Systems and Software Quality

Martin Wieczorek • Diederik Vos • Heinz Bons

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The next step for industrialisation

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Foreword by Walter Brenner

Software Quality: An Evergreen of Information Management

Since the early days of my life, songs like "Yesterday" by The Beatles, "Satisfaction" by The Rolling Stones, "Comfortably Numb" by Pink Floyd or "Layla" by Eric Clapton have given me joy and calmness. It is not that I listen to them every day, but after a few beats I recognise them and appreciate the ingenuity of the musicians who created those songs.

Software quality is a topic that reminds me of my studies in the early 1980s, where program testing was on the curriculum. When I was working for a company in the chemical industry, software quality was one of my daily problems and tasks. Today, software quality is not the institute's research focus, but it is an area that continually challenges my work on information management, industrial services and enterprise systems, design thinking and digital consumer business. As with the evergreens, the same is true for software quality: after a few "beats" one is able to deal with it, to ask questions, to find defects and to derive risks.

One of the characteristics of evergreens in music is that they are made for eternity. A similar conclusion seems justified for software quality: as long as software is developed and maintained and subsequently used, we need to deal with software quality through quality assurance and testing. Every generation of software developers needs to learn about the importance of software quality and the complexity of achieving a high level of software quality. They also need to recognise and understand that strong and sustainable processes help to improve software quality.

To me it is clear: software and its quality will become a key factor in daily business and life. In the near future most of our products and services will depend on software. There will be virtually no products or services that do not have a software component, nor will there be any business or private processes that are not supported, managed or controlled without software. For every private and business question there will be an app to provide the answer. The next stage of development

may emerge from embedded systems and sensors. Embedded systems are processors that are integrated, for example, in cars, planes, harvesting equipment and washing machines and that control them. Sensors enable us to get a digital view on the real world's state and conditions, e.g. room temperature and user's location, and to use this information for further calculations. Global networks interconnect individuals, companies and machines and enable the exchange of data and information. This new digital world functions because of complex software. Inevitably, software quality will be a key factor for many companies that are looking for differentiators for their products, services and processes.

In this book the three authors have taken up the challenge to investigate and discuss systems and software quality. Based on many years of practical experience gained from working for companies of different sizes and in different industries they provide an approach to professionalise the field of systems and software quality. The book is clearly structured and easy to read and recommendable for everybody who has responsibility in this area. The presented approach is pragmatic and helps to put comprehensive processes and governance mechanisms into practice. It is a great merit of the authors that they have developed an approach that takes into account both the quality of business processes and respective software systems and the quality of embedded systems. The authors' holistic view makes clear that integrated technical and economic management models will become even more indispensable in the future to ensure quality of all the software-based systems.

In the past I have seen many approaches which discussed software quality either of business software systems or of embedded systems. Usually people who are concerned with business software and embedded systems work in "separated worlds" inside the company. In the future they must work together because these two "worlds" are increasingly merging; consider, for example, new concepts like "remote monitoring". The holistic approach presented in this book is of great help in this complex learning process about software quality. In this sense, too, there is a parallel with evergreens: take, for example, a recording of "Satisfaction" by The Rolling Stones from the late 1960s and a recording of the same song from 2013 in Hyde Park. You will find that it is the same song text, but the sound has developed significantly since the 1960s. Just as it is gratifying to listen again and again to the evergreens of music, it will be rewarding to read this book and to rethink systems and software quality.

I wish the readers pleasant reading and the authors every success in the highly competitive book market!

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February 2014

Foreword by Wolfgang Gaertner

Testing and Quality Management in software development have become more visible and sophisticated in recent years. There is no doubt that professional testing and a comprehensive quality approach based on proven methodologies are key for successful software development. However, there is no "one fits all" solution that could be universally applied in every context. IT managers still face the challenge of defining a comprehensive quality framework that accounts for the specific environment of the business area, technology, culture, and quality needs of their respective organization.

This book shall be a manual on how to define and establish such a Quality Framework. Gain insights as to how a standardized software factory approach can unleash hidden potential and synergies. See how to approach the quality question on a strategic, tactical, and operational level by getting a notion of suitable software and systems quality. These topics are highly relevant to those who want to take a holistic view on quality and take appropriate action to achieve ambitious goals in a complex environment.

Looking at today's banking business we see constant changes in a dynamic market environment. Globalization and increasing regulatory requirements in all areas of banking are strong drivers for change. In order to compete in this dynamic and challenging market, financial institutions are continuously striving to provide state of the art products and services as well as to reduce their cost base by using a standardized IT infrastructure. Banking IT units are expected to introduce new and innovative technology and to speed up development cycles to allow for shorter time to market so as to support their partners in the customer-facing business areas.

Apart from the usual book of work, today's IT units may have a multitude of tasks and challenges, such as the integration of other financial institutions and the consolidation of IT platforms, to name a few. The acquisition and integration of Postbank and the implementation of a new joint IT platform for both banks are good examples for such a challenge at Deutsche Bank. In order to accomplish this task and the entailing changes, Deutsche Bank introduced the Magellan Program in 2011. Magellan will be completed in 2015 on the basis of synchronized software releases every half year.

In a program like Magellan quality is key for a successful delivery. The impact of the change on the end user and the software maintenance effort are considerable and meeting the quality objectives is extremely important. Quality measures applied in a large program are also a significant cost factor. To achieve the required quality in the most efficient way, Deutsche Bank established a comprehensive quality framework that focuses on items with the highest leverage.

The key factors we have identified and implemented in Deutsche Bank in large programs like Magellan are as follows:

- An obligatory quality framework to ensure standardized SDLC and quality management processes, methods, and tools—from front to back
- Stringent Release Management including Quality Gate control across overall project portfolio
- Integrated but independent Testing Utility acting as dedicated quality assurance function and gatekeeper for production
- Highly standardized tool setup and a comprehensive automation framework across the overall testing process
- Centralized test environments and test data management to guarantee a seamless start into testing activities
- Operational Quality Management for programs and projects to achieve the defined quality goals

In Deutsche Bank we consider the quality of our business processes a key differentiator in a highly competitive market and the underlying methodology is of utmost importance to us. The frame conditions are determined by today's development in the banking industry.

I hope that all professionals will benefit from the authors' ideas, i.e., to get new impulses to adjust or improve their IT processes and the quality of their software systems to the advantage of their business. Ultimately, I wish the authors to have interesting and productive discussions with the readers of this book.

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April 2014

Foreword by Ali Sunyaev

The importance of systems and software quality in the development and operation of information systems (IS) is undeniable. Successful accomplishment of IS projects is a crucial challenge for organisations and the high rate of problematic or failed IS projects is an ongoing problem. Despite several decades of research on this topic, there is still a lack of agreement on what factors lead to success or failure of IS projects. Important aspects of software quality are often not visible, and this holds for high as well as low software quality. Invisibility of high quality refers to missing acknowledgement of quality efforts since they might not be perceived and thus put into question. Invisibility of low data quality may encompass unconsidered costs of rework after deployment, future costs due to side effects, and low quality not directly visible for all users.

In order to examine what factors lead to successful IS projects and high quality software products, the University of Cologne, Germany, conducted an explanatory study, interviewing executives and IT experts in different organisations.[1]

As this book suggests, missing software quality is a *peccatum* and the level of quality is uncertain unless it is planned and controlled. The study shows shortcomings and pitfalls in both planning and control of software quality, and even the definition of software quality is a major challenge.

The definition of software quality is a challenge due to the diversity of quality dimensions, stakeholder perspectives, and project as well as organisational context. Moreover, software quality encompasses a process as well as a product perspective. Therefore, as suggested by the *four* "*P*"*s* concept, a holistic perspective of software quality within an organisation is necessary. The study shows that an organisation-wide quality policy, encompassing a holistic perspective, is a starting point for a common software quality understanding and embedding software quality at the strategic level. Additionally, a quality policy emphasises the importance of

[1] Paul Glowalla, Ali Sunyaev: Software-Quality-Governance, University of Cologne (in German only), February 2014.

software quality given time and budget constraints; a challenge that is addressed in this book as well.

In order to plan software quality it needs to be defined and should, as far as possible, be measurable. However, measuring software quality that encompasses the diverse stakeholders' perspectives is challenging, especially at the beginning. Few metrics are objectively measureable, like the number of defects, and even these numbers are subject to interpretation and so do not necessarily deliver a reliable assessment of software quality. Therefore, besides aiming at measuring software quality, qualitative measures need to be systematically established in order to communicate and learn from non-measurable aspects of software quality within and across potentially different IS projects.

Finally, high software quality is not an endeavour conducted at a single point in time. In order to control software quality, a continuous life-cycle is necessary to refine definition and planning of software quality and subsequently improve software quality and success of IS projects.

For long-term and sustainable software quality improvement, which might even require cultural changes, top management has central responsibility. Top management is responsible for establishing structures and responsibilities to allow for organisation-wide software quality awareness and assigning actions (top-down). Moreover, structures are necessary to allow for systematic learning from each IS project (bottom-up). Key Findings of the study are as follows:

- Quality responsibility should be differentiated into process and product quality, and a persistent delegation across organisational levels is necessary to enforce quality requirements within single projects while using gained experiences to learn across projects.
- A quality policy that increases awareness and facilitates common understanding to avoid diverging perspectives is needed. A quality policy links organisational culture and practices, but changes to culture resulting in practices might take time, since quality management is an educational process.
- Existing metrics are necessary for tangible project management and control and facilitate quantitative assessment of quality activities. However, if deviations occur, additional qualitative assessment is necessary. Since formalisation of project management might improve outcomes, qualitative measures should be formalised as well.

I recommend this book as a valuable resource. It provides insights into the systems and software quality field and inspires readers to adopt the suggested perspective on IS quality. I hope this book will find a broad dissemination and the attention it deserves.

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February 2014

Foreword by Ina Schieferdecker

Cyber-physical systems (CPS) are networked embedded systems interconnected with cyberspace. In Europe, embedded systems are estimated to have exceeded the 10 billion mark. However, only a small share of these embedded systems is networked today. Yet, the interconnection of embedded systems by information and communication networks is growing rapidly. By 2020, there will be nearly 26 billion devices on the Internet of Things.[2]

The networking and interconnection of embedded systems impose new requirements and challenges for their quality engineering: The complexity, heterogeneity and dynamics of CPS in themselves and in the network of devices as well as their openness to cyberspace and their stringent requirements on functionalities, performance, security, safety and resilience call for new approaches regarding their constructive and analytical quality engineering.

Recent research in Germany, Europe and worldwide, for example in the Artemis projects CESAR (Cost-efficient methods and processes for safety-relevant embedded systems) and CRYSTAL (Critical system engineering acceleration), revealed new methods and tools leading to a reference technology platform for CPS. Selected results in quality engineering of networked embedded systems are presented in Zander et al.[3] Still, more research on quality engineering of CPS needs to evolve. But even more importantly, research results need to be transferred to the industry so that new methods, tools and processes can be adopted in daily industrial use.

It is a pleasure for me to present a prelude to this topical and interesting book on the industrialisation of system and software quality. The book reviews the state of the art in industry and standardisation and provides practical guidance on how to establish holistic quality management. Expertise, professional processes and automation are put into focus to master the quality of software-intense systems. By referencing elaborate technological results and best practices, the book presents a

[2] Gartner: "Forecast: The Internet of Things, Worldwide, 2013.", Dec. 2013, http://www.gartner.com/document/2625419?ref=QuickSearch&sthkw=G00259115

[3] Justyna Zander et al.: Model-Based Testing for Embedded Systems, CRC Press, 2011.

solid base for developing expertise and improving processes. A recent study by Fraunhofer FOKUS on "Status and Trends of Quality Assurance of Interconnected Embedded Systems"[4] revealed the increasing need for efficient and effective quality engineering. In the 2nd half of 2013, 19 interviews were conducted with quality managers in the automotive, avionics, transport, medical devices and smart grids industries. The interviews concentrated on product quality and quality governance, product and process quality assurance strategies, quality challenges of interconnected embedded systems and improvement requirements, potentials and options.

It was encouraging to hear that all companies see high value in product and process qualities. Clear structures and responsibilities have been established, although they differ a lot from company to company. Reviews and dynamic testing are integral parts of quality assurance. Yet, more elaborated technologies, methods and tools including, e.g., model-driven quality assurance, model-based testing, simulation or formal verification are not or only seldom in place. This could be one reason why more than half of the interviewees were not satisfied with the outcomes of their company's quality focus. Cost, resource and time limits are often not met because of quality issues. Moreover, many interviewees mention shortcomings in requirements engineering and in component and system acceptance by vendors. The increasing networking, interconnection and openness of embedded systems are seen as new business-critical challenges. In particular, ICT security and privacy matters are of increasing importance and need to be addressed explicitly in quality management. In short:

- Many industries are currently focusing on product quality improvement of networked embedded systems. Therein, quality engineering for safety and security with respect to cyberspace is a major challenge.
- Product quality is seen in conjunction with own process improvements, process improvements with suppliers and advancements of the workforce. Continuous improvement approaches are often the basis for sustainable improvement effects.
- Ever shorter product release cycles and increasing complexity require new approaches in quality assurance. Agile, yet systematic methods in review and testing provide options for effective and efficient quality assurance.

Overall, the industry requires new approaches for the engineering of high-quality CPS. This book addresses integrated and holistic methods and processes for software-intensive systems. It describes a thorough quality focus and how to adopt the quality fabrication methods in industry. Although sophisticated quality engineering is not all about automation, much of it is.

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February 2014

[4] Martin Schneider et al.: Stand und Trends der Qualitätssicherung von vernetzten eingebetteten Systemen, Fraunhofer FOKUS Study (in German only), Feb. 2014.

Preface

Software and systems quality is playing an increasingly important role in the growth of almost all organisations, both profit and non-profit. Quality is vital to the success of companies in their markets. Most small trade and repair businesses use software systems in their administration and marketing processes. Every doctor's surgery uses software to manage patients' records. Banking is no longer conceivable without software. Aircraft, lorries and cars use more and more software to handle their increasingly complex technical systems. Innovation, competition and cost pressure are always considerations in ongoing business decisions. The question facing these organisations is how to achieve the right level of quality of their software and software-based systems and products; that is, a level the market will reward, a level that mitigates the organisations' risks and a level the organisation is willing to pay for.

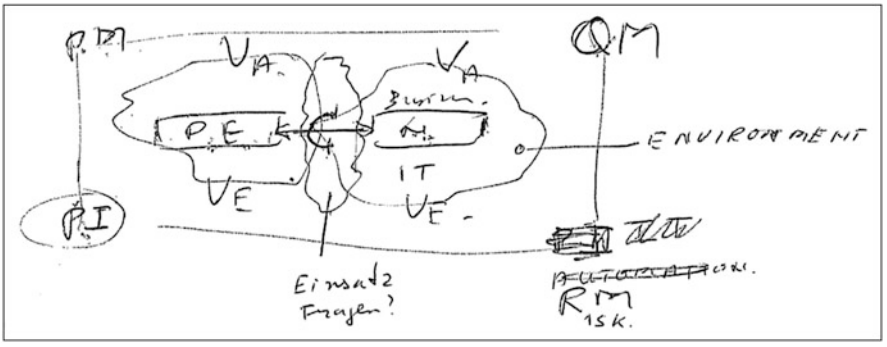
As in all industries, the software industry is subject to change driven from many fronts. New business models are created in response to new demands from different markets. New business processes are defined or existing business processes are adapted to changing business models. New solutions are built as new technologies become available. The changes in business and daily life but also the changes in the complexity and integration of software and systems are increasingly far-reaching. We believe that these changes have a huge impact on the art of development but also result in improved quality governance, quality management and quality engineering. It is not sufficient to define quality by budget and time.

The increasing integration of software as well as the search for suitable supply chain models in the life cycle requires appropriate quality solutions. Major sources for improving effectiveness, efficiency and reliability are re-use, standardisation, automation and specialisation as part of the industrialisation paradigm in the software industry. The rapid evolution of requirements due to new experiences, competition and cost pressure, but also changing technology such as mobile devices, has increased pressure on the software industry and its products. Likewise, there are impacts from new regulations issued by public and private authorities like Basel III, from a wealth of data and information overflow for users and providers

and last but not least from new paradigms in the software industry itself like Agile development, which again pushes new and changing requirements.

For many decades software has occupied two different worlds: the "Embedded World" and the "ICT World" (ICT ≡ IT; although for the scope of this book, our preferred term is ICT). In our experience these two worlds behave differently in how they address the quality of the corresponding artefacts and final results. This book challenges this view and openly asks whether this coexistence and strong separation of techniques and procedures have a place in a future where globalisation leads to more integration and interoperability of formerly uncoupled or loosely coupled systems. What can we learn from both worlds and how can we apply best practices to improve enterprise ICT quality?

Although a number of good practices are in place, there is still room for major improvements. In our view, a holistic approach for systems and software quality is missing in ICT quality. Strategies and frameworks are required that will produce the kind of software and systems we need and we are willing to pay for. Let us therefore look at the two worlds of "Embedded systems" and "ICT systems" and learn from both worlds, from overlaps and individual solutions. Now is the time to take the next step for industrialisation in the software industry. With the aim of integrating a product and project oriented view on the ICT world, we will focus on three concepts in this book: (1) right software and systems quality; (2) industrialisation of quality engineering and (3) a holistic approach to enterprise ICT quality. As far as we are concerned, "Alea iacta est"—the die has been cast.



About the Book

Structure of the Book

As ICT should be an enabler of effective and profitable business today it is worthwhile discussing both aspects of an enterprise; we need to know the capabilities of ICT as well as the business needs. Therefore, our discussions in the next chapters will be along two lines. We will focus on ICT product quality improvements but also take into account the business demands.

ICT product quality is more than having testing processes and a quality management system in place. As already discussed by Heinz Bons, Rudolf van Megen and Peter Schmitz in their book "Software-Qualitätssicherung—Testen im Software-Lebenszyklus" (1982), every testing approach or concept has to answer these five questions when bug fixes, product changes and new products are implemented:

1. What are potential quality assurance and test items?
2. What has to be tested?
3. When should it be tested?
4. How will it be tested?
5. By whom will it be tested?

A quality management system defines and evaluates all the relevant processes. We also know that good processes are necessary but not sufficient to develop, maintain and operate ICT products during the whole life cycle. We believe that a holistic quality approach is needed in an enterprise and that it should entail a fundamental notion of right quality, an implementation framework and concepts and rules for establishing right quality across the strategic, tactical and operational layers.

This book is divided into eight chapters followed by two appendices and a glossary. The questions to be discussed and answered in the chapters are as follows:

1. **Motivation and introduction**. Why do we believe that a holistic quality approach will improve enterprise ICT quality? How do we assess the current situation of enterprise ICT? What can we learn from the embedded world?
2. **The four "P"s of enterprise ICT**. What are the fundamental cornerstones of enterprise ICT? Why is portfolio management worthwhile, along with quality governance, quality management and quality engineering? How to invest in the right projects?
3. **What is right software and systems quality?** What are the determining factors for right quality? What are the relevant quality characteristics? How can we define quality models alongside development and maintenance processes within the life cycle? Are quality characteristics independent of time and stakeholder expectations?
4. **How can we establish right quality for an enterprise?** Why do existing governance approaches not suffice in our view? How do we handle the demands of right quality across the various layers of an enterprise? How is portfolio management related to the business landscape at the strategic layer? Why and how is an application portfolio useful for the ICT landscape at the tactical layer? How does it benefit project execution at the operational layer?
5. **How can we implement a framework for right quality?** What are the fundamental components of our implementation framework? How do they contribute to a factory approach of quality engineering? How is our House of Quality defined?
6. **The Quality Services Factory**. What is a Quality Services Factory? What are the building blocks of a QSF? How can we set up and operate a QSF? What must a QSF take into account in relation to existing business units and ICT service providers?
7. **The benefit of RiSSQ, balancing quality and risk**. What is the benefit of our RiSSQ approach? How can we calculate the right risk/quality level based on time and budget? How do we balance cost of quality and cost of risk?
8. **Summary and conclusion**. What has been achieved in this book? How can we support an enterprise by establishing right quality and implementing a framework? What are the main aspects of a checklist?

Target Audience

This book discusses many different aspects of enterprise ICT and its quality issues. It defines the fundamental notion of right software and systems quality, provides a holistic approach of enterprise ICT quality that combines portfolio management with quality management and quality governance and delivers a framework for implementing right software and systems quality through an industrialised quality engineering.

As such, this book is targeted at senior management and board members who are responsible for business and ICT and for defining and providing appropriate

strategies, values and directives. It is also targeted at executives responsible for implementing corporate strategies, especially the ICT strategy, and for creating optimal rules and conditions, infrastructure and work environment. They include division and department heads, directors of development, governance managers, portfolio managers, product managers, application and system owners, quality managers, process managers, project managers and test managers.

Testers, quality engineers, developers and others who perform operational tasks in the software and systems life cycle are also invited to read this book. We believe the notions and concepts presented here can contribute significantly to improving the quality of the life cycle artefacts and processes.

We recommend Chaps. 1, 2, 4 and 7 to all readers. Chapter 3 is mainly intended for executives responsible for defining suitable quality and risk models. Those who are interested in setting up and establishing a Quality Services Factory should also read Chaps. 5 and 6. Those who are engaged in quality engineering and need to define or adopt quality models should also read Chap. 2.

About the Authors and Contributors

Authors

Martin J. Wieczorek joined SQS Software Quality Systems AG in March 1995. Since then he has been appointed to various roles and responsibilities in the SQS Group, including Head of the "Telecommunications, E-Commerce, and Public" Business Unit, responsible for sales and delivery, Head of Market the "Public" Market Unit, responsible for business development, and "Research and Innovation" Director, responsible for service management and service innovation in the SQS Group.

He has over 30 years' experience in the fields of software and systems development, quality assurance and testing, quality and risk management and process evaluation and improvement. He is experienced in national and international projects and industries such as Telecommunication, Logistics and Public Sector including NATO. As a software engineer he also participated in international space projects like the D1-Mission in the German Space Operations Centre. He also has considerable expertise in training IT professionals and educating students at various universities. He still coaches students in their Bachelor and Master theses.

Martin Wieczorek received his Ph.D. from Radboud University Nijmegen, the Netherlands, in 1994 with his thesis "Locative Temporal Logic and Distributed Real-Time Systems—Specification".

Diederik (Dik) Vos has been CEO of SQS Software Quality Systems AG since October 2012. He is responsible for the company's strategy and the management of the Group Management Board, to which he was appointed in March 2011. Dik Vos started at SQS Group as COO, responsible for global sales and operations. In this role he focused on driving forward company growth and improving the global SQS Group's operational excellence. In 2013 Dik Vos took over the position of director of Thinksoft Global Services Limited, the SQS subsidiary focused exclusively on BFSI testing.

He has considerable expertise in the field of Managed Services, IT Services and Management Consulting. As an internationally experienced manager he has demonstrated an ability to drive change within organisations, developing them into profitable companies while increasing customer satisfaction. He previously held senior management positions at AT&T, Lucent Technologies, AVAYA and International Network Services.

Heinz Bons has been working in the area of Software development and maintenance for 40 years, mainly in the fields of quality management, quality assurance and testing. He gained detailed theoretical, operational and management experience in these fields. He is co-author of one of the first books in German on quality assurance and testing in the software life cycle (published in 1982).

After his studies at the University of Cologne he was a research staff member at the University, including the field of quality assurance and testing. He has been a specialised consultant in these areas since 1981. Heinz Bons is co-founder of SQS Software Quality Systems AG. He was Managing Director and Board Member of SQS for about 25 years. Today he is principal consultant at SQS and responsible for defining, implementing, coaching and improving processes, methods and techniques for testing as well as quality management and quality assurance.

Contributors

Kai-Uwe Gawlik holds a Ph.D. in Physics with a focus on experimental and solid state physics. He has worked with SQS for 17 years, currently as Global Head of Service Management responsible for innovation and industrialisation of SQS services and continuous consolidation of SQS PractiQ best practices. As a project lead Kai-Uwe has worked in small and large quality engineering projects for different industries. His responsibilities and tasks include setting up organisational units, quality management, technical quality evaluation, test data and environment management and testing in general.

Shan Rajegopal a Ph.D. in Business with a focus on operational research. He has worked with SQS since 2013 and is responsible for the set-up of a Global Project and Portfolio Management Practice. Shan is a trusted business advisor and one of the leading authorities in innovation, portfolio and execution management. He provides advice and support in innovation, portfolio investments and delivery management with value realisation for international companies in various industries to radically improve their performance. Shan is also a much sought-after international speaker and author of books.

Thomas Thurner holds a qualification in Electrical Engineering with a focus on Data Processing and Telecommunication. He has worked with SQS for 6 years and is responsible for the "Industrial Services and Solutions" Market Unit. Before that he worked for 19 years in various positions as Engineer, Project Manager and Division Manager in the field of automotive embedded systems. His spectrum includes the development and testing of (safety-related) Mechatronic Systems, Real-Time Operating Systems, Data Bus Networks, Quality Assurance and Fault Tolerant Architectures.

Detlef Vohwinkel holds a qualification in Business Economics with a focus on Business Informatics. He has worked with SQS since 1992 and is currently responsible for the "Process Intelligence" Competence Centre. He acts as a lead assessor in process evaluation and improvement and supervision of process changes for SQS clients. He is one of the founding members of the Test SPICE SIG to systematically develop and enhance the model for improving testing processes. He represents SQS in the advisory board of intacs for the development and quality of the SPICE and Automotive SPICE assessor qualification and is the SQS business liaison for SEI.

Top row, left to *right*: Shan Rajegopal, Kai-Uwe Gawlik, Detlef Vohwinkel, Thomas Thurner
Lower row, left to *right*: Martin Wieczorek, Dik Vos, Heinz Bons

It has been an excellent team approach. We are greatly indebted to Detlef, Kai-Uwe, Shan and Thomas.

Martin Wieczorek, Dik Vos, Heinz Bons

Acknowledgements

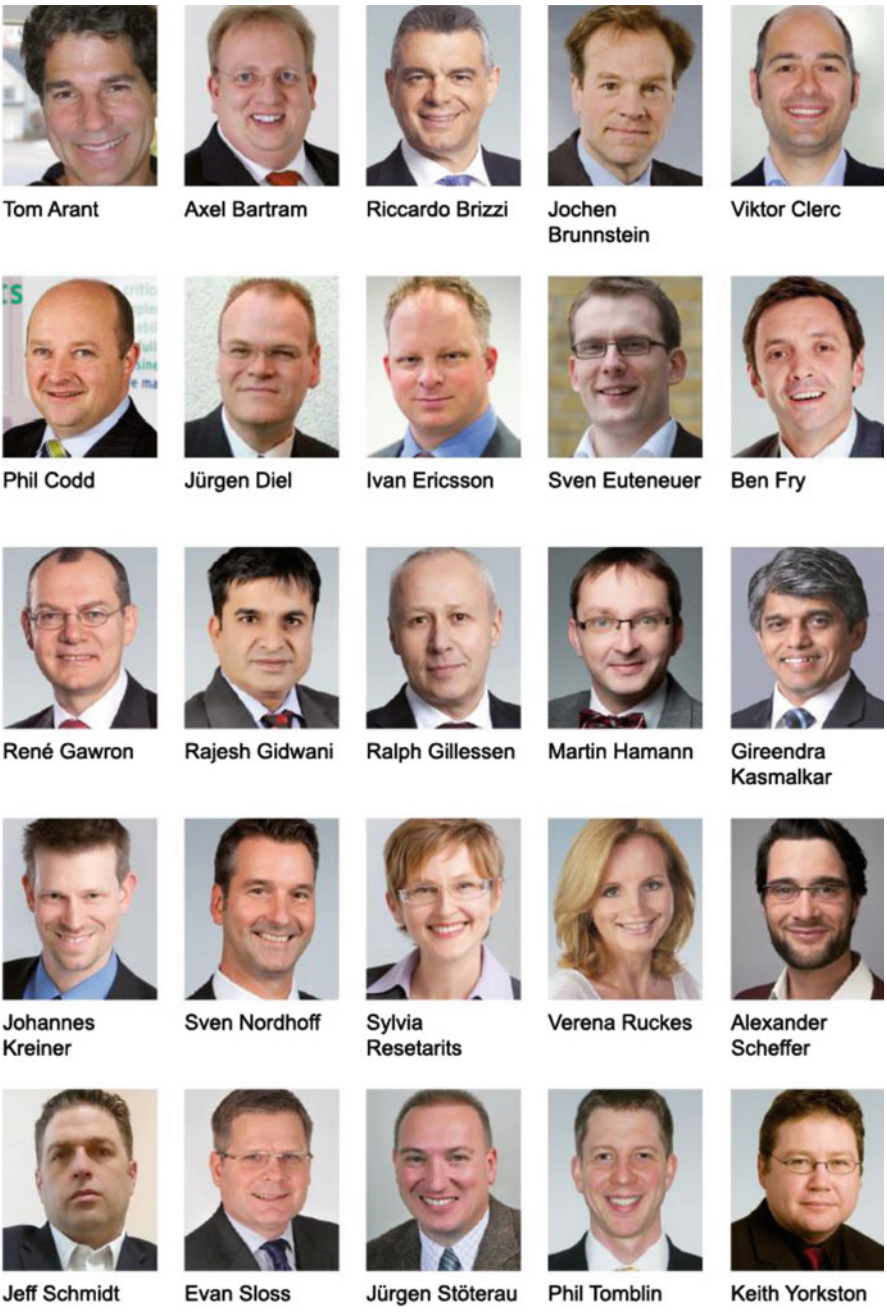
Unlike many other industries and their disciplines, Information and Communication Technology is a young field of research, development and practice. It has led and will lead to many changes in our business and daily life. In the beginning of the 1980s software testing was considered to be superfluous because of upcoming code generation tools and software quality was a strange notion. It seemed only developers had anything to do with testing. Some 30 years later we are in a position to write down our experiences and conclusions of over 7,000 projects in software and systems development, in quality management and quality assurance and in helping companies to improve both their ICT products and processes.

Once we had made the decision to write this book we needed to come up with initial ideas, hold brainstorming sessions and talk to people in the field to get a better understanding of the topics. We were fortunate to have the input of managers, directors and experts and their vision and determination to help us achieve our goals during the entire project. We are greatly indebted to Riccardo Brizzi, Sven Euteneuer, Kai-Uwe Gawlik, René Gawron, Ralph Gillessen, Gireendra Kasmalkar, Shan Rajegopal, Jürgen Stöterau, Thomas Thurner and Detlef Vohwinkel.

As more and more chapters progressed, reviews became essential to improve our lines and thoughts. At this stage, experts from business, ICT, quality management and quality engineering were involved to challenge our reasoning and statements with their experience and knowledge. We are therefore very grateful to Tom Arant, Axel Bartram, Jochen Brunnstein, Viktor Clerc, Phil Codd, Jürgen Diel, Ivan Ericsson, Ben Fry, Rajesh Gidwani, Martin Hamann, Johannes Kreiner, Sven Nordhoff, Sylvia Resetarits, Jeff Schmidt, Evan Sloss, Ian Spurs and Keith Yorkston.

Turning a document consisting of a few chapters into a complete book and getting it published need some final steps. First there is the task of thoroughly reviewing the complete text as to structure and content. We are greatly indebted to Ralph Gillessen, Jeff Schmidt and Phil Tomblin who took the time to make a final review and provided valuable input and feedback. Another task is to formally check references and links and improve illustrations and tables. Many thanks go to Verena Ruckes and Alexander Scheffer for their patience and cooperation in referencing, reviewing and improving layout, text, tables and illustrations.

In a project like this there are many discussions, conversations and informal talks with people who might be forgotten in the above acknowledgements. We therefore extend our gratitude to those colleagues as well. It has been an excellent team approach.



We are proud of what we and those who contributed to this book have achieved.
Martin Wieczorek, Dik Vos, Heinz Bons

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Contents

List of Figures

List of Tables