, SIPOC, value-added analysis, root cause analysis, Pareto analysis, brainstorming, bureaucracy reduction, simple English, and so on (Johannsen et al. 2014; Rasmusson 2006). These are only a few of the hundreds of techniques useful for identifying, prioritizing, analyzing, and fixing errors or inefficiencies in processes.

1.2 Process Management

Process management and improvement requires leaning – that is removal of unneeded steps for improvement, cleaning – that is the simplification and improvement of remaining steps, and greening – that is the potential use of outsourcing, co-production, or automation (Conger 2011). The application of several techniques to each process improvement step is demonstrated through the analysis of a service desk. A typical process improvement initiative undergoes the following steps:

- Map the target business process
- Identify and remove wastes

- Identify problems
- Prioritize problems
- Identify problem root causes and remediations
- Analyze alternatives
- Redesign the process

Within these steps, techniques from lean and six sigma are applied to tasks as appropriate. Techniques included in this chapter are process mapping, identification of input, outputs, and contributors via SIPOC, value-added analysis, root cause analysis, outsourcing, co-production, and automation analyses, and process redesign. These techniques are commonly applied to a wide range of problems or process types and are representative of the reasoning used for process improvement. This chapter focuses on the description and exemplification of these techniques rather than on actually measuring their effect in terms of six sigma performance. In this sense the process improvement techniques presented in this chapter generally contribute to detect and remove errors and waste production within processes. Each of these methods is demonstrated in the FLCo process improvement case.

2 Service Desk Process and Problem Analysis

The purpose of a service desk is to take requests that may be outages, service, or access requests, and satisfy them according to type and priority. Service desk processes can be formalized following the IT Infrastructure Library, (ITIL®, Rudd and Loyd 2007). In the case, the current process is known to be error prone with lost requests, many open requests that are known to have been resolved, overlap of work, and other issues. The case process and its analysis are discussed in this section.

2.1 Process Map

To enable an analysis of the process, a process map is developed. Process maps depict the activities and interactions of all participants in a process. Participants might include people, roles, departments, computer applications, and external organizations. If the focus is the information technology support for a process, more granular analysis showing individual databases accessed and/or updated by a process might also be shown. The case from which the examples were developed is below.

> FL Company (FLCo) is a 4-year Company with both at-work and at-home workers in five lines of business. The company has about 40,000 staff in total spread over six geographic locations with as many as 18,000 staff working at-home at any one time. Ann E. is the newly appointed manager of support responsible for the Computing Services Service Desk function (CSSD). There is at least one CSSD employee at each site; the headquarters has seven permanent employees and many people who are considered local gurus. In addition, work is outsourced to Guardian Help Desk Services (hereafter Guardian).

There are three levels of tech support: Tier 1 (T1), Tier 2 (T2), and Tier 3 (T3). All requests start at T1, the lowest level of support. Guardian is expected to handle 95 % of the 1,000 daily contacts but is handling about 750 calls per day. The other 5 % of contacts and any overflow from Guardian begin at CSSD T1. About 1 % of contacts are sent for T2 resolution. T3, vendors account for about two contacts per week.

Telephone, email, and web forms are the prevalent methods used to initiate contact for the service desk. In-person contacts are rare and are handled by CSSD T1. Typically, the method of contact back to a client is chosen to match the method used to make the request unless some other media is specifically requested. In addition, the IMS ticket management system should be updated with status but it does not always happen.

The general process is that a user initiates contact with an outage, request, or question. The caller is validated as staff and, if needed, the Staff Contact Database (SCDB) of email and phone information is updated. The contact is logged into Information Management System (IMS), a home-grown incident tracking application to which both the Company and the outsourcer have access. A known errors database (KEDB) is checked to determine if there is a known problem with resolution readily available. If an entry is in the KEDB, either a solution or workaround is passed to the user to try to fix the problem. If possible, the request is serviced in the first phone call and the logged request is closed by the individual logging the contact. About 75 % of all calls are resolved in the first contact.

If the request is not serviced in the initial contact, Guardian is supposed to perform some troubleshooting to see if they can fix all problems not in the KEDB; however, they pass on problems when no KEDB entry is found. If troubleshooting is performed, the actions tried should be documented in the IMS software. Guardian transfers calls via an automated call director (ACD) to CSSD T1. Transfers from Guardian usually go to T1 CSSD support which retries the KEDB and troubleshooting, documenting the steps taken. If the individual cannot find a solution, the problem is transferred to T2 support. Only T2 CSSD can escalate to T3, vendor support.

Transfers of responsibility through IMS are automatic. As a service contact is saved, the software checks to see if transfer to another organization is checked. If so, the item is placed on a queue for automated delivery to the next available person in that area (this areas to which electronic delivery is done include CSSD staff (T1 internal) and Technical Services (T2)). If T2 escalates to a vendor (T3), the individual managing the contact also manages all interactions with the vendor(s). Any vendor interactions are supposed to be documented in the IMS but there is no requirement or coercion available to ensure that this is done.

All forms of interaction (phone, email, Internet, or none) can be used for contacts after the first, depending on the nature of the problem (e.g., an item that is on FAQs on the web site is routed there via the initial contact method or email).

IMS is a package for request ticket tracking and routing between tiers. In addition, it is the basis for the web application that provides status, resolution information, and so on via the company web site. Interactions after the first are all supposed to be logged into the IMS software but there is no mandatory entry nor is there automated escalation (e.g., to a high level of support or manager based on time from request to expected resolution or type of request). As a result some requests are lost and others are never closed.

There is no formal classification of users or requests to facilitate resolution or tracking. Thus, when forwarding is done, a request is generically sent to the next level. Items sent to vendors for resolution are not tracked for timely resolution unless the outage affects many users. The last person touching a request *should* be the person who monitors a request and closes it; however, Guardian closes only phone calls resolved during the call. CSSD is responsible for closing requests that are passed to them but there is no clear policy for tracking responsibility. Similarly, vendors do not close requests. Thus, many requests go unclosed with an unknown resolution.

Known problems with the CSSD service desk include duplication of process steps after hand off of work from Guardian to CSSD T1. Status, including resolution is not

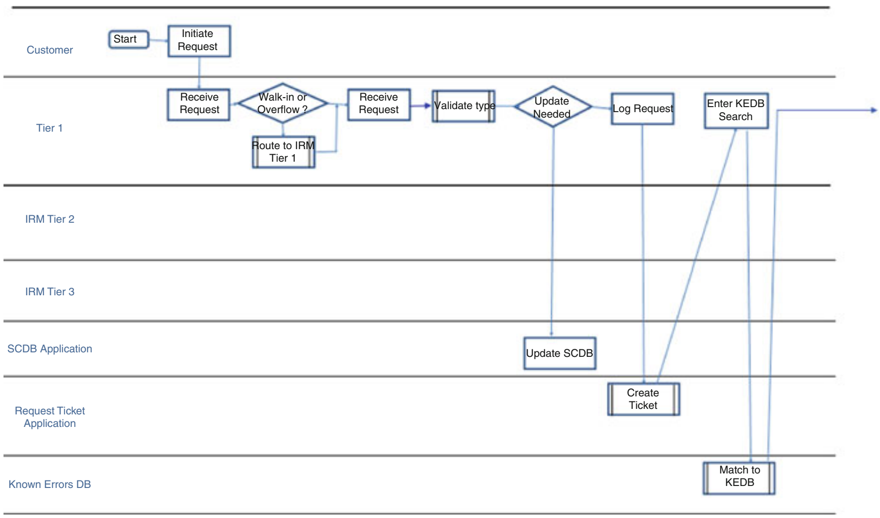

Fig. 2 Current CSSD process

tracked and therefore, is prone to error. There is no reminder system, automatic escalation, and no assigned responsibility for ticket closing. Therefore, lost and unclosed tickets are common. Web forms are used but there is no self-help capability beyond frequently asked questions and no automated help actions. Other problems will become visible through the analyses. Figures 2, 3, and 4 depict the process described above.

2.2 *Process Elaboration*

Complex processes may require more elaborate information. One such Six Sigma technique is SIPOC process analysis. SIPOC stands for **S**uppliers, **I**nputs, **P**rocess, **O**utputs, **C**ustomers (Rasmusson 2006) and a SIPOC analysis is a tabular summary of all related information to each process step (see Fig. 5). Suppliers and Customers are shown on the process map as roles with interactions, but the SIPOC details the actual documents, files, data-bases, and actual data affected by or used in the process.

Obvious as the problems may be, formal review and analysis is needed to avoid missed problems. The first action is to determine required and other process steps using a technique such as value added analysis.

2.3 *Remove Waste via Value Added Analysis (VAA)*

The first step is to remove waste from the process. Some types of waste, e.g., waiting for automated actions to complete, are not able to be removed but might be redesigned to reduce their impact on the process. Value-added analysis (VAA) is a

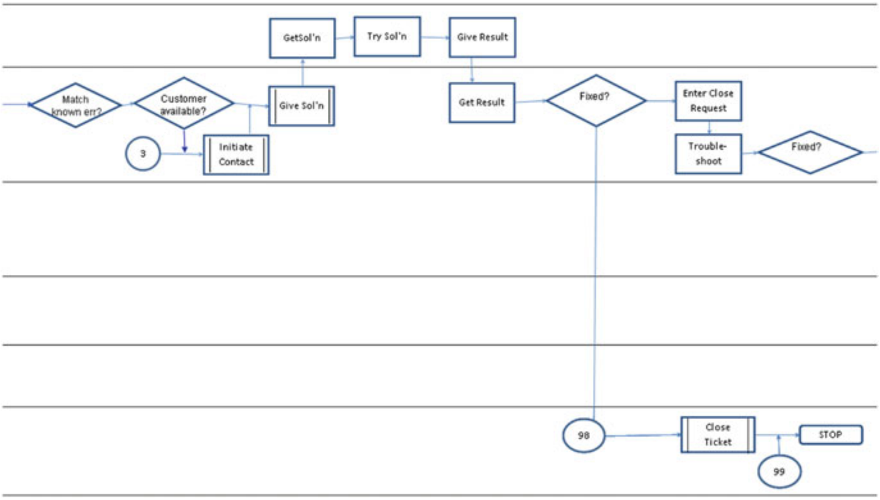

Fig. 3 Current CSSD process – continued

technique that highlights process steps to be evaluated for elimination. VAA is not strictly part of the Six Sigma training but is often used in leaning waste and is a useful complement to Six Sigma analysis. There are four types of event-driven processes: Management, customer affecting, primary (relate to customer affecting, e.g., design engineering), and support (e.g., HR, legal, IT). A single process can have elements of more than one process type within it and, when conducting analysis, part of the task is to tease out each step's type.

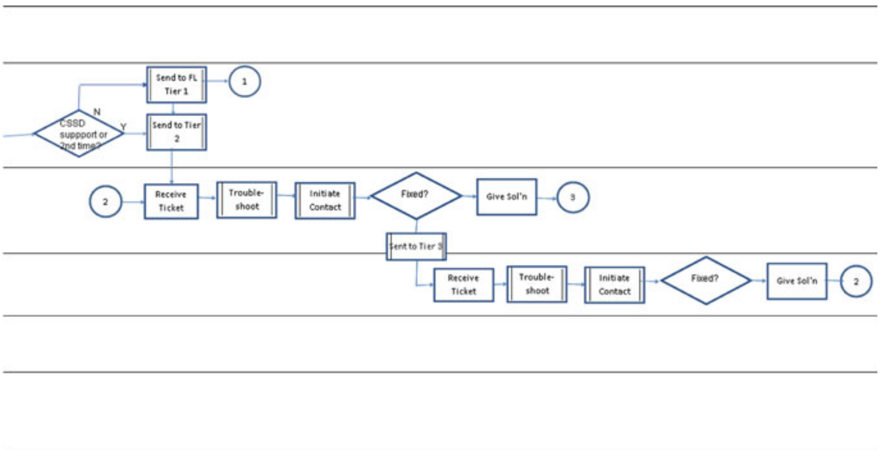

Fig. 4 Current CSSD process – continued

Suppliers	Inputs	Process	Outputs	Customer
Customer	Issue, or request	Initiate request	Open ticket, Updated personal information	T1 Support Staff
T1 Support	Request Information	Receive Request	Request	Customer
T1 Support	If known	Validate cust information	Updated SCDB, as needed	FLCo
T1 Support	Request Information	Log Request	Created request ticket	All support levels, FLCo
T1 Support	Request information	Enter KEDB search	Possible KEDB solution	Customer … to end

Fig. 5 FLCo help desk partial SIPOC Diagram

To conduct value added analysis the following steps are conducted (Conger 2011):

1. Map the process
2. List all process steps and place them in a table with columns for duration, value adding activities (VA), non-value-adding activities that are required (NVA), and non-value adding activities that are unnecessary (NVAU, can be combined with NBVA), and the type of waste for NVA and NVAU activities.
3. Review each process step, asking the questions:
   (a) Does an end Customer require this activity, and will the Customer pay for this activity? If yes, then it is value adding (VA).
   (b) Could a customer-facing activity be eliminated if another activity were done differently or correctly? Is this activity required to support or manage the value adding activities, e.g., legal, HR, etc.? If yes to either, then it is non-value-adding (NVA).
   (c) Could this activity be eliminated without impacting the form, fit, or function of the Customer's "product?" If yes, then it is non-value adding and unnecessary (NVAU).
4. For each NVA and NVAU activity, analyze which of the DOWNTIMe wastes is identified. DOWNTIMe is the acronym for D-efects, O-ver production, W-aiting, N-on-utilized talent or resources, T-ransportation, I-nventory, M-otion, e-xcess processing. This allows discussion with management to determine their ultimate disposition.
5. With key stakeholders, evaluate all NVA and NVAU activities for elimination.
6. Evaluate activities remaining as needed for automation, outsourcing, or co-production

NVA and NVAU activities that don't appear able to be automated or eliminated are marked for further analysis for streamlining, outsourcing, or some other replacement with VA activities. Notice that several steps have both VA and NVA designations. These are because the time is not wasted if a solution is found, but when an escalation is needed, the time spent trying to resolve the issue can be thought of as wasted and therefore, something to minimize or eliminate. Also, the DOWNTIMe designations need some explanation. First, DOWNTIMe designations are decided from the perspective of the person performing the task, not the customer. This is because the customer may not be aware of the activity nor would they care. Customers 'pay' for an answer, not the time leading to getting an answer. From the company's and help desk staff perspective, the time getting to a correct resolution would be VA, but the time to no resolution would be an NVA. Also, DOWNTIMe assignments might have alternate answers or more than one designation. As long as the assignment is defensible, it is acceptable; however, the more accurate, and complete the better as clues to how to minimize the effect of the step if it is required can be gotten from the DOWNTIMe assignment.

Figure 6 reveals a significant number of NVA and NVAU activities. The goal of analyzing this information is to completely eliminate as many of these activities as possible or minimize their impact on the process if elimination is not feasible. The times associated with each step establish a baseline against which to measure changes for improvement. As Fig. 6 shows, a successful resolution on first call (steps up to 'Stop') would take from 2.3 to 5.3 min but only 35 s of that time is designated as value adding. The challenge to the process improvement team is to either eliminate or minimize the effects of the activities in the NVA/NVAU column.

By close analysis of every request type and a determination of which might be redesigned in some way much of the impact of the NVA/NVAU time can be removed. This topic is continued in the next sections.

2.4 Process Cleaning

During the 'cleaning' phase of process improvement, each VA process step remaining after the VAA analysis is evaluated to ensure that it is as efficient and effective as possible. Often the types of analyses performed on NVA/NVAU activities overlap this one as many of those steps also remain. In addition to other 'cleaning' activities, such as brainstorming, streamlining, bureaucracy reduction, and simple English, each known process problem is also analyzed to determine all of its possible root causes and evaluate each of them for improvement. This technique, root cause analysis (RCA) is the topic of this section. Then, the Pareto method for easily prioritizing problems for resolution is discussed.

2.4.1 Root Cause Analysis

The purpose of RCA is to find all potential causes for some problem then ensure that sufficient changes are made to prevent the problem from recurring (Martinez et al. 2012). RCA starts with a problem identified from, for instance, a client brainstorming session, to probe further into the root causes of problems and to ensure that all aspects are evaluated and mitigated.

	Duration	Evaluation		
Process Step	In Ms	**VA**	**NVA/NVAU**	**DOWNTIMe**
Initiate request	3000		NVA	N
Walk-in or overflow?	.5		NVA	N
Route to FL Tier 1	1.5		NVA	M
Receive request	1.5		NVA	O
Validate staff type	4000		NVAU	e
Update needed?	2000		NVAU	e
Update SCDB	10000		NVAU	e
Log Request	10000		NVA	N
Create ticket	5000		NVA	e
Enter KEDB search	10000		NVA	M
Match to KEDB	5000	VA	NVA	W
Match known err?	5000	VA		
Customer available?	2000		NVA	W, N
Initiate contact	20000		NVA	N, M
Give solution	20000	VA		N, M
Get solution	2000		NVA	O, W
Try solution	20000 – 200000		NVA	W
Give result	2000	VA		
Get result	1000	VA		
Fixed?	2000	VA		
Enter close request	5000		NVA	N, M
Close ticket	10000		NVA	W, N
Stop... Continue to end	50	VA		
Total Time each activity (shown)	2.3--5.3 Min	35 Sec	NVA: 1.5 -- 4.6 Min	NVAU – 16 Sec

Fig. 6 Partial value added analysis

The RCA process is used to identify the true root (most fundamental) cause and the ways to prevent recurrence for significant issues for which outcomes can be affected (Martinez et al. 2012). This technique also called "why-why chart" or "five whys." Attention in each level of analysis is drawn to all possible contributing factors through repeatedly asking questions that build on answers to prior questions. The steps to RCA are:

1. *Immediate action*: If the problem is still active, it should be resolved so that a normal operational state is achieved before anything is done.
2. *Identify the problem*: At this stage the problem should be completely, clearly articulated. The author should attempt to answer questions relating to Who? What? Why? When? How? and How many? each relating to the problem to be analyzed.
3. *Identify the RCA team*: The team should include 4–10 subject matter and RCA experts to ensure analysis addresses all issues. The team should be given authority to correct the problems and empowered to define process changes as required.

4. *Root Cause analysis*: The method is applied to ask progressively more detailed levels of probing to determine the root cause. Although called the 5-whys, there is no number of levels that is correct; rather, the probing continues until one or more root causes for each problem are found.
5. *Action Plan*: The corrective action plan should eliminate the problem while maintaining or improving customer satisfaction. In addition to the plan, metrics to determine the effectiveness of the change are also developed. Once complete, the action plan is implemented.
6. *Follow Up Plan*: The follow-up plan determines who will take and who will evaluate the measures of the revised process, how often the metrics will be taken, and the criteria that will be applied to determine that the problem is resolved. The follow-up plan can be created while the action plan is being implemented; follow-up begins immediately upon action plan implementation.

The RCA for the "inadequate training" problem that caused requests to be lost is evaluated here. The RCA would be conducted for each of the problems with appropriate mitigations developed.

1. *Identify the problem* – On December 15, 2012 at a company town meeting, numerous internal customers complained to the CIO about lost and unsatisfied requests. Upon inspection, the CSSD was found to be operating with no written processes. The problem was highlighted by the short tenure of most of the Help Desk staff; 75 % of staff members had been on the job less than 6 months. Neither Guardian nor CSSD took ownership for the lost requests problem so the cause was unknown. No one in CSSD had attended any formal job training. CSSD staff learned problem resolutions on the job from each other. All CSSD staff members were affected by this problem. Further, no Guardian staff had had any FLCo training since the original contract was signed 2 years ago.
2. *Identify the RCA team*: The team consisted of two RCA specialists, two T1 and two T2 CSSD staff, one operations and one application support staff.
3. *Immediate action*: The immediate action was to identify and resolve the lost problems. The CSSD Manager sent an email to all users identifying the loss of service requests and asking anyone with outstanding requests to call, verifying their requests. Two CSSD staff manned phones for 3 days to verify requests and add them to the ticket database, as needed. As a result of this action, 400 requests were identified as outstanding; 100 of those requests had not been in the ticketing system.
4. Action plan: Training, turnover, and lack of multi-user software were key issues. A partial root cause analysis of training issues is shown in Fig. 7. In addition, the team devised a plan to identify and resolve the lost ticket problems.
5. Action Plan – The RCA resulted in many issues being identified. The recommendations for those issues are below.

   - Require the CSSD Manager to remain in the position a minimum of 1 year.
   - Create a process for the CSSD so that there is accountability for all requests with metrics to verify that all requests are logged as received and monitored for daily completion.

Fig. 7 Partial root cause analysis

Root Cause Analysis: Why are CSSD tickets lost?
A. There is no requirement for ticket logging and no follow-up to ensure logging.
Q. Why is no requirement for ticket logging?
A. There is no CSSD written process and high supervisor turnover
Q. Why is there no written CSSD process?
A. High supervisor turnover and lack of interest
Q. Why has there been high supervisor turnover?
A. …
…

- Develop in-house training for CSSD staff that the Manager also attends. In the development of training, use the CSSD process as the basis for the training.
- Create a career path for staff to stay in the CSSD area, if desired, to reduce constant staff change.
- Provide for senior Level-1 staff to mentor junior staff.
- Change job descriptions of the Manager and CSSD staff to provide merit pay for single-call request completion, short times from open to close of requests, etc.
- Create measures to monitor CSSD operation that become the responsibility of the CSSD Manager.

6. Follow Up Plan

- The CSSD Manager should be tasked with monitoring training effectiveness as evidenced through measures to be defined. Metrics and an analysis of them should be in the monthly report (or dashboard if created) to the CIO and Manager of Operations.

As can be seen from the partial RCA of CSSD problems, the technique is useful but requires significant analysis and takes time. It assumes skilled staff is conducting the analysis who minimize opinion and maximize the potential for complete problem mitigation. In addition, the technique focuses on only one aspect of a problem, rather than a whole problem. Thus, many such analyses are required to fully analyze all issues relating to a complex process and all recommendations must be integrated. Next, Pareto analysis can be used to determine priorities for remediation of problems.

2.4.2 Pareto Analysis

A Pareto distribution is a special form of distribution named for Vilfredo Pareto who discovered its 80–20 rule properties (Conger 2011). The Pareto distribution has since been recognized to apply to a wide range of social, geophysical, and scientific situations such as sales revenue from number of customers, error rates in software modules, and manufacturing defects in a process.

A Pareto diagram, in this case, represents problems to be prioritized for further action. Items to be compared are sorted from highest to lowest frequency and placed across the x-axis of the histogram. Item frequencies are on the Y-axis. A cumulative percentage line shows where the 80 % point is found.

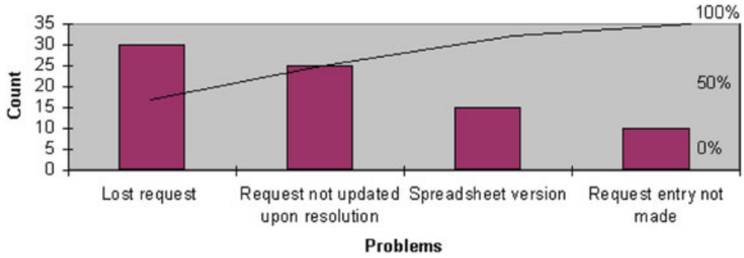

Fig. 8 Pareto analysis of help desk problems

According to classic Pareto analysis, the breakdown is 80–20. However, in reality, many problems show a clear break point at some other distribution such as, 60–40 or 70–30. Variations of Pareto analysis, called ABC and XYZ, look at different distributions for errors or management. ABC concentrates on consumption value of raw materials in different combinations while XYZ analysis evaluates classes of finished goods in terms of their demand qualities as high, medium, low or sporadic (Bhattacharya et al. 2007; Canen and Galvio 1980; Katz 2007; Kumar et al. 2007).

The Pareto diagram for the service desk (Fig. 8) can be interpreted in two ways. The first two categories represent 69 % of the total problems counted; however by adding the third category, 87 % of the problems are presented. Either analysis could be defended, but regardless, the highest priorities would be the focus of immediate remediation. The other items would be considered at a future date. One would not redesign the process without analyzing all of the problems in any case.

The next phase of analysis focuses on the removing or minimizing the impact of process steps on the process. Three kinds of 'greening' analysis for this are discussed in the next section.

2.5 Process Greening

All of the techniques in this section are oriented toward removing or minimizing CSSD responsibility for and the carbon footprint of the process tasks at the case organization FLCo. The techniques – outsourcing, co-production, automation, and environmental greening are each discussed in this section.

2.5.1 Outsourcing

Outsourcing is the movement of a function or its related automated support to another company (Conger 2011). Benefits can relate to increased innovation, upgraded technology, reduced operating costs, and increased work quality (Hassan et al. 2012; Martinez et al. 2012). Since FLCo is already outsourcing T1 support for its Service Desk, the service as provided should be evaluated here.

FLCo has about 25 % of tickets either originating or being passed to its internal T1 service. About 5 % of T1 tickets were planned while the others are overflow that cannot be handled by Guardian. When the tickets are escalated to T1 because Guardian cannot find a solution, duplication of activities in the form of checking the KEDB for a solution takes place. As a result there is wasted effort in that duplication. Some analysis should be performed to determine the reasons why tickets are passed to FLCo T1 and their frequency. If most tickets are passed because the solution cannot be found, further training should be given to Guardian staff to ensure that they search for terms correctly and imaginatively. If that effort fails, further analysis of the whether sought after benefits from Guardian are being gained and, if not, their services should be severed.

The reasons for peak periods should be evaluated to determine if Guardian should add more people to the FLCo account. Escalations to FLCo T1 should be investigated to determine how many are actually solved by FLCo T1 staff and how many are passed to T2. If most are solved by FLCo T1 staff, Guardian staff may need training to improve their resolution and solution finding skills. If most are escalated to T2, one might ask why FLCo T1 is not bypassed to speed the overall resolution process. If there are patterns to the problems, other recommendations might include improving search terms for the KEDB or expanding the KEDB. If an unacceptable number of escalations from Guardian to FLCo T1 occur, e.g., over 40 %, perhaps Guardian is not performing as expected and service level agreements or contracts should be rewritten to establish a threshold and penalize Guardian when performance is unacceptable. In addition, if the number of escalations is not acceptable, perhaps in-sourcing and ending the Guardian contract might be in the company's best interest.

2.5.2 Co-Production

Co-production is collaboration to produce some outcome. In business, co-production typically means off-loading work to customers, vendors, or outsourcers ideally, with no pay for the activity. In the case of a help desk, pushing as much of the help desk process to the user constituted co-production. Off-loading in the form of providing self-service to CSSD customers is the most obvious method of co-production. Allowing read-only access to the KEDB so users might find their own solutions to problems thus, reducing the number of requests that reach CSSD. Self-service ticket creation and entry of contact information removes those steps from the CSSD process.

Every service desk request should be analyzed to determine how human interaction might be removed. Since this also results in automation of CSSD, this analysis is discussed further in the next section.

2.5.3 Automation

Activities remaining after co-production decisions should be considered for further or improved automation. Legacy applications support much of large organizations' work and could often benefit from redesign of databases, screens, or even some of the process steps. In addition, any steps not automated should be evaluated for automation. With process automation software now affordable for even small-sized companies, providing all paper-work movement digitally with automated follow-up, feedback, and escalations can improve processes radically.

For CSSD work, every type of request should be analyzed to determine if an automated solution might be created to add to co-production in the form of self-service. For instance, password resets could easily be automated. Requests for access to applications and data with automatic emails to request and receive authorizations, storage of authorizations for audit purposes, and automated emails to notify access approval or denial all can be automated. Automating such activities could reduce the number of requests that reach CSSD by as much as 30 %. Outcomes of such automation have side effects that also need analysis, for instance, by eliminating all automatable or co-produced CSSD requests, could require a higher level of company knowledge for Guardian and CSSD employees, thus, altering the burden of knowledge needed by the outsourcer or mitigating the outsourcer need altogether.

Specific automation (and co-production) recommendations for the case include:

- Type of requests should be defined for automation
- Web forms and the programs behind them should be expanded to identify type of request and automatically route to automated services and to the most knowledgeable staff.
- Ticket creation, ticket priority, SCDB updates, password resets, and access requests should be fully automated.
- All FLCo staff should be provided with access to the KEDB so they can try to resolve their own problems. Incentives might be considered for the 'solution of the month' to encourage self-resolution.
- As the CSSD ticket is created, the user should be presented with current location and contact information and requested to update it before continuing.
- The IMS ticket system should be updated to automatically escalate any ticket in a queue for longer than 15 min without resolution or comments or a change to 'wait' status (which may also be needed).
- IMS escalation should include a dashboard that shows year to date, month to date and day to date information that can be traced to individuals regardless of company (i.e., both Guardian and FLCo staff) to show first call resolution, average times of resolution, phone wait times, number of contacts per ticket, tickets by priority, self-service usage statistics, and so on.

2.5.4 Environmental Greening

Sustainability, in the sense of reducing a process's carbon footprint, is the focus of environmental greening activities. Before this is performed, all of the recommendations from all prior tasks are listed, grouped by similarity or function, and reduced as needed to remove duplication or inconsistencies. The list and rough process redesign are evaluated to determine opportunities for recycling, use of environmentally favorable technologies, or other aspects of the process that might result in savings to the organization and the environment. These suggestions are then discussed with the project sponsors, along with the other recommended changes to arrive at the accepted set of changes for process redesign.

For the FLCo case, the recommendation would be that the computing operations organization evaluate technology replacement to reduce ventilation and air conditioning, electrical, costs, and space requirements.

3 Process Redesign

Recommendations are summarized then used to develop an ideal process considering different perspectives, for instance values, costs, benefits, current and future customers, and so on (Conger 2011; Linderman et al. 2006; vom Brocke et al. 2010). The final process is derived after discussion with customers to determine what is actually feasible in the target environment.

The case recommendations are:

- Enhance the web applications to expand their capabilities
- Implement automation and co-production recommendations (See recommendations for automation and co-production above)
- Implement incentive programs to encourage staff to self-resolve issues
- Implement a CSSD ticket dashboard
- Remove T1 duplication of effort by passing some Guardian escalations directly to T2 staff
- Evaluate the need vs. cost for Guardian based on percent and type of escalations; tighten the contracts if Guardian support is to be continued
- Require CSSD managers to stay in the position at least 1 year
- Create a process for all CSSD activities, including a requirement that all tickets be closed by the last Guardian or CSSD staff to 'touch' the ticket
- Implement training programs for all Guardian and CSSD staff and managers
- Create a CSSD career path plan
- Alter CSSD job descriptions such that some number of unclosed tickets would constitute a fireable offense
- Initiate a metrics program with drill-down dashboard for CSSD activities

An ideal process would include all of the recommendations but constraints in terms of resources and political realities often intrude to make the ideal infeasible.

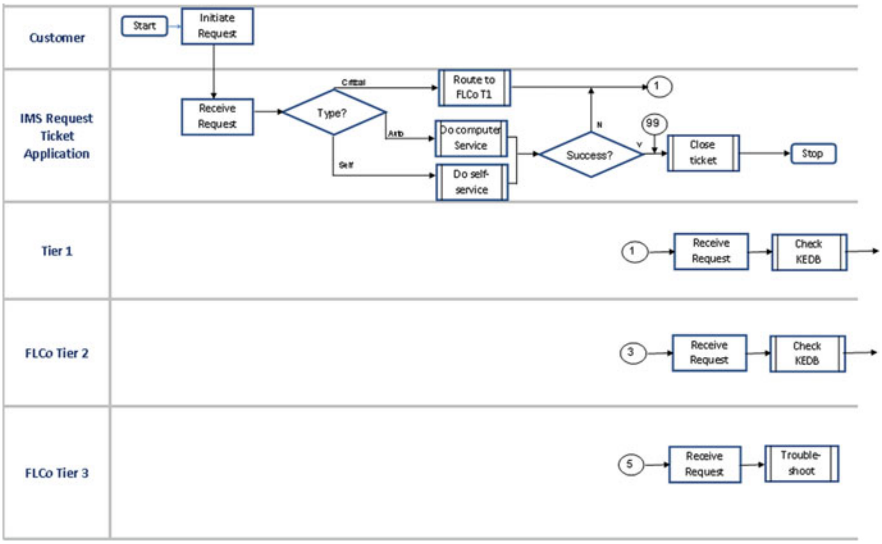

Fig. 9 Recommended FLCo process

Therefore, discussion with clients is done to develop compromises that will work in the target environment.

From that discussion the recommended process is developed. The FLCo recommended process summarized, incorporates the changes that directly affect the process is shown in Figs. 9 and 10.

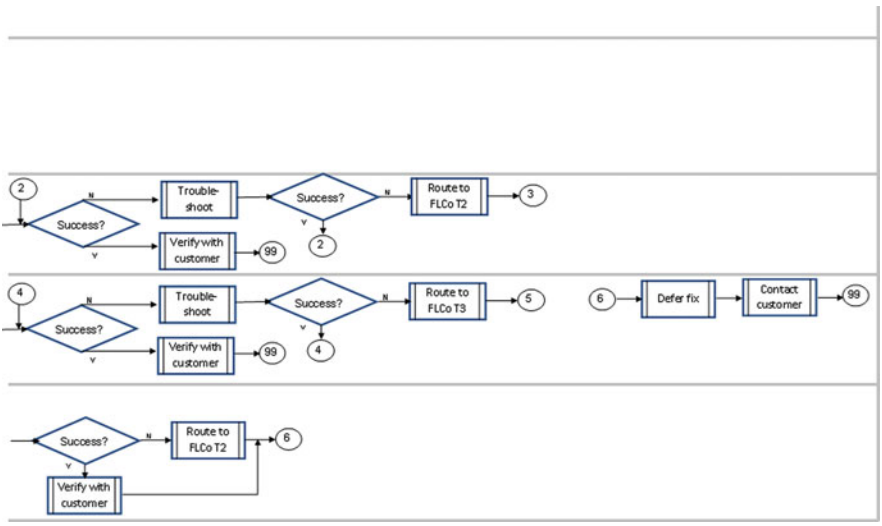

Fig. 10 Recommended FLCo process – continued

4 Discussion

This chapter presents only a few of many techniques available for problem analysis and, while they provide adequate expert guidance to obtain an efficient process redesign, often such simple tools are not adequate.

BPM is critical to organizational success. Six Sigma is a proven, globally accepted technique that facilitates the analysis and improvement of processes (Antony 2006). As demonstrated through the FLCo case, application of numerous techniques is needed to fully analyze a process and determine the importance, priority, causes, and possible solutions to a process's problems. As process areas are more complex, the tools like-wise become more robust and complex. One such technique is failure mode event analysis (FMEA) through which all possible errors for every possible eventuality and stage of a process, usually manufacturing, are analyzed for breadth and depth of impact, expected frequency, and cost (Casey 2008). Thus, many RCAs might be performed to define all possible problems for a single product or process. Then, FMEA analysis would design mitigations based on prioritizing based on potential damage to the organization. Thus, the more complex the problem, the more elaborate the tools and techniques to remove and manage the process and its risks.

There are two main drawbacks to Six Sigma practice. The first drawback is organizational and the second relates to the techniques. Six Sigma can develop its own bureaucracy that risks overpowering the importance of 'getting product out the door.' This is not unique to Six Sigma; the tendency of organizations is to grow or wither. However, companies need to guard against becoming cultist about following Six Sigma and remember that producing products or services for their customers must always come first in importance.

The second issue relates to the techniques. Without Six Sigma, business process management is a set of concepts without an organizing core. However, even with Six Sigma as an organizing theme, there are hundreds of Six Sigma techniques that can be applied to aspects of areas under study (Johannsen et al. 2014). There is little organization of techniques into a cohesive body of knowledge. The various Six Sigma certification levels – yellow, green, brown, black – discuss toolkits from which technique selection is made at the discretion of the user (Andersen 1999). Yet, there is no fixed set of techniques with variation of what is taught from one person to another (Antony 2008).

Within a process improvement project, there are about four key thought processes relating to problem recognition, analysis, redesign, and metrics definition yet Six Sigma is unclear about which methods are best in any given phase or situation. And, occasionally, a method that might be used, such as cause and effect diagrams, is overwhelmed by the complexity of the situation and proves unusable (Conger and Landry 2009). Six Sigma also offers little guidance on how to customize or improvise tools to make them usable in such situations.

Finally, while Lean Six Sigma is useful for removing errors and waste from a process, the techniques do not assist in developing recommendations for change or for designing new processes. Recommendations and design still rely on the skill and insight of the people conducting the analysis. Thus, Six Sigma is a useful way of focusing attention on elimination of waste and the reduction of errors but it can be an overwhelming toolkit without much guidance for developing project outcomes (Johannsen et al. 2014).

5 Conclusion

Process management is a management imperative that is not done once. Either on-going or periodic assessment of processes with improvement analysis is required for businesses to stay competitive. Analysis techniques from Six Sigma complement process management by introducing rigor to waste reduction and quality improvement. This chapter demonstrates how Six Sigma techniques can be applied to process analysis to improve its operation.

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Business Process Model Abstraction

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Abstract In order to execute, study, or improve operational processes, companies document them as business process models. Often, business process analysts capture every single exception handling or alternative task handling scenario within a model. Such a tendency results in large process specifications. The core process logic becomes hidden in numerous modeling constructs. To fulfill different tasks, companies develop several model variants of the same business process at different abstraction levels. Afterwards, maintenance of such model groups involves a lot of synchronization effort and is erroneous.

We propose an abstraction methodology that allows generalization of process models. Business process model abstraction assumes a detailed model of a process to be available and derives coarse-grained models from it. The task of abstraction is to tell significant model elements from insignificant ones and to reduce the latter. We propose to learn insignificant process elements from supplementary model information, e.g., task execution time or frequency of task occurrence. Finally, we discuss a mechanism for user control of the model abstraction level – an abstraction slider.

1 Introduction

Business process modeling is crucial when it comes to design of how companies provide services and products to customers or how they organize internal operational processes. To improve the understanding of processes and to enable their analysis, business processes are represented by models (Davenport 1993; Hammer and Champy 1994; Weske 2012). Process models are used for different purposes: to communicate a message, to share knowledge or vision, as a starting point for redesigning or optimizing processes, or as precise instructions for executing

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business tasks. In such conditions, the goal of a process model is to capture working procedures at a level of detail appropriate to fulfill its envisioned tasks. Often, achievement of such a goal results in complex, "wallpaper-like" models, which tend to capture every minor detail and exceptional case that might occur during process execution.

The desired level of model granularity also depends on a stakeholder working with a model and a current task. Top level company management appreciates coarse-grained process descriptions that allow fast and correct business decisions. At the same time, employees who directly execute processes value fine granular specifications of their daily job. Thus, it might be often the case that a company ends up with maintaining several models of one business process.

Abstraction is generalization that reduces undesired details in order to retain only essential information about an entity or a phenomenon. Business process model abstraction goal is to produce a model containing significant information based on the detailed model specification. Significant information is the information required by a certain stakeholder to fulfill his/her tasks.

We propose a business process model abstraction methodology that can be summarized as follows. As input, we assume to possess a complex process model (a detailed process specification). Afterwards, a number of abstractions are performed on the initial model. Conceptually, each abstraction is a function that takes a process model as input and produces a process model as output. In the resulting model, initial process fragment gets replaced with its generalized version. Thus, each individual abstraction hides process details and brings the model to a higher abstraction level.

When applied separately, process model abstractions do not provide much value to an end user. Rather, it is of interest to study how individual abstractions can be combined together and afterwards controlled in order to deliver the desired abstraction level. As a solution, we propose an abstraction slider – a mechanism providing a user control over process model abstraction.

The rest of the chapter is organized as follows. In the next section, we discuss several application scenarios of process model abstraction. Section 3 introduces a slider and explains how it is employed for the control of process model abstraction. Transformation rules and their composition aimed to allow process model graph generalization are discussed in Section 4. Section 5 presents results of a case study on abstraction efficiency and usefulness conducted together with an industry partner. The chapter concludes with a survey on related work and summarizing remarks.

2 Process Model Abstraction Scenarios

Abstraction generalizes insignificant model elements. Abstraction scenarios have direct implication on the identification of insignificant elements. In this section we clarify the concept of process model abstraction and discuss its common use cases.

We then extract abstraction criterion from the proposed use cases. Abstraction criteria are properties of process model elements that enable their partial ordering. Afterwards, obtained partial ordering is used when differentiating significant model elements from the insignificant ones. It is not claimed for the proposed list of scenarios to be complete. It should be extended once there is a demand for new abstraction scenarios.

Essentially, business process model abstraction deals with finding answers to two questions of *what* and *how*:

- What parts of a process model are of low significance?
- How to transform a process model so that insignificant parts are removed?

Answers to both questions should address the current abstraction use case. The choice of an abstraction criterion helps in answering the *what* question, whereas an answer to the *how* question allows deriving models where insignificant elements are generalized.

Considering aforesaid, business process model abstraction is a function for which it holds that:

- A detailed process model and an *abstraction criterion* are the input of this function; an abstraction criterion helps to differentiate significant model elements from the insignificant.
- The function output is an abstracted process model.
- From the structural perspective abstraction reduces the number of model elements.
- From the semantic perspective abstraction generalizes the initial model.

When studying a business process model, analysts might be interested in tasks which are executed frequently. One can presume that frequent tasks capture main process logic while nonfrequent ones constitute seldom alternative scenarios or exception flow. Preservation of only frequent process tasks might allow faster understanding of the core process logic by an end user. In order to fulfill the described use case, one might classify significant process elements as those that occur often during execution. Thus, the abstraction criterion is the mean occurrence number of a process task.

Mean occurrence number of a process task (m_i) is the mean number that the process task i occurs in a process instance.

Alternatively, analysts might be interested in process tasks that consume most of the process execution time (execution *effort*). These tasks are natural candidates for being studied during the task of process improvement. Once such tasks are optimized, the overall process execution time might drop considerably. Also, in many cases, cost required to execute process tasks is proportional to the execution time. Process task effort is another process model abstraction criterion.

Relative effort of a process task (e_r) is the time required to execute the task.

Absolute effort of a process task (e_a) is the mean effort contributed to the execution of the process task in a process instance. Absolute effort can be obtained as the product of the relative effort and the mean occurrence number of the process task.

As proposed, the effort of a process task is measured in time units (e.g., minutes or hours) and quantitatively coincides with the duration. However, semantically the effort concept resembles the concept of cost. For instance, if two process tasks run in parallel, their total effort is the sum of efforts of each task.

The cost of process tasks and the overall process execution cost are important properties of business processes. Similar to *process task effort* one might define a process model abstraction criterion of *process task cost*.

Process model abstraction criteria can be defined on process fragments. For example, one might be interested in "typical" executions of a business process model. A typical business process execution means that among all possible ways of a process completion, it is the one that is executed most often. Applying such an abstraction to a process model should result in a new model that reflects only most common process scenarios, where a process scenario is a minimal part of a process model that covers certain instance execution.

Probability of a process scenario (P_i) is the probability of the process scenario i to happen when executing the model.

Similarly, process scenarios with the highest duration or cost may be in the focus of process abstraction. As a result of the abstraction, one should obtain a model representing either the most time consuming or the most "expensive" process execution paths.

Effort of a process scenario (E_i) is the effort to be invested in the execution of a process scenario i and can be found as the sum of efforts of all the tasks executed within this scenario.

Figure 1 shows process model fragment, modeled using EPC notation (Keller et al. 1992; Scheer et al. 2005). In the figure, all the outgoing connections of the only exclusive OR split (XOR) are supplied with transition probabilities that sum up to one, i.e., are always progressed upon if reached during execution. All the other connections are assumed to have the transition probability of one. Each function is enriched with relative and absolute (visualized in italic type) efforts given by the time interval in minutes that a worker needs to perform a function. For instance, the function "Contact a representative" has the relative effort of 1 min, meaning that it is expected to take 1 min of worker's time once reached in a process instance. On average, this function requires $1 \times 0.92 = 0.92$ min in every process instance, which constitutes the absolute effort of the function. Note that the absolute effort is obtained under the assumption that the process fragment is executed exactly once in every process instance.

Often, abstraction criteria require models to be annotated with additional information like statistical data on average time required in order to perform process tasks, probabilities of reaching tasks in a process, etc. In many cases, incorporation of such information requires extension of modeling notation.

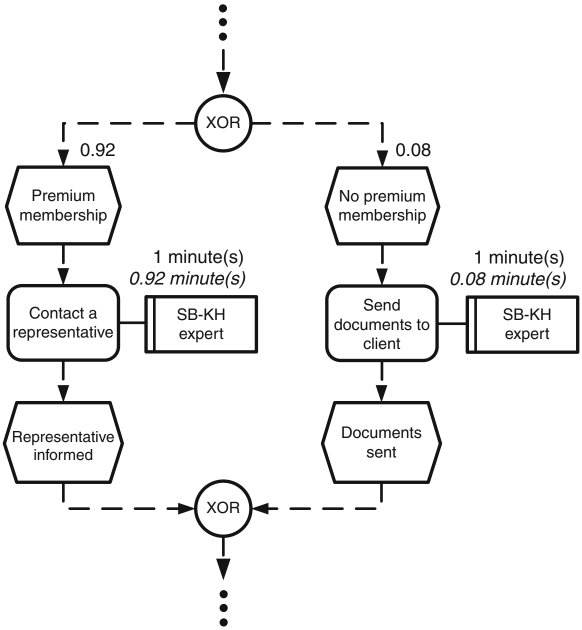


Fig. 1 Example of the EPC fragment enriched with probabilities and efforts

3 Abstraction Slider

In this section, we focus on the *what* question of process abstraction. We present a *slider metaphor* (Polyvyanyy et al. 2008a) as a tool for enabling flexible control over the process model abstraction level. We explain how the slider can be employed for distinguishing significant process model elements from insignificant ones. We provide an example of applying the abstraction slider.

When a user selects suitable abstraction criterion, the desired level of abstraction should be specified. Abstraction level cannot be predicted without a priori knowledge about the abstraction context. In the best case, the user should be able to change abstraction level smoothly from an initial detailed process model to a process model that contains only one task. This single process task semantically corresponds to the abstraction of the whole original process model.

A slider is an object that operates on a slider interval $[S_{min}, S_{max}]$. The interval is constrained by the minimum and maximum values of the abstraction criterion. The slider specifies single criterion value using a slider state $s \epsilon [S_{min}, S_{max}]$ and allows a slider state change operation.

All of the discussed abstraction criteria (see Sect. 2) have quantitative measurement. Therefore, criterion values for a particular criterion type are in a partial order relation. Correspondingly, the partial order relation can be transferred on process model elements by arranging them according to the values of some particular criterion. For example, if a criterion is *task relative effort*, then a 2 min task precedes a 4 min task. The partial order relation enables element classification. It is possible to split model elements into two classes: those with the criterion value

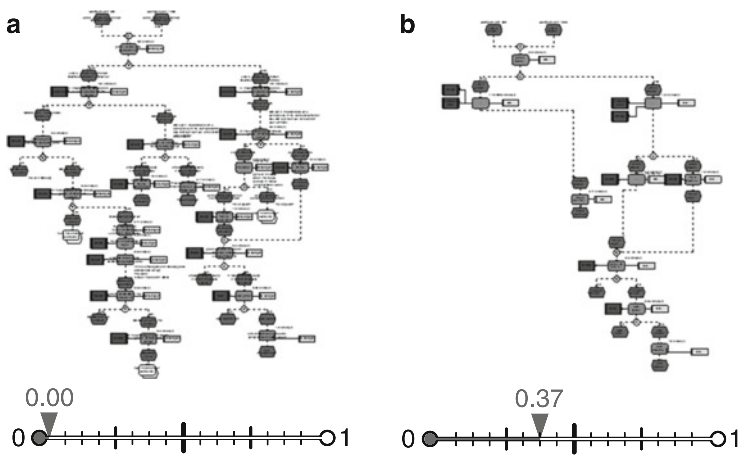


Fig. 2 Process model abstraction slider (function names unreadability intended). (**a**) Initial process model (**b**) Abstracted process model with the slider state set to 0.37

less than and those with the value greater than some designed separation point. Elements that are the members of the first class are assumed to be insignificant and have to be omitted in the abstracted model. Members of the other class are significant and should be preserved in the abstracted model. We refer to the separation point according to which the element classes are constructed as *abstraction threshold*. Assuming an abstraction threshold of 3 min in the example discussed above, the 2 min task is insignificant and has to be reduced. On the opposite, the 4 min task is significant and should be preserved in the abstracted model.

Thus, a *process model abstraction slider* is a slider, which, for a given process model fragment and a specified abstraction threshold, classifies the fragment as significant or insignificant. The abstraction slider interval is defined on an interval of abstraction criterion values, and the slider state is associated with the abstraction threshold.

A slider control regulates the amount of elements preserved in an abstracted process model. In the simplest case, a user specifies an arbitrary value used as a threshold (which means that the slider interval is $[-\infty, +\infty]$). The challenge for a user in this approach is to inspect a process model in order to choose a meaningful threshold value. A threshold value which is too low makes all the process model elements to be treated as significant, i.e., no nodes or edges are reduced. On the other hand, a threshold that is too high may result in a one task process model. To avoid such confusing situations, the user should be supported by suggesting an interval in which all the "useful" values of abstraction criterion lie. Alternatively, the abstraction slider can control a share of nodes to be preserved in a model. In this case, abstraction mechanism has to estimate the threshold value which results in the reduction of the specified share of the process model.

Figure 2 exemplifies the work of process model abstraction slider. It provides a comparison of the initial process model (a) and its abstracted version (b). The business process is captured in EPC notation. In the example, we have used the abstraction criterion of absolute effort of a process task. EPC functions with a higher absolute effort are considered to be more significant. Figure 2a shows the business process model that corresponds to the abstraction slider state of 0.00 – the original process model. The model visualized in Fig. 2b is obtained by changing the abstraction threshold to 0.37. In the proposed example, more than 50 % of the model nodes get reduced. Observe that the process model shrinks to one function when the slider state is set to 1.00.

4 Process Model Transformation

In this section, we address the *how* question of the process model abstraction task. We base our solution on process model transformation rules. In this section, two classes of abstraction rules are introduced: elimination and aggregation. Afterwards, requirements for abstraction and their influence on the transformation rules are discussed. Finally, an example of transformation rules is presented.

4.1 Elimination Versus Aggregation

When the insignificant process model elements are identified, they have to be abstracted. Several techniques can be proposed to reduce insignificant elements. We focus on the two methods: elimination and aggregation.

Elimination means that a process model element is omitted in the abstracted process model. The main feature of elimination is that the resulting model does not contain any information about the eliminated element. Elimination has to assure that the resulting process model is well-formed and that the ordering constraints of the initial model are preserved.

Aggregation implies that insignificant elements of a process model are grouped with other elements. Aggregation preserves information about the abstracted elements in the resulting model. When two sequential tasks are aggregated into one, properties of the aggregating task are derived from the properties of the aggregated tasks, e.g., the execution cost of an aggregating task is the sum of execution costs of aggregated tasks.

In general case, the rules of elimination are simpler than the aggregation rules. Aggregation requires more sophisticated specification of how the properties of the aggregated elements influence properties of aggregating elements. In many cases, elimination is insufficient, since it leads to the loss of important information. If an abstraction cannot tolerate information loss, aggregation should be used.

4.2 Transformation Requirements

Preservation of the process execution logic is an essential abstraction requirement. This means that process model abstraction should neither introduce new ordering constraints, nor change the existing ones. For instance, if an original process model specifies to execute either activity *A* or *B*, it should not be the case that in the abstracted model these activities appear in a sequence. One can employ the notion of *isotactics* (Polyvyanyy et al. 2012) as a requirement for preserving the process execution logic. Isotactics is a behavioral relation on process models that is capable of representing elimination and aggregation of process execution logic and, hence, is advised to be used for describing the behavioral relation of abstraction on process models.

Another essential abstraction requirement is that well-formed process models should be produced, i.e., every model should obey the syntax of the language that it is described with. Thus, transformation rules should take into account features of modeling notations. Consequently, we can expect different rules to be used, e.g., for EPC and for BPMN.

Furthermore, extra requirements on abstraction rules can be imposed. For instance, a company may use process models for estimation of the workforce required to execute business processes. In this case, information about the overall effort of process execution should be preserved. Process model abstractions that preserve process properties are called *property preserving abstractions*. Elimination can be used in a property preserving abstraction with restrictions, since once a model element is omitted all the information about its properties is lost. Therefore, elimination can be applied only to those elements that do not influence the property being preserved.

Every new requirement imposed on an abstraction restricts transformation rules and makes the design of these rules more complex. It is important to learn which class of process models can be abstracted to one task by a given set of rules and abstraction requirements. An abstraction that is not capable of reducing a process model to one task is called *best effort abstraction*. Such an abstraction *tries* to assure that a given process model is abstracted to the requested level using the given set of rules.

4.3 Transformation Rules

A process model abstraction approach is proposed in Polyvyanyy et al. (2008b). Its cornerstone is a set of abstraction rules. Next, we use these rules as an illustration of the concepts discussed earlier and demonstrate how these rules can function together with the abstraction slider and task absolute effort abstraction criterion.

The approach presented in Polyvyanyy et al. (2008b) is capable of abstracting process models captured in EPC notation. Two requirements are imposed on business process model abstractions:

1. Ordering constraints of a process model should be preserved.
2. Absolute process effort should be preserved.

The approach is based on the set of transformation rules called *elementary abstractions*. Four elementary abstractions are proposed: sequential, block, loop, and dead end abstraction. Every elementary abstraction defines how a certain type of a process fragment is generalized. The order of elementary abstractions can vary. Application of an elementary abstraction may succeed once there is a suitable process fragment in a process model.

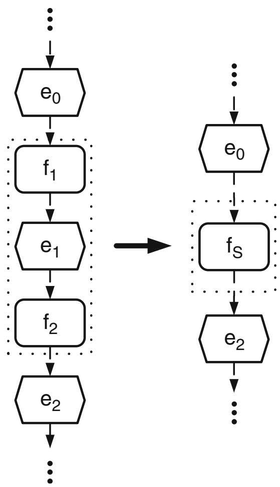
4.3.1 Sequential Abstraction

Business process models of high fidelity often contain sequences of tasks. In EPCs, such sequences turn into sequences of functions. *Sequential abstraction* replaces a sequence of functions and events by one aggregating function. This function is more coarse-grained and brings a process model to a higher abstraction level.

Definition 1. An EPC process fragment is a *sequence* if it is formed by a function, followed by an event, followed by a function.

The mechanism of sequential abstraction is sketched in Fig. 3. Functions f_1, f_2, and event e_1 constitute a sequence. Aggregating function f_s replaces this sequence. Semantically, the aggregating function corresponds to execution of functions f_1 and f_2.

Fig. 3 Sequential abstraction



4.3.2 Block Abstraction

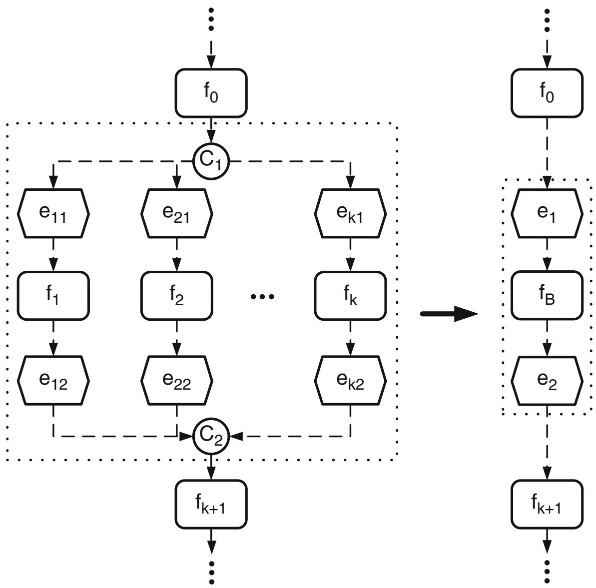
To model parallelism or a decision point in a process, modelers use split connectors with outgoing branches. Depending on the desired semantics, an appropriate connector type is selected: AND, OR, or XOR. In the subsequent parts of a process model, these branches are synchronized with the corresponding join connectors. A process fragment enclosed between connectors usually has a self-contained business semantics. Therefore, the fragment can be replaced by one function of coarse granularity. *Block abstraction* enables this generalization. To define block abstraction, we use a notion of a path in EPC – a sequence of nodes such that for each node there exists a connection to the next node in the sequence.

Definition 2. An EPC process fragment is a *block* if:

- It starts with a split and ends with a join connector of the same type.
- All paths from the split connector lead to the join connector.
- There is at most one function on each path.
- Each path between the split and the join contains only events and functions.
- The number of the outgoing connections of the split connector equals the number of the incoming connections of the join connector.
- The split connector has one incoming connection and the join connector – one outgoing.

Figure 4 describes the mechanism of block abstraction. Block abstraction replaces an initial process fragment by a sequence of event, aggregating function, and another event. Events assure that a new EPC is well-formed. Semantics of the

Fig. 4 Block abstraction



aggregating function corresponds to the semantics of the abstracted block and conforms to the block type. For instance, if a XOR block is considered, the aggregating function states that only one function of the abstracted fragment is executed.

4.3.3 Loop Abstraction

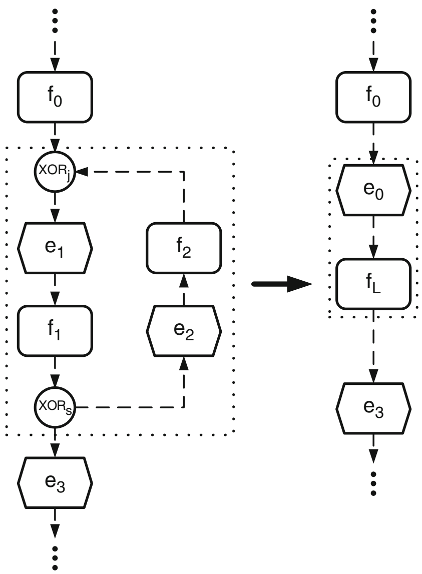
Often, tasks (or sets of tasks) are iterated for successful process completion. In a process model, the fragment to be repeated is enclosed into a loop construct. In EPC notation, control flow enables loop modeling. Wide application of loops by modelers makes support of loop abstraction an essential part of the abstraction approach. Therefore, one more elementary abstraction – *loop abstraction* – is introduced. Following, we define the process fragment considered to be a loop.

Definition 3. An EPC process fragment is a *loop* if:

- It starts with a XOR join connector and ends with a XOR split connector.
- The process fragment does not contain any other connectors.
- The XOR join has exactly one outgoing and two incoming connections.
- The XOR split has exactly one incoming and two outgoing connections.
- There is exactly one path from the split to the join and exactly one path from the join to the split.
- There is at least one function in the process fragment.

As shown in Fig. 5, aggregating function f_L replaces the whole process fragment corresponding to a loop. Event e_0 is inserted between functions f_0 and f_L in order to

Fig. 5 Loop abstraction



obtain a well-formed EPC model. An aggregating function states that functions f_1 and f_2 are executed iteratively.

4.3.4 Dead End Abstraction

Exception and alternative control flow results in "spaghetti-like" process models with lots of control flow branches leading to multiple end events. Abstraction aims to reduce excessive process details. Thus, abstraction mechanism should be capable of eliminating these flows. *Dead end abstraction* addresses this problem. First, the term *dead end* should be specified.

Definition 4. An EPC process fragment is a *dead end* if it consists of a function, followed by a XOR split connector, followed by an event, followed by a function, followed by an end event. The XOR split connector has only one incoming connection.

Figure 6 visualizes the dead end abstraction mechanism. The initial process fragment is provided on the left side of the figure. The dead end is formed by functions f_0 and f_k, events e_k and e_{k+1}, and the XOR split connector. The XOR split has k outgoing branches, and abstraction removes the k-th branch. The abstracted process is presented on the right side of Fig. 6. Rectangles with dotted borders enclose the dead end fragment and its replacement.

Dead end abstraction completely removes a XOR split branch that belongs to a dead end. Aggregating function f_D replaces function f_0. An aggregating function in dead end abstraction has the following semantics: upon an occurrence of function f_D in a process, function f_0 is executed. Afterwards, function f_k may be executed. Upon execution of function f_k, the branch is terminated and f_D is not left. Otherwise, the execution of the branch is continued. When an XOR split has two outgoing connections in the initial process model, the XOR split in the abstracted process

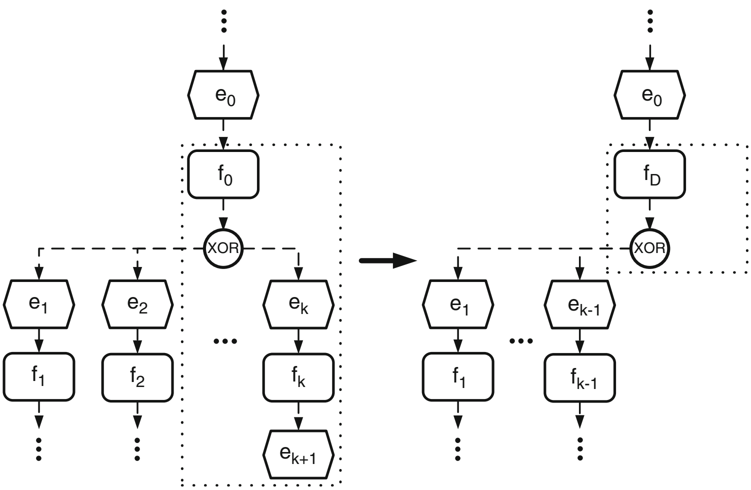


Fig. 6 Dead end abstraction

model can be omitted. A new connection from the aggregating function to the event, following the omitted XOR split, should be added to the EPC.

4.3.5 Abstraction Strategy

A single application of an elementary abstraction is not of great value for the task of process abstraction. Therefore, elementary abstractions can be invoked according to an *abstraction strategy* – a rule of composition of elementary abstractions. An abstraction strategy is a sequence of elementary abstraction steps. Every step aims to simplify a process model. At each abstraction step, one elementary abstraction is applied. Since elementary abstractions are atomic, i.e., they do not depend on the previous ones, one might come up with various abstraction strategies. In general case, different strategies lead to different resulting process models.

We propose to organize the abstraction strategy in compliance with the slider concept. Hence, first we aim to abstract from functions of low significance. Once the function with the lowest significance is identified, it is tested to which type of process fragment it belongs. If a process fragment is recognized, appropriate abstraction transformation rules are applied. Otherwise, another elementary abstraction is tested. The next elementary abstraction to test is selected according to the predefined priority. Abstraction is continued until either no more elementary abstraction process fragments are recognized, or the lowest element significance in the process has reached the preset threshold.

An abstraction strategy using only one type of elementary abstraction can be seen as a basic abstraction strategy. Basic abstraction strategy result in process models where only sequential, dead end, block, or loop process fragments are reduced. For instance, in case of the basic sequential abstraction strategy, sequences of an arbitrary length can be reduced.

Advanced abstraction strategy combine several elementary abstractions and define their priority. The priority dictates the application order of elementary abstractions. One possible strategy is the precedence of sequential, dead end, block, and then loop abstraction.

5 Case Study

In this section, we conduct an in-depth analysis of the proposed mechanisms. We evaluate the results of process model abstractions conducted in a joint project with an industry partner. The project objective was to derive process model abstraction mechanisms and to apply them on a process model repository composed of around 4,000 models captured in EPC notation. The additional requirement for abstraction was to preserve overall process effort, i.e., the overall process effort before and after abstraction should stay unchanged. We evaluate the developed abstraction mechanisms in terms of efficiency and usefulness. An estimation of abstraction efficiency is based on the analysis of the number of model nodes reduced by abstractions. Obviously, this measure does not witness the usefulness of the abstraction. In order to learn the usefulness of abstractions, we appeal to the project partner's expertise.

Following, we provide the results of performing abstraction on a subset of models from the repository composed of 1,195 models; process models with less than 10 nodes are not considered. Three abstraction strategies take part in the case study. Each strategy uses one or several elementary abstractions and applies them iteratively (see Sect. 4.3). The following abstraction strategies are used:

1. Basic sequential abstraction (strategy 1)
2. Sequential then block abstraction (strategy 2)
3. Sequential, dead end, block, and then loop abstraction (strategy 3)

Abstraction strategies are applied with a threshold level equal to the overall process effort. This guarantees that an abstraction tries to reduce all the nodes in a model to the point when no more abstractions are applicable.

Table 1 presents results of applying abstraction strategies, i.e., correspondence between intervals of number of nodes in a model and the number of models that fall into the interval, provided for original as well as abstracted models. The table illustrates how different abstraction strategies reduce the amount of nodes in models.

Additionally, we use the notion of abstraction compression coefficient – a ratio between the number of nodes in abstracted and original models. Each line in Fig. 7 corresponds to the probability density function of the compression coefficient for a certain abstraction strategy. The line for strategy 1 hints on the fact that most of the models were reduced by 40 % or less, whereas in the case of strategy 3, the number of nodes in most models were reduced by 70 % or more. This clearly witnesses that strategy 3 excels its evaluated competitors.

In order to evaluate the usefulness of the abstraction approach, we refer to project partner's experts. Abstractions capable of aggregating more model elements are considered as most valuable. Therefore, in general case, strategy 3 can be seen as the superior one over the other two. The ability to perform more aggregations leads to more combinations of aggregations that contribute to a smoother abstraction experience when performed in the combination with the slider control. Furthermore, the project partners argued that the choice of an abstraction method depends on the structure of a particular process model. For instance, strategy 1 can be seen as useful for a particular process model if it allows the same generalization as strategy 3.

Table 1 Comparison of node reduction caused by various abstraction strategies

Number of nodes	Original	Strategy 1	Strategy 2	Strategy 3
1–10	0	274	511	871
11–20	464	359	306	156
21–30	225	182	137	82
31–40	130	150	81	54
41–50	118	69	56	20
51–60	65	36	38	2
61–70	47	33	29	4
71–80	31	29	18	4
81–90	22	15	5	0
91–100	22	14	2	0
>100	71	34	12	2

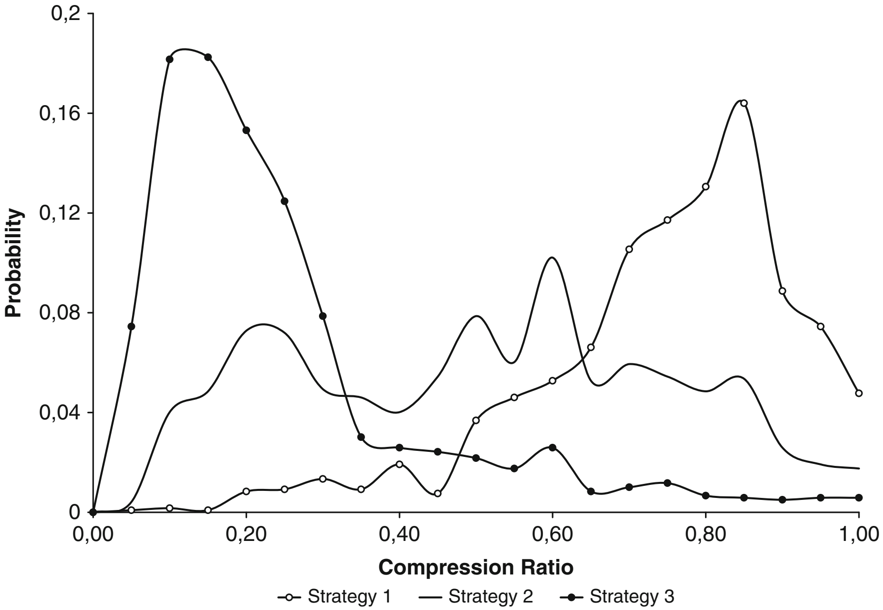


Fig. 7 Comparison of compression ratio for various abstraction strategies

6 Related Work

The problem of managing large complex process models emerges as BPM technologies penetrate modern enterprises. This challenging situation is addressed by various approaches. The authors of several process modeling notations, like Business Process Model and Notation (BPMN) (OMG 2011) or Yet Another Workflow Language (YAWL) (van der Aalst and ter Hofstede 2003) envisioned this problem. These notations allow hierarchical structuring of models. The goal of the hierarchical model organization is to distribute information describing a process among several levels with the general process flow on the highest level of hierarchy and the process details on the lowest one. Unfortunately, such a mechanism is not sufficient to cope with the problem, since it assumes that the hierarchy is designed and maintained manually. Zerguini (2004) proposed an algorithm for identifying special kind of regions called *reducible subflows* in workflow nets. Once such regions are found, a process model can be decomposed into their hierarchy.

A number of studies focused on creation of process views from available process models. The purpose of a process view is to hide certain fragments of a process model. For instance, one can imagine an actor-specific process view or a process view reflecting parts of a process instance to be executed (the last case corresponds to a process view on an instance level). Therefore, the goal of a process view creation differs from the goal of process model abstraction and can be seen as a more generic task. On the other hand, process view creation focuses on the *how* question, but does not discuss the *what* of abstraction, i.e., it does not say how to identify significant model elements. Bobrik et al. (2007) propose an approach capable of creating customized process views on model level and on instance level. The approach relies on graph reduction rules. Eshuis and Grefen (2008) propose a method for constructing views aiming to ease communication between partners by adapting internal process descriptions into ones suitable for external usage. As an input, the approach takes a process model captured in UML activity diagram notation and a user requirement to hide certain process elements. Liu and Shen (2003) propose an order preserving approach for creation of process views. An important issue is that the mentioned approaches do not incorporate the notion of nonfunctional properties of a process and, thus, do not define how nonfunctional properties of a process (e.g., execution effort and execution cost) can be preserved during transformations.

Günther and van der Aalst (2007) proposed a framework allowing to judge about significance of model elements basing on their nonfunctional properties. The framework bases on various metrics evaluating significance of process model nodes and edges. The proposed technique can be employed to answer the *what* question of abstraction, i.e., to derive reasonable significance values for process model elements.

The abstraction mechanism proposed in this chapter makes use of the set of elementary abstraction rules. Each rule has the goal of model simplification and defines how a process model fragment is transformed. Polyvyanyy et al. (2008b) have shown how these rules can be extended for evaluation of nonfunctional properties of model elements. In particular, it is described how properties of aggregating elements are derived from the properties of aggregated. Graph transformation rules are widely used for analysis of process model soundness and are well studied in literature (van Dongen et al. 2007; Liu and Shen 2003; Mendling et al. 2008; Sadiq and Orlowska 2000; Vanhatalo et al. 2007). An approach proposed by Sadiq and Orlowska (2000) presents rules facilitating soundness analysis of process models captured in the notation proposed by Workflow Management Coalition. van Dongen et al. (2007) and Mendling et al. (2008) focus on the rules facilitating analysis of EPC models soundness. Cardoso et al. (2002) propose a method for the evaluation of workflow properties (e.g., execution cost, execution time, and reliability) based on the properties of workflow tasks. However, the approach is restricted to block-structured process models free of OR blocks. One can evaluate the rules proposed in the works mentioned above for their ability to reflect elimination and/or aggregation of process execution related information and, consequently, adopt those ones appropriate for abstraction purposes.

The presented outlook of the related work witnesses: there is no comprehensive approach, which addresses all the aspects of the business process model abstraction task. Several approaches provide a solid basis of reduction rules, capable of handling sophisticated graph-structured processes. However, these approaches do not allow estimating process properties, such as effort or cost. On the other hand, there is an approach (see Cardoso et al. 2002) supporting process properties estimation, but it is limited to block-structured processes excluding OR block constructs. Finally, to the best of our knowledge, there is no means for controlling process abstraction. Therefore, in this chapter, we have shown how process model abstraction can be conceptually realized. We have introduced the slider concept – a mean for the user to control the abstraction. The approach uses transformation rules proposed by Polyvyanyy et al. (2008b). The rules prescribe how the process nonfunctional properties can be estimated.

7 Conclusions

In this chapter, we presented a business process model abstraction technique – an approach to derive process models of high abstraction level from the detailed ones. We argued that the abstraction task can be decomposed into two independent subtasks: learning process model elements, which are insignificant (abstraction *what*), and abstracting from those elements (abstraction *how*). The proposed technique can be applied for abstraction of an arbitrary graph-structured process model.

Several abstraction scenarios were provided to motivate the task of business process model abstraction. These scenarios were used to extract abstraction criteria. Afterwards, we proposed to adopt a slider concept in order to achieve control over abstraction process. Finally, we discussed process model transformation rules, which can be employed together with the slider for abstraction of insignificant model elements.

We proposed a concrete scenario of applying graph transformation rules for the purpose of model abstraction. Elementary abstractions: sequential, block, loop, and dead end abstraction were presented. For every elementary abstraction, it was defined to which type of process fragment it can be applied and in which model transformation it results. It was explained how these individual abstractions can be combined into abstraction strategies. Derived abstraction methodology preserves function ordering constraints of the initial model. To the limitation of the approach, one can count the fact that not an arbitrary model can be abstracted to one function, if such a behavior is desired. We conducted a case study on abstraction efficiency and usefulness with the industry project partner and presented obtained statistical results. The technique of process model abstraction can be extended by other transformation rules that assume process graph generalization, e.g., rules proposed by Liu and Shen (2003) and Sadiq and Orlowska (2000).

In (Polyvyanyy et al. 2009), we presented the triconnected abstraction technique that is based on one generic aggregation rule of generalizing a single-entry-single-exit (SESE) fragment of a process model into a single task. This technique can always simplify a given process model into a single task. However, the triconnected abstraction faces the risk of encountering a large SESE fragment that leads to the aggregation of a substantial amount of process information in a single abstraction step. This deficiency can be partially addressed by *structuring* (Polyvyanyy 2012), i.e., transforming every large SESE fragment into an equivalent fragment composed of several small SESE fragments. Finally, the triconnected abstraction can be practiced as a property preserving abstraction if combined with the approach for property aggregation discussed in (Yang et al. 2012).

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Business Process Quality Management

Hajo A. Reijers, Jan Mendling, and Jan Recker

Abstract Process modeling is a central element in any approach to Business Process Management (BPM). However, what hinders both practitioners and academics is the lack of support for *assessing* the quality of process models – let alone *realizing* high quality process models. Existing frameworks are highly conceptual or too general. At the same time, various techniques, tools, and research results are available that cover fragments of the issue at hand. This chapter presents the SIQ framework that on the one hand integrates concepts and guidelines from existing ones and on the other links these concepts to current research in the BPM domain. Three different types of quality are distinguished and for each of these levels concrete metrics, available tools, and guidelines will be provided. While the basis of the SIQ framework is thought to be rather robust, its external pointers can be updated with newer insights as they emerge.

1 Introduction

Just now, you started to read a chapter about another "framework" with a funny name. It did not deter you so far and we are glad it did not. If you have an interest in process modeling and agree with us that process modeling is an important activity in many contexts, keep on reading. What we want to present to you is an integrated view on many concepts and ideas – most of which, admittedly, are *not* our own – that are related in some way to the *quality* of process models. However, hardly anybody outside a small community of researchers really knows about these notions, how they are related to one another or how they are helpful in any way.

That is exactly what the SIQ framework is about. Its aim is to help you make *better process models*, using the methods, techniques, and tools that are already available.

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Quality is an issue due to a combination of three facts. First of all, Rosemann (2006a) illustrates that large modeling projects can hardly assume that all participating modelers know modeling well. Many of them have only run a brief starter training and have little or no experience. Beyond that, they often model as a side activity to their usual tasks and duties. Second, and as a consequence of that, the quality of process models is often poor. As indicated in Mendling (2008), there are quite significant error rates in process model collections for practice of 10–20 %. Thirdly, this has detrimental consequences of the usage and application of business process models in later design phases. It is a common insight of software engineering, (Boehm et al. 1978; Moody 2005), that flaws can be easily corrected in early design stages while they become increasingly expensive with the progression of a project. Due to these three issues, it is of considerable importance to understand how process model quality can be achieved.

Having said this, the chapter is structured as follows. First, we will reflect on the use of process modeling and the need for a framework as the one we propose. After that, we will explain the framework, which consists of just a small set of quality aspects. If you like, you can go on reading about the various sources we draw from and a methodological justification for the framework. But if you are already convinced and want to start using the framework at that point, that is really fine with us too. The chapter ends with a summary and some final reflections on process modeling.

2 The Power of Process Modeling

Imagine that you are asked to lead a project in your organization to improve the service delivery to customers. Chances are that you will embark on it by focusing on the *business processes* that flow through your organization. Since Thomas Davenport (1993) and Michael Hammer (Hammer and Champy 1993) produced their breakthrough views on the drivers behind organizational performance, the power of *process-thinking* has become deeply entrenched in management practice. By:

1. Understanding all actions in a process, from the first interaction with a customer until the final delivery of a service or product to that customer,
2. Questioning and rethinking the various parts of the process and their mutual relations, and
3. Implementing a thoroughly new process that exploits the benefits of the latest available technologies, you have taken the most effective path towards organizational improvement. Ask any management consultancy firm: This is the recipe they will give you, simply because it works so well.

For a process-oriented improvement project to be successful – whether its goal is to improve customer satisfaction, introduce an ERP system, implement yet another regime of checks and balances, etc. – a deep understanding will be required of the process as it currently *exists*. Not only do you need to understand it: But also all stakeholders should do so. (Do not suppose for a minute that there is agreement between people on what any particular process does, how it works, or even who is involved.) Similarly, the *changed* vision on that process will need to be communicated too, widely and vigorously. This is to ensure that (1) those who are responsible for bringing about the process change will know what to change and (2) those whose work will be affected will know what to expect. Clearly, *communication* is the central word here, both in *as-is* and *to-be* process models.

By far the best way to support communication in process improvement projects is to use *process models*. A process model helps to visualize what the important steps are in a process, how they are related to each other, which actors and systems are involved in carrying out the various steps, and at what points communication takes place with customers and external parties. All this is usually described in a visual way, using icon-like figures that are connected to each other and which are supported with textual annotations. An example can be seen in Fig. 1, where a complaint handling procedure is modeled.[1]

In part, the use of process models is the answer to a lot of the hassle associated with process improvement projects. At the same time, it brings hassle of its own. To start with: Which process modeling technique or tool should you use? In a small country like the Netherlands alone, a stock-taking in March 2008 arrives at *24* different tools available in the marketplace for process modeling, each with its own modeling paradigm. Some vendors will hit you with the intuitive user-interface their tool is equipped with, while others will point out their compliance with a standard you never heard of. So, what is it going to be?

Let us suppose here that you have selected your process modeling tool. That is good: Any choice for a dedicated tool is an infinitely better one than the use of PowerPoint or Visio for process modeling. A next question may well be: Who will make the models for you? Can business professionals be trained to map their own processes or are you better off hiring experts to do this with their input? The different alternatives have their own pros and cons. For example, the right experts will make such models faster, but when they leave your organization again you are left with models nobody cares for or is capable of updating.

The list of issues does not stop here. You will also need to make a decision on which specialists will be involved in the modeling exercise – either active or passive – to provide the content of the process models, how you want to deal with the inevitable updates to your models, where and how you will store process models, how you can allow for reuse of parts of the models you already made, how process models can link up with the working instructions you are using in your organization, how you can keep your process models in line with the compliance documentation you must generate periodically, and how you will distribute the models to interested parties.

Researchers in the BPM field, all over the world, are working very hard on finding answers to these questions and related ones. A very nice and extensive discussion of the issues we mentioned and some others too is, for example, reported in Rosemann

[1] Note that the particular technique being used here is not so relevant.

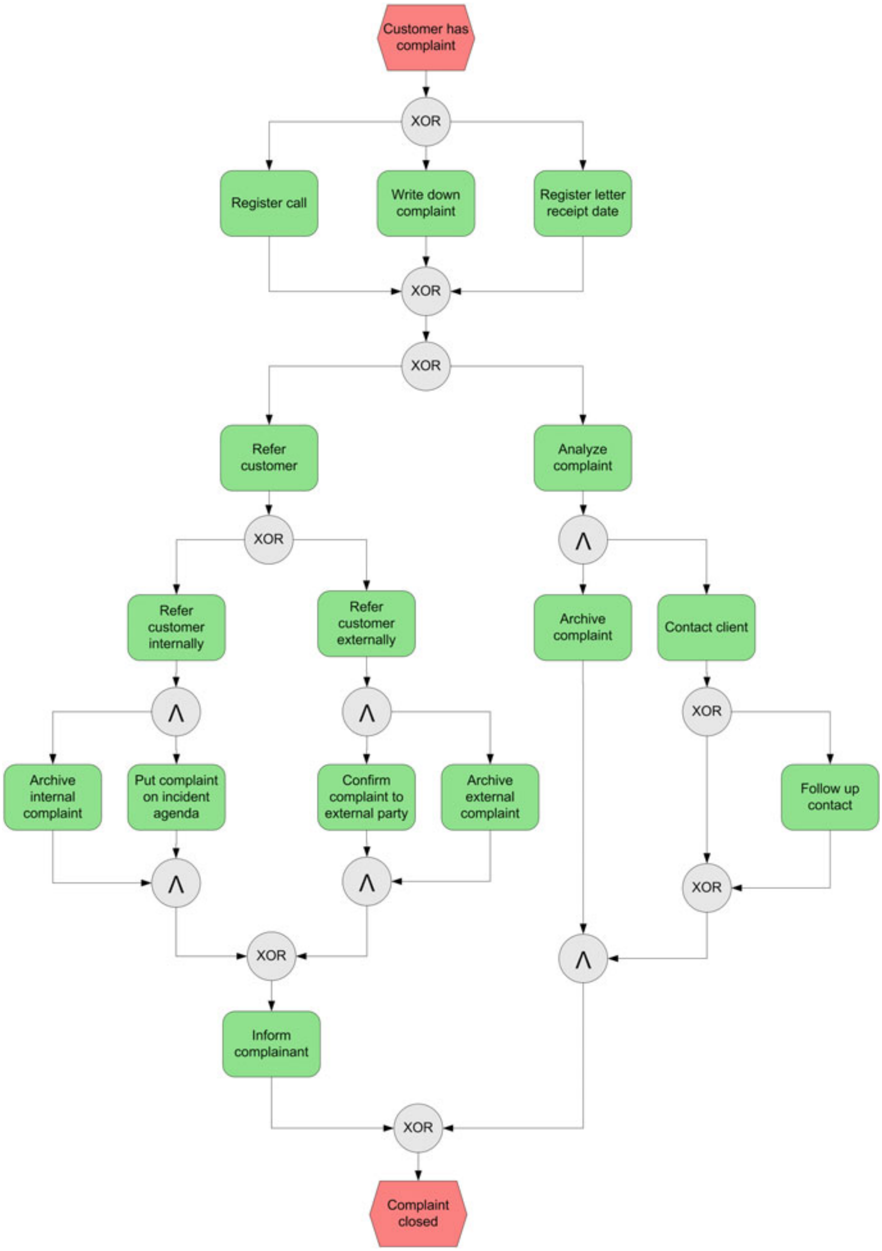


Fig. 1 An example process model

(2006a, b). Process modeling is an art with a history of only 15 years[2] and there is not enough evidence to clearly tell the best way to undertake all things. Moreover, the field is in movement: New process modeling techniques and tools, for instance, are constantly being proposed.

This chapter will not – nor could it – provide you with all the answers to the issues you will encounter in the use of process models to achieve organizational benefits. It will just single out one issue, but an important one at that. The issue is: *What is a good process model*? In other words, how can you tell that a process model that you have created over a period of weeks or months, with the input of perhaps dozens of individuals, actually incorporates the quality to help you communicate about your improvement project? Or better still, how can you ensure *during* your modeling efforts that what comes out of it is a high-quality model? The goal of the framework that we will describe is to help you with these questions.

3 The Purpose of a Framework

Is it really important whether a process model is a good model? Actually, we cannot think of a more important issue. What good is it to invest in process modeling at all if you cannot distinguish between a bad model and a good model? At the universities we work, we tell our freshmen the joke that you can model any business process as a box with one incoming and one outgoing arc: Just remember to label the box correctly with the name of the business process you are interested in. (Students hardly ever laugh.) Clearly, such an approach results in a correct model, but is it a good model? Will it be of help to anyone? Probably not, but why is this?

Let us turn our attention to the framework proper to deal with this question. It will be referred to as the SIQ framework for process models, because it is *S*imple enough to be practically applicable, yet *I*ntegrates the most relevant insights from the BPM field, while it deals with *Q*uality – a notoriously intangible concept. While the acronym accurately reflects our intentions with the framework, it has a deliberate connotation. The main entrance to the ancient city of Petra in southern Jordan, once used by trade caravans to enter the strategically located city, is called the Siq.[3] It is a natural geological vault produced by tectonic forces and worn smooth by water erosion. A visitor that passes through the Siq will eventually stand face-to- face with the beautiful facade of the treasury of Petra (see Fig. 2). Similarly, our SIQ framework is the result of a lengthy, organic evolvement of insights on process models, which – if you allow it to guide you through your process modeling efforts – will result in something really worthwhile: a good process model.

We should make a disclaimer right here and now. The SIQ framework is not the final answer. But it seems unlikely that process improvement projects around the

[2] The publication of Curtis et al. (1992) is used as rough birth date of the modern business process modeling discipline. The specific focus of the paper, however, was on software processes.

[3] http://en.wikipedia.org/wiki/Siq

Fig. 2 The Siq into Petra, with a view on the treasury

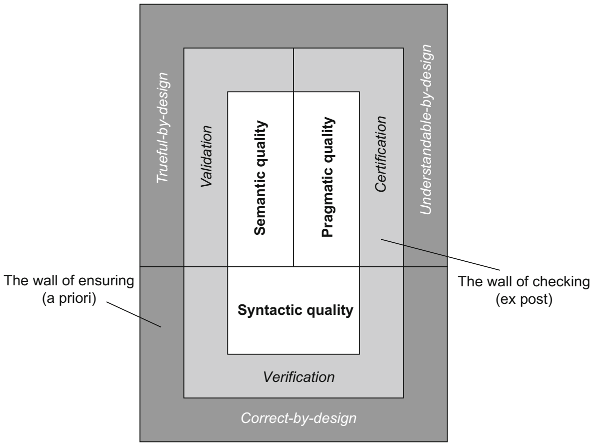
world will be put on halt until that answer has arrived. Therefore, the SIQ framework is built on a basis of three basic types of quality. We propose these as the fundament of process model quality. For each of the three types of quality, we will provide links with the current state of the start to measure these for specific models, which tools are available to establish the metric values, and which guidelines are available to do it right the first time. By the latter we mean that much of the current approaches are *retrospective* in nature: “Give me a complete model and I tell you what is wrong about it”. However, a proactive approach to process modeling seems much more useful: “Follow this guideline and the resulting model will be good”. Both of these views are supported by the SIQ framework.

Does it matter which modeling approach you are using to profit from the SIQ framework? Yes and no. We cannot rule out that you have encountered someone that will convince you of writing process models in Sanskrit.[4] In that case, the SIQ framework will be of limited use beyond just providing a conceptual basis to reason about quality. But if you stick with activity-oriented modeling approaches, as found in EPCs, UML Activity diagrams, BPMN, etc., – in other words, the industry standards – it is not so important which particular flavor you use.

Another issue that concerns the applicability of the SIQ framework is the process modeling *purpose*. As we argued, in many contexts, the goal is to support interhuman communication. This is not the only purpose there is. Process models

[4] The use of *speech-acts* would be a good example of a modeling concept not particularly well supported by the SIQ framework.

Fig. 3 The SIQ framework



can also be used for a wide variety of modeling purposes, look for discussions on this in (Becker et al. 2003; Reijers 2003). If you make a process model that will only need to be interpreted by a computer system – as in some scenario's of workflow management support or simulation experiments – only parts of the SIQ framework will be relevant. The SIQ framework as a whole is relevant for "models-for-people." All other decisions do not affect the applicability of the SIQ framework at all, such as which process is modeled, who will make the model for you, how big the particular model is, etc. The SIQ framework is a one-size-fits-all approach: If you use an industry-like standard modeling approach and it is relevant that people should take a look at the process models, the SIQ framework is for you.

4 The SIQ Framework

The SIQ framework is about process model quality. In line with the ISO 9000 guideline and definitions on model quality from Moody (2005), we could try to become more specific by expressing this as "the totality of features and characteristics of a process model that bear on its ability to satisfy stated or implied needs." Its is questionable whether this will help you much. Therefore, take a look at Fig. 3, where you will see a visualization of the SIQ framework. We will discuss the framework, working inside-out.

4.1 The Center

At the center of the model, in the bright area, you see the three subcategories of process model quality that are distinguished within the SIQ framework. These categories are the *syntactic*, *semantic*, and *pragmatic* quality of the process model under consideration. Before dealing with the "walls" that surround the center, we will first describe these categories in more detail: They represent the main quality goals a process model should satisfy.

4.1.1 Syntactic Quality

This category relates to the goal of producing models that conform to the rules of the technique they are modeled with. In other words, all statements in the model are according to the syntax and vocabulary of the modeling language (Lindland et al. 1994). If a process model is captured as an EPC (Keller et al. 1992; Scheer 2000), it would be syntactically incorrect to connect one event directly to another. Therefore, the model in Fig. 1 would not be a good EPC; the rounded boxes blocks are often used to visualize functions and many are connected in this model. Similarly, a Workflow Net (van der Aalst 1997) is not correct if does not contain a source and a sink place, i.e., a proper start and end of the process model. For most popular modeling techniques, it not really hard to find the rules that determine the syntactical quality, but usually there are hard and soft rules/conventions.

Syntactic quality is the *basis* for each of the other categories. This explains why it is shown as the lower part of the inner passage in Fig. 3, supporting the other categories. It is not sensible to consider the semantic or pragmatic quality of a process model if it contains syntactical errors. Think of it like this: Although you may be able to understand the meaning of a word that is not spelled correctly, you may be in doubt sometimes whether it is the actual word the writer intended. But there should be *no* room for any misunderstanding of the modeler's intent with a process model.[5] As such there is a hierarchical relation between the categories: Both semantic and pragmatic quality assessments *suppose* syntactical correctness.

4.1.2 Semantic Quality

This category relates to the goal of producing models that make true statements on the real world they aim to capture, either for existing processes (*as is*) or future processes (*to be*). This goal can be further decomposed in the subgoals of *validity* and *completeness*. Validity means that all statements in the model are correct and are relevant to the problem; Completeness means that the model contains all relevant statements that *would be* correct (Lindland et al. 1994). So, if a particular process model expresses that any clerk may carry out the task of checking an invoice while in truth this requires a specific financial qualification, then the model suffers from a low semantic quality. Similarly, if this particular task is omitted from the process model while its purpose is to identify all checks in the process, then it also suffers from a low semantic quality. It should be noted that the requirements on *as-is* models may differ from those on *to-be* models. For example,

[5] Note that a process model may certainly contain parts of which the modeler is not completely sure of. The point is that a modeler should model and identify such uncertainty in no uncertain terms that are syntactically correct.

the validity of a model describing an existing situation may obviously be checked more stringently than that of a hypothetical situation.

Semantic quality is a relative measure. In that sense, it is not so different from syntactic quality, which must be established against a set of rules. However, the baseline to determine the semantic quality is normally less explicit than that for syntactic quality. To evaluate a model's validity, we must first be certain about the *meaning* of the model elements that are used, i.e., what does an arrow express?[6] Next, we should compare the meaning of a process model with the *real world* it is trying to capture. In other words, you cannot say much about the semantic quality of a model if you do not understand how things actually take place. Finally, it is the modeling *goal* that needs to be known. In particular, if you want to assess whether a model is complete, you will need to know what insight you hope to derive from that model. So, checking a model's semantic quality can only be done by knowing the *meaning* of the modeling constructs, understanding the *domain* in question, and knowing the exact *purpose* of the process model (beyond that, it must support human communication).

4.1.3 Pragmatic Quality

This category relates to the goal of arriving at a process model that can be understood by people. This notion is a different one from semantic quality. You can probably imagine a process model where big parts from the real world are not captured, which will lead to a low semantic quality. But the same model can be perfectly understood in terms of the relations that are being expressed between its elements, which indicate a high pragmatic quality. But the inverse case – which seems much more frequent if you will browse through some realistic models – could also be true. Therefore, semantic quality and pragmatic quality are not hierarchically related.

Pragmatic quality is the least understood aspect of process model quality at this point. Although practitioners have developed experience over the years of what works well and what does not, few scientific explorations of this aspect have taken place. Evidence is growing, however, that small details of a model may have a big effect on its pragmatic quality.

4.2 The Wall of Checking

Let us now turn to the first "wall" surrounding the heart of the SIQ framework (see again Fig. 3). Process modeling, as much as programming, is essentially a problem-

[6] In an interview, the famous computer scientist Edsger W. Dijkstra said: "Diagrams are usually of an undefined semantics. The standard approach to burn down any presentation is to ask the speaker, after you have seen his third diagram, for the meaning of his arrows."

solving task. This implies that the validity of the solution must be established (Adrion et al. 1982). The three dimensions of quality require different approaches for checking the degree of validity. In particular, in this wall of checking of the SIQ framework, we distinguish between verification, validation, and certification.

4.2.1 Verification (Syntactic Quality Checking)

Verification essentially addresses formal properties of a model that can be checked without knowing the real-world process. In the context of process model verification, static and behavioral properties can be distinguished.

Static properties relate to the types of elements that are used in the model, and how they are connected. For instance, a transition cannot be connected to another transition in a Petri net; in a BPMN model, it is not allowed to have a message flow within a lane; or in EPCs, an organizational unit cannot be associated with a connector routing element. Typically, such static properties can easily be checked by considering all edges and their source and target elements.

Behavioral properties relate to termination of process models. It is a general assumption that a process should never be able to reach a deadlock and that a proper completion should always to be guaranteed. Different correctness criteria formalize these notions. Most prominently, the *soundness* property requires that (1) it has in any state the option to complete; (2) every completion is a proper completion with no branches being still active; and (3) that there are no tasks in the model that can never be executed (van der Aalst 1997). Other notions of correctness have been derived from soundness for various modeling languages (van der Aalst 1997; Dehnert and van der Aalst 2004; Wynn et al. 2006; Puhlmann and Weske 2006; Mendling and van der Aalst 2007). The appeal of behavioral properties is that they can be checked by computer programs in an automatic fashion. For Petri nets, the open source tool Woflan[7] can be used to perform such a check (Verbeek et al. 2001). Indeed, there is a good reason to use verification in the design of process models. Different studies have shown that violations of soundness are included in about 10–20 % of process models from practice (van Dongen et al. 2007; Mendling et al. 2007a, 2008c; Vanhatalo et al. 2007; Gruhn and Laue 2007).

4.2.2 Validation (Semantic Quality Checking)

There are different techniques that support the validation of a process model. Most of them are discussed in requirements engineering (Gemino 2004; Nuseibeh and Easterbrook 2000). A problem in this context is that, as indicated by the high error rates, users hardly understand the behavioral implications of their models. Here, we aim to emphasize two particular techniques: simulation and paraphrazation.

[7] http://is.tm.tue.nl/research/woflan.htm

In essence, *simulation* refers to presenting the formal behavior of the model to the user in an intuitive way. It is closely related to animation as a visualization of dynamics (Philippi and Hill 2007). A simulation shows the user which paths he can use to navigate through the process, and which decisions have to be made. This way, it is easier to assess the completeness and the correctness of a model with respect to the real-world process. In D'Atri et al. (2001), we describe an even more advanced approach to validation: A to-be process model is animated and extended with user-interaction facilities to give end-users a good feeling of how a particular process will behave.

Simulation also provides valuable insights into the performance characteristics of a process, but for this application, the arrival pattern of new cases, the routing probabilities through a process, the involved resources, their maximum workload, and their execution times need to be specified. A good introduction into business process simulation can be found in the chapter Business Process Simulation in the Handbook volume 1 (van der Aalst 2014), while a treatment of this subject in the specific context of process optimization can be found in ter Hofstede et al. (2008). Open source software packages available for business process simulation are CPN Tools[8] and ExSpect.[9]

Paraphrazation is an alternative technique to make a process model understandable to somebody who is not familiar with modeling. The key idea is that the model can be translated back to natural language (Frederiks and van der Weide 2006; Halpin and Curland 2006). The derived text can be easily discussed with a business expert, and potential shortcomings can be identified.

Validation and verification are meant to complement each other. Accordingly, approaches like van Hee et al. (2006) include them as consecutive steps of quality assurance in the overall design cycle.

4.2.3 Certification (Pragmatic Quality Checking)

The pragmatic quality of a model has its foundations in the psychological theory of dual coding, (e.g. Brooks 1967; Paivio 1991). It suggests that humans have two distinct and complementary channels for information processing: visual and auditory. While text activates the auditory channel, a process model stimulates the visual understanding. Accordingly, the Cognitive Theory of Multimedia Learning (CTML) (Mayer 1989, 2001) recommends that learning material intended to be received, understood, and retained by its recipients should be presented using *both* words (activity labels) and pictures (process graph). Furthermore, this theory offers a way to check the learning effect of a model. Gemino and others have identified an experimental design to quantify this learning effect (Bodart et al. 2001; Gemino and Wand 2005; Recker and Dreiling 2007).

[8] http://wiki.daimi.au.dk/cpntools/

[9] http://www.exspect.com/

In practice, you often find a less systematic approach to pragmatic quality. In this setting, the process owner is responsible for a sign-off of the process model, in the sense that he or she is satisfied with the clarity and readability of the model. In essence, this certifies that the model is adequate to be used by the intended stakeholders. The sign-off usually follows up on extensive validation and verification to guarantee that the model is also valid and correct.

4.3 The Wall of Ensuring

Given these different threats to correctness, there have been concepts developed to prevent them right from the start. These concepts constrain the design space. In particular, we distinguish correctness-by-design, truthful-by-design, and understandable-by-design. These are all part of the second "wall" of the SIQ framework, the wall of ensuring (see again Fig. 3).

4.3.1 Correctness-by-Design (Syntactic Quality Ensuring)

There are two essential ideas that contribute to correctness-by-design. The first one is that *static correctness directly guarantees behavioral correctness*. This principle is embodied in the Business Process Execution Language for Web Services (BPEL) (Alves et al. 2007). It imposes a block structure of nested control primitives. Due to this restriction, there are particular challenges of transforming graph-structured languages like BPMN or EPCs to BPEL, (van der Aalst and Lassen 2008; Mendling et al. 2008a; Ouyang et al. 2006). The second concept builds on *change operations that preserve correctness* (Weber et al. 2007). In this way, the modeler is able to add, modify, or delete activities in a process model by using primitives like *add parallel activity*. A criticism on both of these concepts is that not all correct graph- based process models can be expressed as block structure or constructed using change operations. Therefore, correctness-by-design comes along with a restriction on expressiveness. At the same time, it seems reasonable to say that the vast majority of process models can be captured in this way. For example, in an investigation in the Netherlands of a dozen companies that carried out workflow implementations (Reijers and van der Aalst 2005), it would have been possible to capture all encountered business processes using block structures of nested control primitives.

4.3.2 Truthful-by-Design (Semantic Quality Ensuring)

This aspect relates to the ways of constructing process models in such a way that they accurately capture reality. We focus on *process mining* and *natural language processing* as important techniques in this area.

Process mining is an approach to infer what a business process looks like from traces that are left behind in all kinds of information systems when executing that process (van der Aalst et al. 2003). Unlike the traditional approach to ask people who are active in a particular approach to describe that process (cf. Sharp and McDermott (2001) for example), process mining is a much less subjective means to discover that process. For example, if the event log of a specific information system always shows that payment by a client precedes delivery of the goods, process mining algorithms will order these events in the process model in this way – there is no need for interviewing anybody about this. ProM is a state of the art software platform that supports the execution of such algorithms, along with various additional analysis features. In a recent industrial application of the ProM framework (van der Aalst et al. 2007), it was found that, for example, an invoice handling process was characterized by many more points of iteration than the involved business people themselves thought. Process mining, therefore, seems a promising approach to truthfully outline a business process as it actually happens.

Beyond this rather recent development, the relationship between process models and natural language has been discussed and utilized in various works. Fliedl et al. (2005) define a three-step process of building a process model. Based on linguistic analysis, component mapping, and schema construction, they construct the model automatically from natural language text. Just as correctness-by-design, this approach is limited to a subset of natural language.

4.3.3 Understandable-by-Design (Pragmatic Quality Ensuring)

The empirical connection between understanding, errors, and model metrics, for instance (Mendling et al. 2007a, b, 2008c; Mendling and Reijers 2008), has led to the definition of a set of seven process modeling guidelines (7PMG) that are supposed to direct the modeler to creating understandable models that are less prone to errors (Mendling et al. 2008b). Table 1 summarizes the 7PMG guidelines. Each of them is supported by empirical insight into the connection of structural metrics and errors or understanding, which makes it standout in comparison to personal modeling preferences. The size of the model has undesirable effects on understandability and likelihood of errors (Mendling et al. 2007a, b, 2008c). Therefore, G1 recommends to use as few elements as possible. G2 suggests to minimize the routing paths per element. The higher the degree of elements in the process model the harder it becomes to understand the model (Mendling et al. 2007a, b). G3 demands to use one start and one end event, since the number of start and end events is positively connected with an increase in error probability (Mendling et al. 2007a). Following G4, models should be structured as much as possible. Unstructured models tend to have more errors and are understood less well (Mendling et al. 2007a, b; Gruhn and Laue 2007; Laue and Mendling 2008). G5 suggests to avoid OR routing elements, since models that have only AND and XOR connectors are less error-prone (Mendling et al. 2007a). G6 recommends using the verb-object labeling style because it is less ambiguous compared to other styles (Mendling and Reijers 2008). Finally, according to G7, models should be decomposed if they have more than 50 elements.

Table 1 Seven process modeling guidelines (Mendling et al. 2008b)

G1	Use as few elements in the model as possible
G2	Minimize the routing paths per element
G3	Use one start and one end event
G4	Model as structured as possible
G5	Avoid OR routing elements
G6	Use verb-object activity labels
G7	Decompose a model with more than 50 elements

The model that is shown in 1 is, in fact, developed in conformance with these guidelines.

5 Related Work

By now, the SIQ framework has been outlined for you. In case you are wondering about that, it is not the first framework for process model quality. On the contrary, it owes heritage to some notable predecessors. To give the reader a better feeling of the SIQ framework's resemblances to and differences with these earlier frameworks, we will describe the most important ones.

First of all, there are the Guidelines of Modeling (GoM) (Becker et al. 2000, 2003). The inspiration for GoM comes from the observation that many professional disciplines cherish a commonly shared set of principles to which their work must adhere. GoM is intended to be that set for the process modeling community.

The guidelines include the six principles of correctness, clarity, relevance, comparability, economic efficiency, and systematic design. These principles partly overlap with the three main quality aspects that are distinguished in the SIQ framework:

– GoM's correctness refers to both the syntactic and the semantic quality in the SIQ framework,
– GoM's clarity relates to the pragmatic quality in the SIQ framework, and
– GoM's relevance is connected to the semantic quality in the SIQ framework.

In comparison, it is fair to say that the GoM framework covers a broader array of quality issues than the SIQ framework. For example, systematic design is not considered in the SIQ framework, but this may be a highly relevant to consider in certain situations. So in that sense, the SIQ framework is truly a simple framework. At the same time, the SIQ framework is more geared towards integrating a wide variety of existing notions, techniques, and tools from the BPM domain. In that sense, it is a more integrative approach to process modeling quality. What both frameworks share is the intent of their developers: To advocate the development of widely shared and usable guidelines for establishing process model quality.

The second important framework that we should mention here is the SEQUAL framework. It builds on semiotic theory and defines several quality aspects based on relationships between a model, a body of knowledge, a domain, a modeling language, and the activities of learning, taking action, and modeling. It was originally proposed in Lindland et al. (1994), after which a revision was presented in Krogstie et al. (2006). The notions of a syntactic, semantic, and pragmatic quality in the SIQ framework can be immediately traced back to that first version of the SEQUAL framework. But these criteria aspects are not the only SEQUAL notions by far. The most striking characteristic of the SEQUAL framework is that it is so complex. It seems hard to explain to anybody – in particular practitioners – what its various components are and what they mean. Its *raison d'être* seems to be to feed philosophical discussion than practical application: There is nothing close to concrete guidelines, as in GoM or in the SIQ framework, let alone any links to empirical work or tools. Finally, the revision of the original pillars of the SEQUAL framework cast doubts on its robustness. In contrast, the SIQ framework is proposed as an extensible framework, rather than a revisable one.

Finally, Moody has made various contributions on the subject of conceptual model quality (Moody 2003, 2005). Most relevant for our purpose, he investigated the proliferation of various model quality frameworks, discusses many of them, and dryly observes that none of them have succeeded in receiving any acceptance. The most important link between Moody's work and the SIQ framework is that the latter tries to live up to the principles for structuring conceptual model quality frameworks as proposed in the former:

– We decomposed the overall quality notion into the subcharacteristics of syntactic, semantic, and pragmatic quality, described their relations, and – if available – described the metrics for these.
– We used commonly understood terms to distinguish and describe the various quality aspects; descriptions were commonly given in one sentence.
– We provided the links to tools, procedures, guidelines, and related work to clarify how quality evaluations can take place.

Admittedly, we did not provide concrete metrics for each of the characteristics and subcharacteristics we discussed, as is also suggested by Moody. This is a clear avenue for further improving the SIQ framework, so that its chances will be increased of becoming widely adopted and making an impact on modeling practice.

6 Conclusion

In this chapter, we introduced the SIQ framework for the quality of business process models. Its core consists of the three dimensions of syntactic, semantic, and pragmatic quality. These have been discussed in conceptual modeling before, but the SIQ framework has some distinct features of its own. It is much *simpler* than other frameworks, in the sense that only three subcategories of quality are distinguished. You can see from this that it is not so much that *truth* was the dominant principle in developing the SIQ framework, but *utility*. Also, the SIQ framework is a sincere effort to link up with the most powerful and relevant notions, techniques, and tools that already exist but provide part of the picture. In that sense, the SIQ framework is *integrative*: It identifies mechanisms and techniques that can be applied complementarily. What is completely new in the framework is the identification of both *ex post* checking of quality and *a priori* ensuring of quality. In this regard, we have organized existing work on verification and correctness-by-design on the syntax level, validation, and truthfulness-by-design on the semantic level, and certification and understandable-by-design on the pragmatic level.

In the end, frameworks do not become popular by themselves. Readers like you determine whether the SIQ framework meets their purposes or not. But in our mind, there are more important issues than whether you will use the SIQ framework as we described it. We hope that you will remember our claim that process model quality is much more than simply adhering to a particular modeling notation. We also hope that reading this chapter will help you to focus your energies more effectively. Rather than joining "process model battles" – technique X is much better than Y! – focus on creating models that stick to the rules of the technique you are using, rightfully describe what you need, and do so in a way that is comprehensible to the people using it.

We will spend our time and energy on extending the SIQ framework, linking it with the latest insights and tools. A first tangible result is the inclusion of a set of advanced features in the open source Woped tool.[10] Models that are developed with this tool can be checked on both their syntactic and pragmatic quality, respectively through checks on *soundness* and a range of process metrics.

We aim for a close cooperation with our industry and academic partners to further populate the white spaces in the SIQ framework, validate its applicability, and develop even more concrete guidelines on how to create process models. In the mean time, we hope you will try the SIQ framework out. Process modeling is simply too important to carry out poorly.

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[10] See http://www.woped.org

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