International Series in
Operations Research & Management Science

Tomas Backström
Anders Fundin
Peter E. Johansson *Editors*

Innovative Quality Improvements in Operations

Springer

International Series in Operations Research & Management Science

Volume 255

More information about this series at http://www.springer.com/series/6161

Tomas Backström • Anders Fundin
Peter E. Johansson
Editors

Innovative Quality Improvements in Operations

Introducing Emergent Quality Management

Springer

Editors
Tomas Backström
School of Innovation, Design and Engineering
Mälardalen University
Eskilstuna, Sweden

Anders Fundin
School of Innovation, Design and Engineering
Mälardalen University
Eskilstuna, Sweden

Peter E. Johansson
School of Innovation, Design and Engineering
Mälardalen University
Eskilstuna, Sweden

ISSN 0884-8289 ISSN 2214-7934 (electronic)
International Series in Operations Research & Management Science
ISBN 978-3-319-55984-1 ISBN 978-3-319-55985-8 (eBook)
DOI 10.1007/978-3-319-55985-8

Library of Congress Control Number: 2017943089

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

In research focusing on innovation, design, and engineering, there is a belief that such research contribute to society with new solutions, products, and services for the future. But what will the future look like? Future scenarios are often based on what we understand from the present and the past. This can be explained by the fact that human beings are largely unable to think of or imagine something that goes beyond their own personal experience. Already in the eighteenth century Immanuel Kant (1724–1802) claimed that we are not able to think of something that we have not experienced personally, whether personal lived experience or something that we have read or heard from other people. Though there is an ongoing intense and lively debate about the negative effects of climate change and limited natural resources, we can hardly imagine a future without oil, electricity, or food supplies—at least not in the Western world; in many parts of the world this is a reality.

Building a better world requires incorporating insights from the fields of design and engineering design, which contribute solutions to help people improve their living conditions. It is often seemingly minor innovations that lead to dramatic increases in living standards. This book was written by researchers or partners in the Innovation and Product Realization (IPR) division within the School of Innovation, Design, and Engineering at Mälardalen University in Eskilstuna, Sweden. The point of departure at IPR is in a vision of Mälardalen University as a contributor of benefits and values in terms of coproduction, internationalization, and academic excellence. IPR is contributing to a sustainable future, societal development, and industrial renewal from a holistic perspective that takes individuals, systems, and global challenges into consideration in both research and education. This vision guides IPR's interdisciplinary research and educational environment, which consists of scholars, teachers, and graduate students with competencies in various scientific and pedagogical disciplines such as engineering, social sciences, humanities, and art.

Contemporary society faces many emerging or increasing challenges for enterprises and other organizations related to professional life. Many organizations must undergo continual development. This book was written as an answer to this challenge, discussing and suggesting approaches to quality management, operations

management, and innovation management to deal with the task of focusing on innovation, to face the future and remain competitive.

Competitors are diverse, depending on the context, and are located around the globe, from non-European countries to North America, Asia, and Africa. Trade agreements can serve to protect individual countries or federations, whereas research often crosses borders and is considered a global activity. Collaboration in research often leads to new results that will have an impact on people, regardless of nationality or cultural background, as long as the economic resources are available. Research can lead to several kinds of innovation: social innovation, in areas such as health care, teaching, and infrastructure; technical innovations; and innovations in processes. Innovation can come about, for example, by incremental improvements in a design process or production system or by radical and disruptive changes.

Digitalization is high on the agenda of most governments in Europe and the European Union, and there are high expectations with regard to digitalization and how it can enhance flexibility in manufacturing within different kinds of organizations. Digitalization will affect professional competencies as well as professional identities. It will probably also change workplace practices in terms of how flexible one can be and at what cost. However, this is a deterministic view of digitalization, and we might think of alternatives. We must also consider how big data and data visualization will affect how we access data and our ability to decode and use data in a relevant and accurate way. A particular visualization may be too complex or too much information may be extracted to give a comprehensible picture of a complex phenomenon. The gap between those who are digitally savvy and those who are not is often overlooked.

Globalization is another challenge faced by contemporary society. This refers not only to globalizations of local companies but also an increased flow of people from other parts of the world with different experiences, cultures, religions, and languages. This can enrich local cultures if immigrants become fully engaged in their new society, but it could also lead to the opposite if the local society refuses to accept the fact that we live in a global society.

Project managers or organizations that have an awareness of how the inclusion and involvement of several perspectives can lead to intellectual growth in organizations in general or a particular project and support creativity and innovation commonly must have a holistic view. This comes from not only various disciplines, for example, the humanities, social sciences, engineering, and design, but also from people´s different experiences. To meet future challenges and contribute to the building of a sustainable society, a holistic perspective, in which societal needs are taken into consideration with regard to humans and the environment, is required. This also demands an ethical perspective where technological developments do not occur in isolation from the local or global context. What impact will a new product or service have on individual lives, on groups, and on the local and global society? What is the role of the university in times of change?

Universities are required to have an impact on society and to collaborate with external parties such as public organizations, companies, and civil society. Collaboration and coproduction with nonacademic parties require other

competencies among academic staff compared with more traditional academic research, especially in coproductive research, since coproduction involves the employer in the external organization of the research, for example, in the framing of a problem, formulating the purpose of the research, and engaging in the actual research activities. Although the purpose of a project may be formulated by an outside company and an academic institution, the two have different obligations, for example, the company needs to solve a specific problem while the academic institution wants to gain deeper and more generic knowledge in a field. Even if a project is conducted as a productive effort and has an impact on the company, it will not necessarily create value for either society or the university. Value is in and of itself a complex concept, but a trivial criterion is that the involved organizations in a project benefit from the result. If a researcher is unable to formulate research questions in relation to his or her own research area, the result will probably not contribute to the actual research area. The university has a responsibility to ask whether and how a research project or proposed learning outcomes will contribute to the local or global society. With regard to Swedish law on higher education, universities must support sustainable development, which is defined as a healthy and respectable environment, economic and social welfare, justice and equality between men and women, and an understanding of other countries and international affairs. To what degree is research responsible to society? Professor Göran Bexell, former vice-chancellor of Lund University, writes that every individual researcher as well as the departments, faculty and the university are responsible for: choice of research subject, methods, effects of the results and to take part in contemporary debates.

IPR works in three different focus areas of research: information design, product and production development, and workplace innovation and quality management. These areas of focus are divided into three subgroups. The Information Design Research Group has a human-centered design perspective; the group creates knowledge and understanding of how space, text, and visuals communicate messages and contributes to the development and renewal of information design. The Product and Production Development Research Group creates knowledge on the renewal and development of products and production systems. The group contributes by understanding and developing factors crucial for a company's competitive capacity. The Workplace Innovation and Quality Management Research Group uses and develops tools and methods for analyzing how to handle and facilitate change processes in which coworkers take part. With an interest in complexity and organizational learning and with a focus on dilemmas in production system designs, the research group contributes to the fields of innovation management, quality management, and operations management. The main part of the research that is conducted in the IPR research environment is done in collaboration with external organizations. To develop the methods for research in coproduction, IPR has established a living lab. Several of the methods described in the book are developed in living labs; see the chapters written by Melkas, Uotila, and Oikarinen (Chap. 6), Chirumalla (Chap. 7), and Schaeffer (Chap. 8).

The main activities in living lab projects include *exploration* with users, *experimentation* with users, and *evaluation* with users. The research at MDH Living

Lab@IPR takes multiple interests into consideration and works with the concept of community of inquiry and in that way involves groups of individuals in the design process in a company or organization. This means that we regard all stakeholders/employees in an organization or in a product life cycle chain as users. All user groups are embedded in social knowledge and codes, in addition to their working skills. We perform these activities in more of a spiral and iterative, rather than sequential, way. It is a process that contains methods for knowledge exchange; however, even though there is an awareness of the importance of knowledge exchange in order to fulfil a coproduction commitment, it is not an easy task. The academic staff struggle with their traditions about what is required from research projects, and external parties do not necessarily have any experience when it comes to research. This could lead to wrong expectations from both sides: the academic staff do not understand what knowledge they need from the external parties to understand the problem, and the external parties do not necessarily know what to share. The aim of the Living Lab@IPR is to develop methods and tools that support not only coproduction but also the co-creation of new knowledge.

The advantage of coproduction must be explored from several perspectives. Studying problems that organizations outside universities deal with leads to opportunities for university researchers to reflect on their own work and to challenge themselves by formulating their knowledge together with an external party in such a way that it may be useful in terms of framing a problem. A theoretical model for higher education institutions is the knowledge triangle, which highlights the relation between research and education in an attempt to spur innovation.

Eskilstuna, Sweden Yvonne Eriksson

Contents

Chapter 1
Introduction

Tomas Backström, Anders Fundin, and Peter E. Johansson

It is well known that the development of successful business and production systems are full of conflicting forces; initiatives that seem conducive to one line of work can be a constraint on another line of work. This kind of dilemma is the core subject of the current book, and by applying alternative perspectives to such dilemmas, the book will present ideas on how these could be managed in organizations. Organizations need to manage a number of challenges in terms of dualities in order to create a contemporary production system, which seems to be key to future innovative quality improvements in operations. The challenges and dichotomies that are addressed in this book are all part of four interrelated processes that together constitute key elements of a contemporary production system:

- The innovation process—creation and implementation of new offerings and solutions
- The production process—production and distribution of offerings and solutions
- The knowledge creation process—emergence and distribution of knowledge
- The value creation process—created customer value based on the offerings and solutions developed

Over the past 40 years, these processes have been highlighted as essential to prioritize and develop in order to survive and thrive as a company. Where the latter part of the last century was characterized by a strong focus on systematic quality work and learning organizations, the early twenty-first century has paid attention primarily to efficient production through, for example, lean production, as well as followed a trend toward increased focus on innovation. All these trends and movements have most certainly had a significant impact on what it means to have a competitive production system in a global market. One problem with these movements,

T. Backström (✉) • A. Fundin • P.E. Johansson
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Tomas.backstrom@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_1

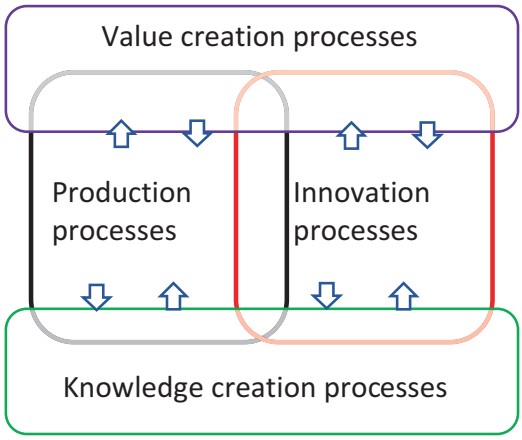

Fig. 1.1 Innovative quality improvement model in a production system context

though, is that to some extent they have been limited to specific departments within a company. In other words, responsibility is distributed to different departments and functions, while the complexity that characterizes today's organizations implies that it is no longer possible to treat their different aspects in isolation. To remain competitive in the long term, evolve with the market, and especially to be at the forefront, companies must have the ability to manage and take multiple aspects into consideration at the same time.

Accordingly, this book focuses on the key processes that have proven to be central to understanding the conditions for the emergence of innovative quality management in a production system context (see Fundin and others in Chap. 2), and in particular how these aspects to a large extent are interdependent and represent each other's prerequisites. Furthermore, this line of reasoning is in many ways reinforced by a recently published Delphi study in Sweden[1] exploring future challenges for quality management within the next 10 years (Eriksson et al., 2016). The results section identifies three challenges that are among the top six ranked challenges in the Swedish study: To make organizations agile and adaptable to rapid changes within the business, to develop an improvement culture within organizations, and to develop processes that are robust while still easily adaptable.

The relationship between the four processes differs depending on which process is being focused on (Fig. 1.1). The processes of innovation and production can partly be seen as two parallel processes that are linked to each other in that the former refers to activities for the creation and development of new offerings/solutions (product/service or new methods/tools) while in the latter, the focus is on how these offerings/solutions are produced and distributed to potential customers. The link between the two processes in terms of innovation and production of new products can be designated as industrialization. The knowledge creation process and value

[1]A similar Delphi study conducted by the American Society for Quality (ASQ) inspired the Swedish study; ASQ carried out its study in 22 countries with approximately 2000 respondents (ASQ, 2013).

creation process, however, are of a different nature than the former two in the sense that they can be seen as being embedded within the explicit processes of innovation and production. The embedded processes constitute the prerequisites for, as well as consequences of, activities undertaken as part of the production and innovation processes. For example, exploration and exploitation of new knowledge is a prerequisite for the development of both new offerings and approaches to producing and distributing them. Similarly, value creation in the form of perceived value to the customer is related to both the process that is the basis for the development of new offerings and the production process.

What is important to emphasize, though, is that these processes are not restricted to any department or part of an organization. Instead, within, for example, a production unit, all four processes are essential to understand and need to be taken into consideration and managed to enable prosperous development. In this book, a basic assumption is that all four processes need to be understood and taken into consideration in order to enable innovative quality improvements: knowledge creation, value creation, production, and the innovation process. Accordingly, the different chapters of the book will give examples of the different processes.

To understand the dynamics that exist within and between each of the four processes is a recurring theme in the research literature within operations management, innovation management, and organizational theory. Within each process a number of fundamental dilemmas have been identified, and the dilemmas are usually described as dichotomies. Dichotomies can be understood as two opposing positions. Moreover, some dichotomies are understood as being two opposing positions at the outer ends of a continuum, and these are interpreted as being mutually exclusive. However, even if there seems to be contradictions between the positions, the relationships between the positions are not fundamentally mutually exclusive. On the contrary, in the case of a pair of dichotomies, they can coexist without any conflict due to the fact that the different parts focus on different processes of the production system. Examples of the former are organizational procedures that, on the one hand enable the achievement of stability in production, which makes for predictability and enables organizational members to act in similar ways, and, on the other hand, that must allow room for change that allows the business to adapt to the various production needs. The contradiction, however, lies in the procedures that are favorable to stability, such as standardized work, are seen as restricting change. However, other researchers have shown that it is not necessarily that one excludes the other (Adler et al., 2009; Feldman & Pentland, 2003), but that the outcome depends somewhat on how we understand these kinds of processes. This in turn depends on what perspective is used, which is further elaborated on in the remaining chapters of the book.

At first glance, there might seem to be substantial overlap between the dichotomies identified for each process; in addition, different dichotomies are usually often simplified and applied by making them synonymous. An example of this is the dichotomy of radical and incremental that commonly is made synonymous with the dichotomy of exploration and exploitation. However, based on our understanding of these key concepts, they represent different phenomena, even though in many

Table 1.1 The four processes and related dichotomies

Key processes of production system	Example of dichotomies		Type of phenomenon
Production process (explicit process)	Stability	Change	*Production activities* Focus on how production and distribution of offerings are made in a functional way
Innovation process (explicit process)	Control	Creativity	*Innovation activities* Focus on activities that develop new offerings and solutions
Knowledge creation process (embedded process)	Exploitation	Exploration	*Amount of knowledge* Focus on different types of learning and knowledge creation that takes place in a system embedded in production and innovation processes
Value creation process (embedded process)	Efficiency	Effectiveness	*Amount of value* Focus on extent to which and in what ways customer value is created as part of production and innovation processes

respects they are interrelated. The dichotomy between radical and incremental refers to what we describe as different property values, that is, the concepts on their own relate to the magnitude of something. When this something is related to improvement and innovation, the dichotomy expresses the degree of change or new value created per unit of time. Based on James March's definition (March, 1991), the distinction between exploration and exploitation refers to the dichotomy between two types of learning in organizations, that is, the difference lies in what is taught and how something is taught in an organizational context. In this context, the connection to radical and incremental change is close to the learning process and a potential outcome that can be evaluated based on the degree of change in the production system. However, if we do not make the effort to separate different processes and dichotomies from each other, the important nuances get lost with a high risk of reducing the complex events that constantly are present in practice (Table 1.1).

The Orchard as a Metaphor: Putting the Four Processes into Context

To give a simplified understanding of how the four processes of a production system interrelate to each other, the metaphor of an orchard full of fruit trees will be used. The production and innovation processes represent different aspects of the trees in the orchard. The production process is about how trees produce fruit using resources like sunlight, water, and minerals from the soil. The innovation process is about how trees grow and evolve. The knowledge creation process, in contrast, is the gardener

of the orchard, who learns about gardening and uses her knowledge to support the production and innovation processes. And the value creation process is the manager of the orchard who decides what type of fruit to grow and which markets the orchard should target to maximize customer value. This means that both the production and the innovation process are about the trees of the orchard and as such are explicit and easy to observe and identify as they evolve. While both the knowledge and the value creation processes are embedded as support functions, formed in contact with the gardening practices and aimed at optimal conditions for the orchard, they are therefore more subtle and harder to observe and identify.

The production process focuses on the value of the fruit produced. A prosperous orchard will produce fruits of higher value than a bad poor orchard. The objective is to maximize the value from the fruit under existing conditions. This seems like a simple objective. One way to reach it is to have an orchard with only one type of tree that produces the highest amount of fruit value under prevailing conditions. The manager decides which type of fruit has the highest value in the market, and the gardener chooses the kind of tree that will produce the most fruit of the given type. Such an orchard will have a stable production of one type of fruit. But this is a very fragile solution since conditions vary over time. Next year the climate could be different, and other varieties of this kind of fruit tree would produce more fruit, or the market might be different and another type of fruit would be more valuable. To be able to deal with changes over time, it might be better to cultivate both different kinds of fruit, as well as different varieties of each fruit, and to have parts of the orchard set up for planting new kinds of fruit trees. However, too much preparation for future changes will yield too little fruit at the moment. A dichotomy for the production process is thus stability and change.

The innovation process focuses on the amount of growth and development of each tree. The more new branches and the more each branch grows, the more growth. The orchard will acquire bigger trees with the potential to bear more fruit. This seems like a simple objective. The more that is created, in terms of new shoots from the tree, which then develop into branches, the better. But this will lead to trees using most of their resources for growth. Less will be left for the production of fruit. The creativity will thus have to be controlled and managed. For example, it would be better to let only those shoots that are growing in a certain direction blossom and develop into branches, which will then have the potential to develop the trees' capacity to bear fruit. But this requires high-level gardening skills, meaning the gardener will have to know how to prune properly, as too much or too little pruning may be very harmful to tree. They could wither and die. A dichotomy in the innovation process is thus creativity and control.

The knowledge creation process focuses on the activities of the gardener, where her mental representation of what a tree is and how it produces fruit is used and developed. A tree could also serve as a metaphor for her mental representation. The more knowledge the gardener has, the bigger the tree, and the richer its network of branches, the higher the potential to add new knowledge in a place where it is needed and can be useful. A highly developed knowledge tree that has grown by the addition of new knowledge to its structure over several years, will be good to exploit

in gardening; when the gardener exploits her tree of knowledge, new details will be learned and assimilated into the tree. However, when, for example, the manager suggests that new types of fruit be cultivated, parts of the old tree of knowledge will become nonfunctional. It will no longer be enough to exploit existing knowledge. The gardener must seek out new knowledge, and this activity may very well challenge the entire structure of the existing tree of knowledge. A new tree may have to be created, a later version of the tree of knowledge. At best, the new tree will include all valid old knowledge, but in a more suitable structure. However, a challenge is to prune and shape a tree that will be able to grow both the new and old types of fruit. Thus, exploration is an important activity, but if the gardener is only exploring for new knowledge and never exploiting the existing knowledge to use, this will not be good for the orchard. A dichotomy in the knowledge creation process is thus exploitation and exploration.

The value creation process focuses on the activities of the orchard manager, where she is developing the orchard value for the customer. This activity's effectiveness is very important. If everything is done in the best possible way, customers will be able to buy the fruit at the lowest possible price and in very good condition; in other words, the customer will experience a high degree of satisfaction. The manager must make sure, for example, that resources are used efficiently, waste is minimal, all fruits reach the customer in good condition, and there are few intermediaries to pay. For this reason, the manager might choose to grow a type of fruit that is easy to produce and transport in large quantities. But perhaps customers will want some other fruit, one that is tasty and healthy. The value to the customer will then be low, even though the efficiency of the orchard is high and costs are low. Efficiency and doing the right thing are also important for delivering value to the customer. The manager must know what types of fruit customers value and make sure the orchard produces them. But producing the right fruit at too high a cost or in poor condition is not good enough either. A dichotomy in the value creation process is thus effectiveness and efficiency.

Outline of the Chapters

The following chapters in different ways address the previously identified core processes of a production system and its related dichotomies.

In Chap. 2 Fundin, Bergman, and Elg provide an overview of the history of the quality movement and the challenges it faces today. The originators of the movement set out to show that achieving quality production requires both effective production with low variation and processes of innovation that will make it possible to surpass customer expectations. However, practices addressing quality in operations once focused heavily on achieving low variation. Modern quality management, though, needs to be able to achieve both low variation and customer satisfaction, and as a solution the authors propose an ambidextrous perspective on the dichotomies.

Automation is a well-established means of industrial competiveness, but it is also challenged by the need for operational flexibility. In Chap. 3, Wiktorsson, Granlund, Lundin, and Södergren give evidence on how manufacturing companies face a number of dilemmas while reaching flexibility by automation. The dilemmas are described based on an empirically driven interview and workshop study with five internationally competitive manufacturing companies. The chapter provides insights on long-standing challenges while implementing automated solutions in manufacturing, and these need to be managed because manufacturing automation will continue to increase.

The involvement of all employees in development work has become a common approach to organization, often based on the belief that all resources should be utilized. In Chap. 4 Johansson addresses the challenges that arise when new tasks become part of employees' everyday workload as they engage in development. Four different ways to organize development work are presented. One conclusion is that development work needs to be treated as a domain-specific competence in itself, which in turn needs to be distributed throughout the organization. With a limited distributed competence for development work, guidance or coaching is needed.

In Chaps. 5, 6, 7, and 8, different ways of working and methods are introduced. Chapter 5 directs focuses mainly on the innovation process, and particularly on manufacturing process innovation. Yamamoto dichotomizes Kaikaku (radical innovation) and Kaizen (continuing work with incremental innovation) as two different, but equally important, activities in production system development. It is shown that Kaikaku and Kaizen rather reinforce each other than constitute a dilemma that must be managed. For example, all employees are normally engaged in a Kaikaku and receive increased competence through their participation, which can later be used in Kaizen work.

In Chap. 6, Melkas, Uotila, and Oikarinen introduce new methods that enable iterative transitions between exploration and exploitation, thereby facilitating the innovation process. The chapter is based on three empirical examples of renewal work in Finnish manufacturing. Two methods are used, innovation sessions and research-based theatre methods, and the chapter shows that making practices and sequences visible and voicing diverse views are essential to organizations' use of the potential hidden in everyday working life.

Learning from experience has become essential for all manufacturing companies if they are to tackle constant changes in their operations. Many companies devote considerable effort to capitalizing on experience through initiatives such as postproject reviews, continuous improvement programs, or lessons-learned practices. In Chap. 7, however, Chirumalla shows that these approaches have failed to address the distinct, complex settings of production and operations, where much of the learning is still of a tacit nature and difficult to articulate. A new method for lessons-learned practice is proposed based on case studies in the aerospace industry.

Chapter 8 addresses the innovation process from the perspective of the room. In this chapter Schaffer explores how space creates different conditions for work. For example, lean production is supported by one type of room and innovation work by another. Six different kinds of space that enable both radical and incremental innovation are

proposed based on empirical research, and they are described in detail. The chapter also elaborates on the need for a participative change process to attain desirable results in the development of workspaces.

Based on the experience and knowledge gained in this book, Chap. 9, by Backström, introduces a synthesis of four ways for an organization to address dichotomies in their development process. It concludes with the formulation of a new paradigm for the quality movement: emergent quality management (EQM). In EQM, dichotomies are no longer treated as dilemmas to be managed; instead, the interaction between the two parts of the dichotomy are important for creating a functional dynamic of the system.

Finally, in Chap. 10, the editors discuss the chapters from the perspective of EQM and draw conclusions with ideas for a prosperous future for innovative quality improvement in operations.

References

Adler, P., Benner, M., Brunner, D., MacDuffie, J. P., Osono, E., Staats, B., Takeuchi, H., Tushman, M., & Winter, S. (2009). Perspectives on the productivity dilemma. *Journal of Operations Management, 27*(2), 99–113.

American Society for Quality. (2013). *The 2013 ASQ Global State of Quality Research*. Milwaukee, WI: American Society for Quality.

Eriksson, H., Gremyr, I., Bergquist, B., Garvare, R., Fundin, A., Wiklund, H., Whester, M., & Sörqvist, L. (2016). Exploring quality challenges and the validity of excellence models. *International Journal of Operations and Production Management, 36*(36), 1201–1221.

Feldman, M. S., & Pentland, B. T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly, 48*, 94–118.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87.

Chapter 2
The Quality Dilemma: Combining Development and Stability

Anders Fundin, Bo Bergman, and Mattias Elg

A Quality Dilemma: Combining Operational Development and Company X's Production System
Within company X there are two main initiatives managing quality: Company X's Production System (XPS) and Company X's Operational Development (OD) program.

Commonality
Both programs aim at the involvement of all employees in the improvement of work that is strategically important for meeting customer demands. These programs foster cultures of improvement in terms of promoting visions of the future and they present principles that are important to follow as a means for achieving a desired future state. The programs train change agents that support both the initiatives of new programs and coaching in currently running programs.

A. Fundin (✉)
School of innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: anders.fundin@mdh.se

B. Bergman
Chalmers University of Technology, Göteborg, Sweden

M. Elg
Linköping University, Linköping, Sweden

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_2

The XPS Program

XPS training programs include important principles to follow, for example, how to improve the quality of products and how to reduce the lead time in production. The program focuses on introducing a common way of working within production in order to increase employee safety and to facilitate balance in the production flow to decrease variations in lead time. It is important to follow the principles; otherwise the XPS system will not work properly. XPS Facilitator training programs aim for an understanding of what principles are important to follow. The overall aim of the program is to satisfy customers.

The OD Program

OD training programs, on the other hand, include important principles to foster an improvement culture and to establish inclusiveness, creating new and better solutions to problems. OD change agents are trained to measure inclusiveness and promote the idea that different kinds of knowledge are important to foster an improvement culture; the more variation the better. Each OD program must come with its own unique setup to establish program ownership. The principles behind OD programs focus on leadership skills rather than follow a certain predefined structure that is deemed correct. OD train-the-trainer programs are designed so that change agents shape their own toolbox useful for driving change depending on different situations. The overall aim of the program is also to satisfy customers.

Dilemma Combining XPS and OD

All things considered, both OD and XPS are important, but they are very difficult to combine. XPS and OD training programs on change agents differ considerably, and rarely are the same people trained to coach both types of programs. The dilemma is that while XPS has an interest in decreasing variation through standardization and fostering a common way of working through principles, OD has an interest in increasing variation and in that way foster a way of believing that unique OD programs are the way forward to the creation of ownership and an improvement culture. XPS programs, on the other hand, do not allow unique programs with variations in design; as long as the system's principles are followed, then companies will be on the right path. For many years there has been on the agenda a need to strategically design a combination of these two different programs to manage change, but all attempts have so far failed. For example, which program is the main program and which is just a contributor? Should XPS be the program to build on using OD value principles or vice versa? The change agent training programs remain the same, which makes it very difficult for change agents to handle situations with

initiative and coach two different programs that are meant to complement each other, but instead compete each other, both philosophically and in practice. This also raises the quality dilemma; both programs are equally valid means of satisfying customers since customers have widely varying customer needs; still, the means differ and they are very difficult to combine.

The Quality Dilemma: What Is It?

Among many definitions of quality, this chapter aims to use the word as defined from the customers' perspective: Quality of a product is "...its ability to satisfy, or preferably exceed, the needs and expectations of the customer" (Bergman and Klefsjö, 2010). By this definition the quality dilemma is also presented as a dilemma regarding how to simultaneously satisfy customers not only through efficiency, to do things right, but also through effectiveness, to do the right things. Any change management approach must meet requirements in daily operations in organizations. Some operational activities will remain and some will need to transform into a new, attractive desirable state. Since being launched by Walter A. Shewhart (Shewhart, 1931, 1939), the quality movement has been developing for more than 80 years. Even if Shewhart (1931) already addressed the need for a distinction between objective and subjective measurements of quality, the quality movement has developed further toward a deeper interest in actually managing the quality dilemma. As stated by Shewhart: "*From the viewpoint of control of quality in manufacture, it is necessary to establish standards of quality in a quantitative manner…This does not mean, however, that the subjective measure is not of interest. On the contrary, it is the subjective manner that is of commercial interest*" (Shewhart, 1931). From a movement that started out being about quality control and means to decrease variation in processes and products (Taguchi, 1993), the quality movement has progressed through means to increase variation to extend products and services to attract a broader base of customers (Kano, Seraku, Takahashi, & Tsuji, 1984; Kano, 2001). The book *Managing Quality* by Garvin (1988) described quality management as an even more multifaceted concept by addressing the importance of not only products, but also services and intangibles as means of satisfying customers. During the 1980s, to help organizations maintain a high quality standard, the ISO9001 Quality Management standard was launched and further adopted during the early 1990s as a way to ensure that things would continue to be done in the right way (Guler, Guillén, & Macpherson, 2002), but not necessarily that the right things would be done from the customer's point of view.

However, few issues are characterized by as much disagreement as the *role* of quality management in the development of organizations. Deming's call for a transformation of management style and of governmental relations with industry has been around for 30 years but the central problem still revolves around the central issues of productivity and innovation (Deming, 1994). In the wake of the quality

movement, a new management philosophy grew with a shift toward customers and the processes that deliver value (Shewhart, 1931). Though this philosophy has been important for many companies in staying competitive and effective, it has also received criticism. In a context where organizations need to focus on short-term results and financial performance, the notion of quality has been associated with standardization, internal efficiency, and efforts to reduce variance that in effect inhibit innovative efforts. The classic study of Abernathy (1978) showed that in the automotive industry, a decline in a firm's financial performance was directly related to its productivity efforts. He argued that in order to compete over time, a firm must be able to both be effective and innovative simultaneously. In another context, Frey (2006) argues that service organizations need to manage involvement by customers; the argument is that quality in terms of both effectiveness and efficiency is dependent on intervention. It is challenging, and this is also where the quality dilemma comes into play. A common interpretation is that quality management is allied with the variance reduction and efficiency orientation of the firm and therefore, as a consequence, the argument goes, supports exploitation activities at the expense of exploration (Benner & Tushman, 2003).

Still, the problem addressed by Shewhart (1939) and other main proponents of quality such as Kano (Kano et al. 1984, Kano, 2001), Ishikawa (1990), Deming (1994), and Juran and Godfrey (1999) was not primarily related to a firm's need to create conditions for its internal efficient use of resources but to enable creative efforts of finding solutions that fit the needs of customers. All else is secondary. Thus, the quality dilemma can be posed as a question: Is it possible for organizations to focus on quality as a means to achieve both efficiency and effectiveness? If so, in what ways can organizations manage their efforts in this direction?

In this chapter we discuss this quality dilemma that has occupied both scholars and practitioners for a long time. Although we have a positive bias toward quality movement and its various principles and practices, we, the authors of this chapter, try to take a bird's-eye view and critically examine various tendencies and approaches. This means that we take seriously the critique among prominent scholars who have developed theories about dual organizational capabilities (exploration and exploitation). Our basic argument is that quality management may become an agent that supports dual organizational capabilities.

In what follows, several propositions concerning the quality dilemma are addressed and challenged:

1. Quality management is associated with adaptive advantage in simple situations only and is ineffective in complex situations.
2. Quality management is associated with standardization and variance reduction activities only and for that reason is opposed to innovation.
3. Quality management is relevant in predictable production environments only and does not work well in unpredictable production contexts.

Hence, the objective of this chapter is to problematize the strategic management of both efficiency and effectiveness through quality management through a discussion on the potential effects that could be unleashed in strategies for quality

management. First, the chapter describes five cases with lessons learned from the dichotomy of efficiency and effectiveness on how quality management could be turned into either a constructive or a destructive dilemma. Then, the history of the quality movement and how it has developed during the last century is discussed briefly. Quality management will be considered in relation to organization theory regarding exploration, exploitation, and dual organizational capabilities. Finally, the chapter concludes with proposals on ways forward for quality management as a strategy for both short-term efficiency and long-term effectiveness and survival.

Quality Improvement Management as a Strategy to Manage Dual Organizational Capabilities

It seems that quality management is used in different ways depending on the context and the problem to solve. To manage the dilemma regarding the fact that quality management as a concept is used in many different ways, this chapter will introduce a quality *improvement* management program as a manifestation of a strategy to manage the potential in dual organizational capabilities. However, the constituents of such a strategy cannot stand alone but instead must be integrated into contemporary quality management ideas and practices. Based on the work of Shewhart, Kano, Ishikawa, Deming, and Juran, a new era of quality management practices has been introduced.

To advance quality management work to higher levels in organizations, business excellence models have been introduced, for example, Malcolm Baldridge National Quality Award (MBNQA) and European Foundation for Quality Management model (EFQM) (Bou-Llusar, Escrig-Tena, Roca-Puig, & Beltrán-Martín, 2009). The development of excellence models has initiated national initiatives, for example, the model developed by the Swedish Institute for Quality (SIQ). Change management has been a constant focus and organizations strive to find new ways to increase the pace of change, in both the private and public sectors, but still with different results, however. One famous initiative to increase the pace of change, which occurred during the same time period in which ISO 9000 and MBNQA were introduced, is the company Motorola's initiative of developing the Six Sigma program concept. In this effort, Motorola was followed by Allied Signal, IBM, and General Electric (Aboelmaged, 2010). However, Six Sigma programs were introduced as structured quality improvement management programs project by project, and the focus of such programs was not really on organizational improvement and innovation capabilities. Additionally, during the 1990s, the total quality management (TQM) concept became popular based on insights of Deming (1994) and Juran and Godfrey (1999). An in-depth review by Dean and Bowen (1994) shows how the total quality concept can be described through principles, practices, and techniques focusing on the customer, teamwork, and continuous improvement (Dean & Bowen, 1994). In practice, however, contemporary quality improvement management programs seem to have a bias towards efficiency (to do things right) on the cost of effectiveness (to do the right things).

To further strengthen the concept of quality management, based on the Toyota Production System (TPS), lean production (LP) was introduced as a way to structure operational work based on principles (Likert, 2004; Womack, Jones, & Roos, 1990); this in turn would facilitate standardized work in operations but also allow for change management through process improvements (Marodin & Saurin, 2013). Among many techniques, value stream mapping (VSM), Kaizen Events, and 5S are just a few of the many approaches to managing change through LP (Adler et al., 2009; Holweg, 2007; Osterman & Fundin, 2014; Shah & Ward, 2003, 2007). Many researchers have discussed the distinction between LP, Six Sigma, and TQM, for example, Andersson, Eriksson, and Torstensson (2006). A common denominator among the three, however, is that they all are different examples of programs that require knowledge and competence on how to manage change through efficiency and effectiveness.

In parallel with the development and introduction of business excellence models, organizational learning became a topic of interest for many scholars (Garvin, 1993; Senge, 1990). It became evident that rigid structures were not capable of managing sustainable change in organizations. Systems thinking and leadership behavior became pillars in approaches to fostering a quality culture and emerged as built-in constituents in change management. The research in these fields was not new—see for example Weick (1979)—but the interest from business scholars in learning how to apply and put the theories into practice became a focus, as did what actually makes sense in organizations (Argyris, 1993; Argyris & Schön, 1996; Cole & Scott, 2000; Schön, 1983; Weick, 1995; Weick, 2000). Managing change through knowledge creation in organizations using not only explicit knowledge but also tacit knowledge of employees was now the focus (Nonaka, 1994; Nonaka & Takeuchi, 1995). Theories on organizational learning were further elaborated, and an important link to the quality movement was made by Cole (2001) and, a few years later, by Lee and Cole (2003), who introduced probe-and-learn as a complement to the old quality management philosophy of doing it right the first time. An interesting observation in the exploratory study of the development of the Linux computer operating system revealed that it was important to involve users in change processes and that more failures early in the change process created a sound learning environment with an ultimately innovative result (Cole & Scott, 2000). The pace of change is now in focus and in line with the research of Weick (2000), theories on organizational adoption of innovations are held to be important in building sustainable organizational learning (Hargadon & Eisenhardt, 2000). In this conception, change processes serve as building blocks for organizational learning and prerequisites to foster a creative climate. Building on the theories of March, an important distinction is made here between effectiveness and efficiency (March, 1991); exploratory strategic change processes aim at effective products or service solutions, whereas exploitative processes are about effectiveness through the execution and refinement of existing processes. These ideas are further explored in change management theories that aim to find a balance and determine the *dynamics* between the concepts of effectiveness and efficiency (Gupta et al., 2006), in other words, organizations face challenges in ambidextrously managing the pace of change (Raisch et al., 2009). From a quality management perspective one can interpret this as making distinctions between

Kaikaku (exploration) vs. Kaizen (exploitation) (Yamamoto, 2013), or radical improvement (exploration) vs. continuous improvement (exploitation) (Stålberg & Fundin, 2016; Stålberg, 2014). As indicated and as illustrated in previously mentioned cases, even if the literature shows examples of how contemporary programs and excellence models should be able to manage dual capabilities in organizations that aim for both effectiveness and efficiency, this is still a challenge in practice. What quality management does in practice and what it is capable of are two different things. Because this chapter has an interest in the latter, Table 2.1 shows an overview and examples of contemporary quality management strategies instituted as quality *improvement* management programs aimed at developing the full potential for adapting dual organizational capabilities (Table 2.1).

Managing the quality dilemma of effectively creating value for customers while still aiming for effectiveness and robustness through quality improvement management programs is not an easy task, however; this dilemma has a lot in common with the so-called productivity dilemma; when quality management is biased toward short-term efficiency, it is at the cost of long-term effectiveness. The effectiveness–efficiency dilemma can take many forms, however; the following section will introduce cases and lessons learned to put the dilemma into different perspectives.

Cases and Lessons Learned

What are the potential scenarios in the dilemma of managing quality for both effectiveness and efficiency? How does one get the most out of a strategy for quality management utilizing the full potential of this dualism that seems so difficult to combine?

To simplify the complexity in these scenarios, we describe them according to three common challenges. To stay competitive organizations must develop quality management abilities to:

1. Work efficiently within a standard
2. Develop the efficiency through incremental improvements
3. Manage effectiveness through innovations and radical improvements

In other words, the following examples illustrate the extent to which the potential of quality management is utilized in terms of efficiency and effectiveness.

Illustrative Destructive Dilemmas

Case A Analog Devices—a producer of integrated circuits (Sterman et al., 1997).

Following implementation of a TQM program, this company made large improvements in quality and productivity. Still, even with the program in place, the company underperformed in revenue growth, profit, and market capitalization compared with

Table 2.1 Examples of contemporary quality improvement management programs and different approaches to efficiency and effectiveness

Quality improvement management program	Practice and organization	Techniques for measurement and evaluation	Approaches to efficiency—focus on low variation in processes	Approaches to effectiveness—focus on customer satisfaction
Six Sigma	Improvement of processes by reducing variation, project by project, based on customer demands Six Sigma project managers and coaches (Six Sigma Black Belt, Green Belt, Yellow Belt and White Belt) support the process improvement work within the organization Experts manage projects in an isomorphic organization (Schroeder, Linderman, Liedtke, & Choo, 2008)	Customer-oriented metrics and financial metrics: Process capability measurements, critical-to-quality metrics, financial measures, and strategic measures (Schroeder et al., 2008)	Focus on low variation in existing processes (Benner & Tushman, 2015) Reduce variation in all processes Reduce costs	Development of products and services that surpass customer expectations(Kano et al., 1984; Kano, 2001) Priority of projects by translation of customer demands using quality function deployment (QFD) (LePrevost & Mazur, 2005) Integrate with TQM programs (Klefsjö, Wiklund, & Edgeman, 2001)
Lean Production program (LP)	Define value for customers in any process (Holweg & Pil, 2005) Lean Facilitators, Coaches and Trainers. LP usually organized plant wise through a support structure Large organizations have usually central Lean offices with trainers	Production system assessments, low number of failures, level of standardized work	Focus on waste, takt time, standardized work, and common way of working	Focus on value creation Support innovation thinking in teams and do new things in new ways (Bessant & Francis, 1999) Promote creativity in teams to achieve agility (Alves, Dinis-Carvalho, & Sousa, 2012) Build a highly committed lean culture (Angelis, Conti, Cooper, & Gill, 2011)

TQM program	Continuously prevent failures and fostering an improvement culture. Development of products, processes, and individuals Involvement of all employees using ordinary organizational structure. Trainers and coaches at central TQM offices usually headed by a quality manager	Employee satisfaction surveys, customer satisfaction surveys, cost of poor quality measures, process capability measurements	Focus on internal processes and internal and local improvement cultures (Sterman, Repenning, & Kofman, 1997)	Invite users in development processes to induce a probe-and-learn behavior (Lee & Cole, 2003) Define customer feedback loops for continuous innovation and development of future offerings (Fundin & Elg, 2010)
Operational excellence (OE) models, for example, MBNQA, EFQM, and SIQ	Values principle of interest: Leadership, customers, people, processes, improve and innovate, agility, management by facts, systems approach and perspective, results, relations with partners and suppliers, and sustainability Trained internal and external OE experts support management teams and process owners through evaluation of the performance of the organization Prize ceremony for high performers	Assessment of compliance to models through auditing	Focus on low variation in existing processes and compliance with current internal standards (Benner & Tushman, 2003; 2005)	Seek new business opportunities and increase market share through innovation. Increase variation in response to new customer demands (Akao & Mazur, 2003)

(continued)

Table 2.1 (continued)

Quality improvement management program	Practice and organization	Techniques for measurement and evaluation	Approaches to efficiency—focus on low variation in processes	Approaches to effectiveness—focus on customer satisfaction
ISO 9000 series	International standard and support on how to manage a business in a structured way geared toward customer satisfaction The standard focuses on needs, and a business adapts its ways of working in unique quality management system Involvement of all employees using ordinary organizational structure Auditors in central quality departments and local departments	Assessment of compliance to standard through auditing 2nd and 3rd part auditing	Focus on low variation on existing processes (Benner & Tushman, 2002) and compliance with current internal standards Organize for fulfillment of customer demands Establishment of routines and standard way of working Documentation, calibration, and control of processes	Implement processes to better understand future customer needs Organize to surpass customer demands Customer satisfaction measures define the efficiency of the quality management system

Even if practical applications are biased toward efficiency, contemporary quality improvement management programs also have a potential managing effectiveness

competitors. The reason for implementing an innovative quality improvement program was that a 5-year target was missed, even though the yearly sales grew at an average rate of just below 30%. The company based its program on principles promoted by Deming (1986), Feigenbaum (1983), Garvin (1988), and Shiba, Walden, and Graham (1993) compiled in an extensive TQM training program. Processes for managing root-cause analysis and process improvements were initiated together with balanced scorecards (Kaplan and Norton, 1996; Kaplan and Norton 2007) linked with financial results.

The results improved significantly; there were fewer defects, and on-time delivery yields decreased by almost 50%. However, the time for product development had not decreased significantly, and the stock price dropped by about 75% between 1987 and 1990. Furthermore, the operating income suffered a large decline in the same time period. Owing to the financial situation at the company, the TQM program was ignored and it suddenly became the basis for a restructuring of the company.

This case shows an example of how a company using a quality management strategy broke down in a complex system, at the expense of customer needs. The TQM program did not achieve the desired effects in product development because in operations the idea of TQM become embedded in a strategy of efficiency only. The case turned into an interesting dilemma. The success of quality management embedded in efficiency only is not sufficient as long as customer value creation suffers. In other words, the efficiency of the TQM program was reflected in the cost of the effectiveness of long-term business operations. All in all, the company was able to manage challenge 1 but had difficulties managing challenges 2 and 3.

Case B Nippon Telegraph and Telephone (NTT)—Increased demands for reliability on the cost of innovation (Cole & Matsumiya, 2007).

The Japanese dynamic random-access memory (DRAM) production industry peaked at almost 80% of the global market share in 1989, but 15 years later that share was down to only 10% (Cole & Matsumiya, 2007). The focus on reliability was high on the agenda for many years, and producers aimed for a durability of up to 25 years. NTT as a major customer of Japanese producers was also the primary driver of producer standards. A differentiation strategy toward reliability proved to be successful in the early 1980s, and this was further elaborated on by prevailing quality departments. Control and inspection steps became a natural part of standardized development processes (Cole & Matsumiya, 2007). The case is very much in line with the productivity dilemma addressed by Abernathy (1978), and Benner and Tushman (2003) describe this dilemma as being about how process management includes activities that are beneficial for organizations in stable contexts. However, process management enables some types of innovation, such as incremental and exploitative innovation, which is unlike radical, architectural, or exploratory innovation, and tends to prevent experimentation. When the DRAM industry shifted to personal computers and consumer products, the pathway of a reliability strategy was very difficult to change when speed to market and cost became totally new market demands (Cole & Matsumiya, 2007).

What, then, is the solution to this dilemma of process management? Japanese DRAM producers had strong internal customers with high demands for reliability; in other words, they were operating as subunits in larger organizations. New customer demands were not passed through to these subunits. This case describes a dilemma involving organizational ambidexterity where some subunits focus on efficiency only and other subunits are connected only through management teams. Quality management is embedded in efficiency and short-term survival at the cost of effectiveness and long-term adaptation to new market opportunities with new customers. It also illustrates an example of a success trap when recognition is linked with current strategies only; in other words, it shows the risk of having "…too much of a good thing" (Cole and Matsumiya, 2007). The case also shows how a company is able to manage challenges 1 and 2, while still having difficulties with challenge 3 and with managing effectiveness through innovations and radical improvements.

Case C Facit—lack of decisions for long-term survival (Starbuck & Milliken, 1988).

In the 1950s the Swedish company Facit was one of the world's largest producers of mechanical and electromechanical office machines. It had a reputation for manufacturing high-quality products. During the period from the late 1950s to the late 1960s, Facit experienced a period of success with high growth and expansion throughout the world. The CEO of Facit, Gunnar Ericsson, led the effort with a focus on strengthening the brand and the marketing organization. International cooperation was also high on the agenda. In the early 1970s the success story rapidly transformed into one of economic crisis. Sales dropped when new competitors, predominantly from Japan, entered the market. Facit, which produced mainly mechanical office machines, did not match up against the relatively cheaper electronic machines. Although collaboration with Japanese companies was pursued during this era, Facit did not manage to make the necessary transformation. The joint operation with the Japanese company was in fact negative for Facit since the products were found to be of low quality.

One of the explanations of why Facit did not manage the necessary transition from being a high-quality producer of mechanical office machines to the new electronic technology was the presence of interorganizational problems in the top management. The team had long-term and personal relations that "kept them from making accurate decisions at an accurate point in time." Quality management became embedded in efficiency only, and decisions about long-term survival and effectiveness were lacking. In other words, even if the company was able to manage challenges 1 and 2, it still had difficulties with challenge 3, which would have been the only way to survive in this case.

Illustrating Constructive Dilemmas

Case D The productivity dilemma—expansion and integration: how contradictory forces sustain productive tension at Toyota (Adler et al., 2009).

The productivity dilemma as described by Emi Osono and Hirotaka Takeuchi in Adler et al. (2009) emerges from the fundamentally contradictory dichotomy of effectiveness and efficiency. Based on empirical research that includes over 200 interviews in 11 countries, the study describes how Toyota manages the productivity dilemma through conflicting forces (Osono, Shimizu, & Takeuchi, 2008). Instead of passively coping with conflicts, the company "*…actively embraces and cultivates contradictions.*" It seems that Toyota "*…actually thrives on paradoxes*" (Adler et al., 2009). The company "*…harnesses opposing propositions to energize itself*" and it becomes a way of life (Adler et al., 2009). Even if the company has a structured way of managing operations through the Toyota Production System (TPS), a quality management system, a supply chain management system, and certain approaches to conducting product development through, for example, concurrent engineering, a union of unique perspectives creates new knowledge and disagreements are sought; see also, for example, Nonaka and Takeuchi (1995) and Takeuchi and Nonaka (2004). Nevertheless, it is essential to understand the organic whole. The company seems to be good at managing the duality of forces for expansion and for integration. The cultivation of forces for expansion and effectiveness are innovation, stretched goals, experimentation and local customization, whereas cultivating of forces for integration and efficiency are part of the founder's philosophy, the company nerve system, and human resource management (Adler et al., 2009).

The paradox in this way of thinking is interesting; instead of using past experience of success as a way forward, the way of working is continuously challenged, which brings about continuous improvement and constant renewal. In other words, the six forces driving disequilibrium in organizational performance and quality management are used for both efficiency and effectiveness. This case is a good example of how a company is able to work with all three challenges: working efficiently within a standard, developing efficiency through incremental improvements, and managing effectiveness through innovations and radical improvements.

Case E Intermountain Healthcare for sustainable change through prompt performance feedback (Daneryd, Stenberg, & Elg, 2014).

Intermountain Healthcare consists of a high-performing healthcare system in the United States, mainly in Salt Lake City, Utah. Intermountain has for more than 25 years been building an organizational culture with strong values focusing on continuous improvement. The result is high-quality care at a lower cost than most other health systems in the United States. By as early as the 1960s, Intermountain Healthcare had started to develop and deploy information technology as a means to providing high-quality healthcare. This enabled a unique tradition of decision support both for care and management. By embedding quality management in clinical practice, Intermountain Healthcare managed to combine both efficiency and effectiveness in its efforts to produce high-quality healthcare. How has this been achieved?

The pioneering work of process orientation started when leading actors from the Institute for Healthcare Improvement (IHI) investigated variations in practice of a range of treatments and their results. Evaluation criteria were based on clinical quality, utilization of finances, and hospital efficiency. The team from Intermountain

discovered significant variations in the way doctors treated patients even though their patients basically had the same characteristics. This led to a deliberate and all-encompassing effort to standardize care within the healthcare system. Although inspired by the quality movement regarding efficiency in industry, the team from Intermountain Healthcare innovated new, more effective ways of managing clinics. Initial guidelines were based on process mapping of current practices and research-based knowledge. Through performance feedback these guidelines were refined in a process where clinical practitioners together decided on new ways of working. This is known as shared baselines and provides a powerful tool for measuring and controlling variations in practices. The standardized processes, defined by the profession itself, are then continuously revised as new knowledge from research or practice is identified. This way of using quality management provides a dynamic and unique way of being both effective in care delivery and efficient by simultaneously paying attention to new opportunities for healthcare service development. All in all, Intermountain Healthcare seems to be able to work with all three challenges, and the company shows how the development of efficiency could be beneficial without sacrificing effectiveness.

To sum up the five illustrative cases: why is it still so difficult to learn from the past? Even if the illustrative constructive dilemmas could show good practices with respect to unleashing quality management's full potential, they are still very difficult to identify and even more difficult to simply copy. As discussed earlier, the quality dilemma has much in common with the so-called productivity dilemma that has been discussed by business scholars for more than 40 years. This commonality provides a convenient segue to the next section, which also discusses potential ways to address the quality dilemma as an important building block in the quality movement.

The Quality Dilemma and the Quality Movement: Potential Pathways

The productivity dilemma had already been addressed by Abernathy and Wayne (1974), and Abernathy (1978) described this as a paradox in which short-term efficiency yields profits at the cost of long-term effectiveness. A few years earlier, Duncan (1976) had also addressed this dilemma emphasizing the need for organizations to designing dual structures for innovation. The dilemma was at the same time also addressed by Ackoff (1979) using a systems perspective on how to predict the future and simultaneously be able to prepare organizations for it. In other words, there must be decision support for effectiveness, learning, and adaption, along with other requirements besides those that support efficiency (Ackoff, 1981). Hence, management and business scholars have discussed the dilemma for many years, and the award-winning paper by Benner and Tushman (2003) brought new insight on how this dilemma affects organizations initiating strategies for process management. Later, Adler et al. (2009) revisited the theme through a number of cases from

Toyota with lessons learned on how to use the dichotomy of exploration and exploitation for both efficiency and effectiveness. The authors conclude with a number of insightful perspectives that go back to the management of dynamic capabilities in organizations and organizing for ambidexterity. The interest in the research by Benner and Tushman (2003) was so high that *Academy of Management Review* published a 10-year-anniversary paper with reflections on the productivity dilemma from the last decade (Benner and Tushman 2015). Revisiting the dilemma led to the conclusion that the business situation had changed and that an important aspect to consider had emerged: the innovation climate with an aim toward fostering open innovation using the Internet and the mass media (Benner & Tushman, 2015).

Thus, even though organizational ambidexterity has been a research topic for several years, interest in it seems to be increasing (Gupta et al., 2006; Raisch et al., 2009; Benner & Tushman, 2015). The ambidextrous capacity of an organization refers to the organization's ability to strategically manage dichotomies *simultaneously*, dichotomies such as differentiation and integration, individual and organization, static and dynamic, and internal and external (Raisch et al., 2009). From a quality management perspective, the idea of managing dichotomies simultaneously has a history of variation thinking; an organization strives for both increased variation through the exploration of current and future customer needs (Kano et al., 1984; Kano, 2001) while at the same time being able to exploit and retain stability and low variation in internal processes, as per the seminal work by Taguchi (1993).

The quality dilemma of using quality management for both development and stability has been on the research agenda for a while. For example, Shewhart used a scale of objectivity and subjectivity, so that object quality drives low variation in processes while subjective quality is of commercial interest (Shewhart, 1931, 1939). Several decades later, Adler and Cole (1993) showed how the quality dilemma could be addressed through different ways of organizing based on studies on how the NUMMI plant initiated LP. Adler, Goldoftas, and Levine (1999) also showed how different organizational mechanisms could be used to manage the dilemma of balancing flexibility and efficiency through metaroutines, partitioning, switching, and ambidexterity. In line with this, Adler (1999) proposed the design of enabling structures and bureaucracies for increased employee involvement. Similar ideas were discussed by Adler et al. (1999) using the case of Toyota, which seems to have had success in managing the paradox of efficiency and effectiveness. What is particularly interesting in Toyota's case is how training and trust are used in combination with structures, procedures, and rules.

As stated by March, the challenge has to do with the organization's capacity to manage exploration and exploitation *simultaneously* (March, 1991). Organizations strive to be innovative and, in doing so, to increase the numbers of products and services it offers as a means of fulfilling or even surpassing customer expectations (Kano et al., 1984; Kano, 2001; Fundin & Elg, 2010). At the same time, customers expect high-quality products and services, which implies internal processes with low variation (Taguchi, 1993). Instead of formulating a strategy for quality management in isolation, depending on whether increased or decreased variation is currently needed, this chapter aims at developing a more holistic perspective on a

supporting framework for conscious long-term strategic decision making through quality improvement management; this implies strategies designed to use knowledge about how to manage both increased and decreased variation simultaneously. The idea has much in common with interesting research by Muhammad and de Vries (2015) and Luzon and Pasola (2011) attempting to show how the role of quality management in creating ambidexterity can be related to quality management practices.

A long-term strategy for managing quality variation requires an understanding of what are the effects of different quality models, practices and techniques. Many different quality management concepts and programs are available; still, it is difficult to know how to strategically select from among them and later adopt the many quality management models at hand to reach the full desired effect (Andersson et al., 2006). Table 2.1 shows examples of the dual capability in many quality management programs and concepts; however, they have a history of being strategically selected to either decrease variation in processes *or* increase variation through, for example, flexible product and services. This way, there is an unleashed potential in quality management programs, for example, TQM programs, Six Sigma programs, and LP programs from a variation perspective. For example, Six Sigma programs decrease variation in processes through process capability measurement techniques, but these programs could also have the potential to *define opportunities* for future customer solutions and at the same time increase variation and gain market share (Klefsjö et al., 2001). Moreover, LP programs are more often used as a means to decrease variation in processes through, for example, takt time, standardized work, and 5S programs, but they also have the potential to explore new values for customers and in that way increase variation (Alves et al., 2012; Stålberg & Fundin, 2016). Another example is how TQM programs are adopted; they have a tendency to foster decreased variation in processes through standardized processes, but these programs also have the potential to increase variation through an open culture, employee empowerment, and executive commitment (Powell, 1995). In other words, it seems to be a challenge to view processes as things requiring ambidexterity that demonstrate robustness and agility simultaneously.

The aforementioned programs that organizations strategically select for managing quality are seldom selected to *complement* each other for different purposes (Andersson et al., 2006). It takes time and effort for employees to understand why the different concepts are selected and why the organization has selected only one concept for managing change through various quality management models and the definition on quality varies (Sousa & Voss, 2002). How, then, could the different concepts be adopted in parallel? Looking at quality management from a variation perspective through quality improvement management, could only one model be sufficient to fulfill the strategic purposes of a business? In other words, could quality improvement management be a path forward for organizations to decrease *and* increase variation simultaneously through new perspectives on strategic quality management?

Organizations want processes to be robust with low variation but at the same time agile enough that they can seize new opportunities for both current and future customers to enhance marketplace performance (Eriksson et al., 2016). Still, the

question remains of how to strategically select different quality management models based on their ambidextrous capability to drive the business to a higher level of both effectiveness and efficiency. A dilemma that many organizations face is the challenges of using many different quality management programs given that these models tend to compete with each other. Instead of looking at the different models in isolation, how might they complement each other, managing change from a quality management perspective for both short-term efficiency and long-term effectiveness? These questions lead to the next section on potential enablers for both stability and development.

Enablers of Importance for Managing Both Stability and Development

The presented constructive dilemmas emphasize a systems approach to improving an organization's dynamic capabilities. In a review of quality management literature together with an analysis of the illustrative cases, a number of enablers for both stability and development stand out. The enablers are described as dichotomies of value principles. Choosing one value principle seems to be harmful to an organization. It is understandable that managing enablers is not an easy task; nevertheless, it seems to be a potential path forward as a way to challenge the quality dilemma. Enablers require organizations to be stable but at the same time be open to change and be able to adapt to new customer demands. The most important observation, however, is that contradictions seem to be in play simultaneously and not sequentially:

1. Organize based on customer satisfaction: *process management* (stability) AND *agility* through continuous, prompt customer feedback (development);
2. Short-term and long-term customer perspective: *satisfy current customers* (stability) AND *future potential customers* (development);
3. Utilization of dynamic capabilities within organizations through incremental and radical improvement: *standardization* (stability) AND *flexibility* (development);
4. Management through a systems approach: *global philosophies* (stability) AND *local adaptations* (development);
5. Management decisions for survival: decision making for both *short-term efficiency* (stability) AND *long-term effectiveness* (development).

Interpretations and different meanings are further discussed using the aforementioned dichotomies as potential strategic enablers in a taxonomy for managing a new paradigm for quality management. The new paradigm is emergent and is built on a need to challenge the initial propositions that introduced this chapter. Emergent quality management is further theorized and elaborated on in this book, and in what follows the enablers put the new paradigm into the context of the quality movement.

Enablers for Emergent Quality Management

While earlier observations provide examples of how exploratory initiatives are consciously initiated through decisions by top management (Dawson, 2004; Osono et al., 2008), a new paradigm calls for enablers that facilitate transitions triggered by individuals and teams. The proposed enablers are not exclusive to any specific quality improvement management strategy; instead they show examples of a foundation for the adoption of any strategy. Three different modes are proposed: Mode I: adopt quality management embedded in exploitation to foster effectiveness only; Mode II: adopt quality management in exploration to foster effectiveness only; Mode III: (which describes the ideal state for operations): adopt quality management as a strategy for both effectiveness and efficiency. In Mode III decisions are taken as a means for utilizing the full potential in quality management; in this mode emergent quality management is valued as a pathway toward both stability and development (Table 2.2).

Discussion: What Is Next?

The phenomenon that already was described as a dilemma of managing standardization and development almost 40 years ago by Duncan (1976), Abernathy and Wayne (1974), Abernathy (1978), and Ackoff (1979) is still in motion. Literature and illustrative cases show that the quality dilemma is yet to be solved and a management decision-support system is still needed regarding the issue of how to challenge the dilemma through life cycles of products and services.

Managing strategic enablers for emergent quality management is not an easy task. For example, how does one predict the life cycles of products and services in a way that makes one better prepared when effectiveness meets efficiency in organizations? The limits of the learning curve by Abernathy and Wayne (1974) may provide some guidance, but how much time is spent on future exploratory visions while challenges for exploitation is high on the agenda for management teams? This way, still with the knowledge that quality management embedded in exploitation and efficiency will only cause robust processes but with a cost on agility. How can this be turned into a constructive dilemma that, *consciously, continuously, and simultaneously*, processes are managed that are both robust and agile? Adler (1999) has an interesting perspective on how to better design bureaucratic organizations as enablers, which has much in common with the ideas in the quality movement and the call for a transformation of management style (Deming, 1986). The organization should be a means for effectively exploiting what customers want and must simultaneously be able to explore new, effective opportunities while delivering on what has already been promised. The opposite path would be of a more coercive organizational design that only nurtures a mechanistic culture, fostering exploitation at the expense of exploration (Adler & Borys, 1996). These ideas are close to the research

Table 2.2 Managing the quality dilemma through a taxonomy with strategic enablers and three different modes

Quality management strategy enablers for duality	MODE I Quality management embedded in exploitation for efficiency only	MODE II Quality management embedded in exploration for effectiveness only	MODE III Emergent quality management for both efficiency (do things right) and effectiveness (do the right things)
Process management (efficiency) AND agility through continuous, prompt customer feedback (effectiveness)	Processes show stability, efficiency, and low variation	Processes show effectiveness and agility	Robust processes show both stability in being able to deliver current technology and agility in being able to adopt new technology
Satisfy current customers (effectiveness) AND potential customers (efficiency)	Current products and services supplied—fulfillment of current customer demands	High variability of products and services—surpassing customer expectations and focus on attracting new customers	Over life cycles of products and services, supply of products and services that both fulfill and surpass customer expectations. Focus on both current and future customers
Standardization (effectiveness) AND flexibility (efficiency)	Kaizen, quality circles—small incremental improvements	Kaikaku, business process improvement—radical improvements	Small incremental improvements managed simultaneously with radical improvements depending on needs (internal and external customer needs)
Global philosophies (effectiveness) AND local adaptations (efficiency)	Closed predictable quality management system—building an exploitation culture (mechanistic organization)	Quality management system open to change—building an exploration culture (organic organization)	Building a culture that fosters both a mechanistic and organic organization depending on needs (internal and external customer needs)
Decision making for both efficiency AND effectiveness	Base decisions on facts that influence current situation to drive efficiency	Base decisions on knowledge that influences future scenarios and effectiveness (toward vision statements)	Base decisions on facts and on knowledge for both current short-term and future long-term scenarios (toward vision statements). Base decisions on facts to enable efficiency and on knowledge to enable effectiveness in operations

Mode III describes situations for emergent quality management

by Spencer (1994) on models for organization for TQM; these models are described as mechanistic, organismic, or cultural. The models show how different organizational models derive different meanings for management teams and employees in the pursuit of a variety of goals, structural rationality, and definitions of quality.

Quality management programs should be enabling and empowering; instead they tend to fall into functions as a coercive means of domination and exploitation. Standardized ways of working build trust, but if the time between value-added work is continuously calculated with new targets to decrease waste, the trust can easily be dissipated (Adler et al., 2009). From a quality management perspective, the challenge seems to be how to organize for a quality strategy without using a coercive approach to managing others. Short-term profits and effectiveness seems to have an effect on long-term benefits and efficiency according to the productivity dilemma as described by Abernathy (1978). Being involved in a vision for a future increased level of trust and standardized work enabled by quality management should be more of a facilitator for innovation instead of being embedded in a mode of exploitation only. As per the illustrative destructive dilemmas, it is easy to be embedded in a mode that shows short-term gains through effectiveness with recognitions for a job well done, but long-term it will have a dramatic effect on future profits and efficiency for customers (Benner & Tushman, 2003, 2015; Sterman et al., 1997). The principal quality management values can be used for different means and, consequently, with different results. It is easy to fall into a mode where operational decisions on quality management compete with strategic decisions. In its place, the formulation of strategic approaches to emergent quality management should include ideas on both effectiveness and efficiency with both current and future customers in mind. At the same time, a systems approach shows agility and the organization must be open to exploratory opportunities or threats, avoiding the risk of falling into an illustrative case of a destructive dilemma.

With similar ideas, but in another context of companies, Steiber and Alänge (2016) focused on the entrepreneurial organization that is dynamic and able to work with both effectiveness and efficiency. Their research is based on observations from Tesla Motors, Google, Apigee, Facebook, LinkedIn, and Twitter (Steiber & Alänge, 2016). There are mainly three ways of managing this type of organization: by many inside the organization, innovation by separate innovation units, or through open innovation approaches. The model, which they call the Silicon Valley Model, fits well in a rapidly changing world but also shows a possible transformation from management through a bureaucracy model to management through an adhocracy model, which gives some interesting perspectives on how to manage a company. The organization optimizes the combination of daily operations and effectiveness with innovation and efficiency. In this way, the organization functions as a system that integrates research and development, production, and sales and marketing. The model seems to work well in high-turbulence markets in developing companies. The illustrative destructive dilemmas in this chapter originate from companies with a long history of producing goods, though, and it seems that this history is pushing quality management toward effectiveness only. In these old-fashioned companies with a long history of quality management program initiatives, how can they then

organize for emergent quality management strategies? Adler et al. (2009) emphasize the importance of *coexisting with contradictions*. A quality management program should be used in such a way as to disrupt the organizational equilibrium. This seems to be the case at Toyota, which continuously uses six different forces for expansion and forces for integration. For example, while global philosophies are used as a force for integration, local adaptation is used as a force for expansion, and the nerve system meets experiments with new ideas on how to improve efficiency. Similarly, Intermountain Healthcare seems able not only to work efficiently within a standard and to develop efficiency through incremental improvements but also to manage effectiveness through innovations and radical improvements; working with all three challenges simultaneously seems to be a successful strategy, though it is not an easy task.

What, then, are potential risks on the journey toward emergent quality management? As per the initial dilemma of combining two different programs for quality management, there is always a risk of competition. Instead of continuously initiating "new" ways of managing quality, what sort of potential can be unleashed in the one quality management program that already is initiated and up and running? The examples of quality improvement management programs in Table 2.1 all have a strong customer focus, though they have different means on how to get there. How can these programs evolve through enablers for emergent quality management? By continuously introducing new programs for managing quality does not seem to be the right formula for finding a commitment on teams that seek pathways toward increased effectiveness and efficiency. More important questions to ask are, for example, what is the current culture for managing quality, and what is the outlook for the future?

On the other hand, is there a risk associated with too much efficiency? The illustrative cases in this chapter do not suggest so; the quality dilemma seems to carry a risk of being embedded in exploitation and effectiveness only. A potential risk, however, could be that one is searching for a balance between the two ways of managing quality. Still, while emergent quality management is an extremely challenging task, it is not about either/or but both/and, to consciously, continuously, and simultaneously managing efficiency and effectiveness upon demands from customers and users. What is even more difficult is to offer customers more than they were expecting. According to Deming, "It will not suffice to have customers that are merely satisfied. A satisfied customer may switch…It is necessary to innovate, to predict the needs of the customer, give him more" (Deming, 1994).

References

Abernathy, W. J. (1978). *The productivity dilemma roadblock to innovation in the automobile industry*. Baltimore: Johns Hopkins University Press.

Abernathy, W. J., & Wayne, K. (1974). Limits of the learning curve. *Harvard Business Review, 52*, 109–119.

Aboelmaged, M. G. (2010). Six Sigma quality: A structured review and implications for future research. *International Journal of Quality and Reliability Management, 27*(3), 268–317.

Ackoff, R. L. (1979). The future of operational research is past. *The Journal of the Operational Research Society, 30*(2), 93–104.
Ackoff, R. L. (1981). *Creating the corporate future: Plan or be planned for*. New York, USA: John Wiley & Sons Inc.
Adler, P. S. (1999). Building better bureaucracies. *The Academy of Management Executive, 13*(4), 36–47.
Adler, P. S., Benner, M., Brunner, D. J., MacDuffie, J. P., Osono, E., Staats, B. R., Takeuchi, H., Tushman, M. L., & Winter, S. G. (2009). Perspectives on the productivity dilemma. *Journal of Operations Management, 27*(2), 99–113.
Adler, P. S., & Borys, B. (1996). Two types of bureaucracy: Enabling and coercive. *Administrative Science Quarterly, 41*(1 (Mars)), 61–89.
Adler, P. S., & Cole, R. E. (1993). Designed for learning: A tale of two auto plants. *Sloan Management Review, 34*(3), 85–95.
Adler, P. S., Goldoftas, B., & Levine, D. I. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization science, 10*(1), 43–68.
Akao, Y., & Mazur, G. H. (2003). The leading edge in QFD: Past, present and future. *International Journal of Quality and Reliability Management, 20*(1), 20–35.
Alves, A. C., Dinis-Carvalho, J., & Sousa, R. M. (2012). Lean production as promoter of thinkers to achieve companies agility. *The Learning Organization, 19*(3), 219–237.
Andersson, R., Eriksson, H., & Torstensson, H. (2006). Similarities and differences between TQM, six sigma and lean. *The TQM magazine, 18*(3), 282–296.
Angelis, J., Conti, R., Cooper, C., & Gill, C. (2011). Building a high-commitment lean culture. *Journal of Manufacturing Technology Management, 22*(5), 569–586.
Argyris, C. (1993). *Knowledge for action, a guide to overcoming barriers to organizational change*. San Francisco: Jossey-Bass Publishers.
Argyris, C., & Schön, D. A. (1996). *Organizational learning II, theory, method, and practice*. Reading: Addison-Wesley.
Benner, M. J., & Tushman, M. (2002). Process management and technological innovation: A longitudinal study of the photography and paint industries. *Administrative Science Quarterly, 47*(4), 676–706.
Benner, M. J., & Tushman, M. L. (2003). Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of management review, 28*(2), 238–256.
Benner, M. J., & Tushman, M. L. (2015). Reflections on the 2013 decade award – exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of management review, 40*(4), 497–514.
Bergman, B., & Klefsjö, B. (2010). *Quality from customer needs to customer satisfaction* (3rd ed.). Lund, Sweden: Studentlitteratur AB.
Bessant, J., & Francis, D. (1999). Developing strategic continuous improvement capability. *International Journal of Operations and Production Management, 19*(11), 1106–1119.
Bou-Llusar, J. C., Escrig-Tena, A. B., Roca-Puig, V., & Beltrán-Martín, I. (2009). An empirical assessment of the EFQM Excellence Model: Evaluation as a TQM framework relative to the MBNQA Model. *Journal of Operations Management, 27*(1), 1–22.
Cole, R. E. (2001). From continuous improvement to continuous innovation. *Quality Management Journal, 8*(4), 7–33.
Cole, R. E., & Matsumiya, T. (2007). Too much of a good thing? Quality as an impediment to innovation. *California Management Review, 50*(1), 77–93.
Cole, R. E., & Scott, W. R. (2000). *The quality movement & organization theory*. London: Sage Publications Inc..
Daneryd, P., Stenberg, J., & Elg M. (2014). *Intermountain Healthcare – Styrning för kvalitet i ett högpresterande system*, Research report, Sveriges Kommuner och Landsting.
Dawson, C. (2004). *Lexus: The relentless pursuit*. Hoboken, NJ: John Wiley & Sons.
Dean, J. W., & Bowen, D. E. (1994). Management theory and total quality: Improving research and practice through theory development. *Academy of Management Review, 19*(3), 392–418.

Deming, W. E. (1986). *Out of the crisis*. Cambridge, MA: Massachusetts Institute of Technology, Center for Advanced Engineering Study.

Deming, W. E. (1994). *The new economics for industry, government and education* (2nd ed.). Cambridge, MA: Massachusetts Institute of Technology Center for Advanced Engineering Study.

Duncan, R. B. (1976). The ambidextrous organization: Designing dual structures for innovation. In R. H. Kilmann, L. R. Pondy, & D. Slevin (Eds.), *The management of organization design: Strategies and implementation* (pp. 167–188). New York: North Holland.

Eriksson, H., Gremyr, I., Bergquist, B., Garvare, R., Fundin, A., Wiklund, H., Whester, M., & Sörqvist, L. (2016). Exploring quality challenges and the validity of excellence models. *International Journal of Operations and Production Management, 36*(36), 1201–1221.

Feigenbaum, A. V. (1983). *Total quality control*. New York: McGraw Hill.

Frey, F. X. (2006). Breaking the trade-off between efficiency and service. *Harvard Business Review, 84*(11), 92–101.

Fundin, A., & Elg, M. (2010). Continuous learning using dissatisfaction feedback in new product development contexts. *International Journal of Quality & Reliability Management, 27*(8), 860–877.

Garvin, D. A. (1988). *Managing quality: The strategic and competitive edge*. New York, USA: The Free Press.

Garvin, D. A. (1993). Building a learning organization. *Harvard Business Review, 71*, 78–91.

Guler, I., Guillén, M. F., & Macpherson, J. M. (2002). Global competition, institutions, and the diffusion of organizational practices: The international spread of ISO 9000 quality certificates. *Administrative Science Quarterly, 47*(2), 207–232.

Gupta, A. K., et al. (2006). The interplay between exploration and exploitation. *The Academy of Management Journal, 49*(4), 693–706.

Hargadon, A. B., & Eisenhardt, K. M. (2000). Speed and quality in new product development: An emergent perspective on continuous organizational adaptation. In R. E. Cole & W. R. Scott (Eds.), *The quality movement and organization theory*. Thousand Oaks, CA: Sage Publications.

Holweg, M. (2007). The genealogy of lean production. *Journal of operations management, 25*(2), 420–437.

Holweg, M., & Pil, F. K. (2005). *The second century: Reconnecting customer and value chain through build-to-order moving beyond mass and lean in the auto industry* (1st ed.). Cambridge: MIT Press Books.

Ishikawa, K. (1990). *Introduction to quality control*. London: Chapman & Hall.

Juran, J. M., & Godfrey, A. B. (1999). *Juran's quality handbook* (5th ed.). New York, USA: McGraw-Hill.

Kano, N. (2001). Life cycle and creation of attractive quality. In J. J. Dahlgaard & S. M. Park Dahlgard (Eds.), *Quality management and organizational development (QMOD) conference proceedings*. Linköping, Sweden: Linköping University.

Kano, N., Seraku, N., Takahashi, F., & Tsuji, S. (1984). Attractive quality and must-be quality. *Hinshitsu, 14*(2), 39–48. (in Japanese).

Kaplan, R. S., & Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review, 76*(1), 75–85.

Kaplan, R. S., & Norton, D. P. (2007). Using the balanced scorecard as a strategic management system. *Harvard Business Review, 85*(7/8), 150–161.

Klefsjö, B., Wiklund, H., & Edgeman, R. L. (2001). Six Sigma seen as a methodology for total quality management. *Measuring Business Excellence, 5*(1), 31–35.

Lee, G. K., & Cole, R. E. (2003). From a firm-based to a community-based model of knowledge creation: The case of the Linux kernel development. *Organization Science, 14*(6), 663–649.

LePrevost, J., & Mazur, G. H. (2005). Quality infrastructure improvement: Using QFD to manage project priorities and project management resources. *International Journal of Quality and Reliability Management, 22*(1), 10–16.

Likert, J. K. (2004). *The toyota way – 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill Professional.
March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 75–93.
Marodin, G. A., & Saurin, T. A. (2013). Implementing lean production systems: Research areas and opportunities for future studies. *International Journal of Production Research, 51*(22), 6663–6680.
Moreno Luzon, M. D., & Valls Pasola, J. (2011). Ambidexterity and total quality management: Towards a research agenda. *Management Decision, 49*(6), 927–947.
Muhammad, A., & de Vries, H. J. (2015). Creating ambidexterity through quality management. *Total Quality Management and Business Excellence, 26*(11-12), 1226–1241.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science, 5*(1), 14–37.
Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How japanese companies create the dynamics of innovation*. New York: Oxford University Press.
Osono, E., Shimizu, N., & Takeuchi, H. (2008). *Extreme toyota*. Hoboken, NJ: John Wiley & Sons.
Osterman, C., & Fundin, A. (2014). Exploring approaches how to measuring a lean process. *Organization - Journal of Management, Information Systems and Human Resources, 47*(3), 132–142.
Powell, T. C. (1995). Total Quality Management as competitive advantage: A review and empirical study. *Strategic Management Journal, 16*(1), 15–37.
Raisch, S., et al. (2009). Organizational ambidexterity: Balancing exploitation and exploration for sustained performance. *Organization Science, 20*(4), 685–695.
Schön, D. A. (1983). *Reflective practitioner. How professionals think in action*. New York: Basic Books.
Schroeder, R. G., Linderman, K., Liedtke, C., & Choo, A. S. (2008). Six sigma: Definition and underlying theory. *Journal of operations Management, 26*(4), 536–554.
Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Currency Doubleday.
Shah, R., & Ward, P. T. (2003). Lean manufacturing: Context, practice bundles, and performance. *Journal of operations management, 21*(2), 129–149.
Shah, R., & Ward, P. T. (2007). Defining and developing measures of lean production. *Journal of operations management, 25*(4), 785–805.
Shewhart, W. A. (1931). *Economic control of quality of manufactured product*. New York: D. Van Nostrand Company, Inc..
Shewhart, W. A. (1939). *Statistical method from the viewpoint of quality control*. Graduate School of the Department of Agriculture: Washington, D.C.
Shiba, S., Walden, D., & Graham, A. (1993). *A new american TQM: Four practical revolutions in management*. Portland, OR: Productivity Press.
Sousa, R., & Voss, C. A. (2002). Quality Management re-visited: A reflective review and agenda for future research. *Journal of operations management, 20*(1), 91–109.
Spencer, B. A. (1994). Models of organization and total quality management: A comparison and critical evaluation. *Academy of management review, 19*(3), 446–471.
Stålberg, L. (2014). *A supportive framework for successful implementation of improvement work*. Licentiate: Mälardalen University.
Stålberg, L., & Fundin, A. (2016). Exploring a holistic perspective on production system improvement. *International Journal of Quality & Reliability Management, 33*(2), 267–283.
Starbuck, W. H., & Milliken, F. J. (1988). Executives perceptual filters: What they notice and how they make sense. In D. Hambrick (Ed.), *The executive effect: Concepts and methods for studying top managers* (pp. 35–65). Greenwich, CT: JAI Press.
Steiber, A., & Alänge, S. (2016). *The silicon valley model: Management for entrepreneurship* (1st ed.). Berlin: Springer.

Sterman, J. D., Repenning, N. P., & Kofman, F. (1997). Unanticipated side effects of successful quality programs: Exploring a paradox of organizational improvement. *Management Science, 43*(4), 503–521.

Taguchi, G. (1993). *Taguchi on robust technology development: Bringing quality engineering upstream*. New York: American Society of Mechanical Engineers.

Takeuchi, H., & Nonaka, I. (2004). Knowledge creation and dialectics. In H. Takeuchi & I. Nonaka (Eds.), *Hitotsubashi on knowledge management*. Singapore: John Wiley & Sons (Asia).

Weick, K. E. (1979). *The social psychology of organizing*. Reading: Addison-Wesley Publishing Company.

Weick, K. E. (1995). *Sensemaking in organization*. California, USA: Sage Publications.

Weick, K. E. (2000). *Quality Improvement – a sensemaking perspective*. In R. E. Cole & W. R. Scott (Eds.), *The quality movement and organization theory*. Thousand Oaks, CA: Sage Publications.

Womack, J. P., Jones, D. T., & Roos, D. (1990). *The machine that changed the world*. New York: Free Press.

Yamamoto, Y. (2013). *Kaikaku in production toward creating unique production systems*. Doctoral thesis, Mälardalen University.

List of Recommended Literature for Further Reading

Adler, P. S., Benner, M., Brunner, D. J., MacDuffie, J. P., Osono, E., Staats, B. R., Takeuchi, H., Tushman, M. L., & Winter, S. G. (2009). Perspectives on the productivity dilemma. *Journal of Operations Management, 27*(2), 99–113.

Benner, M. J., & Tushman, M. L. (2015). Reflections on the 2013 decade award – exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of management review, 40*(4), 497–514.

Spencer, B. A. (1994). Models of n and total quality management: A comparison and critical evaluation. *Academy of management review, 19*(3), 446–471.

Steiber, A., & Alänge, S. (2016). *The silicon valley model: Management for entrepreneurship* (1st ed.). Berlin: Springer.

Chapter 3
Automation and Flexibility: An Apparent or Real Dilemma?

Magnus Wiktorsson, Anna Granlund, Mats Lundin, and Birgitta Södergren

The Relentless Drive Toward Automation

Automation was a foundation of the Industrial Revolution and a known tool for improving competitiveness, especially in manufacturing. There are many reasons to justify automation, such as the increase in labour productivity, reduction in labour costs, mitigation of the effects of labour shortages, reduction or elimination of routine manual and clerical tasks, improvements in worker safety, improved product quality, reduced lead time and the accomplishment of processes that cannot be done manually. These benefits are general and rely on the proper use and implementation of automation. In addition to the broad range of automation success stories leading to breakthrough products, revenues and wealth, history is full of examples of automation misuse with bad social, environmental or economic consequences.

Companies face numerous issues, dilemmas and decision points during the design and development of automated solutions to manufacturing. The trade-offs between costs and capabilities of each specific automated or semi-automated solution are tightly linked to the overall strategy and profile of a given manufacturer. Back in 1969, Skinner pointed out the importance of these operational decisions to a company's future:

> What appears to be routine manufacturing decisions frequently come to limit the corporation's strategic options, binding it with facilities, equipment, personnel, basic controls and policies to a non-competitive posture, which may take years to turn around.

M. Wiktorsson (✉) • A. Granlund
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Magnus.wiktorsson@mdh.se

M. Lundin
Swerea IVF, Mölndal, Sweden

B. Södergren
IPF, Uppsala University, Uppsala, Sweden

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_3

This is even truer today since flexibility is one of the most sought-after properties in modern manufacturing systems (Jain, Jain, Chan, & Singh, 2013).

The dream combination of efficiency and flexibility has been the basis of discussions for decades within operations management and manufacturing strategy. This dream combination of functional requirements has been met by concepts such as flexible manufacturing systems, advanced manufacturing technology, adaptive manufacturing systems and evolvable production systems, all describing automated solutions providing this combination of flexibility and efficiency to end users.

Efforts from different areas have also been presented to relate flexibility to technology initiatives on a more strategic level. McDermott and Stock (1999) relate Denison and Spreitzer's (1991) four ideal cultural orientations to the implementation of advanced manufacturing technology (such as automation). The four orientations *Group* culture, *Developmental* culture, *Rational* culture, and *Hierarchical* culture are positioned in a competing values framework where the first dimension contrasts flexibility with control and stability; and the second dimension in the framework reflects internal versus external focus, where the internal dimension emphasizes the maintenance and improvement of the existing organization, while the external emphasizes competition, adaptation and interaction with the external environment.

It is concluded that an internal orientation (as seen in Group and Hierarchical cultures) was negatively associated with competitive benefits from automation implementation, while at least one type of externally oriented culture (Rational and Development) was positively associated with such benefits.

Still, the challenge of balancing flexibility and aspects such as complexity at the operations management level is ever present (Chryssolouris, Efthymiou, Papakostas, Mourtzis, & Pagoropoulos, 2013) and underexplored (Mishra, Pundir, & Ganapathy, 2014), and few empirically driven studies have been conducted that discuss the actual trade-offs made between flexibility and automation (driving complexity) in operational technology management.

In a review of the literature on the evaluation and selection of advanced manufacturing technologies (such as automation), Goyal and Grover (2012) concluded that very few models have been built to measure the effectiveness of automation. Justification and selection models are also very complex and require large-scale computations, which may make their practical use almost impossible. Also, few models address the fit to the organisational culture, while the importance of finding solutions that best fit the given prerequisites and needs is made clear (Winroth, Säfsten, & Stahre, 2007; Granlund & Jackson, 2013). In response to a lack of easy-to-use methods for making sound automation decisions and selection of automation initiatives, Baines (2004) has developed a nine-step process for technology acquisition, and Thomassen, Sjøbakk, and Alfnes (2014) presented a five-step process for selecting automation technology projects that are designed for simple and efficient use. The process mainly addresses the early phases of the technology selection process and contributes to an improved understanding of how companies can systematically select appropriate automation initiatives.

The aim of this chapter is to detail how the apparent conflicts between automated solutions and maintaining a high operational flexibility is managed throughout

specification, implementation and operation in discrete manufacturing companies. It is based on the presumption that automation and digitalisation of manufacturing will continue to increase, changing the scope of industrial automation, and be an even more central part of every manufacturing operator's, engineer's and manager's daily life.

A Study of Automation in Swedish Manufacturing Companies

An interview and workshop study was conducted at the Swedish sites of five international manufacturing companies, previously presented by Wiktorsson, Granlund, Lundin, and Södergren (2016). All five companies were part of large multinational corporations which had product ownership (including research and development, product development, manufacturing and sales) and were manufacturing development organisations with automation experience. One interview was done at each site, involving a total of 15 respondents representing managers, engineers and operators. The interviews focused on operator involvement, collaboration, competence needs and work content throughout three automation phases, preferably for a specific automation case:

(1) Definition, specification and purchasing of automated solutions;
(2) Implementation and test of automated solutions;
(3) Continuous operations and improvement of automated solutions.

Informants were encouraged to provide responses freely. After the interviews, the results were analysed in order to describe any trade-offs between flexibility and automation described during the interviews. Different dimensions of flexibility and different aspects of automation were identified and grouped into six tentative trade-off situations based on statements from the interviewees. These initially identified six trade-off situations were presented as part of a more comprehensive full-day workshop with participation from the companies. The representation in the workshop included managers, operators, union representatives and human resources, totalling 18 individuals. The purpose of the workshop was to facilitate a second round of discussion on the findings from the interviews and to support the definition of more general trade-off situations. After the workshop, the initially described trade-offs were merged and grouped into four more detailed apparent dilemmas by the researcher team.

Apparent Dilemmas in Achieving Flexibility under Automation

This chapter first, as an overview, introduces the general process and associated industrial challenges related to designing automated systems and in particular flexible automated solutions. Each of the following four sections presents one of the

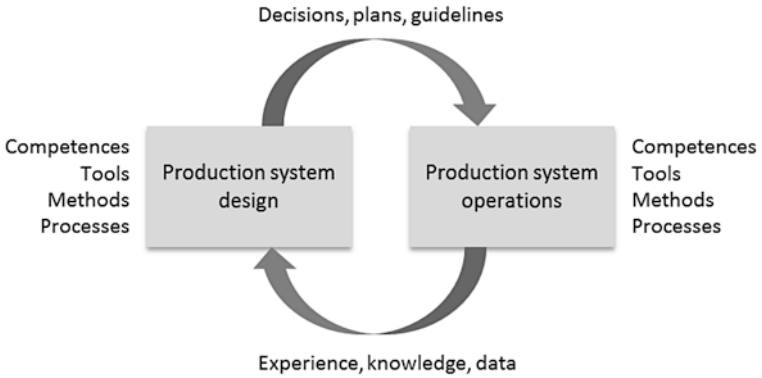

Fig. 3.1 Dual and interacting knowledge areas of design and operation of production systems (Wiktorsson, 2014)

four specific witnessed dilemmas in combining flexibility and automation: (1) degree of automation: high competence versus simple tasks; (2) operative staff flexibility; (3) equipment flexibility: standardisation versus customisation; and (4) development flexibility.

Automation in manufacturing companies includes and involves a broad set of competences and stakeholders. It covers aspects such as technologies, process, methods and organisational solutions. The dual competence areas of *designing* an automation solution (typically led by manufacturing engineers in collaboration with suppliers) and *operating* an automated solution (managed by operational staff, maintenance and manufacturing engineers) requires close interaction, as illustrated in Fig. 3.1. This study covered the entire process from system definition, specification and purchasing, through implementation and test, and finally continuous operations and improvement of the automated solutions.

Mapping the Requirement: Solution Space

Flexibility requirements on the production system originate from a company's business and manufacturing strategy. It can concern delivery capabilities involve aspects such as product range, product mix, volume flexibility and degree of customization. The flexibility requirements on each specific piece of equipment and subsystem is then based on the production system architecture and how it is organised. These requirements are then met by technical solutions, such as automation, in order to achieve productivity, quality, cost, safety or ergonomic benefits. This creates a requirement/solution space, as illustrated in Fig. 3.2.

However, the dream combination in the upper right corner in Fig. 3.2, of economic productivity through automation and flexibility capabilities, is linked to a number of trade-offs between costs and capabilities of each specific automated or

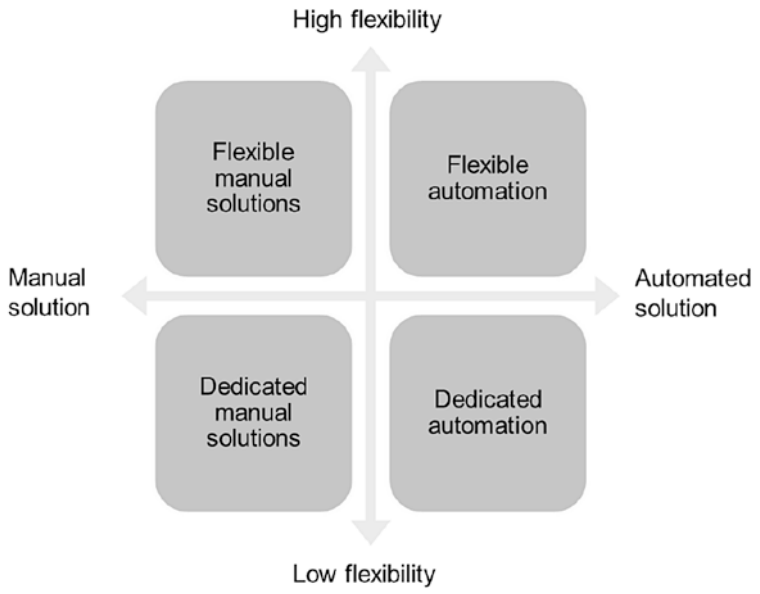

Fig. 3.2 Requirement/solution space of flexibility and automation

semi-automated solution. The interviewed companies presented a number of challenges in reaching this ideal situation.

Four out of five companies showed efforts at increased automation. The strategy was, however, not to automate in general or for the sake of automation, but rather to automate when appropriate or profitable. A company not planning to increase its level of automation had had previous experience of too extensive and highly automated solutions leading to overly complex solutions:

> At our company we have rather decreased somewhat in terms of automation. Previously we have linked many processes in a flow, for example, blasting, machining and welding. It is difficult to coordinate and leads to many stops, in our experience.

The company representatives themselves, however, realized that their current plans to not further automate were not necessarily a consequence of automation not being suitable in their organisation but rather that previous solutions did not fit the organisational culture and the given context and prerequisites.

The degree of automation also varied within a company between the different production lines and workstations. One company representative gave examples on parts of a fully automated production section, but also manual production:

> Our factory has a 'mixed' automation strategy. We have three parallel production lines for the manufacture of <product A>; one fully automated, one semi-automated and one manual production line. The company has chosen this strategy because we manufacture many custom product variants, with different demands on size and product properties. Although our aim is to reduce the number of variants, it is our competitive advantage to deliver customized products. Over time, we have gone from manual to fully automated production. Today we turn back a little, and will continue to invest also in the mixed degree of automation.

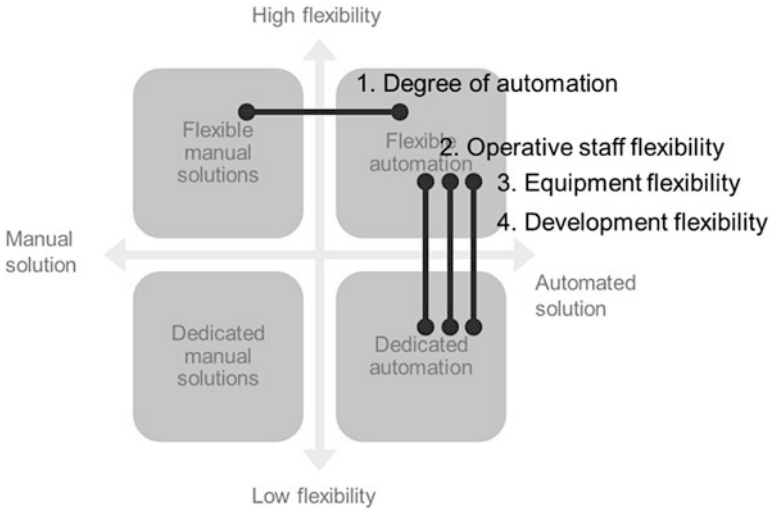

Fig. 3.3 Four dilemmas in combining flexibility and automation

This comment could also be used to illustrate that to some extent there have been trends in the degree of automation and automation decisions have rather been made on the basis of principles such as "fully automated" without considering the needs and prerequitites in each situation.

However, in several of the management interviews, automation was mentioned as a prerequisite for achieving a certain production volume in an internal global corporate competition. In most cases the driver behind an automation investment was a desire to increase volume or efficiency. The specific timing for the investment was spurred by a current solution's poor performance, the need for equipment renewal, developing a new product or technology or workplace issues.

In the analysis of the interviews, it was noted that automation in many cases involved a balance of apparent dilemmas, where the operator's role was key. We identified four different apparent dilemmas between automation consequences and flexibility requirements from a management perspective which are necessary to balance or resolve. The dilemmas were different in nature; their relation to the requirement/solution space are illustrated in Fig. 3.3.

Dilemma 1: Degree of Automation: High Competence Versus Simple Tasks

One classic engineering challenge when it comes to automation decisions concerns what is to be automated and what is to be performed manually. Fitts's Men-Are-Better-At–Machines-Are-Better-At (MABA–MABA) list from 1951 was

created to give guidance in the allocation of functions between humans and machines. However, this viewed automation as an all-or-nothing concept, a perspective that in today's development of human–robot collaboration and user interface development has become more and more obsolete. Automation is rather used to several different degrees or at different levels of automation, that is, on a fraction of automated functions out of the overall functions in a system. In contrast to the view of automation as an all-or-nothing decision, the level of automation can be described as a continuum, ranging between totally manual and totally automatic operations.

In deciding what to automate and what not to automate, several dilemmas arise. One concerns the handling of increased competence needs, but still the need for simple operator tasks. Automation does in some aspects indisputably create new requirements and increased competence within areas such as programming, mechanics and maintenance, but it also changes work tasks and environment for, and thus the demanded competence of, the operator. Greater operator competence is often needed in the handling and surveillance of automated equipment, but partial automation of production processes sometimes also leads to a situation where operators' work tasks decrease in number and are relegated to simple and repetitive tasks of filling, feeding and handling. As stated by one interviewee:

> A common perception is that robots will eliminate the worst jobs. But sometimes robots actually take over the fun parts; we might as well be honest with that too. We have examples far from the myth that robots relieve the heavy or boring parts of a job.

In automation there is a risk that simple manual steps that are 'difficult to automate' will remain in place following automation, so the operator will still have to be on hand to help. These steps can in fact be difficult or too costly to automate because of the high variance in product ranges, nonconformity in goods, tight spaces, the need for visual aids or manual adjustments. An important general choice in automating does, however, stand between advanced and simple work, but it is also not always feasible to automate to the desired extent. Sometimes leaving small portions of work to be performed manually can significantly decrease the overall complexity (and, thus, cost) of an automated system.

Increased automation also calls for new competences which the company itself sometimes cannot handle, leaving the company reliant on third parties to handle its own operations. Some operators do want to learn more and achieve technical excellence, but in some cases they instead find that monotony increases. There are also examples of differing attitudes and competence between different operators, as well as between temporary and permanent staff, sometimes to the extent that it affects operations negatively. Operators usually find that automation relieves the boredom of some operations—but sometimes there is a small group of workers who oppose automation or new work tasks. High flexibility in automated systems, thus, requires operators with both high competence and an ability to perform simpler tasks.

Dilemma 2: Operative Staff Flexibility

As discussed in the previous section, automation leads to requirements for higher and often more specialized operator competence, but from a management perspective, the workforce is also expected to be more flexible in exchanging tasks and handling multiple jobs. When the degree of automation increases, it is not uncommon for the number of staff to decrease and for each person's work tasks and responsibility areas to increase. For example, often each staff member is simultaneously responsible for several different stations, cells or parts of a production line, but there are also often requirements to move between different responsibility areas. This is often a result of desired workplace rotation and a way to create redundancies in competences, but it is also a result of production planning and variation. Several companies strive to maintain a certain proportion of temporary staff for flexibility and in particular to manage short-term variations in production volume and needs. There were statements describing the challenge to bring in temporary staff for the 'right' roles and let the ordinary staff be responsible for the assignments requiring expertise and specialisation:

> Our company needs to have a certain proportion of temporary workers to achieve flexibility. The challenge is to bring in temporary staff for the right roles—not for specialized missions.

Related issues mentioned were job rotation and skill development, where labour constraints imposed challenges. In addition, skill development and broader work roles need to come with certain wage effects, which was shown to be difficult to accomplish.

Dilemma 3. Equipment Flexibility: Standardisation Versus Customisation

As highlighted in the introduction, automation is a proven tool for improving competitiveness, especially in manufacturing. Automation is still most common and most efficient in an environment characterised by standardised processes and few variations in manufacturing, although the benefits of automation ranges over a much broader spectrum of applications. However, several companies assert that today's rapid technology and product development pushes advanced manufacturing technologies and variants being created early in the manufacturing process, challenging standardised processes and automation possibilities. As witnessed by one individual:

> Automated systems also have the difficulty of managing an increase in the number of variants. If the number of variants increases, the result is often lower availability and lower utilisation. We aim to have standardized manufacturing with few variations. Meanwhile, technology development and complex products are driving many variants. This also necessitates a balancing act.

Examples were mentioned of where the so-called special variants were excluded from automation, which lowers efficiency since there is a tendency to increase the number of special variants. As stated previously, however, it is not always feasible to automate to the desired extent. Sometimes excluding small parts of operations from automation can also significantly decrease the overall complexity and thus the cost of an automated solution. Some even refer to the Pareto principle, or the 80/20 rule, when it comes to automation in the sense that 80% of the cost comes from automating 20% of the products.

There is a risk that product development will become more removed from production, creating more and more early versions of a process. The internal interaction between production and product development was mentioned as being even more important than increased automation. In companies with high demands for flexibility, automated systems also need to be designed for rapid adaptation and product variation.

Dilemma 4. Development Flexibility

As partly addressed in previous sections, automation and advanced technical development tend to lead to specialisation, expert roles, reliance on external integrators and purchasing functions. However, proactivity and renewal are presumed to be based on a systemic and holistic perspective. Individual interviewees commented on the challenge concerning continuity in the workforce:

> A holistic approach to and understanding of the entire process is usually seen as necessary in order to be proactive and improve the system. But automation also leads to expert roles that are developed internally. Key individuals are developed, in many cases educated and engaged operators. The dependence on these individuals may increase. They are also attractive in the labour market or advance into other tasks.

Company representatives also commented on becoming too dependent on suppliers' technical experts. The skills in those cases are located outside the company. The division of responsibility among supplier, integrator and the customer (the original equipment manufacturer) was experienced as a challenge. Unfortunately, staff working with technical equipment and systems integration and thus having an overview of entire automation system was often not part of automation projects in today's organisations. This due to lack of acquiring these competences or limited budgets. A high level of flexibility in automated systems, thus, requires both expert skills and holistic perspectives and integrating teams.

Automated complex solutions in dynamic settings require multi-disciplinary teams and broad engagement with a common agenda. However, the roles, functions and (in many cases) different organisations involved in automation solutions are often separately managed with different agendas. The companies involved in this study presented wide variation in the work distribution during the automation process, including internal roles such as production development, production engineering, maintenance, project coordinator and operator teams. A distinction was also

made between regular workers and temporary short-term staff, and the effect this has on running highly automated production systems remained unclear. This dilemma was illustrated by one of the companies:

> A broad, cross-functional commitment early in the process ensures that the solution will be better in many ways. At the same time, you want project efficiency and clarity of roles and responsibilities.

New technology development and implementation will rely on individual initiatives, new roles and innovative behaviour. However, the functional organisation of companies and unions imposes restrictions and limits freedom. There was variation among the companies on the strictness of the roles of different company functions and how the union's role was defined and the attitudes and behaviours this led to. In some companies this was not experienced as an issue, but one manager made the following comment:

> As some individuals of the operative staff develop and begin to take responsibility for development, sometimes tension arises with the union and their colleagues, according to the principle of 'the responsibility lies with the employer'.

Flexibility in terms of operators' participation and ability to take the initiative in the development of new technology, thus, is partly dependent on the work culture, and individual's perception of whether or not there are fixed restrictions in work roles and responsibility.

Solving the Apparent Dilemmas Using a Technology Management Strategy

Much research points to a need for strategy connected to and supporting the automation development process. Granlund (2014) emphasises that a technology strategy cannot be created in isolation from the corporate objectives and the businesses it is intended to support. Both the business strategies and the organizational cultures are important to consider. Successful automation decisions are made in line with what long-term company aims, are synchronised with the company's strategies and also fit its capabilities and preconditions. Before investing in advanced manufacturing technology such as automation, a company must first reassess its direction, strengths and weaknesses and develop a strategy for successful implementation.

The central role of automation in improving industrial competiveness relates to the importance of connecting the decision to automate to performance goals and then determine the appropriate level and type of automation for the company's needs and prerequisites, not the other way around. The key to successful automation thus lies in finding, selecting, acquiring and properly implementing the right type and level of automation in relation to the company's needs, goals and prerequisites. The process of developing automation, which includes all those steps, is thus a

crucial part in determining the success of automation investments and the use of automation. This in turn places great demands on the company's way of working since it requires that the automation development process be well structured and supported.

Hammer (1990) emphasises that automation technology should be used to help consumers of automation equipment "help themselves" and become less dependent on experts. As noted in the study by Baker and Halim (2007), most companies during warehouse automation projects accept help from consultancy firms, equipment suppliers or a system integrator to complete many of the steps in the development process. Hax and Majluf (1991) address the extent to which a firm will rely on third parties as one of the strategic decisions that is linked to technology management and hence needs to be actively addressed. On the same note, Baines (2004) emphasises a rigorous supplier selection due to its large impact on the automation development process and that process's outcome.

The five companies participating in this study were found to balance the four dilemmas discussed here in different ways throughout the three automation phases previously described as they implemented their automation strategies. During the workshop specific examples of positions taken in connection with these four dilemmas were discussed, and the dilemma framework served as a basis for the discussion of automation strategies and technology management in the workshop and further dialogues with the companies.

One additional dilemma that was discussed, but not as clearly detailed or more ambiguously described in the interviews, was the balance between following a strategy versus being 'situation optimal'. This dilemma was indicated by the expressed dilemmas between sticking to one's own approach to automation versus buying standard solutions and the dilemma between policies of staying ahead and developing pre-engineering technologies versus automating with a specific solution when the situation calls for it.

Conclusions and Future of Automation

Automation means using technology to carry out a process or procedure without human assistance. However, many automated systems in manufacturing include devices and techniques that involve a mix of self-action and human intervention. This means that a key feature of automated technology is that it is to be used together with or supported by humans. Another characteristic of automation is that it concerns the physical flow of materials (mechanisation) as well as the flow of information (computerisation). These two dimensions are often integrated as computerised technologies often control and support mechanised technologies.

Empirical Conclusion

This chapter details how dilemmas between automated solutions and maintaining high operational flexibility is managed throughout specification, implementation and operation of automated solutions in discrete manufacturing companies. The interview-based study illustrated which parts companies automate, the strategic consideration among, for example, flexibility, quality and delivery, and actions taken for technical and competence development within the companies. The four identified trade-offs, or dilemmas, further illustrate the ambidextrous behaviour of efficiency and flexibility needed in today's manufacturing operations (Kortmann, Gelhard, Zimmermann, & Piller, 2014). The flexibility needs in the identified dilemmas also cover different perspectives of flexibility—for example competence/skill, product flexibility, volume flexibility, organisation. Finally, it illustrates the importance of investments in high-end manufacturing competence within today's manufacturing companies.

Further studies are needed on each of the dilemmas and their respective origins, nature and consequences. The specific link to each type of flexibility (e.g. variant, mix, volume) is also a subject for further research. Technological development as well as management practice can both eliminate apparent dilemmas or at least minimise their consequences. Further studies can contribute to a decision support instrument and discussion base for the development of an automation strategy and roadmap to manage the dilemmas between automation and various types of flexibility.

Future of Automation

The scope of industrial automation is shifting. The first wave of automation was based on mechanization, the second on the use of microprocessors in industrial applications, while the current wave of automation is based on extreme information availability, cyber-physical systems and data analytics (Larsson, Wiktorsson & Cedergren, 2014). As stated by Andreessen (2011):

> Six decades into the computer revolution, four decades since the invention of the microprocessor, and two decades into the rise of the modern Internet, all of the technology required to transform industries through software finally works and can be widely delivered at a global scale.

The global market of industrial automation is large, profitable and growing. Annual global revenues total $155 billion, $72 billion for factory automation and $83 billion for process automation. The expected growth rate for industrial automation is 50% above the growth of general industrial production indices (compared to 30% in previous years), and the margin is 4% higher in industrial automation than the global industrial average (Credit Suisse, 2014). In the world's largest manufacturing economy, China, there are signs of labour shortages at the low end that will

create upward pressure on wages (Wiktorsson et al., 2016). This, it is believed, will cause automation investment to accelerate.

In response to this third wave of automation based on the Internet of Things, cloud computing and big data analytics, industries, researchers and governments have launched initiatives and development platforms. The declaration of the German government's large-scale investment Industrie 4.0 reads: "Germany is preparing the fourth industrial revolution based on the Internet of Things, cyber-physical production systems, and the Internet of Services - in strong industrial applications ..." SAP, Siemens, Bosch, the automotive industry and research institutions are all involved in the project—from engineers to business management. The 4.0 refers to the idea that the world has gone through three industrial phases and the fourth coming, based on cyber-physical systems, combinations of the Internet, embedded digital technology and the management of large amounts of data. Discussions are held on the nature of transformation. However, in observing manufacturing's transformation, it appears that no disruptive event will transform industry into smart manufacturing or usher in the fourth industrial revolution. Rather, we observe a gradual shift toward more IT-supported business where flexibility and automation are less a dilemma and more a reality.

Acknowledgments The authors gratefully acknowledge the contributions from all the participants in the companies that took part in the study. The financial support from VINNOVA to the "Flaggskeppsfabriken" project is also greatly appreciated. This research was performed in the context of the XPRES framework at Mälardalen University.

References

Andreessen, M. (2011, August 20). Why software is eating the world. *The Wall Street Journal*. Available online https://www.wsj.com/articles/SB10001424053111903480904576512250915629460. Accessed 1 June 2017.

Baines, T. (2004). An integrated process for forming manufacturing technology acquisition decisions. *International Journal of Operations & Production Management, 24*(5), 447–467.

Baker, P., & Halim, Z. (2007). An exploration of warehouse automation implementations: cost, service and flexibility issues. *Supply Chain Management: An International Journal, 12*(2), 129–138.

Chryssolouris, G., Efthymiou, K., Papakostas, N., Mourtzis, D., & Pagoropoulos, A. (2013). Flexibility and complexity: Is it a trade-off? *International Journal of Production Research, 51*(23–24), 6788–6802.

Credit Suisse. (2014). Global Industrial Automation. *The Credit Suisse Connections Series. August 14, 2012*. Available online https://plus.credit-suisse.com/researchplus/ravDocView?docid=1PXntk. Accessed 1 June 2017.

Denison, D. R., & Spreitzer, G. M. (1991). Organizational culture and organizational development: A competing values approach. *Research in Organizational Change and Development, 5*, 1–21.

Goyal, S., & Grover, S. (2012). Advanced manufacturing technology effectiveness: A review of literature and some issues. *Frontiers of Mechanical Engineering, 7*(3), 256–267.

Granlund, A. (2014). Facilitating automation development in internal logistics systems. *Mälardalen University Press Dissertations No. 150*.

Granlund, A., & Jackson, M. (2013). Managing automation development projects—A comparison of industrial needs and existing theoretical support. In *The 23rd International Conference on Flexible Automation and Intelligent Manufacturing*, 26–28 June, 2013, Porto, Portugal.

Hammer, M. (1990). Reengineering work: Don't automate, obliterate. *Harvard Business Review, 68*(4), 104–112.

Hax, A. C., & Majluf, N. S. (1991). *The strategy concept and process: A pragmatic approach*. Englewood Cliffs, NJ: Prentice Hall.

Jain, A., Jain, P. K., Chan, F. T. S., & Singh, S. (2013). A review on manufacturing flexibility. *International Journal of Production Research, 51*(19), 5946–5970.

Kortmann, S., Gelhard, C., Zimmermann, C., & Piller, F. T. (2014). Linking strategic flexibility and operational efficiency: The mediating role of ambidextrous operational capabilities. *Journal of Operations Management, 32*, 475–490.

Larsson, Ö., Wiktorsson, M., & Cedergren, S. (2014, September 16–18). The third wave of automation: Critical factors for industrial digitization. In *6th Swedish Production Symposium SPS 2014*. Sweden: Chalmers University.

McDermott, C. M., & Stock, G. N. (1999). Organizational culture and advanced manufacturing technology implementation. *Journal of Operations Management, 17*, 521–533.

Mishra, R., Pundir, A. K., & Ganapathy, L. (2014). Assessment of manufacturing flexibility—a review of research and conceptual framework. *Management Research Review, 37*(8), 750–776.

Thomassen, M. K., Sjøbakk, B., & Alfnes, E. (2014). A strategic approach for automation technology initiatives selection. In Grabot et al. (Ed.), *APMS 2014, Part III, IFIP AICT 440* (pp. 288–295).

Wiktorsson, M. (2014). Consideration of legacy structures enabling a double helix development of production systems and products. In E. Henriques, P. Peças, & A. Silva (Eds.), *Technology and manufacturing process selection: The product life cycle perspective*. New York: Springer.

Wiktorsson, M., Granlund, A., Lundin, M., & Södergren, B. (2016). Automation and flexibility: Exploring Contradictions in manufacturing operations. In *23rd EurOMA Conference*, June 17–22, 2016, Trondheim, Norway.

Winroth, M., Säfsten, K., & Stahre, J. (2007). Automation strategies: Existing theory or ad hoc decisions? *International Journal of Manufacturing Technology and Management, 11*(1), 98–114.

Chapter 4
Organizing Viable Development Work in Operations

Peter E. Johansson

Prologue

Lean production has become strongly associated with the exploitation of current opportunities and incremental production system development through methods and tools such as continuous improvements, standardized work, and value stream mapping (VSM), and are often seen as contradictory to the exploration of new opportunities and radical change (March, 1991). This contradiction also seemed to be true in a study of individual workers as they were engaged in development work within manufacturing companies. However, what puzzled me was that other observations within the same study indicated that for some individual workers these two orientations of development work did not seem to be contradictory or incompatible at all. On the contrary, this latter group of workers used the same processes and existing methods for creative problem solving and the methods were adapted to fit their current objectives, instead of being used in sequential order as originally prescribed. How could this be so? One answer in the study is that synergies between the two development work orientations of exploitation and exploration are dependent on workers' degree of competence in terms of knowing what to do and how to do it when it concerns development work. This indicates that potential synergies between exploitation and exploration exist not only on a system level but also on an individual level. That is, the principles and methods associated with lean production are not an impediment to exploration in itself since, by the right means, they can be used as a stepping stone, and, depending on the scope of interest and what problem needs to be solved, different trajectories and outcomes can be created.

P.E. Johansson (✉)
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Peter.e.johansson@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_4

Introduction

This chapter deals with the challenges that arise when organizations aim for a distributed involvement of employees in development work. Continuous improvements and development work are a cornerstone of lean production, and manufacturing industries of today are increasingly deploying high-involvement strategies (Bessant & Caffyn, 1997), which means involving employees on all levels and from all parts of the organization in development work. However, the involvement of all employees in any kind of development work entails a range of challenges as it implies that new tasks, or an extended set of the existing work tasks, will emerge as part of the employees' everyday work (Emiliani, 1998). Thus, in addition to an expected appropriation of tasks related to the production of goods or services, employees in manufacturing industries are also expected to engage in development work, which in turn requires them to develop another set of domain-specific competencies (Klotz, Winther, & Festner, 2015). In the context of development work, this requirement for development means having the skills to identify opportunities to act on and recognize possible root causes of a problem and then having the ability to develop solutions that fit into existing operations or, alternatively, see how the current work practices can be adapted to fit the new solutions (Rother, 2009). That is, successful development work requires two different domains of competence merge together.

With only one disposable competence, either in the domain of the specific work area or in the domain of running development work, only limited results will likely be achieved. Not all necessary domain-specific competencies need to be possessed by each individual worker; instead, different kinds of organized collaboration may enable the needed distribution of competencies. A crucial question addressed in this chapter therefore is how development work can be organized to engage employees on all levels in viable development work, which, depending on needs, enables the emergence of both exploitation and exploration. Further, the aim here is to describe the relationship between how development work is enacted and the opportunities afforded for a continuous learning about development work competence.

The following two sections introduce to the reader key concepts and provides the theoretical framework of the chapter. In the first section, key concepts in the context of lean production and how lean practices enables learning are presented, followed by an account of key concepts in change-oriented competence. In the next section, some explanatory cases are provided and four positions representing different ways of organizing development work are identified. Finally, some concluding remarks are provided regarding the chapter's contribution and some practical implications.

Key Concepts

The context of this chapter is development work situated in lean production practice. The literature on lean production is vast (Osterman, 2015) and includes many different approaches to and interpretations of its key constituents. In this section I introduce a

few of the methods and principles associated with lean production and, more specifically, previous research that provides evidence on how different tools and methods affect the learning opportunities for individual workers. A cornerstone of this chapter is the ability to perform successful development work, that is, having the competence to know what to do and how to do it, which is discussed in the final part of this section.

Lean Production and Potential Learning Consequences

As discussed in Chap. 2 (Fundin, Bergman and Elg), there are a multitude of quality and production management approaches on the market today. One of them, lean production, has over the last couple of decades grown into one of the contemporary operations management paradigms in the manufacturing domain (Francis, Fisher, Thomas, & Rowlands, 2014; Stone, 2012; Womack, Jones, & Roos, 1991), and a large number of research articles address the issue of lean production across a wide range of industries (Hines, Holweg, & Rich, 2004; Jasti & Kodali, 2015; Mazur, Mccreery, & Rothenberg, 2012). In its most condensed form, the main purpose of lean production is to continuously increase the proportion of value by reducing non-value-adding activities, that is, waste, in a work process (Womack & Jones, 2003).

Previous research produced indeterminate findings about lean production and its impact on the work environment (Hasle, Bojesen, Jensen, & Bramming, 2012) and, therefore, indirectly how it affords opportunities for continuous learning (Billett, 2001). Some studies indicate that programs such as lean production may actually limit the opportunities for work-based learning because of a strong emphasis on standardization and monitoring of work (Adler & Borys, 1996). Hence, certain processes and tools of lean production provide and tolerate less variation in experiences that have proven to be a core requisite for learning (Marton & Pang, 2006). Contrary to Adler and Borys (1996), Hasle et al. (2012) claim in their study that the impact on the work environment largely depends on how the actual lean practice is designed and enacted; therefore, it is not possible to draw simple cause-and-effect conclusions regarding the relationships of lean production and its opportunities for work-based learning. Fagerlind Ståhl, Gustavsson, Karlsson, Johansson, and Ekberg (2014) also indicate that circumstantial factors shape how lean tools are used in practice. Their study provides evidence of a positive correlation between tools associated with lean production and a climate for so-called innovative learning (cf. Ellström, 2006) in the work setting, which indirectly can be interpreted as an indication that lean production can accommodate favorable conditions for the emergence of practice-based innovations. At the same time, the findings point to differences depending on what lean tools are used. Tools such as VSM were found to have a positive correlation with a climate conducive to innovative learning. As a simplification, VSM is about making a situational analysis of the value stream, for example, mapping a process and identifying which elements bring value to the process and which elements are wasteful. The positive correlation is explained to be related to the fact that tools such as VSM invite a high level of involvement and participation of workers in problem-

solving activities. While tools such as the standardization of work—with a focus on reducing variation by using what is currently the best practice—had a somewhat weaker, albeit positive, correlation with innovative learning climate. This is explained by the fact that standardization represents tools that have more of a monitoring function (ibid.), which is more or less consistent with conclusions suggested by Adler and Borys (1996). They found that the use of different types of tools and methods for development work affords diverse opportunities for work-based learning insofar as they afford different kinds of invitational qualities. These findings justify a more thorough examination of what can explain individual and contextual variations, and in the next paragraph change-oriented competence is presented.

Change-Oriented Competence

Human behavior and actions are dependent on people's previous experiences and the skills and knowledge they have gained through these experiences as well as on the affordances embedded in the current situation where behavior and actions take place (Billett, 2001; Löfberg, 1989). To a certain degree, it is reasonable to assert that actions are intentional, which gives actions a sense of meaning and orientation (Billett, 2009). In other words, people purposefully act to achieve certain goals, goals that can be, but are not necessarily, shared within an organization. When people engage in tasks in a professional setting, the quality of task execution depends on the individuals' ability to perform, that is, their competence related to the specific field of expertise (Ellström, 2011; Ohlsson & Johansson, 2010). However, previous research showed that "[t]he characteristics that increased exploration (extreme outcomes) also increased exploitation (higher level of outcomes)" (Taylor & Greve, 2006, p. 737). Further, Taylor and Greve conclude, "It is not team composition, then, but rather the task and context given to a team that creates a trade-off between exploration and exploitation in product development" (Taylor & Greve, 2006, p. 737). Put differently, too much emphasis on predefined tasks and expected outcomes leads to limited discretion for exploration activities.

It is a well-known fact that a novice to a subject or field, that is, a worker who is new to a subject and who has limited experience and, thus, a low degree of competence tends to approach tasks in a linear and fragmented way because they are highly dependent on the established routines and conventions designed to provide guidance for their actions. At the same time, novices are not fully aware of all the rules or conventions attached to their work (Dreyfus, 2004; Dreyfus & Dreyfus, 1980). In addition, nonroutine tasks and problematic situations often need to be managed and structured for the novice in order for the tasks to become meaningful despite the complex character of the situation. This is well demonstrated when the approach to development work is looked at from a novice perspective. For example, people who lack a deeper understanding of lean production principles tend to simplify and express a black-and-white picture of the relation between exploitation and exploration activities. Thus, for a novice expected to do development work, there

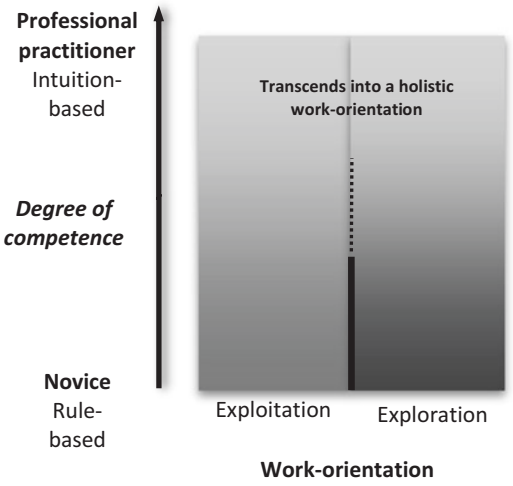

Fig. 4.1 Relation between degree of competence and work orientations

are obvious tensions and contradictions between exploitation and exploration as work orientations. This can in turn be related to the different conventions associated with the two types of work orientations as well as to the expected outcomes of the two orientations. The novice tends to view conventions and guidelines as rules to follow, unlike the professional practitioner (Schön, 1983), who may view them as useful affordances. This implies that for a novice the two orientations of exploitation and exploration are likely to be kept separate so as to make them meaningful. However, as the individual competence is enhanced, the two orientations are experienced as being less contradictory, and they gradually merge and start to enrich each other. The orientations then become more like different paths to deal with various kinds of problematic situations, rather than completely different processes. That is, when the degree of individual competence increases to a certain level, exploitation and exploration as work orientations partly merge and transcend into more of a holistic work orientation (Fig. 4.1).

The ability to perform a wide range of actions is important because situations are always socially and discursively constituted. Fuzzy and problematic situations, which often require nonroutine solutions, are rarely, if ever, given and formulated in practice (Checkland & Poulter, 2007), that is to say, problematic situations require a greater focus on exploration. Thus, a problematic situation is not evident or framed by itself, and, depending on what is framed as a problematic situation, there are several options for what the best solution might be. Development work, from an individual worker's point of view, then becomes a question of being able to identify, develop, and integrate solutions in the production system, and such work has the potential to include both exploitative and explorative activities. Following this, the performance of tasks is based on individuals' understanding of the particular task because tasks and problematic situations need to be formulated—identified—and framed by the individual (Marton & Booth, 1997; Marton & Pang, 2006; Schön, 1983). Schön (1983) describes this by explaining that the professional practitioner makes sense in a coherent way of

situations that initially lack meaning and structure or at least show deficiencies in these respects. A conclusion is that fuzzy and problematic work situations in some ways need to be seen as more or less unique situations in which predefined rules, theories, or models cannot be automatically applied. As Dreyfus (2004, p. 177) concludes, merely engaging in rule-following behaviors will most likely lead to poor performance in the real world. These assumptions are consistent with premises where the context-dependency of tasks are emphasized (Johansson, 2011).

A crucial feature of individual workers' development of competence is the learning that is integrated in the performance of work and over time contributes to an increase of individuals' potential range of capacities (cf. learning curves, Argote, 2012; Eraut, 2004; Goller & Billett, 2014). Learning is increasingly being held as a construct for how people engage in practice, based on their past actions and experiences, as well as the affordances embedded in the workplace (Billett, 2001; Löfberg, 2001). Ericsson (2006) emphasizes that extensive time spent in a particular environment on its own is not a sufficient requirement for the development of professional knowledge and competence. It is also important to ensure the quality of engagement while participating in the environment in which the innovation is to be adopted. Proactive behaviors in which operators actively seek new knowledge or intentionally put themselves in situations that go beyond their areas of expertise are examples of activities that increase variation in experiences and, thus, provide good opportunities to further learn and develop professional knowledge and skills (Goller & Billett, 2014). Also, essential for learning and development of professional knowledge and skills is a different kind of indirect or direct support, for example, feedback on work that has been performed (Döös, Johansson, & Wilhelmson, 2015; Harteis & Billett, 2013; Johnsson, 2016). The importance of guidance and support for learning can be related back to early educators like Dewey (1958) and Vygotskij (1978). For example, Vygotskij formulated the theory of the zone of proximal development, which refers to the ability of an individual to succeed in a task with the support of competent others who are able to expand the scope of their learning (i.e., development). Thus, all of this suggests that there is a range of situational and personal factors that arise as a complex of factors that need to be engaged with and reconciled.

Explanatory Cases

As a means to discuss and illuminate these propositions, several cases comprising studies of development work in companies are discussed and used to elaborate an explanatory account (Johansson, 2017). The case companies—A and B—presented in this chapter are using lean production to manage and run their systematic production development. The following descriptions and analyses are based on interviews with participants in a series of workshops with a focus on organizing development work at the shop floor level. Interviews were conducted with the CEO and the production manager in Company B, team leaders and a project leader in Company A, and shop-floor operators in both companies.

Company A, a production unit situated in a global manufacturing company, has been working for many years with Lean Six Sigma[1] as a program to run development work. The company has its own global production system with support functions at both the global and local levels. The company has established a range of procedures and tools aimed at supporting approaches to conducting development work within various scopes at all levels of operation, procedures that all production units are expected to work in accordance with. Within the production unit are a couple of project leaders who have extensive training and experience in Lean Six Sigma and thus possess expertise in the domain of development work. However, at the shop-floor level, the production operators have limited training in the domain of development work, even though they are expected to be engaged in development work. Company A has several initiatives at all levels of the organization, and in this chapter attention is paid to two particular initiatives: operator projects and VSM events.

Company B, a small and medium-sized enterprise (SME) with approximately 45 employees, is engaged in both product development and production of goods and has worked with lean production for a number of years. The production department is divided into six production teams allocated between two main areas: (1) machinery and automated production and (2) manual production. About 5 years ago, Company B participated in a national training program with the objective of developing its own lean production practice. Since then, two employees have been assigned part-time responsibility as so-called lean coaches. However, at the shop-floor level the production operators at Company B have received no further training in the domain of development work.

Enactment of Development Work in Industrial Production

In the cases, two dimensions emerge concerning how development work activities are undertaken in an industrial production context. The first dimension concerns how it ranges between being self-organized to intentionally organized. Whereas the former means that work is organized based on the initiative of individual workers, the latter means that it is organized with the intention of producing development work. When work is intentionally organized, it is based on a belief that it is important that everyone's skills be used and that there is a need for cross-functional teams to interconnect their competencies to achieve synergies in the development work. The second dimension concerns how it ranges between being self-regulated to expert supported, where the former means that it is based on actors' own perception of what to do and how to do it and the latter that it in some way is supported by a competent other through different kinds of facilitation or supervision. In the matrix of the two dimensions, four positions representing different ways of how work is

[1] Lean Six Sigma is an adaptation of the principles from lean production and Six Sigma. The latter was developed by the Motorola Company. Within the practice of Six Sigma several levels of experts are differentiated: Master Black Belts, Black Belts, Green Belts, and White Belts.

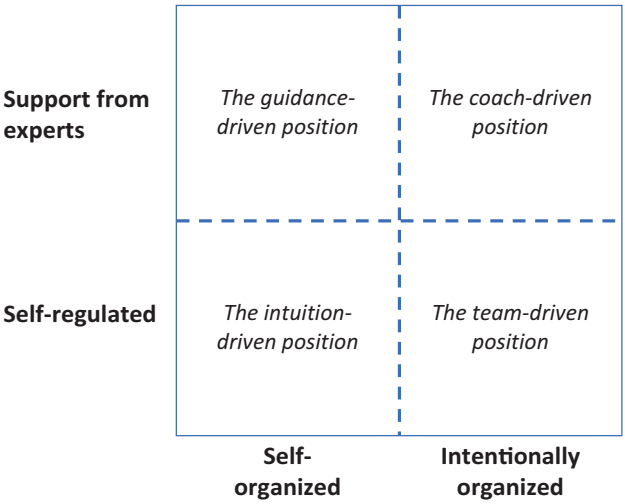

Fig. 4.2 Typology of development work

carried out are identified (Fig. 4.2): (1) intuition-driven position, (2) team-driven position, (3) coach-driven position, and (4) guidance-driven position. In the following sections, these four positions are defined, described, and empirically illustrated.

Intuition-Driven Position

In this, the intuition-driven position, development work is characterized as self-organized, that is, it is based on individual initiatives and self-regulated in the sense that it is based on individuals' acquired knowledge on how to identify problems and produce potential solutions. The interviews with production operators at Company B contain several accounts of how development work is carried out. One type of work can be characterized as reactive and is based on identified deviations related to an operator's job. One such example is when a series of components do not adhere properly during soldering work. When an operator identifies the problem, he or she works out a solution and then takes corrective actions. Another type of development work can be characterized as proactive, for example, when operators try to come up with a procedure for mounting a product in a way that reduces material consumption. Depending on the nature and magnitude of the problem, it is managed either by the operators themselves or by operators in interaction with, for example, the production manager, who work through the problem and together try to find an appropriate solution. As a means to identify or solve problems, Company B has few explicit procedures or tools that are shared among operators. However, there is a developed system in terms of a standardized form that is used to document corrective actions, with the objective of drawing attention to deviations in production and avoiding their repetition over time.

Team-Driven Position

What differentiates intentionally organized work from self-organized work is that there are goals that are expected to be achieved, and the latter also utilize different kinds of formalized collaboration and teams, which are assigned the task of executing the development work. Still, activities in the team-driven position are largely self-regulated regarding the execution of the development work, that is, the team members decide by themselves what development work to do and how to do it. An example of team-driven development work in the empirical material are operator projects (OP projects) run in Company A. In Company A, development work is initiated on several levels. On the shop-floor level, this kind of development work is initiated when a problem occurs that an operator or his/her team leader cannot solve instantly because it requires a more thorough analysis of the root cause and possible solutions. The work procedure, the OP projects, was introduced in the organization some 3 years ago to address this kind of situation. To ensure that the proper cause is identified and that the solutions that are worked out fit into the production system, OP projects are expected to involve workers with different competencies. As a support to the development work in OP projects, operators have access to advanced tools and techniques for problem solving, such as the A3 methodology[2] adapted to fit the basics of DMAIC,[3] and the production operators seem to agree that it essentially is a good work procedure.

However, according to the interviewees, both the production operators, who carry out the projects, and one of the project leaders, the projects have not achieved what was expected, and for various reasons they have not managed to establish OP projects as a work procedure that actually is used in practice. Rather, reasons continue to be found for avoiding its use as part of their work practice. Each production team within Company A is expected to accomplish two OP projects/month, and the interviewees see the projects as a procedure that has become something that they do to satisfy the set goal of a certain number to be carried out per month, which in practice causes people to take shortcuts to reach this figure. From the perspective of operator, this can partly be explained by the fact that they do not believe there are that many problems that need to be addressed. That is, from their point of view, it is not possible to do two such projects a month in each production team. Further, even though the operators have access to advanced tools and methods for problem solving, the solutions and outcomes of the OP projects are in many cases known beforehand and tend to be based on individual operators' intuitive problem solving skills. Thus, it is only ostensibly that the advanced problem-solving method is used, which can partly be explained by the fact that operators at large are unaccustomed to actually using the available tools and procedures. The work in the OP projects reveals the challenges related to intentionally organizing this kind of work, out of which emerge novel solutions.

---

[2] A3 methodology refers to a specific kind of methodology for problem solving and originates from the Toyota Production System.

[3] DMAIC is an acronym for *Define*, *Measure*, *Analyze*, *Improve*, and *Control* and originates from Six Sigma.

Coach-Driven Position

What distinguishes the coach-driven from the team-driven position is that the teamwork is managed and facilitated by a competent other, meaning it is expert supported. In the empirical material, the coach-driven position is represented by the so-called VSM events in Company A. In her role as a project leader, one of the respondents created a workshop for production development inspired by VSM, that is, the process of making a situational analysis of the value stream. VSM events involve people in different positions, for example, production managers, team leaders, and shop-floor operators. The objective of the events is to explore new opportunities for production development within one production unit or across several production units. However, a second and perhaps more tacit objective is to get the participants engaged in the work and create a shared understanding of the operational practice among participants. Also, because the events are characterized by the support of the project leader, they increase the opportunities for questioning and exploring current production practices. A project leader runs the events by facilitating a group through the VSM, but she also facilitates by asking critical questions of the participants, which in turn enables the participants to engage in development work based on their knowledge of the production unit, and collectively they reflect on and work out solutions.

Consequently, a core aspect of the coach-driven position is the support provided by an expert as she facilitates how to make use of all team members' knowledge and skills in the development work. Also, the competent other enables a structured exploration of new opportunities and contributes by having a well-developed ability to discern and know what to do and the scope of work that needs to be done at the right time.

Guidance-Driven Position

The final position, the guidance-driven position, reflects development work that is self-organized. But what distinguishes it from the intuition-driven position is that the actor—for example, a production operator—has access to supervision by a competent other. Thus, the operators are given support or guidance through some kind of tutoring or mentoring, with a focus on what kind of development work to do and how to do it. In Company A, this position can be exemplified by the role of the project leader. As part of her work, she gives support and serves as a sounding board for both production operators and managers regarding the process of how to do development work. In Company B, such a position can partly be identified in relation to an initiative called the development team, which was recently established to accelerate the processes of innovating new products or services. Although the team to some extent is self-organized, the expert also serves as a mentor or supervisor from whom the team members can obtain support in a self-organized way on how to run the processes of new product development.

Competence: The Third Dimension

The preceding accounts illustrate different ways development work is carried out in practice. However, common to both cases is that the management expresses some concerns regarding the results of the ongoing development work. One such expression of concern comes about because the OP projects in Company A generate too few solutions that can actually be regarded as an outcome of the development work. The production operators have access to advanced tools and techniques for problem solving, and yet the solutions described in many cases already seem to be known in advance. Alternatively, the solutions are based on one or more individual operators' intuitive problem solving, and thus they do not use the full potential capacity of the team. Many production operators and team leaders who run OP projects are aware of this problem. One of the reasons why the OP projects not deliver as expected, which is emphasized in conversations with respondents, is that they are forced to undertake projects to reach the set key figures, not because they experience real problems that justify them to run a project. Thus, the projects are in many cases described as so-called rationalizations after the event, which means that they are documenting already known solutions and report them as OP projects.

Even in Company B some concerns have been expressed by the management that an insufficient level of development work is going on. This can partly be confirmed in the empirical material retrieved from the interviews with the production operators. As part of the data collection, the six production teams were able to assess the development work efforts undertaken during the past 6 months. First, the teams performed a self-assessment of their ability to carry out development work. The results of the self- assessment showed great faith in their own ability. As a second task, all six teams were asked to describe the improvement and development activities that they had performed during the last 6 months. This turned out not to be an easy task, however. The team members seemed to be unaccustomed to thinking about improvements; things were just made part of their ordinary work. Yet the groups had rated themselves as highly skilled in performing development work. The measures/solutions that were primarily described were linked to the standardized forms that were used to document deviations and how they had been solved and to point out a number of different improvements that had resolved minor specific and defined problems, for example, they started to store products on a wagon that could be moved around instead of storing them on shelves like they used to do. However, there was a variation in how the groups rated their own development work and what they actually had been able to perform. A couple of the teams could only identify a small number of measures carried out. While the interviewees in the other groups could, after some deliberation, think of a number of things they had actually carried out. They also expressed a strong desire to contribute to the further development of the production environment. This can be linked to the fact that some interviewees experienced participation in development work as something positive and fun to be contributing to, while other interviewees expressed a more passive attitude toward why they should engage in development work at all.

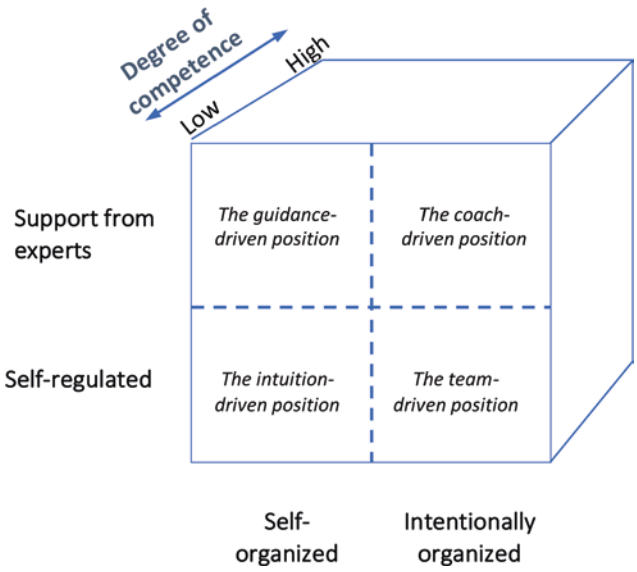

Fig. 4.3 The three dimensions of development work (Johansson, 2017)

Based on the empirical material, it is reasonable to say that there is in some cases a limited distribution of competence in the domain of development work. However, in situations where the development work has been performed with support from an expert, within the domain of development work, and thus been managed or facilitated by a competent other, it has enabled exploration of future opportunities. To be able to appraise the possibilities for development work that holds the potential for exploitation and exploration, it is necessary to also take into consideration a third dimension: the actors' (individual's or group's) degree of competence to carry out development work (Fig. 4.3). Hence, based on the empirical findings, there exist several serious challenges to involving the entire workforce in development work. Even if people are allowed to use part of their time to work on improvements and innovation, there is ambiguity among many employees because they see development work as keeping them from doing what they define as their real work, like the production of goods. And even though employees are willing to engage in development work, in some cases they lack the ability to perform such work with such quality that it enables exploration of future opportunities. Accordingly, self-regulated positions afford limited support to participants in terms of how to conduct development work, and when operators do not know what to do or how to do, this becomes a major impediment for continuous learning to take place during such activities.

Discussion and Conclusions

The aim of this chapter is to give an account of and discuss how viable development work can be organized and engage employees on all levels of an organization which, depending on the specific needs, enables the emergence of both exploitation and exploration. A further aim is to describe the relationship between how development work is carried out and the opportunities afforded by such work for continuous learning of development work competence. It is well known that actors' ability to carry out work tasks emerges over time. For example, previous studies in areas such as manufacturing showed how there is a gradual increase in productivity over time, which can be explained by the occurrence of experiential learning and by the fact that the increase in productivity follows so-called learning curves (Argote, 2012). The empirical material contains several examples of how employees are committed to improving their own operations, which in itself is an important prerequisite for a continuous work-integrated learning (Ericsson, 2006; Goller & Billett, 2014). However, the empirical findings presented in this chapter indicate that this is not a sufficient condition for the long-term development of skills relevant to pursuing structured development work. One conclusion to draw is that development work needs to be treated as a domain-specific competence in itself, which in turn needs to be distributed throughout the organization. With a limited distributed competence for development work, it becomes a far too weak catalyst when this kind of work is carried out in the two self-regulated positions—the intuition-driven and the team-driven positions—and constrains the opportunities for work-integrated learning of such a quality that it otherwise could have contributed to an emergence of exploration. If so, this means that there are a lot of activities in companies and other kinds of organizations that are designated *continuous improvements* and *development work* but that do not actually lead businesses forward in any meaningful way. Thus, one of the main challenges presented in the two cases, and especially prominent when development work was carried out in the self-regulated positions, is to achieve a reflective and explorative practice, a practice where established procedures and processes can be questioned in order to develop new opportunities for contributing to the significant development of the work organization (Engeström, 2001).

Another conclusion, then, is that, even though resources might be allocated to a certain task, it is not reasonable to expect professional-level performance of the task unless people possess the proper competencies to execute the task. Previous research provides evidence pointing to the importance of combined strategies for competence development in organizations, which includes both training activities and organizing for learning in everyday work (Ellström & Kock, 2008). Therefore, it is essential for organizations to provide suitable support and structures to enable continuous learning for their employees to gain relevant experience and over time to learn and develop what can be called a development-oriented competence. This is supported by the empirical findings presented in this chapter, which indicate that facilitation by a competent other can be beneficial for explorative activities through coaching or guidance and thus play a role in changing ingrained behavior patterns

in the search for new solutions. One explanation, inspired by Vygotskij's (1978) theory of the zone of proximal development, is that the conditions for learning in development work become restricted if too much of the individual workers' ability to engage in development work is outside their zone of proximal development. In such cases, it becomes problematic to rely too much on self-regulated development work. Exploration of new opportunities then tends to occur ad hoc (cf. Gustavsson, 2007) because employees are forced to rely on their often limited experience-based skills regarding how to conduct such work. When this is the case, there is a logical explanation to why it is primarily solutions that are too vestigial to end up as radical change or innovations that emerge as outcomes of self-regulated development work. In situations where the development work is expert supported, such as in the coach-driven or guidance-driven positions, the competent other supports through serving as a role model by showing how development work activities can be performed, as well as facilitating the work by providing interpretations and reflections that enable learning that helps expand the boundaries of what employees are able to manage on their own (Vygotskij, 1978). Expert-supported work also enables new competence-bearing relationships (Döös, 2007) to be established, which when formed contribute to a temporary increase in the individual's/group's ability to perform development work. The results bear several similarities to the results described by Gustavsson (2007) in her study of process operators' potential for learning at work, where limited space for creative learning characterized the work, although some potential proved to be locally based and ad hoc.

A frequently used argument when deploying development work in companies is that such work should be integrated as part of the daily operational tasks. In larger companies, support functions and dedicated departments are responsible for development work (Netland, Schloetzer, & Ferdows, 2015), as is the case in Company A. However, in most SMEs, this would not be economically feasible. Implementing development work as a part of daily work may be a reasonable approach as a means to emphasize that it is a prioritized task. The problem with such an approach is that the knowledge and skills that are essential to performing systematic development work would be at risk of being less prioritized. This is partly corroborated by research indicating that the implementation of lean production is promoted by having a dedicated lean team with responsibility for coordinating the implementation, as opposed to having the responsibility distributed throughout the organization (ibid.). In tasks associated with, for example, the production of goods, employees are expected to continuously update their professional skills. To support employees' continuous learning of skills, many companies arrange for training activities on a regular basis, and work is organized in such a way as to foster work-integrated learning, for example, by job rotation. On the other hand, for tasks related to development work, there appears to occur a limited organizing of work practices that support continuous learning and updating of skills in relation to that type of work, although this has proven to be key to organizational success (Bessant, Caffyn, & Gallagher, 2001; Rother, 2009). If development work instead comes to be treated as a task on its own and a unique competence domain, it is possible to find explanations for the discrepancy that may arise between the expected outcomes of development work in operations and what employees are capable of performing in practice. Another conclusion, then, is that it

is not a given that a systematic development work should be preferably regarded as an integral part of daily work. Rather, development work benefits from being considered a competence domain in itself. Although it can take place at the same time, it is important to distinguish development work as a task that requires its own set of skills and knowledge, which in turn requires continuous training which is organized for.

Practical Implications: A Catch-22

Learning the skills and competencies necessary for the domain of development work is dependent on gaining proper training and rich experiences from participating in development work. A consequence of this is that in organizations where development work is not properly organized and supported by competent others, employees do not learn continuously. But without continuous learning, there can be no progress in building adequate competencies that would enable employees to engage in development work, which would most likely lead to repeated failures to deliver desirable outcomes. This can be described as a catch-22:

- Without properly organized and supported development work, people gain limited experience and knowledge about what to do and how to do it,
- which implies limited learning and development of skills and competencies for conducting viable development work,
- which consequently affects the development work taking place and leads to failures in terms of limitations on what is produced as outcomes,
- which in turn gradually establishes an identity that signals 'we can't run development projects'.

To be successful at development work and resolve this catch-22, managers need to recognize engagement in development work as a competence domain alongside the ability to do work-specific tasks. It also becomes very important to start running development work projects on a small scale and give people opportunities to gain experience and learn. Hold modest expectations for the first projects, and encourage workers to see failure as a path forward—as long as lessons are learned from it. Finally, depending on the level of competence distributed in an organization, development work also needs to be adequately supported by experts in the competence domain of development work.

References

Adler, P., & Borys, B. (1996). Two types of bureaucracy: Enabling and coercive. *Administrative Science Quaterly, 41*, 61.

Argote, L. (2012). *Organizational learning. Creating, retaining and transferring knowledge*. New York: Springer.

Bessant, J., & Caffyn, S. (1997). High-involvement innovation through continuous improvement. *International Journal of Technology Management, 14*, 7–28.

Bessant, J., Caffyn, S., & Gallagher, M. (2001). An evolutionary model of continuous improvement behaviour. *Technovation, 21*, 67–77.

Billett, S. (2009). Conceptualizing learning experiences: Contributions and mediations of the social, personal and brute. *Mind, Culture and Activity, 16*, 32–47.

Billett, S. (2001). Learning through work: Workplace affordances and individual engagement. *The Journal of Workplace Learning, 13*, 209–214.

Checkland, P., & Poulter, J. (2007). *Learning for action: A short definitive account of soft systems methodology, and its use practitioners, teachers and students*. New York: John Wiley & Sons.

Dewey, J. (1958). *Experience and nature*. New York: Dover.

Döös, M., Johansson, P. E., & Wilhelmson, L. (2015). Beyond being present: Learning-oriented leadership in the daily work of middle managers. *Journal of Workplace Learning, 27*, 408–425.

Döös, M. (2007). Organizational learning. Competence-bearing relations and breakdowns of workplace relatonics. In L. Farrell & T. Fenwick (Eds.), *World Yearbook of Education*. New York: Routledge.

Dreyfus, S. (2004). The five-stage model of adult skill acquisition. *Bulletin of Science Technology & Society, 24*(3), 177–181.

Dreyfus, S., & Dreyfus, H. (1980). *A five-stage model of the mental activities involved in directed skill aquisition*. University of California, Berkely: Operations Research Center.

Ellström, P.-E. (2006). Two logics of learning. In E. Antonacopoulou, P. Jarvis, V. Andersen, B. Elkjaer, & S. Hoyrup (Eds.), *Learning, working and living. Mapping the terrain of working life learning*. Basingstoke: Palgrave Macmillan.

Ellström, P.-E. (2011). Informal learning at work: Conditions, processes and logics. In M. Malloch, L. Cairns, K. Evans, & B. N. O'Connor (Eds.), *The SAGE handbook of workplace learning*. London: Sage.

Ellström, P.-E., & Kock, H. (2008). Competence development in the workplace: Concepts, strategies and effects. *Asia Pacific Education Review, 9*, 5–20.

Emiliani, M. L. (1998). Continuous personal improvement. *Journal of Workplace Learning, 10*, 29–38.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work, 14*, 133–156.

Eraut, M. (2004). Informal learning in the workplace. *Studies in Continuing Education, 26*, 247–273.

Ericsson, K. A. (2006). An introduction to the Cambridge handbook of expertise and expert performance: Its development, organization and content. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance*. Cambrigde: Cambridge University Press.

Fagerlind Ståhl, A.-C., Gustavsson, M., Karlsson, N., Johansson, G., & Ekberg, K. (2014). Lean production tools and decision latitude enable conditions for innovative learning in organizations: A multilevel analysis. *Applied Ergonomics, 47*, 285–291.

Francis, M., Fisher, R., Thomas, A., & Rowlands, H. (2014). The meaning of 'value' in purchasing, logistics and operations management. *International Journal of Production Research, 52*, 6576–6589.

Goller, M., & Billett, S. (2014). Agentic behaviour at work: Crafting learning experiences. In C. Harteis, A. Rausch, & J. Seifried (Eds.), *Discourses on professional learning. On the boundary between learning and working*. Dordrecht: Springer International.

Gustavsson, M. (2007). The potential for learning in industrial work. *Journal of Workplace Learning, 19*, 453–463.

Harteis, C., & Billett, S. (2013). Intuitive expertise: Theories and empirical evidence. *Educational Research Review, 9*, 145–157.

Hasle, P., Bojesen, A., Jensen, P. L., & Bramming, P. (2012). Lean and the working environment: A review of the literature. *International Journal of Operations & Production Management, 32*, 829–849.

Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: A review of contemporary lean thinking. *International Journal of Operations & Production Management, 24*, 994–1011.

Jasti, N. V. K., & Kodali, R. (2015). Lean production: Literature review and trends. *International Journal of Production Research, 53*, 867–885.

Johansson, P. (2011). *Arbetsplatsens lärmiljöer. En organisationspedagogisk studie av konstruerande av lärmiljö i vuxenutbildningsverksamhet*. Stockholm: Institutionen för pedagogik och didaktik, Stockholms Universitet.

Johansson, P. E. (2017). Kompetens och förutsättningar för praktikbaserad innovation – från självreglerat till expertstött förbättrings- och utvecklingsarbete. *Pedagogisk forskning i Sverige*, 1–2.

Johnsson, M. (2016). Innovation enablers and their importance for innovation teams. Doctoral dissertation, Blekinge Institute of Technology.

Klotz, V., Winther, E., & Festner, D. (2015). Modeling the development of vocational competence: A psychometric model for economic domains. *Vocations and Learning, 8*, 247–268.

Löfberg, A. (1989). Learning and educational intervention from a constructivist point of view: The case of workplace learning. In H. Leymann & H. Kornbluh (Eds.), *Socialization and learning at work. A new approach to the learning process in the workplace and society*. Aldershot: Avebury.

Löfberg, A. (2001). Att upptäcka världen. Perspektiv som murbräcka för utveckling av världen och tänkandet om världen. In H. Montgomery & B. Qvarsell (Eds.), *Perspektiv och förståelse*. Stockholm: Carlssons bokförlag.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*, 71–87.

Marton, F., & Booth, S. (1997). *Learning and awareness*. New Jersey: Lawrence Erlbaum Associates.

Marton, F., & Pang, M. F. (2006). On some necessary conditions of learning. *Journal of the Learning Sciences, 15*, 193–220.

Mazur, L., Mccreery, J., & Rothenberg, L. (2012). Facilitating lean learning and behaviors in hospitals during the early stages of lean implementation. *Engineering Management Journal, 24*, 11–22.

Netland, T. H., Schloetzer, J. D., & Ferdows, K. (2015). Implementing corporate lean programs: The effect of management control practices. *Journal of Operations Management, 36*, 90–102.

Ohlsson, J., & Johansson, P. (2010). Interactive research as a strategy for practice-based learning: Designing competence development and professional growth in local school practice. In S. Billett (Ed.), *Learning through practice. Models, traditions, orientations and approaches*. London: Springer International.

Osterman, C. (2015). *Towards a lean integration of lean*. Licentiate thesis 205, School of Innovation, Design and Engineering, Mälardalen University.

Rother, M. (2009). *Toyota Kata. Managing people for improvement, adaptiveness, and superior results*. San Francisco: McGraw-Hill Professional.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Stone, K. B. (2012). Four decades of lean: A systematic literature review. *International Journal of Lean Six Sigma, 3*(2), 112–132.

Taylor, A., & Greve, H. R. (2006). Superman or the fantastic four? Knowledge combination and experience in innovative teams. *The Academy of Management Journal, 49*, 723–740.

Vygotskij, L. S. C. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Womack, J. P., & Jones, D. (2003). *Lean Thinking*. Free Press: Banish Waste and Create Wealth in Your Corporation.

Womack, J. P., Jones, D. T., & Roos, D. (1991). *The machine that changed the world: How Japan's secret weapon in the global auto wars will revolutionize western industry*. New York, NY: HarperPerennial.

Chapter 5
Kaikaku in Production in Japan: An Analysis of Kaikaku in Terms of Ambidexterity

Yuji Yamamoto

Dilemma Japanese manufacturing companies have been active both in Kaizen—continuous improvement—and Kaikaku—radical improvement. However, compared to Kaizen, Kaikaku is less known and also less discussed in articles and books. Some questions may arise about Kaikaku: What is it? How is it undertaken in practice? How can an organization be proficient in both Kaikaku and Kaizen? In this chapter, these questions will be discussed.

Introduction

It is well known that many Japanese manufacturing companies have successfully implemented continuous improvement, known as *Kaizen*, in production. Kaizen is often considered to refer to a continuous effort through small-step incremental improvements. In contrast to the recognition of Kaizen, it is less widely known that many Japanese manufacturing companies also undertake large-scale improvement that is of a radical and innovative nature, often referred to as *Kaikaku*,[1] in production.

Today's business environment is characterized as hypercompetitive with a high pace of change. In the last decade, factories in Japan have faced severe competition with emerging competitors located in, for instance, East and South Asia. Production-related managers in Japan commonly express fear over their competi-

[1] Kaikaku can alternatively be called *Kakushin* at Japanese companies. The literal meaning of *Kaikaku* is reformation or radical change, while Kakushin means innovation. Since Kaikaku and Kakushin are frequently used as synonyms at Japanese manufacturing companies, in this book these words are considered equivalent and only Kaikaku is used.

Y. Yamamoto (✉)
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Yuji.yamamoto@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_5

tors' pace of increasing competitiveness (Yamamoto, 2013). They acknowledge that Kaizen is still an essential means to maintaining high competitiveness in production. At the same time, they understand that relying only on Kaizen may not guarantee a sufficient pace of improvement to maintain competitiveness. A remark from a former CEO of Toyota Motor Corporation, Watanabe, demonstrates the need for Kaikaku: "Toyota could achieve its goals through Kaizen. In today's world, however, when the rate of change is too slow, we have no choice but to resort to drastic changes or reform: Kaikaku" (Stewart & Raman, 2007).

Kaizen is a widely known term. A large body of literature describes what Kaizen is and how it is implemented in practice. On the other hand, little has been written in English about Kaikaku, what it is and how it looks in practice. For instance, in their description of improvement activities at Toyota Motor Corporation, Womack and Jones (1996) and Liker (2004) mention Kaikaku as radical improvement, but little further description is given as to how it is practiced. According to Bodek (2004), in the United States, Kaikaku is often considered equivalent to *Kaizen Blitz*—an improvement event focusing on a specific area with the aim of delivering a large gain in a short period of time. However, as shown later in this chapter, many Japanese companies do not conceive of Kaikaku as Kaizen Blitz. Apparently, Kaikaku is still somewhat shrouded in mystery. What is it? How is it undertaken in practice? How is Kaikaku related to one of the main themes in this book, ambidexterity? In other words, how can organizations be proficient in both Kaizen and Kaikaku?

There is a way to address these questions. There are Japanese-language journals to which a large number of Japanese manufacturing companies have submitted reports on their Kaikaku activities in production. Thus, the aforementioned questions may be discussed in depth by gaining deeper insight into Kaikaku, by reviewing those reports, and by analyzing the activities that Japanese manufacturing companies refer to as Kaikaku. Therefore, the main topic of this chapter is, first, to describe Kaikaku in production based on a review of many of these reports and, second, to analyze the reported Kaikaku in terms of ambidexterity. As described in a later section, analysis has revealed that many Japanese companies in the reports view Kaikaku as a valuable opportunity to build the capability of both exploitation and exploration within organizations.

The data to be presented in this chapter were obtained from a study conducted in 2011. In the study, the author of this chapter performed a literature review of 65 case study reports describing Kaikaku activities at Japanese manufacturing companies. Most of the reports were from two Japanese-language journals called *IE Review* and *Factory Management*. In the reports, managers and employees who participated in the Kaikaku activities describe what actions were taken during the activities and also present their thoughts and reflections on the activities. The author of this chapter selected the reports that were published from 2000 to 2011 and had a rich description of Kaikaku activities. The list of the reviewed reports is presented at the end of this chapter. Eleven of the 65 reports described Kaikaku activities at small and medium-sized enterprises (SMEs) with fewer than 300 employees. The rest of the reports are at large companies with at least 300 employees.

In the next section, for the purpose of providing readers a basic concept of Kaikaku, the general characteristics of Kaikaku are presented; they are derived from the review of 65 reports. In the third section, a summary of what actions are taken during the Kaikaku activities in the reports is presented. Then, in the fourth section, the Kaikaku activities are analyzed from the perspective of how organizations can be proficient in both Kaikaku and Kaizen.

General Characteristics of Kaikaku

Since Kaikaku may be less familiar to readers, it would probably be a good idea to discuss the general characteristics of Kaikaku before going into detail on the subject. The general characteristics of Kaikaku presented here are identified from the review of the 65 case reports. The characteristics are shown in Table 5.1. These characteristics are compared with those of Kaizen often found in the literature.

Nearly every Kaikaku activity described in the reports entailed some fundamental reconsideration of the existing production systems, aiming at drastic improvements in performance measures in production, such as quality, cost, delivery accuracy, and manufacturing lead time. In the literature, Kaizen is often described as small-step and incremental changes based on existing methods of operating production (Brunet & New, 2003). Kaizen can also bring about fundamental changes and large performance gains over time (Orlikowski, 1996). However, it is more often considered an opportunity rather than a necessity (Orlikowski, 1996).

In the reports, Kaikaku tends to entail large-scale changes involving wide-ranging activities. A production system is a sociotechnical system. In Kaikaku, changes were made to both the technical and social systems, for instance, in production processes, pieces of production equipment, information systems, management processes, manufacturing strategies, and cultures in organizations. In some cases, the scope of the change was not only the production systems but the whole company. In the reports, implementation of lean production was one of the popular

Table 5.1 General characteristics of Kaikaku found in reports compared with characteristics of Kaizen found in the literature

General characteristics of Kaikaku found in reports	Characteristics of Kaizen in literature
Fundamental change aiming to achieve radical improvements in operational performance	Incremental, small-step changes
Large-scale and wide-ranging activity	Small-scale and narrowly focused activity
Deliberate activity initiated from top or senior management	Autonomy-encouraged activity
Discrete effort within a definite period of time	Continuous effort
Involving stretched target setting	Ongoing and incremental targets
A process involving a large-scale change	A process characterized as a PDCA (Plan, Do, Check, and Action) cycle

efforts under Kaikaku. An implementation of lean production often brings about a paradigm shift in the company toward a lean enterprise (e.g., Iwaki, 2005; Smeds, 1994). An implementation of lean production seems to be a typical example of Kaikaku at the time the reports were published. In contrast, Kaizen usually focuses on a narrowly defined area of a system, for instance, a production cell or part of a production line.

In the reports, Kaikaku represented a deliberate effort initiated by top and senior management. It was also driven by strong leadership from the management. Since Kaikaku often changed the processes ranging over different groups, divisions, or departments in the organizations, an effective coordination and direction from high-level management was considered important. Although Kaikaku can be characterized as a top-down approach, this does not necessarily mean that changes are never collaborative or participative. In the reports, many of the Kaikaku activities were initiated by management, but actual changes were driven by employees at lower levels of the organizations. On the other hand, in the literature, Kaizen is frequently treated as a bottom-up approach. It is usually encouraged by the management, but each Kaizen activity is often conducted more autonomously and in a less coordinated manner between improvement groups (Berger, 1997).

Kaikaku was a discrete effort that had a definite time period with specific targets to be achieved at the end of the period. Therefore, Kaikaku was typically seen as a large-scale project or initiative. A Kaikaku activity often contained smaller projects carried out at different points in time during the overall activity. The time frames of a Kaikaku activity ranged from a few months to a few years. On the other hand, Kaizen is normally seen as a continuous effort, reflecting the embedded nature of the practice in a never-ending journey toward quality and efficiency (Brunet & New, 2003).

Kaikaku activities often include significantly stretched targets, for instance, halving manufacturing lead time, doubling productivity, or reducing by half the area of the shop floor used for production. Such stretched targets are usually set by the management in order to provoke people in the organization into questioning the current state of operations and shared mindsets and behaviors. In Kaizen, targets are often ongoing and incremental. They are often incorporated into monthly or yearly quality and productivity targets (Imai, 1986).

At the general level, a process of Kaikaku in the reports resembles a change process often presented in theories of *business process reengineering*, alternatively called *process innovation*. Process innovation often involves changes in various business processes to improve the relevant business performances. Process innovation was a popular topic in both academia and industry in the 1990s and early 2000s. A number of articles describe life-cycle models of process innovation (e.g., Al-Mashari & Zairi, 2000; Motwani, Kumar, Jiang, & Youssef, 1998). A general process of Kaikaku can be described based on the models presented in Fig. 5.1. The process includes preparation, redesign, and implementation steps. Different activities are performed in each step. While Kaikaku involves a process oriented toward a project involving large-scale change, a Kaizen process is often described as a PDCA cycle.

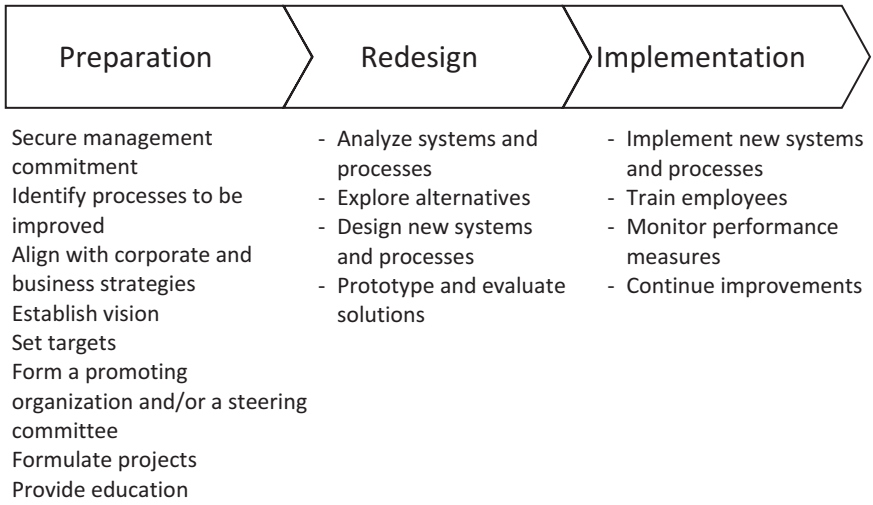

Fig. 5.1 Generic Kaikaku process

In this section, the general characteristics of Kaikaku were presented. The next section will provide a more detailed description of Kaikaku.

How Kaikaku Is Undertaken in Practice

For the purpose of summarizing how Kaikaku was undertaken at the companies in the 65 case reports, the following pieces of information in the reports were collected as data: what actions were taken during the Kaikaku activities, how and why those actions were taken, and thoughts of and reflections on the actions. Sorting the data made it possible to categorize them into the following eight themes.

- Reasons for initiation
- Objectives
- Driving structures
- New processes and equipment
- Design of the new processes and equipment
- Implementation
- Results
- Success factors

In this section, a summary of how Kaikaku was undertaken at the companies in the reports is presented in accordance with these eight themes.

Reason for Initiation

Most of the case reports began by explaining the circumstances behind the Kaikaku activities. There were various reasons for initiating Kaikaku, but they generally relate to concerns that were external or internal to production, as shown in Table 5.2. The numbers beside the data in Table 5.2 correspond to how many reports contained the particular data. The numbers in Tables 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, and 5.9 have the same meaning.

Table 5.2 Reasons for initiation

Concerns external to production	*Concerns internal to production*
Stiff competition (15)	Long manufacturing lead time and large inventory (12)
Emerging competitors (5)	Need for synchronization between sales and manufacturing (6)
Demand for shorter lead time to delivery (8)	Need for faster pace of improvement (4)
Demand for higher flexibility (7)	Need to take on even greater challenges (4)
Increasing product variation (5)	Stagnation of Kaizen (3)
Shorter product life cycles (5)	Need for new thinking (3)
Sales drop (8)	Low motivation of employees (3)
Product price decrease (7)	Need to fulfill business strategy (3)
Increasing volume (4)	Need for total optimization (3)
High raw material cost (3)	Need to reduce manufacturing costs (5)
Decreasing profitability (3)	Decreasing yield (1)
Company in crisis (2)	Too many crises in operations (1)
	Results of internal/external benchmarking (8)
	New product introduction (3)
	Factory renovation and relocation (1)

Table 5.3 Objectives

Quantitative	*Qualitative*
Productivity increase by 30–100% (16)	Development of human resources for improvement and innovation (5)
Manufacturing lead time reduction to one-half to one-third (5)	Building mindsets and behaviors aligned to active improvements (3)
Inventory reduction to one-half (4)	Reenergize innovation efforts (2)
Investment cost in equipment and size of equipment reduced to one-third to one-fifth (3)	All employees' active participation in breakthrough and innovation (2)
Quality loss cost reduction to one-half to one-third (2)	Increase pace of improvement (1)
Reduction of manufacturing area by 30–50% (4)	
Manufacturing line length reduction to one-half (1)	
Yield increase by 12% (1)	

Table 5.4 Driving structures

Supported by consultants (21)	Top management responsible for activities (4)
Steering committees, divisions, or teams to support or drive the activities (19)	Regular briefing sessions to report on progress (4)
Regular factory inspections by senior managers (5)	Internal audit system (1)

Table 5.5 New processes and equipment

Lean production	*Human resource development*
One-piece or small-lot flow (26)	Routines for education and skill development (13)
Kanban and pull system (22)	Multiskill management (4)
Cellular layout (15)	Routines for improving innovation capacity (2)
Waste-reduced manual operation (10)	*Others*
Short time setup (9)	Factory internal logistics (6)
Improvements of tools and fixtures (9)	Product design for manufacturing (5)
Even workload (4)	Simultaneous engineering (4)
5S (4)	Factory external logistics (4)
Simple, compact, and low-cost pieces of equipment, aligned with production processes (17)	Daily follow-up system (2)
Flexible or reconfigurable lines (6)	Quality tracking system (2)
Production planning and control system	Standardized design processes (1)
Production planning system supported by IT (18)	Cost management system (1)
Production monitoring and control system supported by IT (14)	
Operation control board (7)	

Table 5.6 How new processes and equipment were designed

Analytical tools	*Cross-functional team work*
Seven types of waste (24)	Corporation of product and production engineers (3)
Time measurement (5)	Operators joined in equipment development (2)
Process mapping (2)	Frequent experiments at shop floors to obtain quick feedback (1)
7 losses in TPM (2)	Internal struggle for equipment development (1)
Video analysis (2)	
7 quality control tools (1)	
Considering the ideal state	
Human movement should be minimized (4)	
Points other than those that add value are waste (4)	
Material and information flow should be as simple as possible (2)	
Fixtureless assembly (1)	
Value engineering (1)	

Table 5.7 How implementation was undertaken

Role of management	*Structure of smaller improvement projects*
Driving changes with strong leadership (6)	*Plan and follow-up*
Close communication with employees (4)	Setting of targets and schedules for each improvement project (4)
Creating alignment (1)	Review of each improvement project after the completion (1)
Changing oneself (1)	*When projects were undertaken*
Training	1 month every half a year (1)
Training for managers and employees (18)	1–2 days every month (1)
Workshops and pilot projects (5)	1–2 h every week (2)
Motivating employees for changes	During overtime and weekends (1)
Creating sense of achievement (3)	*Who carried out the projects*
Visualization of results (3)	A group of employees from other divisions (3)
Visualization of problem (2)	A team consisting of specially trained employees (3)
Careful attention to employees' desires (1)	Every employee belonged to a small improvement group (1)
Mindset required for changes	
Challenging spirit (4)	
Speed of each improvement project (3)	
New thinking (1)	

Table 5.8 Results of Kaikaku activities

Production lead time reduced to 1/2–1/20 (31)	Cost of poor quality reduced by half (2)
Productivity increase by 30–400% (31)	Number of quality complaints reduced to one-half to one-third (2)
Production area reduced to 1/2–1/33 (18)	Number of design errors after start of production reduced by 80% (1)
Inventory reduced to 1/3–1/7 (14)	Yield increased by 16% (1)
Production line length reduced to 1/2–1/10 (3)	Material cost reduced by half (2)
Production capacity increase by 52% (1)	Assembly parts 30–55% less (2)
Investment cost in equipment reduced to 1/2–1/10 (5)	Motivated employees (15)
Equipment size 40 to 75% less (3)	Improved skills in improvement and innovation (6)
Equipment development lead time reduced to one-thord to one-sixth (3)	

Note that the numbers in those tables should be treated with caution. The reviewed reports had no common way of describing the Kaikaku activities. For instance, some reports mostly described the solutions created during the activities (e.g., a description of functions and structures of newly developed automated assembly cells), while other reports mainly described how managers and employees engaged in problem solving during Kaikaku. Owing to the variety of reporting on Kaikaku activities, the numbers will be regarded as only indicative with limited statistical significance.

Table 5.9 Success factors

Role of top management	*Evolutionary approach*
Leadership (7)	Accumulation of everyday effort leads to dramatic change (4)
Enthusiasm (4)	Taking steps to see more (1)
Setting challenging goals (4)	Speed of each improvement cycle (5)
Continuous communication (2)	*Visualization*
Prioritizing the initiative (1)	Visualization of results (5)
Creating alignment (1)	Visualization of problems (4)
Setting clear manufacturing strategies (1)	Real-time visualization of progress in operations (1)
Mindset	*Team work*
Unlearning (9)	Close cooperation with divisions and functions (6)
Challenging spirit and experimentalism (7)	Physical closeness of cooperating functions (1)
Total optimization (5)	*Analysis and design*
Creative thinking (2)	Thorough problem analysis (3)
Process perspective (2)	Creating ideal state (3)
Sense of urgency (1)	*Others*
Persistence (1)	Learning from others (4)
Everyone's participation	Wisdom of many (2)
Everyone's involvement and motivation for improvement (8)	Support organization driving and assisting improvements (2)
Cycle of problem solving leading to motivation and skill increase (5)	Use of IT to assist design processes and develop knowledge database (2)
Improvements by people who work there (1)	
Enjoying improvements (1)	

With respect to concerns that are external to production, the increasing level of competition in the global arena was frequently mentioned in the report as a reason for initiating Kaikaku. The need to deal with customers' demands for a shorter lead time to delivery, increasing product variation, and shorter product life cycles were other major reasons to launch many of the Kaikaku activities. The need for change was an urgently felt one at most of the companies, but it was in terms of preventing a possible crisis down the road. Only a couple of companies launched the initiatives because they were already in crisis and required dramatic and immediate improvements in their operations.

As for concerns internal to production, the need for shorter manufacturing lead times and lower inventories was a frequently mentioned reason for the Kaikaku activities. Dissatisfaction with the present pace of improvement and the need for attaining a higher improvement pace was another major motivation for the initiation of Kaikaku. For instance, Fukushima (2007) and Omori (2009) mentioned that the companies started the activities because their improvements had been slow and reactive. These companies wanted to pick up the current pace of improvement. A number of companies that had been working with Kaizen for decades also initiated

the activities. For instance, one company started Kaikaku because Kaizen had stagnated owing to increasing product variation and shorter product life cycles (Sawa, 2007). Another company initiated the Kaikaku activity to encourage employees to be more innovative in making improvements (Shirai, 2007). Other reasons include the need to fulfill the business strategy, introduce new products, relocate a factory, and carry out renovations (Table 5.2).

Objectives

The companies in the reports referred to the activities as Kaikaku or other similar words to show that the activities represented radical approaches to improvement. Some of the reports presented visions and road maps toward the desired states that were often illustrated in figures. As shown in Table 5.3, quantitative performance targets were set with respect to, for instance, quality, productivity, lead time, amount of inventory, and area of shop floor. Nearly all of the targets were considerably stretched. At a company, such challenging targets were set for the purpose of driving people in the organization to leave behind the prevailing incrementalism and be more active in bringing about innovation (Matsuo, 2007). Better team work was also expected to come about by having stretched targets at some companies (Sawa, 2007; Shirai, 2007). The time frames in which the targets were to be met varied from 6 months to 5 years.

A number of companies in the reports also had qualitative objectives related to organization development. For instance, increasing the pace of improvement, reenergizing innovation efforts, and developing employees' abilities for improvement and innovation were articulated as objectives (e.g., Akita, 2004; Hora, 2003; Nakagi, 2004; Noguchi, 2007; Yoneya, 2001). These qualitative targets were considered to be as important as achieving numeric performance targets.

Driving Structures

The reports contained descriptions of how the Kaikaku activities were driven at a management level, although the descriptions were often not detailed. They are summarized in Table 5.4. As mentioned later, many Kaikaku activities involved an organization-wide implementation of lean production. Many reports mentioned that the companies received guidance from external consultants for the implementation.

In many Kaikaku activities, steering committees, divisions, or expert teams were created to support or drive the activities. Their role included, for instance, giving general directions for improvements, creating targets and road maps, conducting analyses, assisting in the implementation of solutions, and providing education. The members of the committees, divisions, or teams worked full- or part-time for Kaikaku and usually performed various functions in the organizations. They often had rich experiences in large-scale changes or advanced technical skills.

Some reports described how the activities were followed up at the management level. For example, monthly in-depth follow-up sessions were held in order to check the progress of Kaikaku and discuss necessary actions. At some companies, regular factory inspections were conducted by senior managers, where the managers walked through the shop floors and indicated areas to be improved.

New Processes and Equipment

In the reports, various new production processes, operational routines, and pieces of equipment were presented as solutions created in the Kaikaku activities. They are clustered as shown in Table 5.5. Nearly two-thirds of the activities involved implementation of lean production. Therefore, many solutions were related to lean production. Examples are one-piece or small-batch flow, Kanban, pull systems, workload leveling, short-time setup, and waste-reduced manual operations.

On the other hand, several companies in the reports seemed to have already established lean production before the launch of the Kaikaku activities. At those companies, more attention was paid to developing pieces of production equipment suitable for lean production, which were often simple, compact, low-cost, and aligned with the production processes. Such equipment was frequently mentioned as lean equipment (e.g., Akita, 2004; Takahashi, 2001; Yoneya, 2001). Some of those companies also developed reconfigurable assembly lines. For instance, one company developed reconfigurable automation assembly lines consisting of robot modules that could be added to or removed from the lines depending on product variations and volume (Yoshida & Fujiwara, 2007). Other companies focused on continuous monitoring of production status by connecting all the production equipment to the IT system (e.g., Banzai & Watanabe, 2007).

A number of companies in the reports focused on human resource development in the Kaikaku activities. New routines for education and skill development were created during the activities. Some companies tried to increase the innovation capacity of managers and employees. For instance, one company required every manager to create a vision and set ambitious targets in their areas of responsibility in order to encourage them to think and act in a more innovative way (Tanahashi, 2009).

There were many other kinds of solutions presented in the reports (Table 5.5). They were related to, for example, internal logistics, multiskill management, daily follow-up systems, quality tracking systems, simultaneous engineering, and standardized design processes.

How New Production Processes and Equipment were Designed

A number of reports contained descriptions of designs for new production processes and pieces of production equipment. A summary of this theme is presented in Table 5.6.

The reports mentioned several well-known analytical tools that were used to generate solutions. They included, for instance, seven types of waste, time measurement, process mapping, and video analysis. During the design activities, different kinds of ideal states were considered as a way to generate novel solutions. One report stated that pursuing ideal states helps to free designers from conventional solutions and ways of thinking (Maruyama, 2008). At one company, an ideal length of the manufacturing line was calculated to minimize the amount of walking (Fujimoto, 2009). At another company, a new layout was designed taking into consideration minimum material movement, human movement, and material and information handling (Sato, 2005). At some companies, it was considered that only those points where value was added to the products in the production processes were the necessary parts of the factory, and the rest of the factory was waste (Sawa, 2007; Tanahashi, 2009).

Several reports mentioned that cross-functional teams contributed to the creation of new solutions. Different kinds of cross-functional teams served different purposes. One company, as reported by Shirai (2007), created a cross-factory support team consisting of experts from various divisions to assist in generating unprecedented ideas and developing novel production equipment. At another company, future products and future production systems were simultaneously developed, which led to the creation of a novel reconfigurable automation line (Watabe, 2010). Close cooperation of production engineers and operators was also mentioned in some reports.

How Implementation Was Undertaken

There were greatly varied descriptions in the reports regarding how the new production processes, operational routines, and pieces of equipment were implemented. A summary of this theme is presented in Table 5.7.

One of the groups shown in Table 5.7 is related to roles of management during the implementation. Several reports mentioned that the changes were driven by the strong leadership of the top management. The management engaged in close dialogue with employees to communicate the purpose of the changes in the form of, for instance, regular round-table conferences. In a report, a director of one company commented that managers themselves needed to change in order to motivate employees to initiate changes (Kamata, 2000).

Training was often provided to facilitate implementation. In lean implementation, for instance, managers, change agents, and employees were sent to external or internal training programs to gain the knowledge and skills necessary for the implementation. In other Kaikaku activities, companies organized internal workshops to study and disseminate a new way of working.

Several reports mentioned that motivating employees for change was essential for an effective implementation. Companies in the reports had different ways of motivating employees during the implementation. Some reports mentioned that a sense of achievement increased the motivation for further improvements. At one company, for instance, employees reduced the area for the inventories to less than

half (Takahashi, 2001). They became confident in their efforts and gained energy for further improvements. A few companies in the reports showed the improvement results to employees in order to share the sense of achievement. Visualization of problems was also mentioned as a means to increase the sense of urgency for improvements among employees.

Kaikaku activities in the reports were mostly divided into a number of smaller improvement projects, each of which had certain themes and targets. These projects normally took from a few weeks to several months. Several reports described how these smaller improvement projects were driven during the Kaikaku activities. Descriptions were related to three areas: planning of and follow-up on improvement activities, when they were conducted, and who conducted them (Table 5.7).

Some reports mentioned that a certain mindset was necessary for the implementation. A couple of reports wrote that a challenging spirit among the employees contributed to the realization of seemingly difficult changes. This challenging spirit will be described subsequently in another theme. Other reports mentioned that the speed of each improvement project was crucial because it decided the overall speed of the Kaikaku activity.

Results of Kaikaku Activities

Most of the reports showed the results of Kaikaku activities. A summary of the results is presented in Table 5.8. More than half the reports showed radical improvements in production lead time or the amount of inventory. Major improvements in productivity were also frequently reported. Other results, for instance, in production area, cost of investment in equipment, size of equipment, quality loss cost, and material cost, were also dramatic, with improvements of 30% or more. Other than these improvements in performance measures, nearly one-third of the reports mentioned that increased motivation and skills in improvement and innovation among managers and employees were significant results of the Kaikaku activities. For example, the president of a company commented that he observed a behavioral change in the employees from a conservative type—preferring to maintain the status quo and avoid changes—to an innovative type—favoring questioning the status quo and undertaking experiments (Kamata, 2000). He stated that this change was the most significant achievement of the Kaikaku activity.

Success Factors

In most of the reports, the authors or the managers involved in the Kaikaku activities reflected on what had contributed to or what had been important for the success of the activities. A summary of their reflections is presented in Table 5.9.

One group in Table 5.9 is related to the roles of the top management. Top management's leadership and enthusiasm were mentioned as critical success factors for

many of the Kaikaku activities. Other managerial roles, for instance, communicating the need for Kaikaku to employees, setting challenging targets, having a clear strategy and tactics, and giving high priority to the activities, were stated as being important.

A number of authors and managers commented that certain mindsets were essential to the success of the activities. Challenging spirit, experimentalism, and unlearning were often mentioned as important to bring about radical changes. In a report, Ozawa (2006) mentioned that the culture of advocating experimentation, admiring challengers, and tolerating failures helped to overcome highly difficult challenges. Another report author reflected that a challenging spirit and persistence in the group contributed to creating solutions that had been thought impossible at the beginning (Kishimoto & Fujita, 2009). Further, in another report, one company manager pointed out that explorative improvements made with a challenging spirit might result in failures, but people could learn from them and prevent the same mistake from occurring again (Kamata, 2000). Other mentioned mindsets were, for instance, creative thinking and a sense of urgency.

Everyone's participation was also frequently considered important for the success of Kaikaku activities. A number of the reports mentioned that everyone's involvement and motivation were key to obtaining the desired outcomes in the activities. Several authors and managers stated that empowerment and skill development occurred through the problem-solving cycles. They reflected that such a development was one of the most critical parts of the Kaikaku activities. For instance, one company director commented that employees in the organization identified challenges, overcame them, and then gained a sense of achievement. Top management admired their efforts, which increased the motivation for improvement even more. By iterating this process, the motivation and skills for improvement increased (Yoneya, 2001). The director believed that the iteration of the process was the most important element of the Kaikaku activity. In another report, a company manager pointed out that explorative improvements develop people (Kamata, 2000). The more people could achieve such improvements, the more difficult challenges they could address. This manager stated that iterating this improvement cycle as fast as possible was key for the Kaikaku activity (Kamata, 2000).

Several authors of one report commented that taking steady steps rather than abrupt ones was a way of effecting radical improvements. In one report, it was mentioned that people could see more improvement opportunities by working on improvements gradually, step by step (Fujimoto, 2009). In the context of taking steps in the Kaikaku activities, a number of authors and managers mentioned that the speed of each improvement cycle was important to maintain a good pace of change in the activities.

Other groups of success factors are shown in Table 5.9. Examples are visualization, close cooperation with different divisions and functions, imagining some kind of ideal state when designing new processes and equipment, and learning from others.

Analysis of Kaikaku Activities in Terms of Ambidexterity

As mentioned earlier, this chapter discusses the following three questions: What is Kaikaku? How is Kaikaku undertaken in practice? And how can an organization be proficient in both Kaikaku and Kaizen? The first two questions were discussed in previous sections. In this section, the third question will be discussed based on the Kaikaku activities presented in the previous section.

Before discussing the third question, it is worth mentioning one additional characteristic of Kaikaku that was not mentioned in the general characteristics presented in the second section (Table 5.1). The additional characteristic emerged when a deeper insight into Kaikaku was obtained through organizing a summary of Kaikaku activities. The identified characteristic is that Kaikaku requires everyone's exploration effort. In the 65 reports, the importance of everyone in the organization having a specific mental mode related to exploration, for instance, a challenging spirit, give-it-a-try mentality, and unlearning, is frequently mentioned. In the Kaikaku activities, managers often encouraged everyone in the organizations to think and act in a more explorative way than they were used to. Apparently, companies used the word *Kaikaku* as a way to make managers and employees be aware of this mental stance toward exploration.

The characteristic can be further explained using Fig. 5.2. The figure shows that problem-solving activities with different degrees of innovativeness involve both exploitation and exploration to different extents (in this figure's caption, exploitation and exploration are understood as types of acts carried out during problem solving by individuals or groups). Problem solving with a high degree of innovativeness tends to involve more exploration than exploitation. In an organization, some groups may be engaged mostly in incremental improvements, while others may be in innovation. Using Fig. 5.2, the aforementioned characteristic can be understood such that in a Kaikaku activity, everyone should be encouraged to work toward right side of the rectangle in Fig. 5.2. The characteristic represents an interesting contrast to the common practice of managing exploration in organizations: exploration is often encouraged and facilitated in a limited part of organizations, for instance, in research and development departments.

Here, we return to the question of how an organization can be proficient in Kaikaku and Kaizen simultaneously. Is it possible to draw any implications from the question in the review of the 65 case reports?

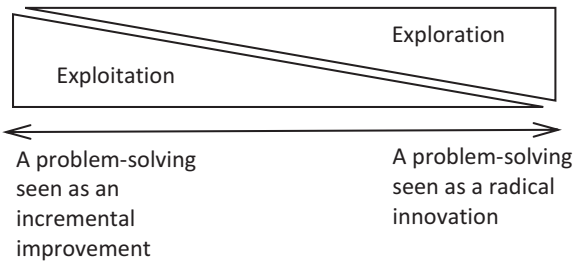

Fig. 5.2 Extent of exploitation and exploration involved in problem-solving activities with different degrees of innovativeness

Unfortunately, none of the reports directly discussed the question. On the other hand, many of the reports focused on the development of individual abilities. Those reports discussed the notion that everyone in the organizations obtaining high proficiency in both exploitation and exploration was considered critically important for the Kaikaku activities as well as for the companies. The companies seemed to consider that the development of abilities at the individual and group levels would eventually lead to the emergence of the abilities at the organization level. A comment in one report is representative: Kaikaku was undertaken with the motto that a change in individual behaviors will lead to a change in workplace climate, which in turn will lead to changes in organization cultures (Hamada, 2003).

As described in the previous section, in several reports, the authors and managers involved in the Kaikaku activities recognized that employees' abilities in exploitation and exploration were developed through the iteration of improvement cycles. For instance, one report mentioned that through the improvement cycles people increased their motivation and abilities in exploitation and exploration, and at the same time operational performance improved (Kamata, 2000). In the reports from Yoneya (2001) and Kamata (2000), the managers acknowledged that iteration of the cycle is one of the most important elements in Kaikaku activities. The cycle can be modeled as a learning cycle (Fig. 5.3).

At the beginning of the learning cycle in Fig. 5.3, problems and challenges are identified and often visualized to increase the sense of urgency. They are resolved, and the results are visualized to be shared throughout the organization. Problem solving often leads to identifying further improvement opportunities. People who were involved in bringing about the improvements gain skills and knowledge in problem solving. At the same time, they acquire a sense of achievement and become motivated to take on even more difficult challenges. Some improvements may not pan out, but the participants reflect on and learn from the failures. In this way, operational performance in production is improved and at the same time people gain the abilities and motivation for exploitation and exploration. As Kaikaku is often treated

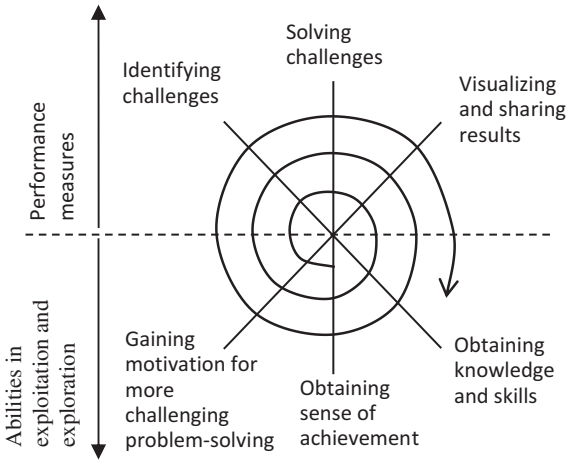

Fig. 5.3 A learning cycle including improvement of performance measures and development of abilities in exploitation and exploration

as an exploration effort involving everyone, problem solving in each learning cycle is gradually pushed toward right side of the rectangle shown in Fig. 5.2.

The preceding analysis allows us to assert that actively iterating the mentioned learning cycle is one way of achieving high proficiency in exploitation and exploration, which can facilitate acquiring a high proficiency both in Kaizen and Kaikaku at the organization level. The importance of iteration makes sense because the more opportunities one has to engage in improvement and innovation, the more likely one will become trained in them. This agrees with a notion of Bessant (2003) that is frequently referred to in the research of innovation management. Bessant states that developing the abilities to exploit and explore resembles the process of becoming an athlete: it requires constant and purposeful training.

Further, the companies in the reports seemed to make various efforts to create organizational conditions so that the cycle would keep iterating. Examples found in the reports are the encouragement of experimentation, top managers' involvement in improvement cycles, routines for visualizing problems and results of problem solving, creating expert teams to support problem solving, and putting in place follow-up and reward systems (Horio, 2008; Mishima, 2004; Nagai, Mizutani, & Osakabe, 2001; Taniguchi, 2009). Horio (2008) and Sasaki (2009) also mentioned that constantly providing employees with opportunities to engage in improvement and innovation is a key for the iteration of the cycle. An implication of those reports is, therefore, that creating the aforementioned kinds of organizational conditions to keep iterating the learning cycle is important for establishing proficiency in exploitation and exploration.

Moreover, perhaps because managers were implicitly or explicitly aware of the effect of individuals' skill development during Kaikaku, several companies in the report formulated "double objectives" in Kaikaku, that is, they had numerical performance objectives in terms of, for example, productivity, quality, cost, and lead time while at the same time having qualitative objectives that were often related to improving employees' abilities to exploit and explore. As discussed in previous sections, some companies initiated Kaikaku activities to enhance Kaizen because Kaizen had been slow and reactive (Fukushima, 2007; Omori, 2009). Some other companies have been active in Kaizen for decades, and they initiated Kaikaku to make employees more competent in innovation (Shiina, 2009; Shirai, 2007). Different levels of improvement and innovation abilities at the organization level are shown in Table 5.10. The table is based on an analysis of the Kaikaku activities in the reports and was inspired by the maturity levels in improvement suggested by Bessant (2003). The review of the reports implies that Kaikaku can be seen as an opportunity or means to step up the levels shown in Table 5.10 and eventually achieve the highest level—*continuous innovation*: improvements and innovations are simultaneously pursued by applying individuals' high proficiency in exploitation and exploration. It can be asserted that stepping up among the mentioned levels as a long-term organization's goal can be one of the organizational conditions supporting the development of abilities to exploit and explore.

Regarding the question of how to be proficient in Kaizen and Kaikaku simultaneously, one may wonder how Kaikaku and Kaizen can be effectively undertaken at

Table 5.10 Four levels of improvement and innovation abilities in organizations

Ability level	Characteristic behavior or pattern
Level 1: Firefighting	Few improvements are made; a lot of time is spent on resolving urgent problems that are continuously emerging.
Level 2: Local improvements	Operational processes are more stable than at level 1. Improvements are carried out at a local level but have limited strategic impacts.
Level 3: Strategic continuous improvement	A strong culture of continuous improvement exists in the organization. Improvements are linked to strategic objectives. Innovation can occasionally occur.
Level 4: Continuous innovation	Incremental improvement and radical innovation are simultaneously sought and continuously take place in the organization.

the same time. Interestingly, only a few reports briefly mentioned the simultaneous undertaking of Kaikaku and Kaizen. For instance, one report said that Kaizen activities still had to be done but many of them were aligned with the focus areas and the objectives in Kaikaku (Yoneya, 2001). Another report described how indirect workers also participated in improvements on the shop floor so as to have enough manpower to drive the Kaikaku activity (Tsukame & Sakamoto, 2011).

Although it is difficult to draw any conclusions with the limited amount of data, a review of the reports implies that undertaking Kaikaku and Kaizen simultaneously is quite possible and seems to be a matter of resource allocation. It can be assumed that companies can allocate more resources to Kaikaku if the production processes are stable and Kaizen is sound. On the other hand, some companies in the reports were in crisis and initiated Kaikaku activities in order to urgently improve their production processes and shift employees' mindsets toward thinking about more active improvements. Considering that all the companies in the reports engaged in Kaizen to different degrees, it seems that Kaikaku can be initiated along with Kaizen, if management feels it is necessary and is willing and able to invest the resources for it.

Conclusions

This chapter has discussed large-scale improvement in production that is of a radical and innovative nature called Kaikaku. Based on a review of 65 case reports describing Kaikaku activities at Japanese manufacturing companies, general characteristics of Kaikaku have been described. A summary of how these companies undertook Kaikaku activities in practice was also discussed. Kaikaku was further analyzed in terms of ambidexterity, in other words, how organizations can be proficient in Kaizen and Kaikaku simultaneously. Some implications of the question were drawn from the analysis of the reviewed Kaikaku activities. The descriptions and discussions presented in this chapter make clear that Kaizen and Kaikaku have

a relationship of mutual dependency. When Kaikaku is undertaken, it is often divided into a number of smaller improvement projects, and the exploration of each project can be seen as a Kaizen activity. In this sense Kaizen can be viewed as an integrated part of Kaikaku. Therefore, effective Kaizen can positively affect the results of Kaikaku. On the other hand, Kaikaku can be used to change organization cultures toward more active Kaizen. Kaikaku can have a positive effect on Kaizen. In this book the concept of duality was also discussed. A duality can also be found between Kaizen and Kaikaku.

Finally, based on the analysis and discussions in this chapter, some key learning points for production managers can be identified. They are summarized as follows:

- Kaikaku can be seen as an organization-wide, large-scale improvement approach that is of a radical and innovative nature.
- Kaikaku can also be seen as an all-encompassing exploration effort in which all managers and employees are encouraged to act and think more exploratively than they are used to doing.
- Kaikaku can represent a valuable opportunity to train managers' and employees' capability in exploitation and especially exploration.
- In connection with the third point, Kaikaku can have a "double objective"—targets related to performance measures that should be met at the end of Kaikaku and targets related to building the capacity for exploitation and exploration.
- Kaikaku and Kaizen are often mutually dependent. Effective Kaizen often has a positive influence on Kaikaku, and Kaikaku can stimulate Kaizen.

References

Al-Mashari, M., & Zairi, M. (2000). Revisiting BPR: a holistic review of practice and development. *Business Process Management Journal, 6*(1), 10–42.

Berger, A. (1997). Continuous improvement and kaizen: Standardization and organizational designs. *Integrated Manufacturing Systems, 8*(2), 110–117.

Bessant, J. R. (2003). *High-involvement innovation: Building and sustaining competitive advantage through continuous change*. Chichester: Wiley.

Bodek, N. (2004). Lean into it. *Industrial Engineer, 36*(7), 58–59.

Brunet, A. P., & New, S. (2003). Kaizen in Japan: An empirical study. *International Journal of Operations & Production Management, 23*(12), 1426–1446.

Imai, M. (1986). *Kaizen: The key to Japan's competitive success*. New York, NY: McGraw-Hill/Irwin.

Iwaki, K. (2005). *Jissen Toyota seisan hoshiki*. Tokyo: Nikkei. (in Japanese).

Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York, NY: McGraw-Hill.

Motwani, J., Kumar, A., Jiang, J., & Youssef, M. (1998). Business process reengineering: A theoretical framework and an integrated model. *International Journal of Operations & Production Management, 18*(9/10), 964–977.

Orlikowski, W. (1996). Improvising organizational transformation over time: A situated change perspective. *Information Systems Research, 7*(1), 63–92.

Smeds, R. (1994). Managing change towards lean enterprises. *International Journal of Operations & Production Management, 14*(3), 66–82.

Stewart, T. A., & Raman, A. P. (2007). Lessons from Toyota's long drive. *Harvard Business Review, 85*(7/8), 74–83.
Womack, J. P., & Jones, D. T. (1996). *Lean thinking: Banish waste and create wealth in your corporation*. New York, NY: Free Press.
Yamamoto, Y. (2013). *Kaikaku in production toward creating unique production systems*. Doctoral thesis, School of Innovation, Design, and Engineering, Mälardalen University.

Recommendation for Further Reading

Bessant, J. R. (2003). *High-involvement innovation: Building and sustaining competitive advantage through continuous change*. Chichester: Wiley.
Boer, H., & Gertsen, F. (2003). From continuous improvement to continuous innovation: A retro perspective. *International Journal of Technology Management, 26*(8), 805–827.
Buckler, B. (1996). A learning process model to achieve continuous improvement and innovation. *The Learning Organization: An International Journal, 3*(3), 31–39.
Edmondson, A. C. (2008). The competitive imperative of learning. *Harvard Business Review, 86*(7–8), 60–67.
Fujimoto, T. (2007). *Competing to be really, really good: The behind-the-scenes drama of capability-building competition in the automobile industry, (English translation from the Japanese original by B. Miller)*. Tokyo: International House of Japan.
Hayes, R. H., & Pisano, G. P. (1994). Beyond world-class: The new manufacturing strategy. *Harvard Business Review, 72*(1), 77–84.
Hino, S. (2006). *Inside the mind of Toyota: Management principles for enduring growth*. New York, NY: Productivity Press.
Nonaka, I. (2007). The knowledge-creating company. *Harvard Business Review, 85*(7,8), 162–171.
Schroeder, D. M., & Congden, S. W. (1995). Integrating manufacturing innovation through organizational learning. *Production and Inventory Management Journal, 36*(3), 55–60.
Schroeder, R. G., Scudder, G. D., & Elm, D. R. (1989). Innovation in manufacturing. *Journal of Operations Management, 8*(1), 1–16.
Smeds, R. (1997). Radical change through incremental innovations: Generic principles and cultural differences in evolution management. *International Journal of Technology Management, 14*(1), 146–162.

List of the Reviewed Reports Describing Kaikaku Activities at Japanese Manufacturing Companies

Akita, H. (2004). Naiseika to chie de moukaru kaisha heno kakushin. *Factory Management, 50*(1), 53–59. (in Japanese).
Anonymous. (2003). Line ROA wo shihyo ni shita seisan kakushin katsudou. *Factory Management, 49*(2), 7–17. (in Japanese).
Anonymous. (2007). Kojo to desk work no renkei niyoru nagare seisan kaikaku. *Factory Management, 53*(10), 40–47. (in Japanese).
Anonymous. (2009). 8 tuno kakushin project wo kaishi, zensha ichigan taisei de taishitsu kyoka he. *Factory Management, 55*(10), 24–31. (in Japanese).
Banzai, M., & Watanabe, Y. (2007). Seisan Kakushin katudo wo sasaeru "mieruka" no teian to keyparts naiseka jidoka no suishin. *IE Review, 48*(2), 37–41. (in Japanese).
Eno, K., & Fukutomi, N. (2007). Jutyu seisan hin ni okeru monozukuri kaikaku. *IE Review, 48*(2), 33–36. (in Japanese).

Enomoto, M. (2007). Seisan Kakushin to Monozukuri kyoka. *IE Review, 48*(5), 20–24. (in Japanese).
Fujimoto, A. (2009). TPM katsudou ni yoru seisansei 2 bai no model line. *IE Review, 50*(3), 73–78. (in Japanese).
Fujita, Y. (2005). "Saikyo no monozukuri shudan" wo mezashite Sanyo tokyo manufacturing no seisan kakushin. *Factory Management, 51*(3), 52–73. (in Japanese).
Fukushima, A. (2007). Kouritsu wo motometa monozukuri heno kosu-seisansei kojou-katsudou. *IE Review, 48*(2), 26–30. (in Japanese).
Fukutomi, Y., & Sasaki, T. (2004). Sharyo you suishinseigyo souchi kumitate kojo ni okeru seisan kakushin katsudou no suishin. *IE Review, 45*(3), 23–27. (in Japanese).
Hamada, M. (2003). Seisan kakushin no nami wo ukete datsubungyo kadokuji no seisan kanri. *Factory Management, 49*(1), 6–10. (in Japanese).
Hattori, A., & Nakagawa, K. (2006). Gyomuyou kuchoki reitoki ni okeru seisan kakushin heno torikumi. *IE Review, 47*(5), 37–42. (in Japanese).
Hirose, M. (2005). Jidou souko to computer ni yoru seisan kanri system wo haishi shi kurojika jitsugen. *Factory Management, 51*(3), 32–41. (in Japanese).
Hora, H. (2003). K-UP undou gannen keijo rieki 2 bai wo mezashite. *Factory Management, 49*(1), 11–15. (in Japanese).
Horio, C. (2008). 21seiki ni ikiru jinzai. *IE Review, 49*(1), 36–42. (in Japanese).
Ishibashi, F. (2003). Mikomi seisan hoshiki kara zyutyu seisan hoshiki heno kakushin. *Factory Management, 49*(1), 25–29. (in Japanese).
Iwasaki, M. (2001). Kaikaku ga kaikaku wo yobu seisan kakushin katsudou. *IE Review, 42*(4), 27–32. (in Japanese).
Iwata, T. (2003). 100 nen no dento wo uchiyabure! oriya no seisan kakushin katsudou. *Factory Management, 49*(1), 45–49. (in Japanese).
Kamata, Y. (2000). Okyakusama ga mieru monozukuri. *Factory Management, 46*(16), 9–43. (in Japanese).
Kanno, Y. (2002). Wakuwaku kojo kaikaku no nouhau. *Factory Management, 48*(1), 55–59. (in Japanese).
Kato, H. (2008). Workhead to ryohin joken (kakouten) wo tsuikyu suru. *IE Review, 49*(3), 32–37. (in Japanese).
Kawakami, H., & Kobayashi, K. (2005). Jido hanbaiki seisan ni okeru shijo henka no supi-do ni awaseta monozukuri. *IE Review, 46*(4), 39–44. (in Japanese).
Kishimoto, N., & Fujita, K. (2009). Cost up ni uchikatsu seisan kakushin. *IE Review, 50*(1), 27–32. (in Japanese).
Kobayashi, K., & Shimizume, T. (2011). Keizoku shita seisan kakushin katsudou ni yoru kyo-usouryoku no kyoka. *IE Review, 52*(4), 23–28. (in Japanese).
Kumagai, S. (2000). Seisan kakushin katsudou wo toshite: Katsudou no naiyou to seika. *IE Review, 41*(4), 13–17. (in Japanese).
Maruyama, T. (2003). Seisan kakushin ni yoru ishiki kaikaku de zaiko, lead time, shikakari hin wo 50% sakugen. *Factory Management, 49*(1), 20–24. (in Japanese).
Maruyama, Y. (2008). Sekisui ryu IE ni yoru monozukuri kakushin. *IE Review, 49*(1), 31–35. (in Japanese).
Matsuda, K. (2000). Zyuchu kaihatsu gata system seihin no seisan kaikaku heno torikumi. *IE Review, 41*(2), 75–80. (in Japanese).
Matsuo, H. (2007). Seizou kakushin katsudou ni okeru 3 nenkan no torikumi. *IE Review, 48*(3), 79–84. (in Japanese).
Mishima, H. (2004). Yaruzo! konbea toruzo! ikkonagashi! *Factory Management, 50*(1), 20–25. (in Japanese).
Miyake, M. (2008). Okizuki tyuzou syokuba ni okeru monozukuri kaikaku katudou. *IE Review, 49*(1), 83–88. (in Japanese).
Mizuguchi, H. (2006). Cell seisan donyu ni yoru lead time no tanshuku. *IE Review, 47*(5), 47–52. (in Japanese).

Morita, M. (2003). Gemba kara start saseta Hiokidenki no HiPS katsudou. *Factory Management, 49*(12), 72–80. (in Japanese).
Nagai, M., Mizutani, K., & Osakabe, Y. (2001). Through put saidai wo mezashita seisan kakushin. *Factory Management, 46*(8), 34–71. (in Japanese).
Nakachika, K. (2000). Seisan kakushin de majime seiryuka layout henkou wo jishi. *Factory Management, 46*(1), 134–139. (in Japanese).
Nakagi, A. (2004). Seisan kakushin "Unichikara" katsudou de shueki kaizen wo! *Factory Management, 50*(1), 26–31. (in Japanese).
Nakamura, Z. (2003). *Mono koto bunseki de seikou suru simple na shigoto no hassou hou*. Tokyo: The nikkan kogyo shimbun. (in Japanese).
Nakayama, C. (2004). Kenwood no seisan kakushin 1. *Nikkei Monozukuri*, September, Nikkei Bussiness Publications, 201–205. (in Japanese).
Nakayama, C. (2004). Kenwood no seisan kakushin 2. *Nikkei Monozukuri*, October, Nikkei Bussiness Publications, 273–277. (in Japanese).
Nakayama, C. (2004). Kenwood no seisan kakushin 3. *Nikkei Monozukuri*, November, Nikkei Bussiness Publications, 257–261. (in Japanese).
Nakayama, C. (2004). Kenwood no seisan kakushin 4. *Nikkei Monozukuri*, December, Nikkei Bussiness Publications, 193–197. (in Japanese).
Noguchi, H. (2007). Ikinokori wo kaketa monozukuri ryoku no saikochiku. *IE Review, 48*(5), 29–34. (in Japanese).
Okuno, K. (2002). NEC kansai no seisan kakushin "push-gata" kara "pull-gata" he. *Nikkei Microdevices*, June, Nikkei Bussiness Publications, 80–85. (in Japanese).
Omori, K. (2009). Mieru seisan wo mezashite jigyo bu wo kaeru. *IE Review, 50*(1), 21–26. (in Japanese).
Otomo, H. (2001). Seisan kaikaku ni yoru cho teikosuto seisan heno chosen. *IE Review, 42*(4), 41–45. (in Japanese).
Ozawa, H. (2006). TC-1 shisou ni yoru seisan kakushin. *IE Review, 47*(5), 63–69. (in Japanese).
Sasaki, M. (2009). IMM de susumeru seisan management system. *IE Review, 50*(2), 39–43. (in Japanese).
Sato, K. (2001). Monozukuri gizyutsu kakushin. *IE Review, 42*(4), 6–11. (in Japanese).
Sato, K. (2005). Shijo heno tsuiju wo kanou ni suru ikko nagashi zenkishu mainichi seisan no jitsugen. *IE Review, 46*(4), 51–56. (in Japanese).
Sato, K., Nagata, K., Koyama, T., & Tanaka, H. (2001). Johou system to yugou shita seisan kakushin katsudou. *IE Review, 42*(4), 72–75. (in Japanese).
Sawa, J. (2007). Seisan Kakushin katsudo to konnichi no kadai. *IE Review, 48*(5), 15–19. (in Japanese).
Shiina, R. (2009). Kaizen katudou keizoku no point. *IE Review, 50*(5), 27–30. (in Japanese).
Shiki, K. (2003). Nihon ichi no kagusanchi ni kakushin no nami wo. *Factory Management, 49*(1), 30–34. (in Japanese).
Shimoda, K. (2004). 3 shuno katsudou wo yukiteki ni kumiawasete shueki kaizen wo jitsugen shita seisan kakushin. *Factory Management, 50*(1), 32–39. (in Japanese).
Shirai, Y. (2007). 1/3 ni kodawatta Simple and Slim setsubi-zukuri heno chosen. *IE Review, 48*(2), 21–25. (in Japanese).
Shirato, K. (2009). Cost up ni taiou suru monozukuri to seisan kakushin. *IE Review, 50*(1), 33–39. (in Japanese).
Takahashi, S. (2001). 60 nenrai no zyurai taishitsu wo hitei shite. *Factory Management, 47*(14), 30–47. (in Japanese).
Tamori, S. (2003). Dango seisan kara 1 setto nagashi heno chosen. *Factory Management, 49*(1), 40–44. (in Japanese).
Tanahashi, T. (2009). Henka shitsuzukeru kojo wo mezasu keizoku teki kaizen katsudou. *IE Review, 50*(5), 39–44. (in Japanese).
Tanaka, M. (2004). Kaizen wo susumeru to mondai no honshitsu ga mietekuru. *Factory Management, 50*(1), 60–66. (in Japanese).

Tanaka, S. (2002). Seizou gemba to kyoutsu staff bumon ga ittai to natta seisan kakushin katsudou. *IE Review, 43*(5), 83–87. (in Japanese).
Tanaka, T. (2005). Daisha biki konryu seisan hoshiki no tanjo. *IE Review, 46*(4), 31–37. (in Japanese).
Taniguchi, Y. (2009). Seisan kakushin katudou keizoku heno torikumi. *IE Review, 50*(5), 21–25. (in Japanese).
Tsukame, M., & Sakamoto, T. (2011). Gemba wo shuyaku ni zenin de gemba wo tasukeru kaizen katsudou. *IE Review, 52*(3), 17–22. (in Japanese).
Watabe, N. (2010). Seisan gizyutsu ga redo suru sekkei kakushin to seisan kakushin no ayumi. *IE Review, 51*(1), 29–34. (in Japanese).
Watai, T. (2004). 1 rino 100 po yori 100 nin no 1 po - seisan kakushin de shokuba wo mamoru. *Factory Management, 50*(1), 46–52. (in Japanese).
Yoneya, M. (2001). Zeiin de kachitotta genka teigen 100 okuen. *Factory Management, 47*(14), 3–29. (in Japanese).
Yoshida, M., & Fujiwara, H. (2007). Inverter no seisan kakushin. *IE Review, 48*(5), 45–49. (in Japanese).
Yoshida, S., & Saito, A. (2008). Tannoki to teikosuto de fukakachi wo umidasu. *IE Review, 49*(3), 27–31. (in Japanese).

Chapter 6
Iterative Transitions Between Exploration and Exploitation: Experiences from the Finnish Manufacturing Industry

Helinä Melkas, Tuomo Uotila, and Tuija Oikarinen

Dilemma: Transition from Exploration to Exploitation

Various methods have been developed for enhancing explorative and exploitative activities in organisations. The activities may be quite successful, but a dilemma often arises when the emphasis should shift from exploration to exploitation, or vice versa. This transition does not or should not happen just once; exploration and exploitation may continuously iteratively alternate, when suitable conditions exist. We have observed and examined different methods for different purposes and contexts and noted how they generate different kinds of knowledge. Even the characteristics of the aforementioned dilemma vary depending on the type of organisational network in question. We thus need to find appropriate ways to smoothen the iterative transitions between exploration and exploitation within organisations. This chapter presents specific methods for paving the way to such iterative transitions. Through the use of these methods, the various dualities that exist within organisations, which are presented in the introductory chapter, may also be worked with and even utilised in renewal processes.

Introduction

According to March (1991), the relationship between the concepts of exploration and exploitation is a central issue in studies on adaptive organisational processes. From a long-term perspective, both are necessary. This chapter describes methods

H. Melkas (✉) • T. Uotila • T. Oikarinen
Lappeenranta University of Technology, LUT Lahti, Finland
e-mail: Helina.Melkas@lut.fi

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_6

for advancing exploration and exploitation in industrial settings and presents the experiences of Finnish manufacturing companies that have used such methods. Several concepts for understanding change processes—primarily from a knowledge and information perspective—are presented as the theoretical basis for this chapter. The chapter explores the foundations of exploration and exploitation (March, 1991) and incorporates both the absorptive capacity (e.g. Todorova & Durisin, 2007) and analytical and interpretative innovation processes (Lester & Piore, 2004) into a novel framework for different types of networks, including production, development and innovation networks (Smedlund, 2009). The framework is utilised in empirical research that focuses on how to employ the renewal and innovation potential that emerges through the interplay of different forms of heterogeneous knowledge—knowledge-sharing and co-creation.

In addition to the theoretical considerations, this chapter includes introductions to the various renewal methods, manufacturing company case studies, a discussion and conclusions. This work will provide insight into the practical implementation of exploration and exploitation activities and into overcoming the dilemma of transitioning between exploration and exploitation activities in different contexts. In particular, this research addresses *iterative transitions between exploration and exploitation*.

By producing a novel framework, we aim to deepen the understanding of exploration and exploitation in different contexts. Exploration is often associated with practical endeavours and interpretative innovation processes, whereas exploitation is usually associated with analytical innovation processes. The absorptive capacity sheds light on how knowledge and information are handled in the processes. In this chapter, the word *exploration* henceforth refers to a wider concept encompassing exploration, interpretation and transformation, and the word *exploitation* henceforth refers to a wider concept encompassing exploitation, analysis and assimilation (Fig. 6.2). From a broad perspective, there is an iterative transition in the shift between these concepts; this transition can be facilitated by the skilled use of participatory renewal methods.

By presenting empirical research on the renewal methods developed in Finland's Lahti region—in particular, innovation sessions and research-based theatre (RBT) methods—the chapter shows that making practices and sequences visible and voicing diverse views are essential to organisations' utilisation of the potential hidden in everyday working life. These methods will be defined and discussed later in the paper. The methods appear to function quite well with regard to exploration and exploitation in a process because they include elements that encourage both strategies. But the dilemma in transitioning between exploration and exploitation at the organisational level in different contexts requires careful attention and deliberate emphasis. In the best-case scenario, the alternative iteration between exploration and exploitation may also help manufacturing companies manage the various dualities that exist in the production systems presented in the introductory chapter of the book.

Theoretical Building Blocks

This chapter leans on theories about exploration and exploitation (e.g. March, 1991) and presents a novel framework combining March's ideas, the concept of absorptive capacity (as discussed by Todorova & Durisin, 2007), analytical and interpretative innovation processes (Lester & Piore, 2004) and the context of various organisational networks (Smedlund, 2009). First, we must present the theoretical building blocks. In this research, the different organisational networks provide the context, and the other building blocks are the different theoretical perspectives on knowledge search, creation and conversion processes. The chapter is concerned first and foremost with the handling of knowledge and information within a production system. As it stands, the handling of knowledge and information is not sufficient; there are usually other aims—for example, radical and incremental innovations or efficiency and effectiveness. On the other hand, the building blocks focus on various phenomena (such as organisational functions, organisational abilities, organisational innovation processes and organisational networks); however, because they are closely connected to how knowledge and information are handled within the system, they are addressed in this chapter as well.

Exploration and Exploitation

The relationship between the concepts of exploration and exploitation is a central issue in studies on adaptive organisational processes. Whereas the former relates to the search for new possibilities, the latter refers to reliable certainties (March, 1991). According to March (1991), exploration includes activities related to language such as search, variation, risk-taking, experimentation, play, flexibility, discovery and innovation. On the other hand, exploitation is associated with terms such as refinement, choice, production, efficiency, selection, implementation and execution. March (1991) noted that both exploration and exploitation are essential functions that organisations must have to prosper over time, but these strategies also pose a problem insofar as they compete for the same scarce organisational resources. Thus, the big challenge at an organisational level is to find a suitable trade-off between explorative and exploitative functions. The concepts of exploration and exploitation also present a temporal conflict. Adaptive processes characteristically improve exploitation more rapidly than exploration. There is often a built-in tendency to emphasise exploitation activities at the expense of exploration activities. However, remaining competitive over time also depends critically on sustaining a reasonable level of exploration, so these tendencies to increase exploitation and reduce exploration can increase unwanted path-dependent behaviour (March, 1991). Finding the suitable trade-off between exploration and exploitation, then, necessarily involves conflicts between short-run versus long-run gains and between gains in individual knowledge versus gains in collective knowledge (March, 1991).

According to Li, Vanhaverbeke, and Schoenmakers (2008), some scholars interpret exploration activities as a distant and exploitation activities as a proximate knowledge search within innovation networks. Li et al. concluded that most researchers who employed the idea of local or distant knowledge search interpreted exploitation as activities in search of familiar, mature, current or proximate knowledge, while exploration was seen to consist of activities in search of unfamiliar, distant and remote knowledge. This notion is especially relevant with regard to technological innovation: a local search provides firms with advantages in making incremental innovations, while a distant search might yield opportunities for a firm to achieve radical innovations. In the context of innovation systems, Gilsing and Nooteboom (2006) defined exploitation functions as 'efficient employment of current assets and capabilities needed to survive in the short term' and exploration functions as the 'development of novel capabilities needed to survive in the longer term'.

Absorptive Capacity

Information and knowledge fuel renewal and innovation, and when they are sourced from networks, absorptive capacity becomes a key issue. Absorptive capacity was originally defined by Cohen and Levinthal (1990) as an organisation's ability to value, assimilate and apply new external knowledge. Kim (1998) argues that absorptive capacity requires companies to develop learning capabilities, the capacity to assimilate knowledge for imitation, and problem-solving skills, which create new knowledge for innovation. Moreover, Zahra and George (2002) defined two different types of absorptive capacity: potential absorptive capacity, which is important in acquiring and assimilating external knowledge, and realised absorptive capacity, which refers to the functions of transformation and exploitation with regard to the acquired knowledge. Naturally, both are important in innovation processes: potential absorptive capacity enables the exploration of knowledge (often) through the weak ties of the innovation network, and realised absorptive capacity secures exploitation (often) through the strong ties of the network. To better understand the characteristics of absorptive capacity, we must take a closer look at its different parts:

- Acquisition, referring to the actor's ability to identify and acquire externally generated knowledge that is critical to its operations;
- Assimilation, referring to the actor's routines and processes that allow it to analyse, process, interpret and understand the information obtained from external sources;
- Transformation, denoting the actor's capability to develop and refine the routines that facilitate combining existing knowledge with newly acquired or assimilated knowledge;
- Exploitation (i.e. implementation), referring to the routines that allow actors to refine, extend and leverage existing competencies or create new ones by incorporating acquired and transformed knowledge into their operations (Zahra & George, 2002).

According to these definitions, absorptive capacity is like a funnel, where potential absorptive capacity (visionary capability) secures the newness and diversity of the knowledge needed, whereas realised absorptive capacity (innovative capability) represents the operationalisation of the new knowledge within the existing processes in order to allow the actual innovation processes to take place. In their article, Todorova and Durisin (2007) present an interesting interpretation of the concept of absorptive capacity in which they criticise Zahra and George's (2002) model based on several points, the main point being that the phases of absorptive capacity presented by Zahra and George (acquisition, assimilation, transformation and exploitation/implementation) are not consecutive but rather alternative routes in a learning process (where route one is acquisition–assimilation–exploitation/implementation, AAI, and route two is acquisition–transformation–exploitation/implementation, ATI). Based on findings from cognitive psychology, they propose that when a new idea fits well into existing cognitive schemas, it is only slightly altered to improve the fit and then incorporated into the existing cognitive structures. The existing cognitive structure does not change, and the knowledge is 'assimilated'. On the other hand, a process of transformation takes place when new situations or ideas cannot realistically be altered to fit within existing knowledge structures. In the latter case, the cognitive structures of the individuals themselves must be transformed to accommodate the idea or a situation that they cannot assimilate (Todorova & Durisin, 2007).

Analytical and Interpretative Innovation Processes

A further challenge for management is how to flip between the two fundamentally different approaches of analytical and interpretative innovation processes (Lester & Piore, 2004) (Table 6.1). Organisations need to 'look at the world simultaneously through both analytical and interpretative lenses and flip back and forth between them as conditions require' (Lester & Piore, 2004, p. 74). The transition between analytical and interpretative modes requires making alterations in the forms of knowledge and in their representational practices, as well as in styles of communication and interaction. In the research literature, Schreyögg and Geiger (2006) note

Table 6.1 Comparing analysis and interpretation (Lester & Piore, 2004, pp. 97–98)

Analysis	Interpretation
• The focus is a project with a well-defined beginning and end • The thrust is to solve predefined problems • Managers set goals • Managers convene meetings and negotiate to resolve different viewpoints and eliminate ambiguity • Communication is the precise exchange of chunks of information	• The focus is an ongoing and open-ended process • The thrust is to discover new meanings • Managers set directions • Managers invite conversations and translate to encourage different viewpoints and explore ambiguity • Communication is fluid, context-dependent and undetermined

the need to facilitate the switching between interpretative and analytical modes. As such, boundary objects (Brown & Duguid, 1998) and special broker roles (Gherardi & Nicolini, 2002), amongst others, have been suggested as intermediaries. The innovation potential emerging through the interplay of different forms of heterogeneous knowledge has been widely noted by researchers (Nonaka & Takeuchi, 1995; Cook & Brown, 1999; Amin & Roberts, 2008), which encourages us to study how the combination of interpretative and analytical modes could potentially be fostered. One form of knowledge cannot necessarily be converted into another (Cook & Brown, 1999), but it can be used as an aid in acquiring and creating new knowledge (Oikarinen, Kallio, & Pässilä, 2011a).

Organisational Networks

Smedlund (2009) discussed the structures and management of intra-organisational networks within knowledge-based organisations that utilise their knowledge resources for the purposes of value creation. Because production, development and idea generation are a firm's fundamental tasks, by successfully managing the intra-organisational networks in these tasks, a firm can generate a sustained competitive advantage over other firms in the market. With regard to structure, a production network is centralised, a development network is distributed and an idea generation network is decentralised (Fig. 6.1). Each task-related network needs different management initiatives. The ideal team communication network structure when it comes

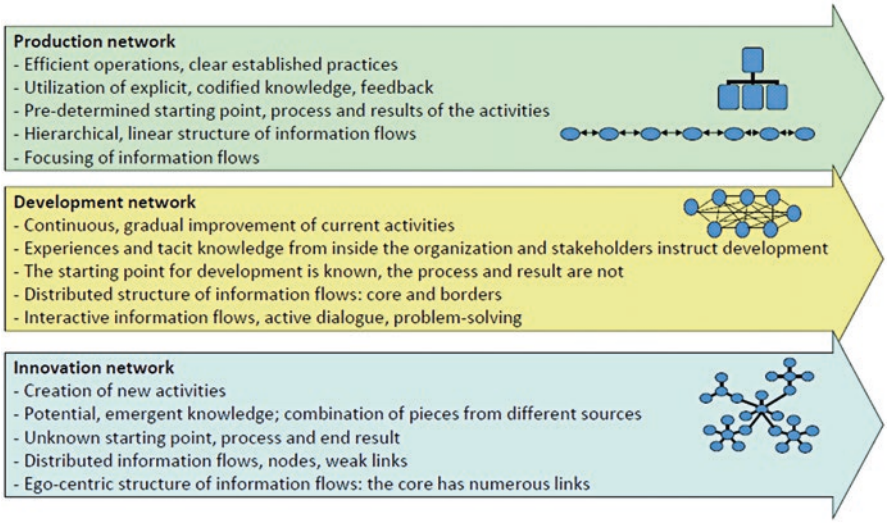

Fig. 6.1 Illustration of organisational networks (adapted from Smedlund, 2009, p. 55, 61; idea generation has been replaced by innovation)

to production tasks is hierarchical; in development tasks, it is core–periphery. In idea generation, on the other hand, tasks are ego-centric. The results of Smedlund's study indicate that there is not one but many optimal network structures, depending on the task. As a managerial implication of the study, Smedlund suggested that by managing the three task-related organisational networks separately, a firm can achieve improved simultaneous scanning of the environment, seizing of opportunities and transformation of the organisation—mechanisms also known as a firm's dynamic capabilities.

Iterative Transitions Between Exploration and Exploitation

By leaning on theories of exploration and exploitation, we present a novel framework combining March's (1991) ideas, the concept of absorptive capacity (as discussed by Todorova & Durisin, 2007), analytical and interpretative innovation processes (Lester & Piore, 2004) and the context of various organisational networks (Smedlund, 2009). The framework (Fig. 6.2) serves as a basis for empirical research and for finding ways to overcome the dilemma of transitioning between exploration and exploitation in organisational renewal processes.

Through iterative transitions between exploration and exploitation, we focus on how to utilise the renewal and innovation potential emerging through the interplay of different forms of heterogeneous knowledge by enhancing knowledge-sharing and co-creation. From a learning perspective, a practice-based innovation approach resonates with kinds of learning different from science- and technology-driven innovation. The mainstream innovation literature overemphasises the role of individuals or learning that is discussed in a limited manner in terms of the professional expertise of knowledge workers. Innovation is considered to have either a top-down

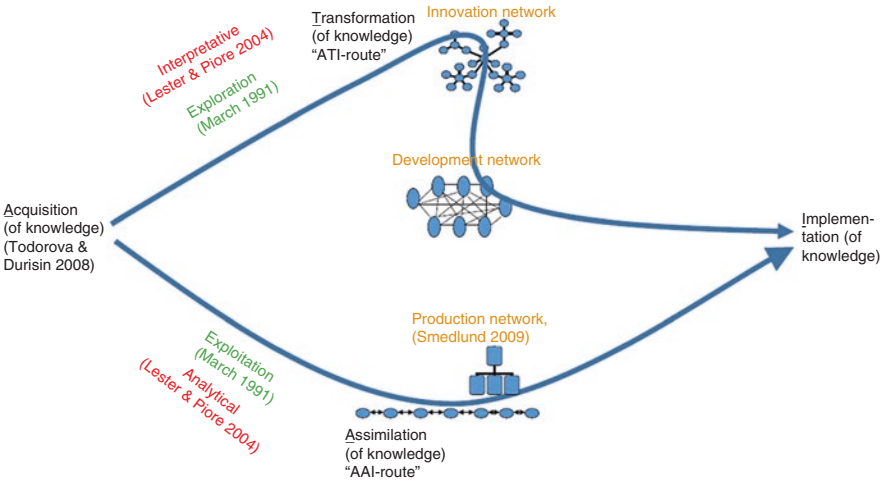

Fig. 6.2 The research framework

strategic design or bottom-up initiatives. We propose that in order to cope, particularly with the new challenges of practice-based innovation, the dynamics of multifaceted learning and interactions for knowledge-sharing, integration and co-creation are critical within and across network organisations. The key challenge lies in how to enhance this kind of learning in work organisations and how to facilitate interaction between organisations (Oikarinen, Pässilä, & Hong, 2011b).

As Phillips (1995) noted, there is a whole array of alternative representational practices (such as short stories, dance, film, sculpture, poetry and computerised hypertext) that are considered legitimate approaches to studying knowledge in organisations. However, the traditional 'fact' approach to knowledge in organisations, which emphasises analytical behaviour and explicit knowledge, does not cater to these alternatives (Phillips, 1995; Vickers, 2008). The second barrier is the notion that one form of knowledge cannot be converted into another form (Cook & Brown, 1999), but it can be used as an aid in acquiring and creating new knowledge. Leveraging divergent knowledge through wide participation across network organisations typically does not occur on its own; it needs to be facilitated and brokered. Heron and Reason (2001, p. 149) emphasise the use of the expressive forms of presentational knowing (symbols, metaphors) to facilitate reflection phases, from action to descriptive and propositional knowing. Presentational knowing can provide access to felt experience and draw upon emotional connections to not only the experience and self but also to others and thus advance social bonding and networking (Taylor & Ladkin, 2009, p. 56). From an innovation perspective, the knowing is often intuitive, imaginative or sensuous, and of all the forms of knowing, it is most accessible through presentation (Taylor & Ladkin, 2009). The development of presentational knowledge is thus highlighted as an important but often neglected bridge between experiential and propositional knowledge (Grisoni & Page, 2010).

The challenge lies in how these outcomes of interpretative processes can be useful for analytical, exploitation-like management. The multiple voices and ideas generated in the interpretative, explorative model need to be categorised, evaluated, prioritised and selected for implementation. The resources, responsibilities and timetables must be set. From the analytical, exploitation-like perspective, the preference is to define clear development targets that are measurable and can be controlled. The question is how these thick descriptions of interpretation can be grasped analytically. We agree that organisations have untapped potential when it comes to encouraging practice-based innovation. This, however, calls for the organisations to rethink their managerial practices: how the outcomes of interpretative, explorative polyphony and multi-voiced sketches of possibilities can be bonded to analytical, exploitation-like processes (Gherardi & Nicolini, 2002; Oikarinen et al., 2011a).

Methods

This empirical research concerns the ways in which different types of manufacturing companies have engaged in exploration and exploitation activities by utilising different methods. This chapter presents research findings on how theatre-based

methods and innovation sessions specifically have been utilised by manufacturing companies and groups of companies in their practical renewal and innovation efforts and describes the results and outcomes. This study concentrates on one Finnish region: the Lahti region. Finally, we contemplate the possible lessons learnt for the iterative transition between exploration and exploitation based on our qualitative data.

The framework in Fig. 6.2 contains the theoretical concepts and different network types. The research focuses on three manufacturing companies and their related networks. Two of them represent a development network, and the other represents an innovation network. However, the networks are not 'pure' networks because each contains characteristics from both types. University–company collaborations take place in the upper and middle parts of Fig. 6.2, and the lower part is not addressed in this study. Though this part is equally important in industry, it typically focuses on collaboration between (client) companies and developer (consultant) companies and thus does not usually constitute a 'playfield' for a university unit. The arrows represent the different routes identified by Todorova and Durisin (2007): (1) AAI and (2) ATI. Truly connecting the different phases along the ATI route appears to be especially challenging in practice.

This study is a retrospective account of the cases and presents the different methods, companies and networks. The results will synthesise earlier studies from various perspectives and present a new qualitative analysis of the case materials with a focus on exploration and exploitation, enabled by the framework presented in Fig. 6.2.

Key Renewal Methods

Innovation Sessions

Koen et al. (2001) stated that prior to the starting point of well-known innovation process models—for example, the stage-gate model (Cooper, 1993)—there is a phase called the 'front-end of innovation'. The front-end includes idea generation and the organisation of promising ideas. This phase is difficult to plan because it is often chaotic and uncertain (Koen et al., 2001). Many of the different instruments developed in the Lahti region, such as innovation sessions, focus on this early phase. The front-end phase is arguably vital for any type of innovation, whether it involves a process or a product, or whether it is social, organisational or another type of innovation. However, the transition between exploration and exploitation requires close attention, as in this study.

The innovation session method (ISM) is a method that belongs in the 'toolbox' of the Lahti Living Lab. Lahti Living Lab brings people into the centre of innovation with the purpose of helping companies and organisations develop their products so that they are user-centred and to have users participate in the innovation process. At the same time, new solutions and business opportunities are sought amongst rising

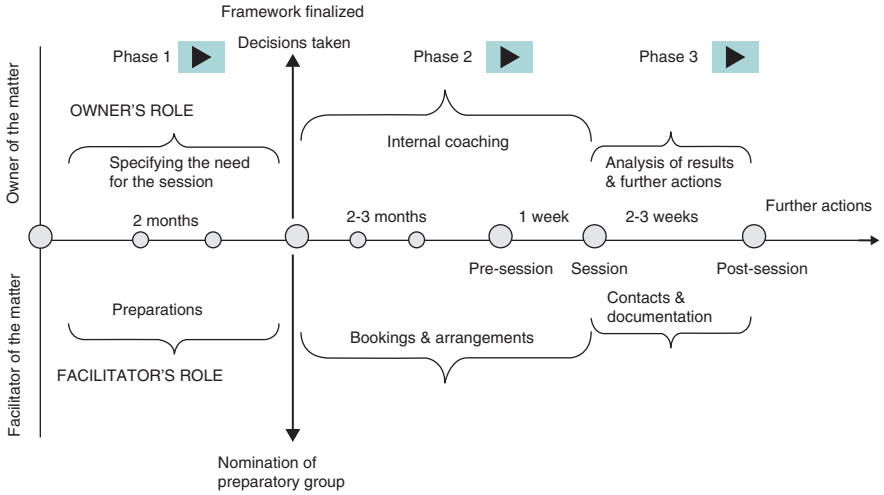

Fig. 6.3 Progress of an innovation session process (Pässilä, Frantsi, & Tura, 2008)

trends and weak signals. RBT is another method developed within the Living Lab (see subsequent discussion) (Pässilä & Oikarinen, 2014). The ISM and the other methods complement each other and are selected and tailored based on organisational needs. The ISM supports the generation, selection and advancement of practice-based innovation processes—in particular, exploration in them. The purpose is to combine 'intra-organisational' and 'extra-organisational' expertise to enhance organisations' innovation activities. The sessions are tailored to the specific needs and aims of the target organisation, although active measures are also taken to introduce new, unorthodox themes into the organisation. The sessions are arranged for a heterogeneous group of people, often consisting of representatives of different sectors (public, private and non-governmental) and different hierarchical positions within organisations, professions and academia.

Both process and session brokers are brought in to facilitate discussions and idea generation by furthering knowledge transfer and by spanning the network's structural holes (Burt, 2004) and different distances between the participants (Parjanen, 2012). Various tools to facilitate group work and creativity are utilised. The innovation sessions are not single events; rather, session planning considers the innovation process as a continuum (Fig. 6.3). The innovation sessions have been found to create opportunities for single new innovations, but their success depends mainly on whether new interfaces can be offered for actors and organisations and whether new ideas are generated that can yield later successes (Pässilä et al., 2008). The results of the innovation session processes include new business ideas, service concepts, enhanced products, product development projects, operations models, clarifications and strategies (in 95% of the sessions). Almost 100 innovation sessions have been organised in the Lahti region, and nearly 200 organisations have benefited from the sessions, including some 125 companies. The innovation sessions have obtained the

status of a best practice for innovating regions in Europe, and an idea developed in an innovation session won the innovation competition EBN EuroLeaders Award (Tura, 2009; see also Melkas, Uotila, & Tura, 2016).

Research-Based Theatre

RBT is a research strategy that includes theatre as a way to conduct and represent scholarly research methods through the process of theatricalising data into an integrated script and then rehearsing and performing the material (e.g. Pässilä, 2012; Pässilä & Oikarinen, 2014). The main phases of the RBT process are illustrated in Fig. 6.4. In the storytelling sessions, the aim is first to share people's own experiences and feelings during the development of practices, organisational change or the like with colleagues and to create a reflective zone where employees and managers can interact and reflect on the situation. During this phase, arts-based inquiries with employees and managers from different units—for instance, production, sales, research and development (R&D) units and executive group—as well as customers are organised; this step is often preceded by interviews with customers and company representatives. The opening up the hidden, avoided and unspoken aspects of executives', managers' and employees' experiences is initiated through the use of 'theatrical images' (photographs where actors demonstrate different positions and gestures using their bodies) (Image 6.1). Theatrical images are applied in the organisation as the starting point of an inquiry into practices.

In the dramatisation phase, the collected material is analysed in order to structure the data and transform sensitive issues into a form of applied theatre and to create an arts-based reflection platform for employees and managers to explore alternative ways of interpreting their experiences. This phase is carried out in cooperation with researchers and professional actors. In the organisational theatre session, a culmination point in the process, the aim is to discuss and reflect on the emotions, problems and power tensions related to the ongoing development or change process. This is done by organising a dialogical theatre session for employees and managers (see also Fig. 6.5). Customers and other stakeholders may also participate. The participants discuss what should be done to solve problems, how to deal with complex emotions and how to reduce power tensions between professional groups (for

Image 6.1 An example of theatrical images (Pässilä et al. 2013)

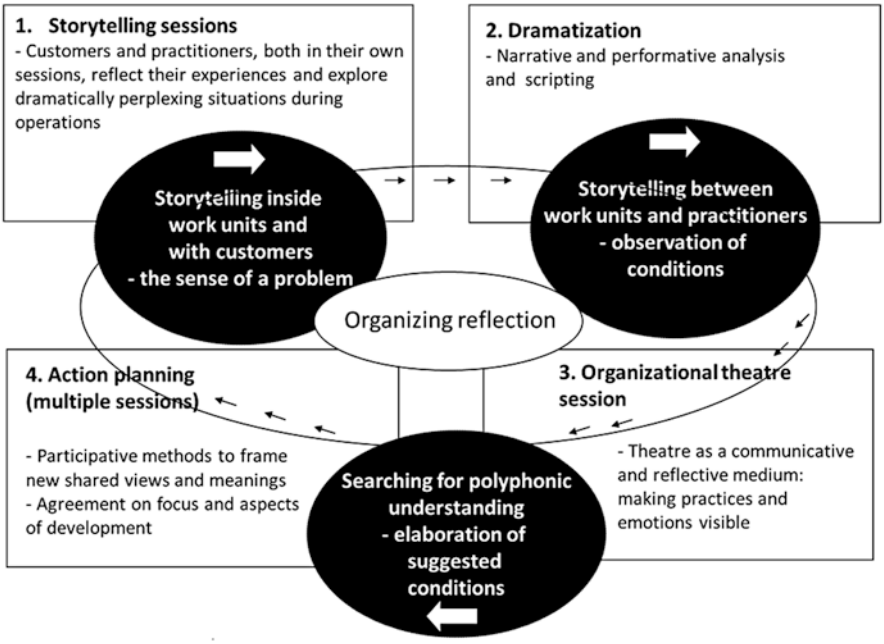

Fig. 6.4 Main phases of RBT (Pässilä et al., 2013)

Fig. 6.5 RBT in action (the 'cycle' and phases 1–4 as in Fig. 6.4)

instance, between production, sales and R&D units or between employees and managers). The purpose of the final phase of the process, action planning, is to reflect on and evaluate the experiences and insights generated in the previous three phases, 'transforming' the knowledge into actionable plans and building concrete development activities to tackle the issues acknowledged during earlier phases, thereby representing a transition from exploration to exploitation. This phase may be followed by opening up the process in other directions and organising separate customer and stakeholder sessions, which would return to more explorative phases.

Company Cases: Starting Points, Processes and Outcomes

Case 1 A packaging company (an example of a development network using theatre-based methods).

Case 1 draws upon a long-term participatory action research-based development project (lasting about 4 years) in a large industrial company producing packaging materials and packages. The project was triggered after the need was detected for the company to develop collaboration between its production and sales departments. The focus of the development was very operational at first: to improve current practices in order to decrease the number of reclamations by customers. The work began with the sales department and one production site. Another production site later joined the project.

The process thus started from the reclamation problem identified in the production department, which functioned as the boundary object. Linear knowledge flows and production processes did not function, and this had degenerated into blaming and finding 'guilty' parties. Applying theatre was necessary to make the different parties' perspectives visible to and understood by everyone and to enable problem-solving for the reclamation problem in a neutral way that recognised development needs. The work was done by a development group in which everyone had experience with the issues at hand. Soon, the need to add a customer-oriented perspective was identified. The customer's voice was first included in the project as an object of innovation. Over the course of the project, the company's management team felt the need to develop collaboration efforts with their customer organisations. Representatives from three customer organisations participated in the workshops, which were organised on the case company's premises (RBT phase 4, action planning sessions). By including customers, the problem-solving turned into a ricochet to further widen the development work and take it in a more innovative direction. Innovation groups were formed with the customers. Other stakeholders were also invited for the purposes of weak-link thinking.

The focus of the development shifted into a more proactive form as the management team became convinced that with the help of joint forums of co-creation with their customers, they could innovate totally new ways of doing business together. The role of the customer was thus converted into the subject-role of an active participant. Four facilitated projects with customer organisations followed. The focus

of the development was to jointly create cooperation practices that would help them better serve their end-clients together. With each customer organisation, one product and its production process was chosen as the concrete boundary object (Oikarinen et al., 2011a, 2011b).

The theatre session in Case 1 involved the development group's interpretative work, which resulted in new insights into the reclamation problem, which in turn led both parties to an analytic process (an Excel file with actions and new guidelines for a linear process, assimilation) and the generation of new innovation groups for the purposes of interpretative innovation (transformation), together with customers, eventually leading to product, process and collaboration innovations.

The outcomes were as follows: (1) a new kind of collaboration with four different customer organisations, with the aim of innovating and exploring novel products and practices; (2) within the company, improved interactions between horizontal, vertical and functional silos; (3) broader interaction between organisations to cover a larger group of participants, rather than the initial buyer–salesperson or managerial interaction. Thus, the interaction no longer concentrated solely on production efficiency or on solving a single problem (or its consequences) quickly, but the best experts in the theme in question were involved in the interaction, and new opportunities were created jointly. As a result, the production problem of this case generated and brought about the construction of both new development and innovation networks, reflecting also an iterative transition between exploration and exploitation in different phases. Such a transition can also take place across networks.

Case 2 A wood-processing company (an example of a development network using theatre-based methods).

Case 2 is based on empirical data collected during an organisational development process in a large Finnish wood-processing company. The most active part of the process continued for about 2 years, but certain activities were implemented even after that. The case concerned the aim of increasing employees' involvement in the ongoing organisational changes within the company. The company is a traditional family-owned industrial forest company in southern Finland, though it also operates in other countries. The third generation of the owning family is actively involved in the company's operations. The company has been experiencing general structural changes in the business field of the forest industry, which has faced fundamental difficulties during the last decade or so in Finland. In 2011, the board of directors launched a new strategy for the company: three independent units were reorganised into one unit, and new core values—integrity, courage, creativity and profitability—were launched for the employees. The change process was conducted 'by following rules and order'. Still, the employees and managers were confused in the midst of change; managers assumed they had sufficiently explained why and what kind of changes were needed, but employees felt that they were given only abstract strategical ideas—not practical solutions. The employees agreed with the managers that reforms had to be adopted—but how? At that point, the managers contacted the university researchers, and the idea of using theatre-based methods to address these issues was brought up; the idea was to interpret together past experiences and reflect on the steps the company could take in the future (Pässilä et al., 2013).

Case 2 thus started from an organisational reform and a resulting new operational practice. Theoretically, this could also have been the continuation of an innovation session. In RBT, it was the question of a joint process of giving meanings: what does the change mean for one's own work, and what is the joint new whole? Applying theatre was needed to create distance so that the issues could be examined from different perspectives and new joint perspectives (strategies, aims, practices) created. It was a question of an interpretative approach by which the groups could co-create new meanings together based on their experiences. Storytelling sessions were organised for the units; individual- and work-group-level experiences were opened up. A theatre session then followed to improve the sense of community and spark a discussion to address difficult questions, with the help of the theatrical scenes based on people's stories (Fig. 6.5). The metaphor of ice hockey was used in the session to highlight the community and everyone's role in the common 'game'.

From the perspective of transformation, at the individual level, Case 2 largely concerned a need for a shift in how employees viewed their identity. A clear supervisory organisation had existed previously, but during the reform, an objective was to increase employees' willingness to take initiative (note also the values of courage and creativity). The managers did not provide ready-made operational models or solutions, but they expected the employees to build them themselves. This caused confusion amongst the employees. With the help of RBT, the groups reflected on their work identities (what is important in my work?) and on what was going to change and how to co-create new rules for the game. The organisation thus explained the new direction, and groups and individuals had to digest this in order to put the plan into action. They were, however, not used to such tasks and challenges; thus, a significant amount of transformation was needed in this difficult renewal period.

Additionally in Case 2, the customer organisations later joined in, and the customer was, in a way, a boundary object whose needs served as the basis for developing new operational models. Case 2 showed that bringing customers in can help a company 'sharpen', provide a common direction and divert attention away from internal 'torsion'. Bringing the customers into the longer process was one example of a transition between exploration and exploitation; they caused a new 'shift'.

Case 3 A metal-industry company (an example of an innovation network using innovation sessions).

Case 3 concerns a medium-sized, family-owned, metal-industry manufacturer that makes stainless steel sink units and sink bowls for domestic kitchens, as well as waste-sorting systems. For years, the company has been active in regional innovation development in the Lahti region and has actively utilised innovation development services on several occasions. The company has used the ISM in three development phases. The first session aimed to find product innovations in nanotechnology, recycling and ageing. The second session focused on nanotechnology, and the third on e-business.

Case 3 stemmed from an R&D need: the company wanted to gain new external knowledge and utilise weak links. They had lots of gaps/distances to bridge and needed brokerage and facilitation using different methods to achieve this. Idea preforms were created that still required transformation, assimilation and analysis

before they could be implemented. Case 3 was characterised by a duality of traditional (steel) and new (nano) technologies. Another goal of these sessions was to break down the silos and create a development network across silos within the organisation. This was expected to eventually lead to a product innovation, which often in turn leads to changes in practices and the breaking down of silos.

The third session, for instance, was based on a structural hole that was revealed between the company and e-business. E-business was seen as a way to potentially increase business and promote internationalisation. Shortening product life cycles, combined with changing customer needs, were seen as new challenges for the current business. Nowadays, customers want faster and easier service. They also need information about products after they have bought them. The e-business topic was also selected because the case company did not know much about e-business possibilities. To shorten the cognitive distance between the experts and management, the preparatory phase of the third session was prolonged, compared to Sessions 1 and 2. In addition, the longer preparatory phase made it possible for management to better commit to the process (Parjanen, Harmaakorpi, & Frantsi, 2010).

These are certainly examples of how iterative transitions between exploration and exploitation were made in this case because the company was involved in three innovation session processes, each with its own 'lifecycles' that led to different lessons learnt in different phases, but the combination of the sub-processes was also an example of a larger iterative transition between exploration and exploitation in Case 3. Theoretically, if an innovation session process leads to a new product or production process, such a need could lead to an RBT session to construct a common understanding about new practices and collaboration required by the innovation. The methods were, however, not combined in this way, though this could provide an intriguing avenue for future cases.

The innovation session represented a first attempt to combine the new technology, nanotechnology, which until then was unfamiliar, with more traditional and already familiar technologies. Thus, as an outcome, the case company achieved new insights into novel technology combinations as well as their business potential. The next step was to launch a joint R&D project with a Finnish research organisation related to nanotechnology utilisation. The case company also launched a joint pre-study with a company specialising in nanotechnology and introduced, later on, an improved product to the market. It also hired an outside expert to look for new ways to apply nanotechnology in its products. After concluding the explorative innovation session processes, Case 3 led to several new exploitative and explorative activities.

Summary of the Cases

Cases 1 and 2 dealt with the duality of different operational logics, silos and paradigms (innovation versus production). Through the methods, different parties' perspectives were made visible (e.g. sales and production; managers and employees).

When new operational practices are constructed, common understanding is needed, and this was achieved with the help of RBT. Case 3 was also characterised by a duality of traditional and new technologies; additionally, the case company hoped to address the issue of silos within the organisation. All the cases were characterised by a relatively high degree of self-organisation, although external facilitators, brokers and researchers were also involved. It should also be noted that these companies did not necessarily make explicit or implicit choices between exploitation and exploration, as claimed by March (1991), but they were—even surprisingly—open to a novel kind of renewal process with completely new types of methods. Perhaps as a result, the outcomes were numerous and varied, and the collaboration lasted for several years in each of the cases. This, again, may well lead to more sustainable results in the long run.

There were different phases of involvement with customer organisations. New 'branches' were created during the activities; there were both intended and unintended positive consequences. On the other hand, discerning what is intended and unintended may be very difficult—sometimes even counterproductive—in open processes such as these. As noted by Lester and Piore (2004), interpretative processes are ongoing and open-ended, new meanings are discovered and managers only set directions.

Discussion and Conclusions

In this chapter, two renewal methods were introduced, and the case companies' paths were shown. Phases of when and how the iterative transition between exploration and exploitation took place were noted. To conclude, the transition took place in both an emergent and a facilitated manner. In fact, a transition appeared to have taken place between these emergent and facilitated ways as well. Based on the analysis results, we have updated Fig. 6.2; the new Fig. 6.6 contains the methods and iterative transitions between exploration and exploitation and thus summarises this retrospective study.

A certain division between the whole and the details of change can also be discerned. Exploitation, analysis and assimilation do not focus exclusively on the whole, and exploration, interpretation and transformation do not focus exclusively on the details; looking at both aspects is necessary in the case of exploitation and exploration. However, in exploitation (understood in the wider sense), the focus is on the existing whole; it utilises the existing resources in the whole to create value for the existing whole. New details are absorbed into the existing whole and assimilated, or 'hidden' there without having much impact on the whole, beyond improving or widening the whole to a certain degree. Analysis implies that dividing the whole into smaller pieces can lead to better understanding of the whole because these details only have meaning as parts of the whole. Exploration, understood in the wider sense, also has to do with both details and the whole. It concerns creating a new whole, and this is done by noting deviant details. The focus is thus on details.

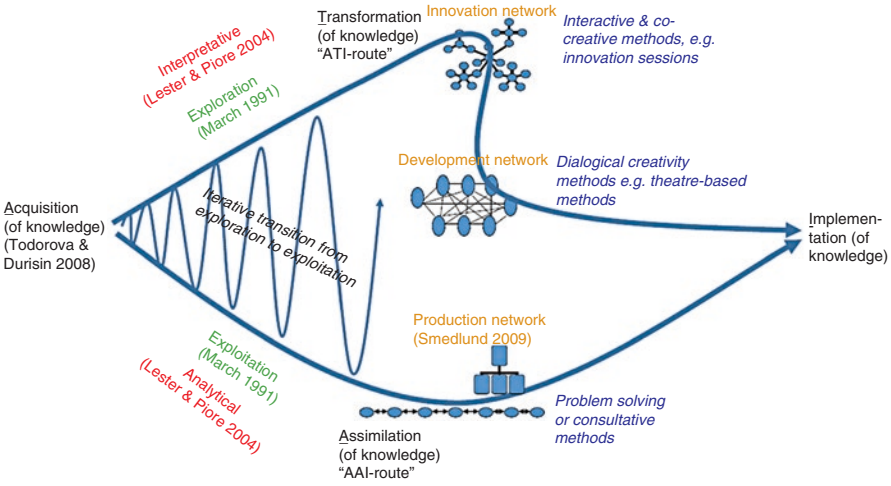

Fig. 6.6 Concluding framework of iterative transition on the basis of this study

Exploration implies the search for new knowledge and information that may lead to changes to the whole, thereby creating value in a new way. New pieces of information—details that are not part of the existing whole—are sought. Transformation then takes place when the pieces of information cannot be assimilated into the existing whole. This initiates the transformation of the whole (Backström, Chap. 9).

This crucial difference between the whole and the details makes it possible to solve the paradox of the seemingly impossible simultaneous combination of exploration and exploitation, as the two phenomena are located on different hierarchic levels; exploitation has to do with the whole, and exploration with the details. The two levels make it possible to work on these strategies simultaneously. They even require each other: the details construct and reconstruct the whole, and the whole gives the details a chance to collaborate (Backström, Chap. 9). The weights of the details and the whole are different in the different phases of the processes, and they also depend on the organisation in question, its starting points and its needs. RBT, for instance, is characterised by varied focus on the details and the whole, and this from the perspectives of different people or groups of people.

It is challenging to present the outcomes of exploration in such a way that they can be utilised in analytical decision-making. How can a rich, multi-voiced dialogue or ideation be summarised so that not too much is lost? Further research is needed on this, as well as on how the management team can be assisted in leading processes in which the outcomes are unknown. Integration of the realms of exploitation-like management and explorative management is also an avenue for future research. Although only two renewal methods were investigated in this chapter, we conclude that different timeframes for development and different networks, amongst others, require careful pondering on the renewal methods that are eventually chosen. Various

methods generate different kinds of knowledge—for example, self-transcending, tacit or explicit (e.g. Pässilä et al., 2013). These different kinds of knowledge have varying 'qualities' and can be used to facilitate either explorative or exploitative renewal processes in organisations, though even here the iterative transition between exploration and exploitation remains a challenge that must be tackled.

Both innovation sessions and RBT are strong participatory methods that are essentially based on participant experiences. They produce insight and tacit knowledge that are very challenging to convert into explicit knowledge and communicate to those members of the organisation who have not participated in the process. Operationalisation of such knowledge is problematic. In the worst-case scenario, participatory methods may create tension between those who are involved and those who are not. This is a further 'duality' to be considered in skilful ambidextrous quality management in the future.

In our case studies, these problems did not arise. On the contrary, there was sufficient courage amongst individuals at different levels to explore novel methods and, through these methods, explore and acquire new views more generally. The methods investigated (e.g. storytelling and dramatisation based on that in RBT) encourage this. When ideas are then brought forth for exploitation at the organisational level, the approach generates resources for new exploration cycles at the individual level as well. On the other hand, because the mainstream innovation literature overemphasises the role of individuals, it should be noted that both of the methods focus on the balance between the role of individuals on the one hand and the role of groups and organisations on the other. Ideally, the acquisition–transformation–assimilation–implementation route in Fig. 6.6 covers this whole in a fruitful way.

The challenge of renewal lies in the interface, particularly in how to open the explorative, interpretative world to the exploitation-like, analytical world. The process implies continuous 'swinging', and the phases are not categorical. Each workshop and meeting has both exploitation-like, analytical and explorative, interpretative aspects. The explorative aspects are not automatically appreciated from the managerial perspective. We emphasise that making practices and sequences visible and voicing various views are essential if organisations want to exploit the potential hidden in everyday work life. Managing iterative transitions and the swinging between exploration and exploitation rests on reconciling them. This reconciliation is a source of new knowledge generation. Naturally, it is filled with tension, because different perspectives and different kinds of knowledge are to be combined in a multidisciplinary manner. Managing this as a generative source of renewal requires research on bridging actions in the interface of exploitation and exploration. Knowledge leveraging, sharing, meaning-making and co-constructing, as well as making decisions about resources, timetables, responsibilities, targets and evaluations, are constant processes. There is no comprehensive management method or approach to link them (Oikarinen et al., 2011a). Van de Ven and Johnson (2006, p. 808) stated, 'Once different perspectives and kinds of knowledge are recognised as partial, incomplete and involving inherent bias with respect to any complex problem, then it is easy to see the need for a pluralistic approach to knowledge co-production amongst scholars and practitioners.' We strongly agree with them.

References

Amin, A., & Roberts, J. (2008). Knowing in action: Beyond communities of practice. *Research Policy, 37*(2), 353–369.

Brown, J. S., & Duguid, P. (1998, Spring). Organizing knowledge. *California Management Review, 40*(3), 90–111. doi:10.2307/41165945.

Burt, R. (2004). Structural holes and good ideas. *American Journal of Sociology, 110*(2), 349–399. doi:10.1086/421787.

Cohen, W., & Levinthal, D. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*, 128–152.

Cook, S. D. N., & Brown, J. S. (1999). Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization Science, 10*(4), 381–400.

Cooper, R. G. (1993). *Winning at new products: Accelerating the process from idea to launch*. Cambridge, MA: Addison-Wesley.

Gherardi, S., & Nicolini, D. (2002). Learning in a constellation of interconnected practices: Canon or dissonance? *Journal of Management Studies, 39*(4), 419–436.

Gilsing, V., & Nooteboom, B. (2006). Exploration and exploitation in innovation systems: The case of pharmaceutical biotechnology. *Research Policy, 35*, 1–23.

Grisoni, L., & Page, M. (2010). Two to the power of three: an exploration of metaphor for sense making in (women's) collaborative inquiry. *Organization Management Journal, 7*, 12–25.

Heron, J., & Reason, P. (2001). The practice of co-operative inquiry: Research 'with' rather than 'on' people. In P. Reason & H. Bradbury (Eds.), *Handbook of Action Research* (pp. 144–154). London: Sage.

Kim, L. (1998). Crisis construction and organizational learning: Capability building in catching-up at Huyndai Motor. *Organization Science, 9*, 506–521.

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., Elkins, C., Herald, K., Incorvia, M., Johnson, A., Karol, R., Seibert, R., Slavejkov, A., & Wagner, K. (2001). Providing clarity and a common language to the "fuzzy front end". *Research-Technology Management, 44*(2), 46–55.

Lester, R. K., & Piore, M. (2004). *Innovation—The missing dimension*. Cambridge and London: Harvard University Press.

Li, Y., Vanhaverbeke, W., & Schoenmakers, W. (2008). Exploration and exploitation in innovation: Reframing the interpretation. *Creativity and Innovation Management, 17*(2), 107–126.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87.

Melkas, H., Uotila, T., & Tura, T. (2016). Policies of related variety in practice: The case innovation session method. *European Planning Studies, 24*(3), 489–510.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company: How Japanese companies create the dynamics of innovation*. New York: Oxford University Press.

Oikarinen, T., Kallio, A., & Pässilä, A. (2011a, August 12–16). Shared leadership for innovation through interactive and interpretive discourse. In *Transcending boundaries for successful Continuous Innovation, CINet PDW Workshop in 2011 Annual Meeting of Academy of Management West Meets East: Enlightening, Balancing and Transcending*, San Antonio, TX.

Oikarinen, T., Pässilä, A., & Hong, J. (2011b, December 4–7). *Dramatizing as a learning facilitator for practice-based innovation in networks*. Paper presented in the 7th International Conference on Researching Work and Learning.

Parjanen, S. (2012). *Creating possibilities for collective creativity. Brokerage functions in practice-based innovation*. Acta Universitatis Lappeenrantaensis 474, Lappeenranta University of Technology, Lappeenranta.

Parjanen, S., Harmaakorpi, V., & Frantsi, T. (2010). Collective creativity and brokerage functions in heavily cross-disciplined innovation processes. *Interdisciplinary Journal of Information, Knowledge, and Management, 5*, 1–21.

Pässilä, A. (2012). *A reflexive model of researched-based theatre. Processing innovation at the crossroads of theatre, reflection and practice-based innovation*. Dissertation, Acta Universitatis Lappeenrantaensis 477, Lappeenrata University of Technology.

Pässilä, A., Frantsi, T., & Tura, T. (2008). Älyllistä ristipölytystä; innovaatiosessiomenetelmä. In eds. V. Harmaakorpi, & H. Melkas (Eds.), *Innovaatiopolitiikkaa järjestelmien välimaastossa*. Suomen Kuntaliitto; Acta no. 200/2008.

Pässilä, A., Melkas, H., & Uotila, T. (2013). Facilitating collaborative knowledge creation by using 'research-based theatre' in organizational innovation: Experiences from a Finnish wood-processing company. *Futures, 47*, 59–68.

Pässilä, A., & Oikarinen, T. (2014). Research-based theatre as a facilitator for organisational learning. In P. Meusburger, A. Berthoin Antal, & L. Suarsana (Eds.), *Learning organizations: Extending the field* (pp. 203–221). Dordrecht: Springer.

Phillips, N. (1995). Telling organizational tales: on the role of narrative fiction in the study of organizations. *Organization Studies, 16*(4), 625–649.

Schreyögg, G., & Geiger, D. (2006). Developing organizational narratives: A new dimension in knowledge management. In B. Renzl, K. Matzler, & H. Hinterhuber (Eds.), *The future of knowledge management* (pp. 82–98). Basingstoke: Palgrave Macmillan.

Smedlund, A. (2009). *Network approach to Fundamental tasks in knowledge-based organizations*. Doctoral Dissertation Series, Department of Industrial Engineering and Management, Helsinki University of Technology, 2009/13, Espoo. URL: http://lib.tkk.fi/Diss/2009/isbn9789522481467

Taylor, S., & Ladkin, D. (2009). Understanding arts-based methods in managerial development. *Academy of Management Learning & Education, 8*(1), 55–69.

Todorova, G., & Durisin, B. (2007). Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review, 32*(3), 774–786.

Tura, T. (2009). Innovaatiosessio [Innovation session]. A presentation (in Finnish). Lahti Science and Business Park/Lappeenranta University of Technology, Lahti. Unpublished manuscript.

Van de Ven, A., & Johnson, P. (2006). Knowledge for theory and practice. *Academy of Management Review, 31*(4), 802–821.

Vickers, D. (2008). Beyond the hegemonic narrative—A study of managers. *Journal of Organizational Change Management, 21*(5), 560–573.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization and extension. *Academy of Management Review, 27*(2), 185–203.

Chapter 7
Lessons Learned Practice in a Complex Production Environment

Koteshwar Chirumalla

Introduction

In today's rapidly changing business environment, manufacturing companies are under constant pressure to produce products of increased quality, reliability and performance, while reducing time to market, development costs, and risks. Companies are therefore constantly dealing with complex issues and continuous changes. The ability to learn from experience has therefore become essential for companies not only to adapt to their continuously changing environments (Dodgson, 1993; Garratt, 1990) but also to achieve the aforementioned targets (Thomke & Fujimoto, 2000). A manufacturing company, in the view of operations management, can be typically viewed from two perspectives (Wiktorsson, 2014). First is production system *operation* (also referred to as a running factory), which mainly concerns the execution of real production with the implementation of improvement initiatives, such as total quality management (TQM), Six Sigma, and lean production. (Ohno, 1988; Liker, 2004; Womack & Jones, 1996). Second is production system *design* (also referred to as a developing factory), where the main focus is on designing and executing an effective lean production system through the industrialization process and projects. From a learning perspective, the developing factory primarily records its learning experiences on a project-to-project basis in the form of post-project reviews or in the form of a gate-to-gate model (see the stage-gate model in Cooper (2008)). On the other hand, the running factory's learnings are captured in different means of practices, for example, improvement reports, nonconformance reports, or even special investigation reports. Such ad hoc approaches and practices

K. Chirumalla (✉)
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Koteshwar.chirumalla@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_7

impose challenges for manufacturing companies to create and build an effective knowledge base to achieve long-term competitiveness.

One of the common notions used for capitalizing and reporting past and ongoing experiences both in practice and in the scholarly literature is lessons learned (LLs) (Kotnour, 1999; Paranagamage, Carrillo, Ruikar, & Fuller, 2012; Chirumalla, 2013, 2016). An LL can be regarded as guidelines, tips, or checklist of what went wrong or right in a particular event (Stewart, 1997). LLs benefit companies in two important ways: as a process for reflecting and identifying actions to avoid and solutions to implement in similar tasks or projects, and as a mechanism to document learnings to share with others (Kotnour, 1999). However, many organizations struggle with the collection and dissemination of lessons, which greatly hinders the attainment of potential benefits from LL practices (Milton, 2010; Williams, 2008; Rhodes & Dawson, 2013). Milton (2010) found that 60% of 74 examined organizations that attempted to implement LL processes were dissatisfied because lessons were identified and captured but often not followed through on and applied internally to deliver the intended changes in personal or organizational behaviors, processes, best practices, or standards. Similarly, Williams (2008) found that 62.4% of 522 project practitioners had a formal procedure for learning lessons, but only 11.7% of that group used it because their methods did not clarify root causes (i.e., the entire cause-and-effect chain causing the problems) of project outcomes. This creates a situation where lessons are just *identified* in companies, but they are not *learned* or "reused" in new situations. This means that from day-to-day work new knowledge is *explored* in practice, but companies are not successful at *exploiting* them within the organization (e.g., Adler et al., 2009). There exists a tension between exploration and exploitation because processes of exploration may bring into question, challenge, and even replace institutionalized norms embedded in exploitation processes (Hislop, 2013). Consequently, the ability to organize, structure, and systematize new knowledge through organizational routines is crucial for successful exploitation (Adler et al., 2009).

The extant literature presents a mix of several LL approaches from different disciplines (e.g., Milton, 2010; Tan et al., 2006; Williams, 2008). However, the approaches fail to address the distinct, complex settings that arise in production and operation phases. Moreover, with the emergence of integrated product and service offerings or product–service systems (Baines et al., 2007; Annarelli, Battistella, & Nonino, 2016), there is increasing demand to capture and feedback learnings from later phases of the product lifecycle, such as use, maintenance, and end of life, to improve the design and manufacture of new products and associated services (Goh & McMahon, 2009; Masood et al., 2014; Chirumalla, 2016). Many of these activities from later phases of the product lifecycle are to a greater extent skill-oriented activities, in which much of the learning is still tacit (Polanyi, 1967) in nature and difficult to articulate. Research shows that individuals working on skill-oriented activities more often share their know-how and experiences through embodied interactions using verbal and symbolic forms of communication (i.e., verbal interaction), rather than various forms of decoded and written forms (i.e., written documentation)

(Styhre, Josephson, & Knauseder, 2006; Wood, Rust, & Horne, 2009). Thus, there is a need for practical methods and techniques for capturing LLs from skill-oriented activities especially in the context of complex production and operations where skill-oriented activities are predominantly high.

Examples from Industrial Practice

The aircraft engine component manufacturing company is moving toward becoming a service provider and taking over responsibility for the lifecycles of their components. One of the design leaders in the product support team received a complaint from one of their customers about deviations in an engine's intermediate compressor case. It took months to dig into the project archives and the exchanged emails in correspondence with the supplier and the customer to identify the root causes. Based on their investigation, the team wrote a long summery report (around 40 pages), including answering questions such as why the problems were occurring. What did they discover? What decisions were taken? At the end of this report, 10–15 lessons learned are identified and documented in a bulleted list as a record of actions to the different departments to avoid repeating the same mistakes again in subsequent products. Although the audit department usually does a follow-up, there was no precise information on how this knowledge should be shared and fed back to other departments internally. Most of these lessons are beneficial for informing designers in prestudy and concept study phases about products' behavior from a lifecycle perspective. For example, if a lesson might be relevant to the definition work, then it should be fed back to the product's definition department to formulate a new design practice in case no design practice is available; otherwise it should be added to the checklist in the design review process. Eventually, the summary report is stored in the database with references to other reports. However, only people working on the same project can access this document. Other people can see that there is a document, but they cannot open it. Hence, in most cases, practitioners need to find someone who can come up with good examples; otherwise they must conduct a new analysis. This shows that there is a lot of ambiguity both in creating newly explored knowledge and in sharing it across organizational boundaries.

Against this background, based on case studies in the aerospace industry, this chapter presents a proposal for a new method for LL practice using videos as an enabling medium. The method can help to capture learning points with specific recommendations, promoting process-based rather than a project-based learning. Such a process-based approach could help companies exploit newly explored knowledge across organizational boundaries.

The remainder of this chapter is structured as follows. First, the literature on LL practices is reviewed. Then the proposal for a new method for LL practices is introduced with the reasoning from the empirical data. Third, the validation activities performed in the aircraft engine component manufacturing company are presented and discussed. Finally, conclusions are drawn and implications summarized.

Lessons Learned Practice

This section introduces the theoretical basis for this study, which includes reviewing areas and key concepts such as type of knowledge and lessons learned methods and techniques.

Type of Knowledge

Knowledge represents information combined with context, insight, and reflection (Alavi & Leidner, 2001). One of the most common distinctions made with regard to knowledge is between explicit knowledge and tacit knowledge (Nonaka, 1994; Polanyi, 1967). Explicit knowledge is knowledge that can be relatively easy to express, articulate, share, and transfer (Nonaka, 1994). It consists of facts, rules, relationships, and policies that can be found not only in an organization's documents and repositories but also in organizational routines, processes, practices, and norms (Davenport & Prusak, 1998; Nonaka, 1994). Tacit knowledge is deeply rooted in an individual's actions and experience as well as in ideals, beliefs, or emotions, which cannot be conveniently expressed or written down to communicate or share with others (Polanyi, 1967); as noted by Wood et al. (2009, p. 68), "you just feel it." Nonaka (1994) identified two elements (or dimensions) of tacit knowledge: cognitive and technical (Fig. 7.1). *Cognitive* here refers to an individual's mental models consisting of beliefs, ideas, gut feelings, values, perceptions, intuition, and so on, while technical knowledge is related to concrete know-how, crafts, rules of thumb, hands-on experience, knowing-in-action, and skills that apply to a specific context.

Another type of knowledge related to tacit knowledge is procedural knowledge, which is a type of knowledge someone has and demonstrates through the process of doing something, that is, knowledge gained from the experience of undertaking a task. Procedural knowledge is partly situation- and context-specific (Goldkuhl & Braf, 2001) and contextualization is important to improve understanding of knowledge (Nonaka, 1994). Because knowledge is created in various contexts, it cannot be perfectly understood when isolated from those contexts (Goldkuhl & Braf, 2001). This requires information about who created the knowledge and why, where, when, and how it was created and used (Ahn, Lee, Cho, & Park, 2005). As noted by Alavi and Leidner (2001, p. 127): "When the context surrounding knowledge

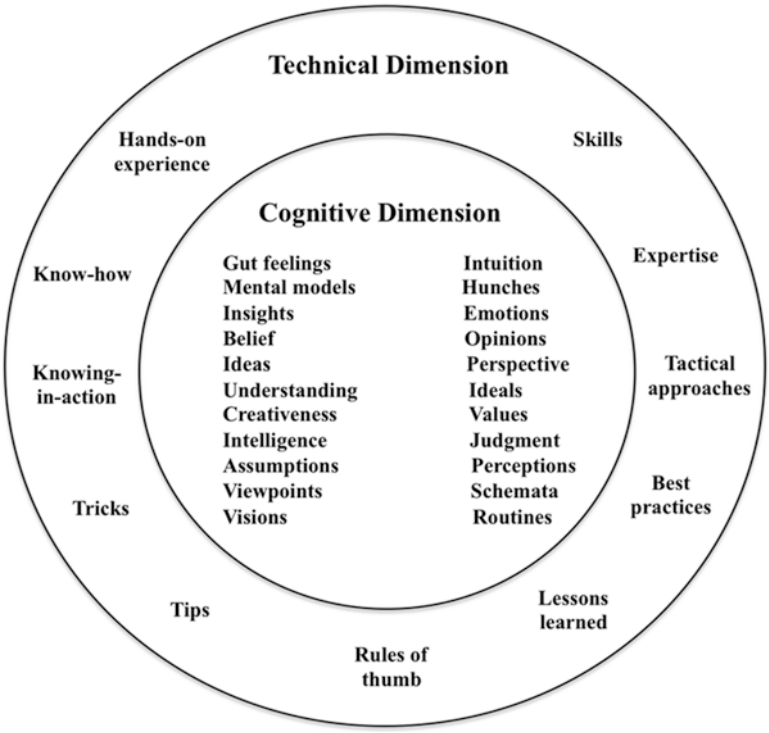

Fig. 7.1 Tacit knowledge examples in Nonaka's two dimensions, adapted from Nonaka (1994)

creation is not shared, it is questionable whether storing the knowledge without sufficient contextual detail will result in effective uses. This could lead to the essence of the knowledge being lost."

Lessons Learned Methods and Techniques

Weber, Aha, and Becerra-Fernandez (2001) identified the essential components of a generic LL process as *collect*, *verify*, *store*, *disseminate*, and *reuse*. Accordingly, LLs are collected from organizational members and verified by a team of experts with respect to correctness, redundancy, consistency, and relevance. Later, the lessons are stored in a repository and then disseminated to promote their reuse in various ways, such as broadcasting through bulletins, notifications, or alerts. O'Dell and Hubert (2011) stated that the LL approach typically focuses on a few key questions: What was supposed to happen? What actually happened? Why was there a difference or variation? Who else needs to know this information?

The literature contains reports of various formats and capture techniques for LLs (Williams, 2008). A few common ones are LL sessions, after action reviews, project debriefings, post project reviews (PPRs), and postmortems. Research has recognized the importance of projects as sites for learning, both within projects (intraproject learning) and from projects involving the wider organization (interproject learning) (Kotnour & Vergopia, 2005). Project-based learning is defined as encompassing learning within projects (intraproject learning or exploration) and also learning from projects to other projects (interproject learning or exploitation) and to the wider organization (Scarbrough et al., 2004). The shortcomings of existing LL practices have been well documented across multiple industries (Tan et al., 2006; Weber et al., 2001; Williams, 2008), especially those related to PPRs, the most common kind in many industries. Tan et al. (2006) identified two major shortcomings with standard PPR practice. First, the learning captured is not shared effectively and there is no established way to locate the learning embedded in reports for reuse. Second, the current practice of distilling the key learning captured in PPRs in point form is too brief for understanding and efficient sharing of the knowledge captured. Further, Goffin et al. (2010) revealed that PPR reports are often limited to capturing merely explicit knowledge and that much of the tacit knowledge that emerges in PPRs is likely to be lost due to difficulties in articulating the way tasks were performed and problems solved. Further, researchers have argued that descriptions of the context and background of lessons are crucial for their reuse (Milton, 2010; Williams, 2008). Milton (2010) reported that two factors determine the amount of context that is needed for lessons: their simplicity or complexity and the similarity of the context within which they will be reused. He stated that a simple lesson (i.e., a lesson with a lower context) can be documented in a few lines, expressed in a process flowsheet or diagram, and may be captured using a template. In contrast, a more complex lesson (i.e., a lesson with a higher context) may be highly situation-specific and much more difficult to express in writing.

Tan et al. (2006) proposed a methodology for LLs featuring background information, an abstract, conditions for reuse, relevant details, and references. Similarly, Milton (2010) proposed an LL structure that included the context, a description of the event, root causes of problems, lessons identified, and suggested action. Several researchers assert that telling stories is an appropriate social method for capturing LLs related to complex issues and skill-oriented tasks, especially those related to tacit knowledge (Goffin et al., 2010; Milton, 2010). Stories are useful vehicles for capturing complex situations in a way that listeners can engage with and understand on a deep level (Goffin et al., 2010). Orr (1996) found that Xerox's technicians employed storytelling for sharing problems, solutions, and best practices from their day-to-day experience. "Stories are good at presenting things sequentially (this happened, then that)...causally (this happened because of that). Thus stories are powerful ways to understand what happened (the sequence of events) and why (the causes and effects of those events)" (Brown & Duguid, 2000, p. 6). Milton (2010) acknowledged that a story can support a lesson by providing valuable background and context, and thus stories are easiest to learn from when they carry a learning point that is a specific, actionable recommendation. Orr's (1996) study of technicians is a good

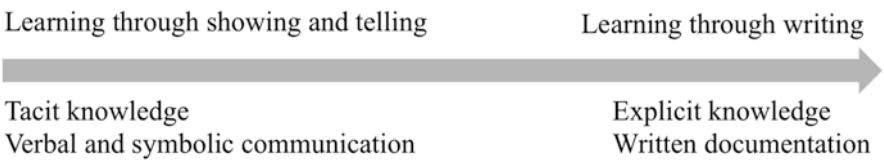

Fig. 7.2 Two different types of learning, adapted from Styhre et al. (2006)

example of how verbal interaction enables a community of practice to share know-how and information and to make sense of ambiguous events and occurrences. According to Styhre et al. (2006), practices of showing and telling predominate in some industries. There is a distinction between learning through writing—learning that is supported by the use of written documents—and learning through talking—learning taking place in verbal and symbolic interaction between individuals, where showing and telling are inextricably entangled and an integral component of the learning process (Styhre et al., 2006), as shown in Fig. 7.2. Further, in their view, talking can complement written documents and protocols to make everyday practices work more smoothly, since it can offer more detailed and contextual explanations and descriptions than written documents (Styhre et al., 2006).

According to Styhre et al. (2006), learning is a process wherein knowledge and know-how are shared through activities where individuals tell and show how certain operations are carried out in the best way (p. 84). On a similar note, many researchers have shown that video recordings can enhance LL-capture practices. For instance, Sharif et al. (2005) viewed videos since they are capable of providing richer details related to lessons and are easy to understand and relate to new tasks, so their use improves the chances that lessons will be reused (Weber et al., 2001). Similarly, Xerox technicians have proactively extended lesson representation with richer media attachments to further promote their reuse (Weber et al., 2001). Further, the US Center for Army Lessons Learned (CALL) has used videos for recording field observations that are used to develop comprehensive training resources for various purposes, such as a compilation of how-to videos on military operations (Weber et al., 2001). Video can convey much more of the detailed richness of an actual setting than text, photos, or audio recordings (Ylirisku & Buur, 2007). With their ability to scan the external environment and capture subtle, complex aspects of skill-oriented activities (as noted, *inter alia*, by Chua, Lam, & Majid, 2006; Wood et al., 2009), videos enrich the description of knowledge with contextual cues. Ylirisku and Buur (2007) used video as a medium to raise designers' awareness of contexts in which products are used in more varied ways. They asserted that video captures what happens in the field with detailed richness—that is, portraying the personalities and feelings of people—leaving more room for discussion than text, photos, and audio recordings. Furthermore, video has proven to be an efficient medium for conveying procedural knowledge and tacit knowledge and is invaluable for capturing subtle or complex aspects of performed activities (Wood et al., 2009). Wood et al. (2009) investigated the use of videos to elicit,

record, and transmit the tacit nature of complex skilled practices, such as crafting knives. They developed a web-based learning resource—with step-by-step instructions using video demonstrations—for novice craft practitioners based on observations and video recordings of an expert craftsman's working methods, tips, and best practices. The study demonstrated that video-based learning resources offer more flexible learning modes for novice practitioners to acquire and refine difficult new crafting skills. However, producing purposeful and meaningful videos with sufficient length is a challenge. Scriptwriting (or preparing a story) was the most important activity for producing purposeful videos (Corbally, 2005). In summary, the way video is produced and its content play a crucial role in the learning process. Currently there is limited research on how video as a medium can be used in recording LLs in a suitable structure and format.

Challenges in Lessons Learned Practice

The case studies showed that the current procedures for capturing LLs from manufacturing, serial production, use, and maintenance phases have varying ad hoc text-based formats, resulting in diverse formats of LL reports. In particular, they are not suitable for codifying LLs related to the tacit dimension of knowledge from skill-oriented activities in downstream phases. These lessons from downstream phases are often highly contextual and, as concluded by Milton (2010), difficult to express in writing. One production lead for a manufacturing startup described the problem as follows:

> I have a lot of experience in welding sheet metal parts, but it is very difficult to capture it...I know it and I have a feel for it, but I can only capture some of it. The problem is that I cannot go into it deeply because I don't know how to express it exactly on paper ... so others cannot see the where, how and why details, and they will not understand what is important.

There is huge potential to apply lessons captured in serial production, product support, and use phases in new design projects based on other product types. Because these lessons are not specific to particular design projects, they are stored in different databases in a different format under different terminology. Hence, opportunities to learn in the early phases are lost because the development teams might not be familiar with these lessons. As a design leader describes it:

> A lot of problems that we discovered in the product support phase are from casting processes. Since during the production most of our products undergo a casting process, many of our lessons learned are definitely applicable to several other products and projects.

Moreover, there is a need to store each LL with indexes of their context and the underlying process in order to facilitate deep learning on a specific issue. For example, if any specific lesson is learned that is related to cleaning small holes in complex parts, manufacturing personnel could easily learn it if it is classified at a process-level lesson rather than a project-level lesson. Hence, it is essential to gen-

erate and store lessons at a process-based level. One experienced informant stated as follows:

> We should store lessons learned for turning, milling, welding, sheet metal forming and so on. We should have the lessons learned for every type of process we undertake. Because these processes are pretty much done in the same way regardless of its product X or Y.

Furthermore, companies struggle to reuse experiences from past LL reports mainly because they often lack contextual information and root-cause analysis of problems. The current LLs lack contextual knowledge related to learning—that is, the lessons' background, analysis, root causes, and applicability—prompting a search for a method to capture LLs at a process-based level with a richer context. Lessons are also listed in reports in a very abstract manner; notably, there is often no description of either how they may be applicable to other products or projects or who may benefit from them. One of the experienced manufacturing leads described this problem as follows:

> We do not go into much detail in our lessons learned...In the reports I can see a few lessons learned, but they do not have detailed information on background, analysis, generalizability, and, more importantly, to whom it will be applicable. Without this, it is difficult to decide whether to reuse lessons learned or not.

Hence, in the case-study companies, even if relevant documents from different systems were identified, development teams generally turned to people they knew or trusted or to people they had been working with for a long time, to identify and interpret the context of LLs to validate their relevance and applicability in their particular work context. Further, the reuse of LLs is restricted in practice owing to barriers imposed in relation to project type or product type. Although different product types have similar kinds of analysis in common, designers cannot use the LLs from reports because the document says that this is only applicable to a particular product. This leads people to reinvent the wheel in different projects or to miss opportunities to learn how to avoid costly mistakes. Hence, finding generic forms of LLs and making them powerful is crucial for companies.

Seven Steps of Lessons Learned Representation: A New Method

Based on a consideration of the previously identified challenges and requirements, a new method is developed for representing LLs in a standardized format using videos as enabling media (Chirumalla, 2016). This method includes a seven-step representation format of LLs consisting of the following items:

1. Lesson learned statement,
2. Working context,
3. Task description,

Table 7.1 Layout of proposed LL methodology format

Number	Step	Guideline	Notes
1	Lesson learned statement	Shortly summarize main points about this lesson and why it is important for others to know	
2	Working context	*Describe the task background:* Name of person, job role, product type, and project name. What is the operational level of the task within the product development process? Who are the stakeholders?	
3	Task description	*Briefly describe the task:* How was the task planned/executed? What key parameters or tools were used? Under what conditions was the task executed?	
4	What went wrong or well?	*Describe problems/successes that you came across during the activity:* What was the problem/favorable outcome? Where/how did you identify the problem(s)/favorable outcome? What is the effect of the problem(s)/success on task execution?	
5	Lesson learned	*Describe the lesson that you learned:* What are the root causes of the problem/success? What steps have you undertaken to solve the problem or to achieve success? How can the problem be avoided or how can the success be repeated?	
6	Lesson learned measures	*Describe the measures taken for the improved solution of the problem(s):* How can your LL improve the problem area or success area? How would you quantify the change/improvement and compare it with preexisting solutions?	
7	Applicability and delimitations	*Describe the applicability or delimitations of the lesson learned:* Who are the potential beneficiaries of your lesson? Where can the lesson be applicable? What is the level of quality? What additional activities are necessary? What are the limitations/boundaries of your lesson?	

4. What went wrong or what went well,
5. Lesson learned
6. Lesson learned measures, and
7. Applicability and delimitations.

A set of guiding questions has been formulated for each step to help users come up with their LLs in a clear, concise, and informative manner, as shown in Table 7.1:

1. *Lesson learned statement*: This is a brief statement (short sentence) introducing the LLs to knowledge seekers that summarizes the main points and explains why it is important.
2. *Working context*: This provides information about the background and working situation of the task related to the LLs, including the person's name, job role,

project name, type of product, and operational level within the phases of the global product development process, and a list of stakeholders involved during the task.
3. *Task description*: This is a short description of the task related to the LLs, including how it was executed, the conditions and circumstances where it was executed, and key parameters or tools used.
4. *What went wrong or what went well*: This is a detailed explanation of successes or failures during the activity. It pinpoints where—and how—the problem/favorable outcome occurred as well as its effects on the execution of the task or project.
5. *Lesson learned*: This is a detailed description of the LL, recognizing the new or improved solution to avoid the problem or repeat the favorable outcome, including any additional relevant experiences. It focuses on what was learned that would benefit the performance of a future activity or project.
6. *Lesson learned measures*: This describes how effective the LL was, for instance, some measure of its effects on performance, such as a quantified change in time, costs, or quality in the process relative to previous conditions.
7. *Applicability and delimitations*: This spells out the applicability of the LL in terms of tasks and projects, including (for instance) potential beneficiaries (or target audiences) for whom it may be applicable, its limitations, and additional activities that may be required for further validation.

Validation of LL Method in Industrial Setting

Three industrial practitioners (a quality leader, product support phase design leader, and a stress analysis leader) tested the new proposed LL method. The process for the validation is as follows. Participants were asked to identify the LLs from their past experiences. Then they prepared and formulated the scriptwriting for the LLs using the methodology (seven steps and guidelines). In a final step, they recorded the LLs using a video. A screenshot from the resulting LL video and a transcript is shown subsequently in Fig. 7.3 and Table 7.2, respectively. This captured LL is from the serial production and product support phase. The design leader prepared and explained an LL story regarding inspection criteria following the seven steps and guidelines.

This LL from the product support phase is procedural and context-specific knowledge, which needs to be shown and explained in a visual manner using verbal and symbolic communication, as shown in Fig. 7.3. While recording the LL, the practitioner pointed out the relevant location on the product four times, as shown in Table 7.2, to show the circumstances in which the problem and lesson identification occurred. In this way, video-based LL can capture what happens in the field with detailed richness, as claimed by several authors, such as Wood et al. (2009) and Ylirisku and Buur (2007). The video LL can capture the detailed context (i.e., situation in which something happens) by describing the physical, social, or other cir-

Fig. 7.3 Screenshot from serial production inspection criteria LL video

cumstances within which an action occurs. Figure 7.4 shows several screenshots from the earlier video where each screenshot provides details about who identifies the new knowledge, when it is identified, what is identified, where the knowledge is identified, how it is identified, and why it is identified. Such practice can be applied to capture and share the context surrounding new knowledge creation in sufficient detail.

Discussion, Practical Implications, and Future Work

To cope with new challenges in the setting of complex product and production development environments, the speed at which companies learn from past experiences and ongoing initiatives is becoming critical. There is a need for enhanced methods and tools to improve the capture and reuse of LLs from different phases of product lifecycles to support early design phases. In this line, this chapter proposed a new method for LL practices, which includes a standard, seven-step representation format, together with guidelines, using videos as enabling media. The validation activities in an industrial setting showed that the seven-step LL method could help practitioners to prepare, structure, and formulate concise LLs with a richer context in a meaningful way. The method seems to be beneficial in capturing lessons from skill-oriented activities in narrative form (Orr, 1996; Brown & Duguid, 2000) by visually showing and telling (Styhre et al., 2006) defects, problems, or improvements in complex products and associated actions in production or product support phases, for instance.

Because practitioners lacked a generic level format to capture process-based LLs from downstream phases, they believed that the new method could be a better choice

Table 7.2 Captured LL about inspection criteria in a serial production (transcribed from LL video)

Lesson learned statement During large-scale serial production of cast parts, it would be much too costly to check all the dimensions specified in the drawings. Therefore, generally a plan for reduced inspection is formulated in association with the first article inspection review (FAIR). This LL is basically about the criteria that must be met to accept the reduced inspection plan
Working context My name is Stefan Jansson. I have been working at […] for the last five years. Currently, I work as a design leader in the Trent 900 Intermediate Compressor Case (ICC) product support team. This ICC is part of […]'s Trent 900 engine, which is mounted on the […] airplane [pointing to it in the video]. The stakeholders related to this task will be design and quality control personnel at the company or the casting supplier, which in this case is the American company […]
Task description During visual inspection upon parts arrival, it was suspected that the front engine mount package [pointing to it in the video] tilted somewhat. To check this, we decided to thoroughly measure the front engine mount lug. During this thorough measurement it was concluded that the front engine mount was tilted, but also these regions [pointing to them in the video], which we call bridges, between the lugs were a bit too thin, thinner than specified in the drawing
What went wrong? The problem was that the casting supplier changed the casting process after the first article inspection review. During the first article inspection review, this dimension here between the lugs [pointing to the location in the video] was excluded from the inspection plan. However, what they should have done was that as soon as they changed the casting process the reduced inspection plan should have been updated to make sure that any excluded dimensions were still fulfilling the drawing requirements. The problem with this deficit in the mean thickness of the bridge region is that the component's life fatigue was not fulfilling requirements anymore [pointing to it in the video]. This came to our attention after we went through the first article inspection review documents and discussed them with the clients
Lesson learned One of the root causes of this problem was that the initially accepted reduced inspection plan was never updated after the casting process had changed. To find this root cause, we performed a "5 times why" analysis, both here at the company and together with the casting supplier. In addition, we performed what we call a Kepner–Tregoe exercise, which is also an analytical procedure to find the root cause of problems such as this. To avoid having this problem occur again in the future, our quality department will send out a requirement document clearly stating that after modifying any casting process after an initial FAIR, a delta FAIR needs to be done to ensure that all the parts' dimensions still meet requirements
Lesson learned measures I believe that this lesson learned will have a significant impact on both our product's technical requirement fulfillment and costs, because if we can identify and resolve such problems, we won't need to do repair work, and obviously the product cost will be lower. In addition, we won't have to handle nonconformances that we would usually discover later in the process
Applicability and delimitations I believe that this lesson learned is relevant for all the company's cast products. It should be vital to everyone working within design, quality, and production

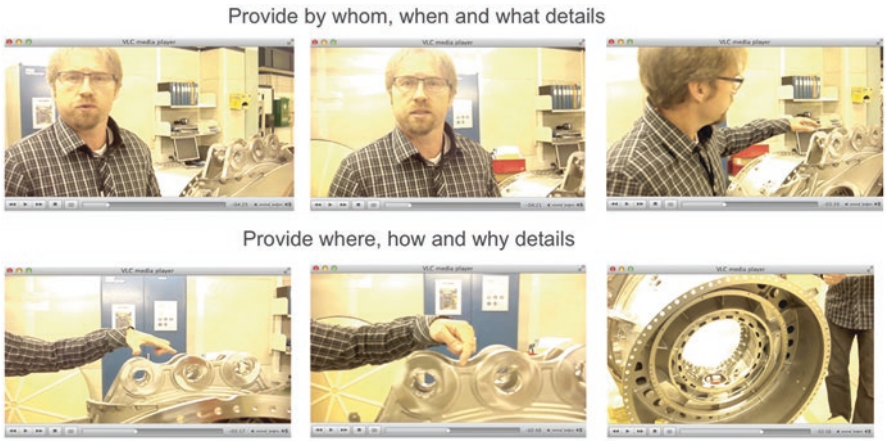

Fig. 7.4 Different screenshots covering key aspects of context surrounding new knowledge or LL creation

to leverage the high-context specific lessons than current alternatives. One practitioner acknowledged that:

> The template is a good help to define the lessons learned generation process. If prepared, I think this is a good way to spread information from experience.

This observation as a minimum showed that practitioners overcome the script-writing problem for making a purposeful LL video, which was emphasized in theory as a critical problem (Corbally, 2005). Further, practitioners were asked how easy they found the method to use compared to the text-based LL approach. All of them agreed that experience-based "knowing" is easier to record with video-based LL compared to the text-based approaches. One practitioner described the benefit as follows:

> Using videos for lessons learned can be beneficial as it allows us to capture and highlight good or bad examples from production such as design mistakes found in the manufacturing phase…That cannot be easily documented to understand them. You have to see them. I mean it is easier to see someone explaining how a fixture works than to read about how to fix it.

This shows that video-based LL opens up new possibilities for people involved in manufacturing and subsequent downstream phases to provide a rich overview of processes, especially for the purpose of highlighting specific features of product components. According to the practitioners, these videos made it possible for them to provide recommendations to designers at a specific component level. For instance, if designers are working on a cast product, using video LLs they can be shown visually that "You should think about these problems in the design phase." In this way, video-based LLs can convey a learning point with more specific details and actionable recommendations to the component designers in early phases, enabling them to access more context-specific lessons than traditional project-specific LL documents.

In addition, all practitioners agreed that it is easier to capture people's interest by video than in a written document, as several previous authors concluded, for example, Daily (1994) and Ylirisku and Buur (2007).

However, the practitioners also agreed that behavioral changes are required to adopt the new method. Motivating people to appear in videos and explain their LL would be a major challenge, but they also said that this does not just apply to videos but also to the implementation of any new procedure within the company. Implementing training programs and aligning the capture process with routine business activities are considered to be crucial. To improve adoption of the new method, it will be important to provide users with detailed guidelines to preparing, producing, editing, and publishing well-structured videos.

Moreover, LL videos could be useful as rationale carriers to explain to novice designers *why processes are as they are* and *why products are the way they are*. Thematically classified LLs captured by video could provide a valuable knowledge base for tutorial-based training for novice designers as well as for development teams before they begin new design projects, as also noted by Chua et al. (2006) and Wood et al. (2009). All of the practitioners believed that such a video-based solution would be useful for fostering a cross-project learning environment within their companies by disseminating LLs from successful and unsuccessful outcomes, for instance, good and bad examples from production and inspection. This could leverage problem-based learning that enhances novice workers' deep learning on various complex issues. In accordance with earlier researchers' claims regarding the information a person can absorb when watching videos rather reading a lot of text, one of the senior design leaders made the following statement:

> You know the saying that a picture is worth 1000 words. Then imagine the flow of pictures in a video. You are seeing things happening, and then you really understand what is going on, what it is, how it works, and so on.

This implies that using videos to capture LLs can provide more background and contextual understanding of complex issues, thereby stimulating learning and reuse in new situations, as identified by Chua et al. (2006). Such a practice could possibly support the exploitation of newly explored knowledge and innovative solutions (Adler et al., 2009) in complex production environments. This chapter proposes a practice-based method through which exploration can be achieved at the individual level with the creation of new knowledge with a richer context and so support exploitation processes and activities at the organizational level.

Further research is needed to thoroughly evaluate the method in terms of the time required to (1) formulate, (2) record, and (3) edit and publish an LL, compared to the text-based approach. In future research a full-scale video-based LL-capturing portal should be developed that will permit participants to access LL-capturing videos and store and share them with social media functionalities such as tags, thereby allowing other people to search for and access relevant video-based lessons for reusing in a new design task. Further studies are also needed to assess the effectiveness of video-based lessons, relative to text-based lessons, for improving contextual awareness of past experiences, thereby facilitating the execution of new design

tasks. The following questions should be addressed in a future comparison with text-based lessons:

- How useful is the seven-step LL method for understanding a lesson context sufficiently to enable reuse in a new situation?
- How effective are video-based LLs in decision-making processes relative to text-based LLs?
- What are the effects of visual appearance and storytelling on the reusability of LLs?
- How do video-based LLs affect individuals' learning capabilities relative to text-based lessons?

Other researchers have asserted that stories and video formats promote "unconscious" learning, which helps people remember them for a long time. These effects need to be considered in future work to address such issues as how well decision makers can learn over time using video-based lessons relative to text-based lessons. The results could provide insights into how LLs are reused in realistic situations, which could be helpful in designing support mechanisms for a robust LL system.

References

Adler, P. S., et al. (2009). Perspectives on the productivity dilemma. *Journal of Operations Management, 27*, 99–113.

Ahn, H. J., Lee, H. J., Cho, K., & Park, S. J. (2005). Utilizing knowledge context in virtual collaborative work. *Decision Support Systems, 39*(4), 563–582.

Alavi, M., & Leidner, D. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly, 25*(1), 107–136.

Annarelli, A., Battistella, C., & Nonino, F. (2016). Product service system: A conceptual framework from a systematic review. *Journal of Cleaner Production, 139*, 1011–1032.

Baines, T. S., et al. (2007). State-of-the-art in product-service systems. *Journal of Engineering Manufacture, 221*(10), 1543–1552.

Brown, J. S., & Duguid, P. (2000). Balancing act: How to capture knowledge without killing it. *Harvard Business Review, 78*(3), 73–78.

Chirumalla, K. (2013). *Development of a methodology for lessons learned practice: From post-project learning to continuous process-based learning*. PhD thesis, Luleå University of Technology, Luleå, Sweden.

Chirumalla, K. (2016). Organizing lessons learned practice for product-service innovation. *Journal of Business Research, 69*, 4986–4991.

Chua, A. Y. K., Lam, W., & Majid, S. (2006). Knowledge reuse in action: The case of CALL. *Journal of Information Science, 32*, 251–260.

Cooper, R. G. (2008). Perspective: The Stage-Gate® idea-to-launch process-update, what's new, and NexGen systems. *Journal of Product Innovation Management, 25*, 213–232.

Corbally, M. A. (2005). Considering video production? Lessons learned from the production of a blood pressure measurement video. *Nurse Education in Practice, 5*(6), 375–379.

Daily, B. (1994). Multimedia and its impact on training engineers. *International Journal of Human-Computer Interaction, 6*(2), 191–204.

Davenport, T., & Prusak, L. (1998). *Working knowledge: How organizations manage what they know*. Boston: Harvard Business School Press.

Dodgson, M. (1993). Organizing learning: A review of some literatures. *Organization Studies, 14*(3), 375–394.
Garratt, B. (1990). *Creating the learning organization*. London: Simon & Schuster.
Goffin, K., et al. (2010). Managing lessons learned and tacit knowledge in new product development. *Research-Technology Management, 53*(4), 39–51.
Goh, Y. M., & McMahon, C. (2009). Improving reuse of in-service information capture and feedback. *Journal of Manufacturing Technology, 20*(5), 626–639.
Goldkuhl, G., & Braf, E. (2001). Contextual knowledge analysis—Understanding knowledge and its relations to action and communication. In *Proceedings of 2nd European Conference on Knowledge Management*, IEDC-Bled School of Management, Slovenia.
Hislop, D. (2013). *Knowledge Management in Organizations: A Critical Introduction*. Oxford: Oxford University Press.
Kotnour, T. (1999). A learning framework for project management. *Project Management Journal, 30*(2), 32–38.
Kotnour, T., & Vergopia, C. (2005). Learning-based project reviews: Observations and lessons learned from the Kennedy Space Center. *Engineering Management Journal, 17*(4), 30–38.
Liker, J. K. (2004). *The Toyota way: 14 management principles from the world class great manufacturer*. New York: McGraw-Hill Education.
Masood, T., et al. (2014). Integrating through-life engineering service knowledge with product design and manufacture. *International Journal of Computer Integrated Manufacturing, 28*, 59–74. doi:10.1080/0951192X.2014.900858.
Milton, N. (2010). *The lessons learned handbook: Practical knowledge-based approach to learning from experience*. Oxford: Chandos Publishing Ltd.
Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14–37.
O'Dell, C., & Hubert, C. (2011). *The new edge in knowledge: How knowledge management is changing the way we do business*. Hoboken, NJ: John Wiley & Sons.
Ohno, T. (1988). *Toyota production system: Beyond large scale production*. Cambridge, MA: Productivity Press.
Orr, J. E. (1996). *Talking about machines: An ethnography of a modern job*. Ithaca, NY: Cornell University Press.
Paranagamage, P., Carrillo, P., Ruikar, K., & Fuller, P. (2012). Lessons learned practices in the UK construction sector: Current practice and proposed improvements. *The Engineering Project Organization Journal, 2*, 216–230.
Polanyi, M. (1967). *The tacit dimension*. London: Routledge and Kegan Paul.
Rhodes, L., & Dawson, R. (2013). Lessons learned from lessons learned. *Journal of Knowledge and Process Management, 20*(3), 154–160.
Scarbrough, H., et al. (2004). Project-based learning and the role of learning boundaries. *Organization Studies, 25*(9), 1579–1600.
Sharif, M. N. A., et al. (2005). Facilitating knowledge sharing through lessons learned system. *Journal of Knowledge Management Practice, 3*, 1–7.
Stewart, T. A. (1997). *Intellectual capital: The new wealth of organizations*. New York: Crown Business.
Styhre, A., Josephson, P.-E., & Knauseder, I. (2006). Organizational learning in non-writing communities: The case of construction workers. *Management Learning, 37*(1), 83–100.
Tan, H. C., et al. (2006). Live capture and reuse of project knowledge in construction Organisations. *Knowledge Management Research & Practice, 4*(2), 149–161.
Thomke, S., & Fujimoto, T. (2000). The effect of "front-loading" problem-solving on product development performance. *Journal of Product Innovation Management, 17*(2), 128–142.
Weber, R., Aha, D. W., & Becerra-Fernandez, I. (2001). Intelligent lessons learned systems. *Journal of Expert Systems Research & Applications, 20*(1), 17–34.
Wiktorsson, M. (2014). Consideration of legacy structures enabling a double helix development of production systems and products. In P. Paulo & S. Arlindo (Eds.), *Technology and manufacturing process selection: The product life cycle perspective* (pp. 21–32).

Williams, T. (2008). How do organizations learn lessons from projects-and do they? *IEEE Transactions on Engineering Management, 55*(2), 248–266.
Womack, J. P., & Jones, D. T. (1996). *Lean thinking: Banish waste and create wealth in your corporation*. New York: Simon & Schuster.
Wood, N., Rust, C., & Horne, G. (2009). A tacit understanding: The designer's role in capturing and passing on the skilled knowledge of master craftsmen. *Journal of Design, 3*(3), 65–78.
Ylirisku, S. P., & Buur, J. (2007). *Designing with video*. London: Springer.

Chapter 8
Already There? Cultivating Emergent Places for Radical Innovation in Operations

Jennie Andersson Schaeffer

Dilemma

Company X is advanced when it comes to managing and executing incremental improvement in strategies and methods. The factory premises have workplaces and work processes to support continuous improvement in order to create lean production. For example, it has so-called improvement places with boards on the production floor that it uses as a visio-spatial method of involving all the workers in making production more effective. Those places support incremental improvements because they are both places for members of a work team to share thoughts and values around problem solving and to externalise knowledge around step-by-step changes. These places also serve as sites for trying out different practices related to incremental improvement.

The higher management level has a strong awareness of the need to be 'more innovative,' that is, to also support radical innovation within operations. One issue the management prioritized was the creation of opportunities to support more diversified production and to be agile in handling consumer demand. They also have a sense of urgency, because they know that a combination of both incremental and radical innovations could mean the survival of the company.

Company X had an innovation laboratory, which it envisioned as being a place where a diverse team could work out a radically new production strategy that would transform the factory. The innovation laboratory functioned as a central hub for the radical change project in production—for a while. Sometime following its inauguration, it was slowly transformed into office space. The people working on

J.A. Schaeffer (✉)
School of innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Jennie.schaeffer@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_8

the radical change project also had to do other work in the organisation and the innovation laboratory no longer exists. There were indicators of fading support for more radical innovation.

The dilemma for Company X was that the drive to change and the curiosity to try out new things like an innovation laboratory were based on outside-in thinking. The company was looking for good examples of radical innovation efforts and thus was 'buying' an explicit part of a work process—the place—as an innovation laboratory, but the use of the place and the practices of radical innovation had a weak organisational connection, which drained this more radical innovation effort. Imagine if Company X had instead combined its curiosity with another form of design process—starting with involving the people working there to explore implicit values, places and work processes supporting radical innovation and then codified that process so that it aligned with their practices. Imagine if the places and practices that could support radical innovation—or at least their beginnings—were already in place—just needing to be cultivated by management.

Introduction

What happened in Company X is not surprising and is supported by research findings. There is support for and much interest in the idea of using innovation laboratories (e.g. Oksanen & Ståhle, 2013). Such a place is characterised by a movement of users from their day-to-day activities to specially designed research area (Lewis & Moultrie, 2005) or to a building dedicated to innovation (Von Krogh, Ichijo, & Nonaka, 2000). According to Lewis and Moultrie (2005), the physical design of the new place is central to its functionality in reducing hierarchy and supporting participation and in reinforcing corporate commitment to innovation and creativity. In other words, the physical design of the workspace affects activities related to creativity and radical innovation, and the design of innovation laboratories has been a focus in both practice and in research.

With the construction of an innovation laboratory, though, the possibility of having radical and incremental innovation efforts co-exist is supposed to be supported by the spatial separation between the incremental and the radical innovation work. However, such a separation may also be harmful for change and innovation processes. Designing workplaces that support innovation in manufacturing facilities involves dealing with various challenges. One is supporting the co-existence of diverse innovation efforts, such as incremental innovation (small steps to improve processes, products, services that produces new versions of those) and radical innovations in processes, products, and services that can bring about revolutionary change at a systemic level (Tidd, 2001). The creation of an innovation laboratory is not an easy way to make the organisation radically innovative if the aim is for the organisation to be better at balancing radical and incremental improvement efforts as a part of its everyday work. Rather, an innovation laboratory can be a costly idea

if members of the wider organisation are not trained to use it, if it is poorly designed, and if the training of capabilities for radical innovation is not supported by the organisation. According to Lewis and Moultrie (2005), an innovation laboratory can have a short lifespan if these elements are not in place.

Another major challenge for industry is the substantial financial investment required to set up such a laboratory (Lewis & Moultrie, 2005). Having the ability to learn to design and use everyday workplace premises for activities that support both incremental innovation and radical innovation activities put the possible development of the two kinds of innovation activities in the hands of many employees and thus creates a broad resource for innovation in the organisation.

This chapter provides an understanding of the characteristics of workplaces in lean production contexts emerging as places for radical innovation and the conditions that allow them to emerge and survive in an environment dominated by incremental improvement. The chapter continues with a discussion of the theoretical background of different characteristics and processes for supporting knowledge-sharing in radical innovation and the concept of *ba*, which is a shared space for knowledge-sharing processes. Then the chapter introduces examples of emerging places for radical innovation in operations: chameleon places, undercover places, grey zone places, satellite places, accessing places and temporary places.

The chapter closes with some practical suggestions on how to use a design process to explore and develop the places that have the potential to support radical innovation activities in an organisation.

To conclude, innovation laboratories are useful, but another way of understanding, creating and cultivating them is possible. This chapter proposes, that instead of letting an innovation laboratory be a single economic and managerial priority, organisations use a decentralised, varied palette of places to foster radical innovation.

Study Summary

The characteristics that describe capabilities for innovation and the examples used in this chapter were among the results of a study on places for radical innovation (see Table 8.1). The characteristics were identified in a literature study. The examples are from among places identified by industrial workers' and managers' in five manufacturing plants in Sweden as workplaces or parts of workplaces that supported or hindered innovation. Photo-based interviews were used to communicate with workers and managers. The characteristics of these workplaces were compared to the characteristics of radical innovation (Table 8.1), and those places that seemed to support radical innovation were chosen for a more thorough study. Six categories of places that could support a radical innovation culture emerged in the lean production context based on findings in materials from the companies.

Table 8.1 Characteristics to describe capabilities for radical innovation

Characteristic	Source
1. Openness	Ekvall (1997), McLaughlin, Bessant, and Smart (2008), Peschl and Fundneider (2012)
2. External input/weak ties	Granovetter (1973), Chesbrough (2003), McLaughlin et al. (2008), Oksanen and Ståhle (2013), Turner and Lee-Kelly (2013)
3. Informal communication	Ekvall (1997), Dixon (1999), Allen and Henn (2007), Moultrie et al. (2007), Fayard and Weeks (2011), Penn and Hillier (1992)
4. Risk taking	Ekvall (1997), McLaughlin et al. (2008), Peschl and Fundneider (2012)
5. Play/improvisation	Leonard-Barton and Swap (1999), McLaughlin et al. (2008), Fayard and Weeks (2011)
6. Incubation	Leonard-Barton and Swap (1999), von Stamm (2008), Fayard and Weeks (2011), Peschl and Fundneider (2012)
7. Permission	Ekvall (1997), Fayard and Weeks (2011), Peschl and Fundneider (2012)

Theoretical Background

The workplace that companies create is a part of its organisational culture, related to the practices in it, and used by workers and managers to support knowledge creation. Raisch, Birkinshaw, Probst, and Tushman (2009) have discussed different aspects that affect companies when trying to combine both radical and incremental innovation (i.e. that affect their level of innovation ambidexterity). A company can have a strategy of either separating incremental and radical innovation activities or integrating them (Raisch et al., 2009). The integration or separation of radical and incremental innovation takes place on an individual or organisational level. On the individual level, ambidexterity is rooted in individuals' ability to combine the competence of openly and radically exploring how to produce something valuable and new and the competence of building on what they already know in order to improve processes. The individual dimension of ambidexterity is difficult to handle because it demands that a person inhabit or be able to mediate between two 'thought worlds'. Innovation requires acquiring insights from a variety of specialties, in other words, from different thought worlds or thought collectives (Fleck, 1979; Dougherty, 1992). At the organisational level, a company that has departments with different thought worlds and different bases of knowledge faces obstacles to the easy sharing of ideas. A central idea or action presented by one person risks then be viewed as meaningless by someone in another department (Dougherty, 1992). The organisational routines and the layout of buildings and workspaces can separate the various thought worlds (Dougherty, 1992). Research and development (R&D) departments are then separated from other parts of the company (Volberda, 1998; Tushman et al., 2010). This way of handling ambidexterity is explained in detail as *sequential* in Chap. 9 of Backström (Fig. 9.1).

Workplaces and Practices

Information flow plays an important part in the innovation process, for example in the practice of informal communication and openness (see Table 8.1). One study showed that for genuine innovation to occur, the critical information input needs to come not from others in the immediate workgroup but from colleagues in other parts of the organisation (Allen, 1977). The physical layout of the workplace has a great impact on the degree to which people see their colleagues' knowledge as being important in their own work. It has, for example, been shown that *how* people from one workgroup found the knowledge of another workgroup useful in their work was dependent on the physical integration of a unit in a building. The building's layout affected the movements of people and those people considered the knowledge that those they passed more frequently to be more useful than the knowledge of someone in a part of the building that they did not see (Penn & Hillier, 1992).

How people form their workplaces is stimulated by the dominant culture in the organisation. According to Schein's theory of culture (1984), a culture is formed by groups of individuals that have formed common basic assumptions and ways of acting. The assumptions, such as beliefs, habits of perception, thoughts, and feelings, are not visible, but are manifested in visible artefacts, which include written language and visuals and physical space. According to Schein (1984), organisational artefacts like a building, an office or a coffee room can reveal information about spoken and unspoken assumptions, rules and values.

A culture for radical innovation is characterised by an emphasis on emergence and openness (Peschl & Fundneider, 2012; Ekvall, 1997), which creates a demand for places that can support such a culture. However, operations organised by the principles of lean production where the formal, explicit level emphasises a culture that values formality, structure, clear separations between different functions, explicit expressions, and so forth. In such organisations, possible alternatives for innovation become invisible since they do not represent the dominate culture and point of view. This tends to limit opportunities for informal unplanned communication, a practice emphasised as supporting radical innovation (Fayard & Weeks, 2011). When places exist in lean production facilities that could be considered to support practices for radical innovation, they tend to become invisible. The problem in industry is that they are not part of conscious work because the potential for radical innovation is considered to exist in another place (e.g., the R&D department) and occur on a much large scale.

Radical innovation can bring about outcomes characterised by radical novelty and the placing of a high value on processes, business models, products or services (March, 1996; He & Wong, 2004; Peschl & Fundneider, 2012; Turner, Swart, & Maylor, 2013). Managing radical innovation presents a challenge because the process includes uncertainty, novelty and complexity (Peschl & Fundneider, 2012). Innovating and creating new knowledge in the radical innovation mode cannot be managed in a mechanical manner. Radical innovation is supported by innovation from within (Peschl & Fundneider, 2008). It has been argued that an environment in which everyone has the opportunity to create innovations and change, without

hierarchies and decisions from above, is more creative and brings about outcomes with a high level of novelty (Vedin, 2000). Peschl and Fundneider (2008) advocate an exploration of what wants to emerge. Emergent innovation depends on a large number of people in an organisation understanding and being able to reframe their deeply held assumptions. Additionally, existential reflection and learning are important and represent a knowledge that does not relate primarily to the past but that grows out of what is expected to emerge in the future (Peschl & Fundneider, 2008).

What is new and existentially exploratory on the individual level can be radical on an organisational level if there is a connection between the levels. The qualities required for emergent radical innovation are characterised by Peschl and Fundneider (2012) as forming an 'ecosystem of openness'. The characteristic of openness is related to trust, since a strong level of trust creates opportunities and ideas and encourages all employees to voice their opinions (Ekvall, 1997). Indications of an openness to allow patterns, ideas and rules to emerge over time and to have a loosely structured organisation mentioned by McLaughlin, Bessant and Smart (2008).

External input is important in building a radical innovation culture, bridging ties and looking outside one's closest social network to search for new knowledge supporting innovation (Granovetter, 1973; Chesbrough, 2003; McLaughlin, Bessant, & Smart, 2008; Raisch et al., 2009; Turner & Lee-Kelley, 2013). The characteristic of risk taking involves tolerance for uncertainty and ambiguity, rapid decision making and actions, or concrete experimentation. Risk taking supports innovation as described by Ekvall (1997) and McLaughlin, Bessant and Smart (2008). Play and improvisation is also important to create a good ground for a radical innovation culture, i.e. discovery and experimentation, building on others, co-creating prototypes, creating a spontaneous and relaxed atmosphere and train divergent thinking (Leonard-Barton and Swap, 1999; Ekvall, 1997; McLaughlin, Bessant, & Smart, 2008). Incubation is also needed - were those describing radical ideas is given room to develop, as discussed by von Stamm (2008), and place for people to reflect individually and in groups, as discussed in Leonard-Barton and Swap (1999), Fayard and Weeks (2011) and Peschl and Fundneider (2012). Permission is also needed meaning the approval from management to make contacts, give and receive information, discuss problems and take initiatives of different kinds (Ekvall, 1997 and Fayard & Weeks, 2011).

In the example about Company X, we can say that it had established a connection between the knowledge, values and actions around incremental innovation and the physical workplace, but had not established a connection when it came to knowledge, values and action for radical innovation. They needed new knowledge and to develop new practices that supported radical innovation. The concept of *ba* (Nonaka & Konno, 1998) will be used in this chapter to understand how the physical place can be involved in learning *new practices*, for example in developing knowledge of radical innovation (see Table 8.1 earlier). *Ba* can be considered a shared space that serves as a foundation for knowledge creation. *Ba* is a useful concept for reasoning about places of innovation since it involves a combination of the culture and mindset of a workgroup with a physical space. It can help to shed

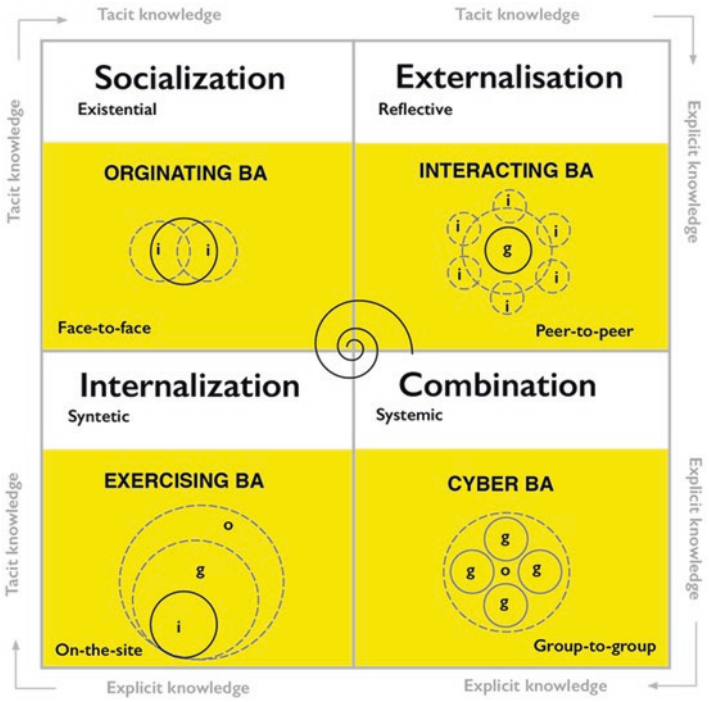

Fig. 8.1 Spiral evolution of knowledge conversion and self-transcending process and four types of *ba* corresponding to SECI model: *originating ba*, *interacting ba*, *cyber ba* and *exercising ba*. 'I' in the figure means individual, 'g' means group and 'o' means organisation. (SECI model from Nonaka and Konno, 1998.)

light on how companies can use their workspaces to learn new practices for radical innovation. *Ba* is a context that includes physical, virtual and mental space and joins the physical workplace with the knowledge that can be created in individuals, informal groups, workgroups and organisations. *Ba* exists on individual, group and organisational levels.

According to Nonaka and Konno (1998), *ba* can be physical (e.g. an office or production facilities), virtual (e.g. email, Skype conferences), mental (e.g. shared experiences, ideas, ideals) or a combination of these. The individual self is embraced by the mental, physical and virtual *ba* of the team—so the *ba* for individuals is the team within an organisation and all levels are connected in creating new knowledge. The process in learning something new involves different stages and is called the SECI model, where SECI stands for socialisation, externalisation, combination and internalization, which represent different stages of learning (Nonaka & Konno, 1998).

Four common types of *ba* are presented in Fig. 8.1. They correspond to a spiral process of learning that goes through four stages: socialisation, externalisation,

combination and internalisation. Each category describes a *ba* especially suited to each of the four knowledge conversion modes. These bas offer platforms for specific steps in the knowledge spiral process. Each type of *ba* supports a particular knowledge conversion process (Nonaka & Konno, 1998).

The *originating ba* is supported by reflection on tacit knowledge, knowledge that is hard to communicate, such as subjective insights, intuitions and hunches deeply rooted in experience. Originating *ba* is a place for socialisation, not necessarily talking, but spending time in the same environments, sharing values and being together. It is a place where people can come into contact with the tacit knowledge of others and also reflect on their own. From this *ba* emerges care, love, trust and commitment (Nonaka & Konno, 1998).

In the *interacting ba*, the knowledge shared is explicit. Tacit knowledge is made explicit with the help of dialogue. Here groups have a mix of specific knowledge and competencies, and when they share it in a conversation between groups and individuals, the individual's mental models and skills are transformed into common terms and concepts. People engage in a joint creation of meaning and value (Nonaka & Konno, 1998).

In *cyber ba*, knowledge is explicit and combines knowledge from different groups on a systemic level. It is, according to Nonaka and Konno (1998), a place of interaction that is most effective in the virtual world and combines old and new knowledge and systematises it throughout the organisation, for example, through on-line networks, documentation or databases.

In the *exercising ba*, explicit knowledge is internalised in individuals, and the process of making explicit knowledge tacit by action, training, use and practice is facilitated (Nonaka & Konno, 1998).

Examples of Emerging Places for Radical Innovation in Operations

Six categories of places that could support a radical innovation culture in a lean production context emerged from findings in the material from the companies. The six categories are chameleon places undercover places, grey zone places, satellite places, accessing places and temporary places, here integrated in the framework of the SECI model (Nonaka & Konno, 1998). They are presented in what follows in relation to the SECI model (Fig. 8.2). They support different phases of knowledge creation on radical innovation. Chameleon and undercover places are emergent places that exemplify originating *ba*. The grey zone and satellite places may serve as places of support for knowledge-sharing, as in an interacting *ba*, accessing places are examples of cyber *ba*, and temporary places share many similarities with exercising *ba*.

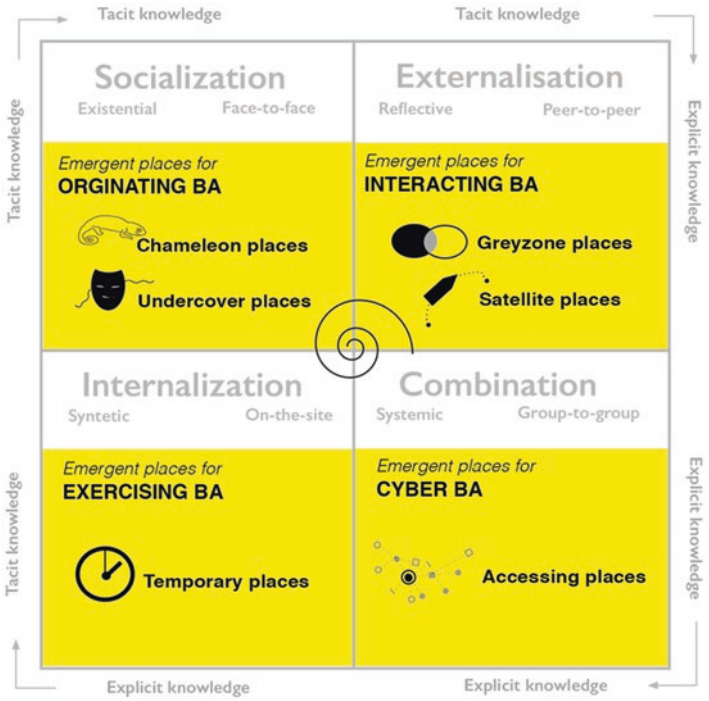

Fig. 8.2 Six categories of places that could support a radical innovation culture to emerge the lean production context. The six categories are undercover places, grey zone places, satellite places, chameleon places, temporary places and accessing places, here integrated in the framework of the SECI model. (Adapted from Nonaka and Konno (1998) by the chapter author.)

Chameleon Places

The first examples from industry are called chameleon places. A chameleon place is a place supporting originating *ba*, since it is a place where an organisation can acknowledge the importance of deeply held individual reflections on the what, why and for whom the organisation and the individual exist. A chameleon place requires organisational support for iteration between individual reflections and face-to-face reflections, to encourage people to spend time together there.

One example of a chameleon place is night production because of its shifting character. For example, during the day when production is run, the workplace has the qualities expected for a place dominated by 5S, efficiency and stability. But with shifting contexts, for example, —when day turns to night and production slows—the place can be experienced differently and become a place for free thought, refection, relaxation and new ideas, as described by one manager. It emerges as a radical innovation place, contributing with a difference to the routines of production in the daytime.

Chameleon places provide an opportunity for reflection; they serve as an escape from what is expected in everyday routines and everyday life in the workplace. The qualities experienced there can allow one to think and act differently from the group or organisation, under the protection of the changed variables. The protection then provides opportunities for incubation and privacy, which Leonard-Barton and Swap (1999) and Fayard and Weeks (2011) have indicated were important for innovation. They create an environment conducive to listening to weak signals and to reflecting on and questioning oneself and one's work (Peschl & Fundneider, 2012).

Undercover Places

An undercover place is one that, on the surface, seems to fit in the dominant culture but is actually one where another culture is able to enter. The main example of an undercover place in the empirical material was the coffee room. Radical innovation culture plays by the rules of informal communication, openness and not forced change and has a loosely structured organisation. The undercover place supports originating *ba* by facilitating face-to-face communication, with users sensing a low threshold for expressing thoughts, which gives workgroups a homey and welcoming feeling. Undercover places let people share feelings and mental models related to visions and ideas around a radical innovation culture that are beyond the day-to-day activities. Coffee rooms have been described as places supporting informal conversation, creating trust, allowing for discussion and cooperation, similar to the findings in research on places supporting radical innovation by Ekvall (1997), Allen and Henn (2007), McLaughlin, Bessant and Smart (2008), Nonaka, Toyama, and Konno (2000) and Fayard and Weeks (2011).

Based on the motifs analysed from the manufacturing companies, their function is doubled in their undercover character. To have a coffee with someone seems rational and works well in the culture of workers in Swedish industry. Within the seemingly organised and structured way of working and taking breaks, radically innovative ideas can have soil in which to grow when people spend time together. The coffee breaks were scheduled in such a way that workers, at least in the companies studied, had the right to at least two breaks during the workday. As a result, employees were allowed or forced to leave the shop floor or their desks. The undercover place was able to exist 'in disguise' and supported radical innovation practices by not having too much of a contrast with the routines in the workshop.

To have a coffee was functional and part of a basic need (drinking) that could fit into production thinking and culture. This is the cover. Under the cover, the coffee room was a place that marked a culture of values, artefacts and thinking that were different from the values, artefacts and thinking in production. For example, production was, in the description of one operator, about rationality, but the coffee room was a place that connected the rationality in the working sphere with the word 'home' and the private sphere and was a place open for discussions about things other than work. As he expressed it, it was a place for the soft side of life 'about

feelings and experience…about our existence'. The undercover place is a place that shares qualities of dwelling, feelings of home and caring. It is a place described as an opening to being with a place and with others like at home, an innovation that is akin to something alive, coming from inside and dynamic, which are qualities in the ecology of openness, as mentioned earlier (Peschl & Fundneider, 2012). It is a place to create trust between people, a place to be together, sharing tacit knowledge.

An undercover place like a coffee room might help an individual handle the co-existence of two different innovation cultures because it provides a different physical place with artefacts, thoughts and values that help a person to mediate between or separate two thought worlds and find an arena for the radical innovation culture within the culture of incremental innovation. A company can support the two thought worlds' co-existence by developing different places for them. The coffee room seems to allow for ambidexterity on an individual level in a production unit, which is difficult to achieve because it demands that one person inhabit two thought worlds (Dougherty, 1992).

Grey Zone Places

Grey zone places are places supporting interacting *ba* since they are experienced as places in between, because they have a quality of permission to externalise contrasting thoughts and collective reflection. Grey zone places often emerge in the periphery of fixed and ordered production spaces. An example of a grey zone place was one designed as a temporary place but that remained for months. In continuous improvement work, all objects and places are approved according to an operator. In this place, the furniture was placed on the shop floor at workers' initiative, but the place was not approved or removed by management. The operator called it an illegal meeting place since all the objects were placed there without permission, out of a need to have a meeting place with proximity to the shop floor.

A grey zone place provides a certain balance between what is standardised, controlled and safe and what is improvised, uncontrolled and unsafe. The name was chosen to illustrate that grey zone places hold a blend of contradictions. They can provide autonomy, because they exist owing to a problem in the system. A grey zone place supports collective, face-to-face interactions, much like the description of a dialoguing *ba* in Nonaka, Toyama, and Konno (2000). What especially characterises them is that they are experienced as places that play with boundaries, both boundaries experienced in organisations and in the physical representation of *ba*. To create the right condition for *ba*, autonomy, as previous research showed, is one aspect that has to be provided since it supports commitment and motivates the search for new knowledge (March, 1996; Nonaka, Toyama, & Konno, 2000). Grey zone places give radical ideas room to develop and change direction and users the chance to reflect, which is important in supporting radical innovation (von Stamm, 2008; Peschl and Fundneider, 2012). A grey zone place is a place for sharing knowledge between different groups by making it easily accessible to many workgroups

and creating opportunities to make tacit knowledge explicit by informal meetings and dialogue, by allowing people to show each other objects or study a machine or a production line together.

Satellite Places

A satellite place is a place off the factory grounds that emerges as a possible place for a radical innovation culture because it has a weak link (but still a link) to the factory premises, its culture and everyday routines. According to the operators and the managers in the study, a moving car had emerged as a place supporting radical innovation. The car is an example of what can be called a satellite place. The car, in terms of how managers or operators used it, moved with clear start and end points. Because it has a defined starting point and an endpoint, it could emerge as a radical innovation place since transport between two places can be considered rational and thus supporting the emergence of less control during transport. The materiality, both as a means of dislocation from everyday activities and an unusual sensory experience, is presented as one important aspect in the design of place for innovation, where, for example, smells and the texture of materials are considered to support innovation (von Krogh et al., 2000). The satellite place in this example adds another facet to this: it is speed and acceleration—the experience of a place moving. The satellite places are places supporting interacting *ba* since they are experienced as giving opportunities to engage in free dialogue, giving users an informal way of sharing what they know and make tacit knowledge explicit using, for example, metaphors or descriptions.

Satellite places hold within their physical enclosures opportunities for another culture that supports incubation and privacy, but also with multimodal stimulation in visual impressions, speed, informal conversation, music and texture, in the experience of the persons that described the car as a place supporting innovation. Informal and unplanned communication creates opportunities for new ideas and facilitates trust and cooperation, as discussed by Dixon (1999), Allen and Henn (2007) and Fayard and Weeks (2011).

Accessing Places

An accessing place is a place with the potential to support the building of relations with people with whom it is possible to exchange new knowledge and acknowledges that the design and functionality of a website or an entrance can support that. Accessing places provide entry to an organization. The examples from industry include a company website, databases or the entrance to a company building. They were perceived by the participants in the study as hindering innovation because their design and function at the moment hindered possible external input, which is one

factor that enhances radical innovation capability. Accessing places can be related to cyber *ba* in Nonaka and Konno (1998) (even if not all of the examples include virtual communication) since, if they were used to their full potential, they could be places for systematic external inputs that combine explicit knowledge from customers with existing knowledge in a company. This is a missed opportunity when developing places for radical innovation in the companies studied. Those places could be more effectively used for emergent communication with clients and customers and to systematise the knowledge gained. An entrance and a website, for example, could serve as a base for capturing new knowledge from people external to the company. That knowledge could then be transferred and integrated into shop floor meetings, which are usually associated with incremental improvements or synthesised and visualised in one place in the company where strategic decisions are made.

Accessing places have the potential to reinforce external communication by systematically letting the users to welcome, invite and make connections with others outside the close social network of the organisation. Accessing places have the potential to b supports features of radical innovation that encourage using bridging ties and looking outside close social networks to seek out new knowledge, which have been described as being important for innovation by Raisch et al. (2009), Turner and Lee-Kelley (2013), McLaughlin, Bessant, and Smart (2008) and Chesbrough (2003).

Temporary Places

Temporary places are a category of place that has been introduced in previous research and are said to initiate a focus on discovery and experimentation (McLaughlin, Bessant, & Smart, 2008), a place to learn how to build on others' ideas and co-create prototypes (Leonard-Barton & Swap, 1999), which is then considered to support innovation. The temporary place, by its temporality, could be experienced to support a spontaneous, relaxed atmosphere (Ekvall, 1997). A temporary place is an exercising *ba* since it supports the internalization, by active participation and action, of externalised knowledge on radical innovation. A temporary place is a place that can be easily configured, moved to different locations and created in a few minutes. In a temporary place, the temporality is supported by a special attitude toward furniture and goings-on in the place. One example from an operations context was the use of a movable cart and some chairs in an improvement meeting.

One team leader gave an example of how he created a frame to nurture a radical innovation culture within a framework of incremental innovation. In changing the conditions of use for a meeting place, reflection on the everyday routines in the use of a meeting place was made possible, and the workers themselves could create a meeting place. Temporality in placement and a vaguely defined use of furniture prevent temporary places from being easily integrated into everyday routines using 5S because they are not being used in a standardised, ordered manner, where objects

preferably have marked out placements (see Greif, 1991; Feld, 2001; Bicheno, 2004; Liker, 2004). A temporary place deals directly with everyday work and the altering of everyday routines and use of places. Moving a cart that the men used as a coffee table shows, for example, that a temporary place is a place in which there are less established practices of how to be with each other at a meeting. Holding meetings in a fixed place means, the team leader explains, that the people already know who was supposed to talk, and what they were expected to say. The team leader encouraged the workgroup to meet in a way that focused on what a meeting room was for them. The users, one may say, could see possibilities for innovation when they consciously saw and used the place as a tool for the meeting. The moving of furniture could be a contributing factor, allowing meeting attendees remove themselves from their everyday routines for a moment.

Discussions and Conclusions

The main finding of this chapter is that ambidexterity and places that support different aspects of a radical innovation culture emerge in operations, but are not seen as resources in operations, either in theory or in practice on a formal level. Places that support such a culture are informal, emergent, hidden, existential and disguised. It can be a challenge to link them to a formal management plan. Emergent ambidexterity in a system builds on individuals, moments, ideas—is possible, but needs support at the organisational level. Places supporting radical innovation capability in different ways can be seen on an individual level and an informal group level, but they must be reinforced and connected to the organisational level.

Practical Implications

Different methods can be used to understand more about workplaces in industrial production companies and the role they play in knowledge creation around incremental and radical innovation. One method is the photo-based interview (Schaeffer, 2014). It provides an effective rich and deep format for communicating with users about workplaces and parts of workplaces they experience as supporting and hindering innovation. Encouraged by a request, the participants photograph places that they consider to be supporting or hindering innovation and write comments about them. The photograph can be viewed on a screen or printed out and used as reflection material in individual and group interviews. After the interviews the descriptions can be compared to the framework of radical innovation capabilities (Fig. 8.3).

In Fig. 8.4 a design process is proposed that can include the photo-based interview focusing on the user's reasoning and experience, in the process of the use and re-creation of workplaces in relation to innovation, wherever they may occur. Understanding workplaces as holding several emergent uses and meanings has

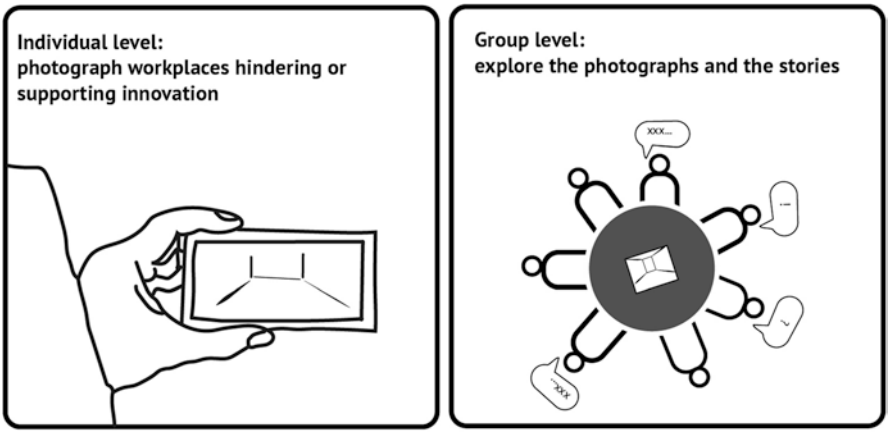

Fig. 8.3 Parts of the process of a photo-based interview. (Illustration by chapter author.)

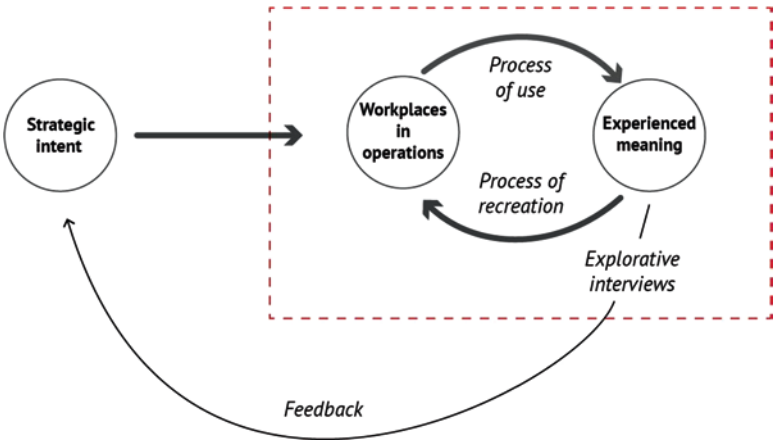

Fig. 8.4 Modified framework for identifying and evaluating emergent workplaces for innovation in the context of an organisation. The areas for places supporting radical innovation in everyday experience are close to the user's experience *(red box)*. These areas include the actions, objects and reasoning in and on a user's workplace, and involve the relation between physical place, process of use, process of re-creation and the experienced meaning. (Figure content by J. Schaeffer, partly based on Moultrie et al. 2007.)

methodological consequences that affect how a study can be framed and described. The proposed framework takes into consideration that the original purposes (strategic intent in Fig. 8.4) behind the use of places may be other than for innovation. This does not exclude places from being experienced and described as important in relation to innovation in their current use (the process of use, Fig. 8.4). The places are then understood differently (the experienced meaning in Fig. 8.4). The proposed

design process also takes into consideration the temporality and rearrangement of different objects that create places for innovation (the process of recreation in Fig. 8.4). The proposed design process makes it possible to provide feedback at the strategic level (arrow feedback, Fig. 8.4).

Photo-based interviews to explore the usage and the experienced meaning of the workplace can be used in an early phase of a design process. The design process in Fig. 8.4 considers the fact that many workplaces are already built and cannot be completely rebuilt. The study then focuses on how the physical space is used and experienced and the way workers and managers use them in relation to radical innovation, the experienced meaning.

As a result of gathering that knowledge, a process of redesigning workplaces can begin, which can mean a change in policies concerning the use of a car, for example, or for conducting meetings in new ways or supporting and allowing spaces on the shop floor where many different competencies can meet. The process supports the identification of emergent places for radical innovation and then continues by finding ways to nurture and support their use.

What follows is a suggestion of how to nurture emergent places for innovation found in the study presented in this chapter.

Emergent Places for Originating ba

Chameleon places: Enable spaces that users experience as having integrity, spaces than can be used without being immediately visible to others. Think of them as a kind of hideout. Develop a permissive attitude to their use, which allows for deep individual reflections on the what, the why and for whom the organisation works. Provide organisational support for iteration between the individual and group reflection.

Undercover places: Identify and enable places for users to have face-to-face communication, places with a homey and welcoming feel that lowers the threshold for expressing thoughts and emotions and mental models related to visions and ideas around a radical innovation culture that is beyond the day-to-day doings.

Emergent Places for Interacting ba

Grey Zone places: Protect the places that users experience as places ‘in between’ and have a quality of providing permission for users to externalize differing thoughts that ‘differ’ with the ideas that are considered acceptable in the facility or at a more official level. Those places often emerge on the periphery of the fixed and ordered spaces in production facilities. Strategically plan how to support collective reflection in those places.

Satellite places: Allow for the use of spaces away from the production site that create opportunities for employees to have free dialogue and informal ways of sharing knowledge and ideas.

Emergent Places for Systemic ba

Accessing places: Create spaces that embrace clients' and visitors' presence and contributions. Identify, for example, how your entrance could be a place that welcomes outsiders so they are comfortable in sharing explicit knowledge that you could combine with knowledge existing in your company.

Emergent Places for Exercising ba

Temporary places: Nurture spaces that users experience as temporal and easily modified. Allow for the conversations that occur in them to support the work of training in improvisation, risk-taking, openness and listening to weak signals. Support the internalizing of externalized knowledge on radical innovation by active participation and action.

One point of discussion based on the results is whether it is possible to cultivate places for radical innovation within manufacturing production units. One threat to supporting places for radical innovation is to make the places and processes important and include them in routines supported by 'guidelines'. Within a culture dominated by incremental innovation, giving attention to places supporting a radical innovation culture *may destroy the conditions that make some of them functional.* As presented, some of the places for radical innovation emerging within an incremental innovation culture seem to be dependent on non-transparency and on the possibility of going unnoticed. The suggestions are, rather, intended to be adapted by designers, managers and users to be used as an input to a design process for future or existing workplaces to support a radical innovation culture in an incremental one.

It must also be noted that the radical side of the ambidextrous company and the places supporting radical innovation can unbalance power relations in the production area since radical emergent innovation brings with it a period of uncertainty and profound change and not immediate success, as discussed by Peschl and Fundneider (2008). Success in the creation of a highly nurturing explorative climate to generate profoundly new knowledge is a support to radical innovations (Peschl & Fundneider, 2008). Supporting a radical innovation culture with help of workplaces may lead to more risk taking and a greater risk of chaos. As a result, it must be taken into consideration that developing places for radical innovation demands thoughtful concern before starting a process to create them or support their spontaneous emergence. The framework presented in this chapter can contribute to a discussion of what is possible or desirable in designing places for innovation in a manufacturing context and as a starting point for a design process.

References

Allen, T. J. (1977). *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organization*. Cambridge, MA: MIT.

Allen, T. J. and Henn, G. (2007) The organization and architecture of innovation: Managing the flow of technology. Butterworth-Heinemann Burlington, MA.

Bicheno, J. (2004). *The new lean toolbox: Towards fast, flexible flow*. Buckingham: Production and Inventory Control, Systems and Industrial Engineering Books.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Press.

Dixon, N. M. (1999). *The organizational learning cycle : How we can learn collectively* (2nd ed.). Aldershot: Gower.

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. *Organization Science, 3*(2), 179–202.

Ekvall, G. (1997). Organizational conditions and levels of creativity. *Creativity and Innovation Management, 6*, 195–205.

Fayard, A.-L., & Weeks, J. (2011). Who Moved My Cube? Creating workspaces that actually foster collaboration. *Harvard Business Review, 89*(7), 103–110.

Feld, W. M. (2001). *Lean manufacturing: Tools, techniques, and how to use them*. Boca Raton, FL: St. Lucie Press.

Fleck, L. (1979). *Genesis and development of a scientific fact*. Chicago, IL: University of Chicago Press (First published in German, 1935).

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*(6), 1360–1380.

Greif, M. (1991). *The visual factory: Building participation through shared information*. Portland, OR: Productivity press.

He, Z., & Wong, P. (2004). Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science, 15*, 481–494.

Leonard-Barton, D., & Swap, W. C. (1999). *When sparks fly: Igniting creativity in groups*. Boston, MA: Harvard Business School.

Lewis, M., & Moultrie, J. (2005). The organizational innovation laboratory. *Creativity and Innovation Management, 14*, 73–83.

Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.

March, J. G. (1996). Continuity and change in theories of organizational action. *Administrative Science Quarterly, 41*(2), 278–287.

McLaughlin, P., Bessant, J., & Smart, P. (2008). Developing an organisation culture to facilitate radical innovation. *International Journal of Technology Management, 44*(3/4), 298–323.

Moultrie, J., Nilsson, M., Dissel, M., Haner, U. E., Janssen, S., & Van der Lugt, R. (2007). Innovation spaces: Towards a framework for understanding the role of the physical environment in innovation. *Creativity and Innovation Management, 16*(1), 53–65.

Nonaka, I., & Konno, N. (1998). The concept of 'Ba': Building a foundation for knowledge creation. *California Management Review, 40*(3), 40–54.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long Range Planning, 33*(1), 5–34.

Oksanen, K., & Ståhle, P. (2013). Physical environment as a source for innovation: Investigating the attributes of innovative space. *Journal of Knowledge Management, 17*(6), 815–827.

Penn, A., & Hillier, B. (1992). The social potential of buildings: spatial structure and the innovative millieu in scientific research laboratories. In *Proceedings of the Corporate Space and Architecture Conference, Paris available from the Bartlett School of Graduate Studies*, University College London, London

Peschl, M. F., & Fundneider, T. (2008). Emergent innovation and sustainable knowledge co-creation. A socio-epistemological approach to 'innovation from within'. In M. D. Lytras, J. M. Carroll, E. Damiani, et al. (Eds.), *The open knowledge society: A computer science and information systems manifesto* (pp. 101–108). New York: Springer.

Peschl, M. F., & Fundneider, T. (2012). Enabling spaces as a sustaining framework bringing forth game-changing innovations. *Journal of Organisational Transformation & Social Change (OTSC), 9*(1), 41–61.

Raisch, S., Birkinshaw, J., Probst, G., & Tushman, L. M. (2009). Organisational ambidexterity. *Organization Science, 20*(4), 685–695.

Schaeffer, J. (2014). *Spaces for innovation*. Dissertation. Västerås: Mälardalen University Press.

Schein, E. H. (1984). Coming to a new awareness of organizational culture. *Sloan Management Review, 25*, 3–16.

Tidd, J. (2001). Innovation management in context: Environment, organization and performance. *International Journal of Management Reviews, 3*, 169–183. doi:10.1111/1468-2370.00062.

Turner, N., & Lee-Kelly, L. (2013). Unpacking the theory on ambidexterity: An illustrative case on the managerial architectures, mechanisms and dynamics. *Management Learning, 44*(2), 179–196.

Turner, N., Swart, J., & Maylor, H. (2013). Mechanisms for managing ambidexterity: A review and research agenda. *International Journal of Management Reviews, 15*, 317–332.

Tushman, M., Smith, W. K., Wood, R. C., Westerman, G., & O'Reilly, C. (2010). Organizational designs and innovation streams. *Industrial and Corporate Change, 19*(5), 1331–1366.

Vedin, B. A. (2000). *Innovation och Kreativitet [Innovation and Creativity]*. (in Swedish). Furulund: Alhambra.

Volberda, H. W. (1998). *Building the flexible firm*. Oxford: Oxford University Press.

Von Krogh, G., Ichijo, K., & Nonaka, I. (2000). *Enabling knowledge creation: How to unlock the mystery of tacit knowledge and release the power of innovation*. New York: Oxford University Press.

von Stamm, B. (2008). *Managing Innovation, Design and Creativity* (2nd ed.). Chichester: Wiley.

Further Readings

One inspirational text that is easy accessible is Fayard, A.-L. and Weeks, J. (2011) "Who Moved My Cube? Creating workspaces that actually foster collaboration" in *Harvard Business Review* issue July–August. Also recommended to read is Nonaka, I., & Konno, N. (1998). The concept of 'Ba': building a foundation for knowledge creation. The dissertation *Spaces for Innovation* (Schaeffer, 2014) will give a deeper insight in the study presented here and a guide to the photo-elicitation interview on page 52 ff.

Chapter 9
Solving the Quality Dilemma: Emergent Quality Management

Tomas Backström

A new paradigm is called for, as proposed in Chap. 2, to acquire a quality management approach that manages to solve the contemporary quality dilemma of companies, as well as future challenges. Both practitioners and academics call for ambidexterity in operations, to be able to combine two sides of the dichotomy imposed by the dilemmas of the production system: on the one hand side exploitation, stability, control and efficiency (doing things right) and, on the other hand, exploration, adaptability, creativity and effectiveness (doing the right things). But the existing paradigm of quality management has not been able to fully solve this task, despite decades of effort. On the contrary, dichotomies like, for example, exploration and exploitation are often seen as opposed and impossible to have at the same time. "Organizational separation offers a primary solution to the balance dilemma in the literature on ambidexterity" (Lavie, Stettner, & Tushman, 2010, p. 131). That is, the two activities are distributed to different units, each highly differentiated and specialised in exploration or exploitation. Exploration is, for example, performed by the research and development (R&D) department and exploitation by the production departments. These different units employ separate business models and managerial teams, as well as different measurement and incentive systems (O'Reilly & Tushman, 2008; Taylor & Helfat, 2009). Further, their learning contexts are physically and culturally separated from one another in order to avoid conflicts in prioritisations and procedures (Christensen, 1997).

A consequence of an organisational separation is that the quality management of production systems tends to focus on efficiency and, thus, on stability and low variation. This is described in Chap. 2: The quality management practices of today have such a focus on and address high variation as a potential disturbance and side activity. But in operational practice there is a perceived need among quality

T. Backström (✉)
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: Tomas.backstrom@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_9

managers to also better address development and innovation in production systems, according to the Delphi study among practitioners presented in Chap. 2 (Fundin, Bergman and Elg). As an answer to this, a new paradigm for quality management is introduced in this book: Emergent quality management (EQM). The foundations for EQM are a more complex understanding of system dynamics and the relation between exploration and exploitation. The goal of this chapter is to initiate a formulation of a new community of understanding of how quality management should be performed and studied.

The eight preceding chapters have been functional. The authors have presented specific dilemmas and suggested new approaches to understanding and managing them. Such practical examples are a good starting point for a new paradigm. This chapter aims for a higher level of abstraction and generalisation. It is the first integrated presentation of the new paradigm of EQM. The goal is to give an understanding of quality management that is more comprehensive than the existing paradigm. The new paradigm involves managing dichotomies by transcending the system boundaries of the existing paradigm. The dichotomy between, on the one hand, stability, low variation and exploitation and, on the other hand, innovation, high variation and exploration is understood as necessary elements that reinforce each other, instead of competing and conflicting activities that are better kept apart. Dichotomies are needed to induce energy and synergy according to EQM. The ontologies behind EQM are complex systems theory and critical realism (Archer, 1995); they are combined around the concept emergence, a central concept of both ontologies.

A dichotomy consists of two opposed parts or subclasses. Since the two parts are opposed, it might seem impossible to have them both at the same time. Let us use the dichotomy of explore vs. exploit as an illustrative example. In a classic article about this dichotomy, March (1991) describes exploration as things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery and innovation, while exploration includes refinement, choice, production, efficiency, selection, implementation and execution. March means that for company survival there is a need to have them both at the same time, but it seems impossible to achieve this: They compete for resources, include two conflicting types of activities that are iteratively self-reinforcing, and they demand different approaches to work, as well as different knowledge and cultures for their performance (e.g. Gupta, Smith, & Shalley, 2006). Thus, the ambidexterity of having exploration and exploitation at the same time seems to be a paradox, that is a statement that contradicts itself and yet might be true. The two parts in a paradox "are contradictory yet interrelated elements – elements that seem logical in isolation but absurd and irrational when appearing simultaneously" (Lewis, 2000, p. 760). Lewis (2000), who has explored paradoxical relationships, means that a typical reaction to a paradox is defensive, meaning it aims to suppress the relatedness of contradictions, for example, by denying one of them: "Both exploration and exploitation are essential for organizations, but they compete for scarce resources. As a result, organizations make explicit or implicit choices between the two" (March, 1991, p. 71).

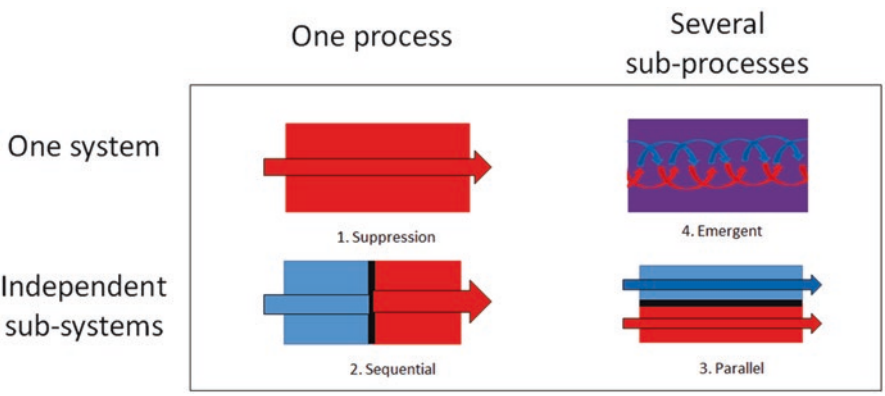

Fig. 9.1 Four ways for an organisation to handle dichotomies in a development process

There are, however, better ways than denial to deal with this paradox, including in the existing paradigm (e.g. Gupta et al., 2006; Lavie et al., 2010). Still, the suggested solutions include some sort of separation between activities for exploitation and exploration. Different kinds of separation are possible; two dimensions can be used to describe them. Are the activities seen as being performed in one system or in different independent subsystems, or are they seen as being integrated into one development process or performed in several subprocesses? In this chapter the separation is carried out from the perspective of a development process, not an organisation as with earlier separations (e.g. O'Reilly & Tushman, 2008). The two dimensions combined produce four quadrants (Fig. 9.1):

1. One system and one process.
   Suppression, where one part in the dichotomy is suppressed and the other part of the dichotomy gives the form and the focus of both the system and the process.
2. Several subsystems and one process.
   Sequential. As in organisational separation, the system is divided into subsystems, one for each part in the dichotomy. The subsystems are isolated from each other and as independent as possible. The one development process is divided into different sequential phases, each phase performed by a subsystem specialised on this part of the dichotomy.
3. Several subsystems and several subprocesses.
   Parallel, different independent subsystems, each with different subprocesses. One system and one process for each part of the dichotomy. The processes are run independently in parallel to each other.
4. One system and several subprocesses.
   Emergent. The dichotomy of the system is managed as two interconnected subprocesses at different levels of the same system: the emergence of structures on an aggregated level and the interactions between smaller parts of the system at the individual level.

Four different approaches to handling dichotomies in a development process have been outlined. With the exception of the first one suppression, because it is so simple, they will will now be further described and analysed under their own heading. Following that is a description of the new EQM paradigm.

Sequential, Independent Subsystems and One Process

According to Lavie et al. (2010), the sequential approach (also called organisational separation) is the primary solution to the exploration vs. exploitation dichotomy. The dynamics of the system is understood by splitting the process into a linear sequence of phases. The actions in one phase build on what happened in the previous phase, so that the development consists of actions or events that build on each other, like a chain of cause–effect relationships. The different phases of this linear process take place within different subsystems, different organisations or organisational parts. For example, in the development of production systems, the first, more explorative, phases often are performed by an R&D department when it comes to developing new products and by the manufacturing engineering department when it comes to the industrialisation process and designing a new production system. The last phase, the exploitation of these new developments to produce products and provide value to customers, is performed by the line of production.

It may be confusing to define organisational separation as sequential. From the perspective of the organisation, it is a parallel approach since different parts of the organisation work with the two dualities in parallel. But from the perspective of a development process, as in this chapter, it is sequential, since one unit performs the first part of the process and then another unit takes over for the next part of the process.

Dividing a change-and-development process in this way into a linear sequence of phases of, for example, exploration and exploitation, is the dominant approach to understanding, describing and managing those phases. This is true also in the literature on creativity, innovation, product development and organisational change (e.g. Anderson, Potocnik, & Zhou, 2014; Cooper, 1990; Kotter 1996). The first phases are more about idea generation, concept development and exploration, and the last phases are about the realisation of ideas, value capture and exploitation. If exploration and exploitation are seen as conflicting and competing activities, it is easy to understand the reason behind organisational separation, where some units are specialised in exploration and the beginning of the change process while other units specialize in exploitation and the end of that process.

There are several advantages to managing the dichotomy in a sequential manner. First, it is close to our culture's everyday view of processes as being sequential, so it is easy for most people to understand. Further, the clear division between activities makes it easier to plan and control the development process, for example, by using a stage–gate process (Cooper, 1990). In addition, it makes specialisation possible when you staff, manage and organise for the two different kinds of activities.

The crucial task here is the processes by which these units are integrated in a value-enhancing way; the managerial challenges are substantial (O'Reilly & Tushman, 2008). As is the case with many other highly demanding tasks of an organization, responsibility for balancing the two activities rests with senior management (Andriopoulos & Lewis, 2009; Smith & Tushman, 2005; Westerman, McFarlan, & Iansiti, 2006).

However, the sequential approach has several severe drawbacks. One of them is the reason for this book: it is not enough to focus exclusively on exploitation in a line organisation. Production personnel must also be engaged in exploration work (e.g. Pot, 2011; Xu et al., 2007), for example, by including development and innovation in quality management. For companies under high levels of pressure to change and that are forced to adopt short lead times, it is not sufficient to use a sequential approach. There is no time to wait for one phase to be completed before starting the next. Usually companies combine the sequential approach with a plan-and-control perspective on change, where plans and decisions about goals to attain are made in advance for each phase. This does not work in the case of radical, disruptive or bold development and innovation because the goals are not known ahead of time. Even Robert Cooper, the founder of the stage–gate process, recognises this and suggests that companies foster a climate, culture and organisation that promotes bolder innovation (Cooper, 2011).

The sequential approach represents a gross oversimplification of the actual dynamics of a system, which increases the sense of being able to plan, control and organise for both stability and change. But trying to do that risks destroying the system's natural development dynamics (see "Emergent, One System and Two Interdependent Subprocesses" in what follows) and lose both time and resources. It will always take longer to implement development sequentially, and it will require a disproportionate amount of resources to communicate among the different phases of the development process, and yet there will be inaccuracies because of communication problems. The synergy between the different parts of the development process will be damaged, and skills and other resources included in phases other than the current one cannot be used.

Parallel, Independent Subsystems and Subprocesses

The parallel approach deals with a dichotomy by letting the two parts work in parallel with the two independent subprocesses. Each subprocess is run within its own independent subsystem. When it comes to stability and change in a production system, both can be performed within the same production line, which includes the same people. But since the processes are managed and organised in different ways, with different procedures and tools, they can be seen as being performed by different subsystems. Typically there is a temporal separation; most of the time is spent on exploitation, while exploration is a side activity performed either regularly or on special occasions or events. From an organisational perspective this is a sequential

approach since the organisation sometimes works with exploration and sometimes with exploitation, but from our perspective of a development process this is a parallel approach. One example is the methods of quality management presented in Table 2.1. In practice those methods focus on efficiency, stability and low variation, or the exploitative side of the production system, while effectiveness, adaptability and high variation, or the explorative side, are side activities to be performed as needed; this is a parallel process in another subsystem. Another example of the parallel approach is when companies have special events for innovation activities once or a couple of times each year (e.g. Peschl & Fundneider, 2014).

Temporal separation, with cycles of exploration and exploitation, during which an organisation focuses only on one dominant activity and later shifts to another, is mentioned in the research literature as a way to attain ambidexterity. Lavie et al. (2010) assert that temporal separation is rooted in the notion of punctuated equilibrium. The punctuated-equilibrium model describes system dynamics as long periods of stability and incremental change, punctuated by short, radical breakthroughs. Some argue that punctuated equilibrium, with a total focus on one side of the dichotomy at a time, is better than letting the two co-exist all the time (Gupta et al., 2006). The concept of punctuated equilibrium is one that is addressed in complex systems theory, and using EQM allows us to better understand. It will therefore be treated more thoroughly under the heading "Emergent Quality Management Paradigm."

It is not uncommon for organisations to communicate expectations on creativity and innovation to their employees. Some companies have a special time, often Friday afternoons, set aside for employees to be creative and innovative and explore various projects (e.g. Teglborg-Lefevre, 2010). From Monday morning until midday on Friday employees work with production in the regular production system. But on Friday afternoon they step out of the production system and into a subsystem for exploration and innovation. The production system is typically designed to ensure stability, low variation, predictability and exploitation. It uses plan and control and leans on organisational structures to reach this. In contrast, the subsystem for innovation often depends on individual employees' autonomy and abilities. Thus, above the temporal separation is a hierarchical separation. Exploitation is mainly due to the organisation while exploration is mainly due to the individual employees.

The change process in the sequential approach was divided into several phases. But it was still one process since each phase was expected to be followed by the next phase, depending on the other phases, and the exploitation was the goal for the whole process from the beginning. In the parallel approach there are, of course, expectations that the exploration will be of value, that some of the experiments will be further exploited, but there is no need to show that before they get started. The exploration subprocess is allowed to run independently of exploitation subprocesses. In the sequential approach, the independent subsystems are different units specialised in the different activities of the dichotomy. In the parallel approach, they are instead the organisation and the individual, and the organisational subsystem and the individual subsystem are treated as if they were independent.

The organisation and its employees are, of course, not independent, but the parallel approach treats them as if they were. This may sound strange, but it is in com-

plete accord with the traditional academic division of the world. Individuals can be studied, described and managed by psychologists with only little attention paid to their living situations, and organisations can be a subject of study for sociologists or management researchers without recognising the people within them. Creating organisational skills for exploration becomes a matter for the HR department with individual focus in the course of hiring, training and forming work situations from an individual perspective. While creating organisational skills to exploit is primarily an issue for the management team and staff, imposing a division of labour, organisational structures, standards, procedures and technical and administrative systems grows out of an organisational perspective.

Activity on the explorative side is not as systematically supported or managed as on the exploitative side. Instead, the focus in the literature is on soft aspects like innovative leadership, enabling spaces, innovative climate or innovative culture (e.g. Ekvall, 1996; Gumusluoglu & Ilsev, 2009; Martins & Terblanche, 2003; Peschl & Fundneider, 2014). In the parallel approach these soft features are organisational realities influencing individual employees; there is no discussion of how individuals affect them. These soft features seem to be independent of individuals. For example, Ekvall explains that the innovation "climate is regarded as an attribute of the organization, a conglomerate of attitudes, feelings, and behaviours which characterizes life in the organization, and exists independently of the perceptions and understandings of the members of the organization. …Climate is conceived as an organizational reality in an 'objectivistic' sense" (Ekvall, 1996, p. 105).

The parallel approach has several advantages when it comes to managing the dichotomy. People and organisations are completely different phenomena. Both are important for an organisation to function well, and different skills are required to understand and manage them. Dividing them into two independent phenomena makes it much easier to deal with each of them. The parallel approach is especially important in the most common form of organisation, where the organisation, because of its size and situation, chooses a more formal and bureaucratic approach to structuring work. The production system requires an organisation that supports exploitation. However, such organisations are often very stable and difficult to change, so for long-term sustainability there is also a need for a parallel process of change that involves employees in innovation work.

There are also several problems with the parallel approach. One is the risk of co-evolutionary look-in (Burgelman, 2002). The development of structures for exploitation, stability, control and efficiency weakens an organisation's long-term ability to adapt. These structures are based on individuals' autonomous work with exploration, adaptability, creativity and effectiveness. But as soon as these structures become strong and successful, they will hinder further adaptation because rational individuals will follow them and no longer be autonomous.

Another problem is the division of the production system into two independent subsystems: individual employees for exploration and organisational structures for exploitation. Individuals perform all activities, both explore and exploit, in the company. The organisation supports exploitation, but individuals need just as much support when performing exploration. Further, the connection between explore and

exploit is unclear in the parallel approach. Good ideas from employees often go unrecognised by companies and will therefore not be used (see Chirumalla's chapter). Finally, focusing on individuals and the organisation separately makes it impossible to exploit the synergies that exist between levels. Only together can they provide both better exploration and exploitation, as will be discussed in the next section.

Emergent, One System and Two Interdependent Subprocesses

The difference between the parallel approach and the emergent approach is in how the production system is understood and, thus, managed. In the emergent approach, the individual and the organisation are seen as one system. The individual employee is dependent on the organisation for all activities, both exploration and exploitation. And the organisation is nothing without employees using it to organise their work. In the emergent approach, we have a contextual ambidexterity between exploration and exploitation. Contextual ambidexterity is supported by research that shows how cultural values that promote innovation can coexist with values of efficiency (Lavie et al., 2010) and that individuals can maintain a co-existence of creativity and efficiency (Miron, Erez, & Naveh, 2004). Exploration and exploitation are *not independent* processes, as in the parallel approach, where individual employees have to focus on either exploration or exploitation at a given time or location (Adler, Goldoftas, & Levine, 1999). In the emergent approach, the two processes are *interdependent* on each other; they are dependent on and support one another.

Behind the emergent approach are theories about dependencies between individual actors and collective structures, for example, the theory of structuration developed by Giddens (1984) and the social construction theory developed by Berger and Luckmann (1966). The difference between the parallel and emergent approaches can be illustrated by how Ekvall (1996) describes the difference between climate and culture. While Ekvall (1996) describes climate as a parallel phenomenon, Schein (1985) describes culture as an emergent phenomenon. Ekvall (1996) explains that "Climate is conceived as an organizational reality in an 'objectivistic' sense…The framework also means that organizational climate is not identical to organizational culture. If climate, in this approach of viewing it, is to be included in a culture model, it should be regarded as a manifestation of culture on what Schein (1985) has described as the level of 'artefacts' including 'visible and audible behaviour patterns'" (Ekvall, 1996, pp. 105–106). This means that climate is something objective out there, an artefact, independent of the individual actors. It is independent since individuals normally do not influence climate and since the climate is there independently of which individuals take part in the organisation at the moment. We have two independent subsystems as in the parallel approach. Culture, on the other hand, is defined by Schein as "the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration…" (Schein, 1985, p. 9). Here the individual actor takes part in the construction and reconstruction of the culture of

the group. The culture emerges out of interactions among individuals, and it is used in those interactions. Thus the individual and the culture are dependent. We have one system that includes both individuals and collective structures.

Sometimes this kind of actor–structure system is explained by using the metaphor of two sides of the same coin. But the emergent approach goes one step further. Actors and structure are always interconnected with each other in a circular causality (Haken, 1996). The two processes—actors' exploration and the structures of exploitation—are interconnected and reinforce each other. The conflict in goals between exploration and exploitation at individual and team levels (Levinthal & March, 1993) is thus transcended. This is a theoretical transcendence, meaning that by using a new paradigm (EQM, described in the next paragraph) it becomes obvious that the dichotomy is not a problem that must be managed but a necessary feature of wholeness. Transcendence thus means that it is no longer a paradox and a source of anxiety that must be managed by dividing them (Lewis, 2000). Understanding quality management under the emergent approach, with one system and two interconnected processes, is a way to attain both exploitation and exploration at the same time. A description of this new paradigm will follow under the heading "Emergent Quality Management Paradigm."

The emergent approach deals with individual employees, their interactions and the organising structures at the workplace. Individual employees are the carriers of the individual–wholeness dichotomy. Functional quality management according to EQM requires employees that on the one hand are strong individuals skilled at exploration and on the other hand well-integrated parts of a strong wholeness, a collective skilled at exploitation. A research review (Backström & Söderberg, 2016) gives examples on what this might mean:

- Strong individuals have high self-efficacy and motivation, are autonomous, individualistic and creative and search for opportunities, knowledge and information externally;
- Being part of a strong collective is to feel safe as part of that collective, to have cohesion, that is be committed to the collective of people and desire to maintain a membership in it, be engaged in interaction and reflection with other members of the collective, share mental models with them and be committed to the objectives of the collective and oriented to superior performance of common tasks.

The interactions among individuals of a collective are especially important in the emergent approach because it is the cause of emergence. Interaction can be supported by giving employees space for, and reasons to communicate, and developing a competence in communication (Backström, 2013), for example, changes in the layout of spaces (see Schaeffer's chapter) and the development of meeting structures in ways intended to increase possibilities of interaction. Also, bonding activities outside of work can be used; for example, a company might offer lunch at a restaurant with good, cheap food, where the CEO eats with the workers and encourages the participation of other managers as well. Another approach is to distribute responsibilities and tasks among small groups of employees and give group members reasons to interact with one another in striving toward common goals.

This also removes competitive pressures that might otherwise inhibit cooperation. Feedback on performance is important to aid self-organisation through simple and frequent measures of Key Performance Indicators at collective level and/or feedback from customers (Hagström, Backström, & Göransson, 2009). Employees' competence in communication can be increased by training them in to create a positive social climate, develop dialogue competence and adopt an improvisational attitude (Backström, Moström Åberg, Köping Olsson, Wilhelmson, & Åteg, 2013).

Included in the organising structures are, according to Backström (2013), both the *formal structures* that managers and their staff have designed as technical and administrative systems, visions and goals, and departments and reporting lines and *emergent structures* like common habits, culture and relatonics (the pattern of relations used in a work task (Backström & Döös, 2008). Managers of an organisation have several tasks to facilitate EQM. One task is to design organisational structures that enable employees to be both strong individuals and well-integrated parts of a strong collective, as well as enable good communication in the organisation. Another task is to engage in communication at the workplace to ensure that also the emerging structures are fitted to EQM and the goals of the organisation.

One form of organisation for the emergent approach is the enabling bureaucracy (Adler & Boris, 1996; Adler, 1999), where the formal procedures of the bureaucracy are designed to enable employees to deal more effectively with inevitable contingencies of the system. This enables employee-driven change processes at the same time as stability is ensured by the procedures in place (Adler & Cole, 1993). Contextual ambidexterity is strengthened by a supportive context that empowers employees to meet performance standards guided by shared ambitions and a collective identity (Ghoshal & Barlett, 1994).

Emergent Quality Management Paradigm

The direction of the main information flow has changed in many modern large organisations. The traditional flow of information vertically, of instructions and reports between managers and subordinates, has been complemented by a horizontal information flow between co-workers. One reason behind this is that more responsibilities are being distributed among co-workers because of, for example, increased demands for short lead times in the development of products. Thus, there is an increased need for co-workers to receive information about the current situation from colleagues, rather than waiting for instructions from managers. To describe, understand and manage the old type of organisation with vertical information flow it is enough to understand it as including two levels connected by an information flow: the manager/organisational structure level and the subordinate level. These levels can be focused on independently. That is sufficient for understanding and managing information received and transmitted by workers, how that information is produced and what consequences it has. The situation in a modern organization, with mainly horizontal information flow, is very different. The connection

between the two levels is now not only a relatively simple information flow, which can be seen as a context for the focused level. It is instead a circular causality that constructs and reconstructs both of the levels in a mutual process of emergence. The two levels can no longer be understood independently; the interconnection between them is instead the most important feature of the organisation.

Emergence includes two levels at the same time. One level has individuals, ideas, separate units, details and moments, and the other has groupings, thought systems, amalgamations, wholes and history. The two levels are in the same system, only with different resolutions. Zooming in will reveal the details, the fine-grained activities; zooming out will disclose the coarse-grained patterns. The details are vibrant and in a seemingly chaotic motion. At the fine-grained level it may be hard to see the patterns and structures. But at the coarse-grained level you will see patterns and organising structures that develop slowly relative to the changes at the fine-grained level. The relations, interactions and cooperation among the small parts at the fine-grained level are more important for the dynamics than the parts themselves. It is through the interactions at the fine-grained level that the structures at the coarse-grained level emerge, and it is the relations, interactions and cooperation at the fine-grained level that the coarse-grained structures organise. Time is also of importance for emergence; it takes time for structures to emerge. Activities and events at the fine-grained level will cause changes in the coarse-grained structures as time passes. At the same time, these changes in the coarse-grained structures will change the pattern of activities and events at the fine-grained level.

An impressionistic painting can be used as a metaphor for this approach to understanding reality. Zooming in will show only dots in different colours; it will not enable one to imagine what the painting as a whole depicts. Likewise, zooming out will allow one to see the whole picture, but now the dots disappear and one is unable to see how the painting was made. The only way to fully grasp the painting is to alternate between the close-up view and the view from a distance. And zooming in, it is better to focus, not on each individual dot, but rather on the interactions among the dots. To quote Vincent van Gogh: “I am always in hope of making a discovery there, to express the love of two lovers by a marriage of two complementary colours, their mingling and their opposition, the mysterious vibrations of kindred tones”. It is these kinds of interactions that build the painting’s motif.

This chapter started with the observation that both practitioners and academics call for ambidexterity in operations and quality management, to be able to combine two sides of a dichotomy, to have an ambidextrous organisation (Benner & Tushman, 2003). The original meaning of *ambidexterity* is the state of being equally adept in the use of both the left and right hands and in using them at the same time. In the traditional paradigm the left hand equals one side of a dichotomy, for example exploitation, and the right hand the other side of it, exploration. But in the new paradigm, EQM, the metaphor of ambidexterity leads one’s thoughts in the wrong direction. A better metaphor is how one hand is able to perform by using the different parts of the hand. While the palm, fingers and fingertips are exploring for the best grip of, say, a tool, the whole hand exploits the tool to perform the task. Further, the important thing when it comes to parts of the hand is not the parts themselves but

their relations, how they function in concert. This metaphor also helps us understand that it is natural and productive to use both sides of the dichotomy, the parts and the whole, at the same time, not something extraordinary requiring extra effort. Just do not divide them; use both at the same time, all the time, all of you.

The emergent approach to managing dichotomies includes how the two processes are dependent on one another, cause each other and explain the dynamics of the system. The emergent approach is based on both realist social theory (Archer, 1995) and complex systems theory (Solé & Goodwin, 2000). Emergence is a central concept in both of those theories. Archer (1995) argues that Giddens' theory of structuration (Giddens, 1984), which we used earlier to understand the emergent approach, does not develop the relation between the individual actor and the collective structure thoroughly enough, that the "endorsement of their mutual constitution precludes examination of their interplay, of the effects of one upon the other and of any statement about their relative contribution to stability and change at any given time" (Archer, 1995, p. 14).

Emergence means events that re-occur at lower levels (in our case individuals) may form structures at a higher level (in our case a collective of individuals). Structures that persist for a time and, as long as they do, govern and organise interactions among subsets of individuals form a collective of people who act as one entity. Examples of such structures at a workplace are common habits, culture and relatonics, the pattern of relations applied in a work task (Backström, 2013; Backström & Döös, 2008). Over time, information from individual interactions is stored in these collective organising structures. The very notion of emergence, therefore, contains within it the presence of a categorical dichotomy between acts/events at the individual level and the very same acts/events as they unfold at the collective level (Hazy & Backström, 2013). This dichotomy includes within it a circular causality—with both downward and upward influence simultaneously in force—between these levels, as described, for example, by the mathematician Hermann Haken (1996).

Individual differences in understanding and ways to act are dampened or amplified by the pre-existing collective structures. But the collective structures are at the same time reproduced, adapted or transformed by enacted individual differences. Constructive feedback on individual differences strengthens the structures, while positive feedback produces elaborations on structures. The surviving elaborated structures entrain the actions of an ever-increasing proportion of the collective. The consequence is that individual actions exhibit emergent regularities or patterns at the collective level (Backström, 2013).

Individuals and structures are distinct from each other and irreducible to one another. The first three approaches to managing dichotomies suggested in this chapter thus represent very simplified models of reality. Archer (1995) describes the relation between individuals and structures as follows:

1. A structure necessarily pre-dates action(s) leading to its reproduction or transformation.
2. Structural elaboration necessarily post-dates the action sequence that gave rise to it.

3. Once a structural elaboration has taken place, the powers and properties defining and distinguishing the structure are relatively autonomous from individuals.
4. Such autonomous properties exert an independent causal influence in their own right, and it is the identification of these causal powers at work that validates their existence, because they may indeed be non-observables.

Dynamics of a Production System According to Emergent Quality Management Paradigm

Complex systems theory includes several mechanisms to explain the dynamics of a system, that is stability on the one hand and incremental and radical changes on the other. The theory of self-organised criticality explains why many phenomena in nature have the same kind of fractal power distribution between size and frequency; the large ones are exponentially fewer than the small ones. An example of this is when a sand pile is built by adding sand slowly to the top of the pile (Solé & Goodwin, 2000, p. 54). First the grains stay where they land. But as more sand is added, the slope of the pile increases until it reaches a maximum critical angle, and a landslide occurs. Most landslides are small, but from time to time, a very large landslide will happen. The influx of sand constantly builds up tension. Small landslides at the top release some tension. But many small landslides at the top create tension a bit further down and a somewhat larger landslide will release that tension. This creates additional tension even further down the pile, causing even larger landslides, and so on. The theory of self-organised criticality is one way to explain how several small incremental changes build up tension in a production system, which must be released by radical changes.

The theory of a percolation threshold gives one possible answer to punctuated equilibrium, where long time periods of stability are punctuated by short, radical breakthroughs. An example of a percolation threshold is forest fires (op. cit. p. 44). If the tree stands are not dense, the fire will not spread. But at the percolation threshold, the trees are so dense that the fire spreads to the entire forest. The theory about the percolation threshold may explain how a production system may be stable despite multiple efforts at change but suddenly transforms when information communicated in a way that changes everyone at the same time.

But another theory behind punctuated equilibrium may be the most interesting for EQM. Biologists stress the difference between genotype, describing the inherited information found in an individual organism's genes, and the phenotype, which describes the appearance and behaviour of the organism during its life. Although genomes gradually change over time, this may not affect the phenotype. However, this drift can lead to an unstable situation where a small change radically changes the phenotype (Gell-Mann, 1994, p. 283). For a production system the genotype can be translated into the skills, competences and values of individual employees and the phenotype to the behaviour of the system, determined by the organising structures. This theory can then be used in EQM to inspire a conscious development of

individual employees in a way that gives the organisation the potential to transform itself when needed. For example, including creative tasks and a need to search for external information in standard tools to deal with stability problems can be a way to train employees to be ready when there is a need for a major transformation.

The Four Different Approaches are Complementary

Four different approaches to managing the dichotomies of the production system have been described in this chapter: suppression, sequential, parallel, and emergent. In the first three approaches, the dichotomy was removed either by suppressing one part of it or by dividing dichotomies into different subunits. But the fourth, emergent, approach is to make use of the dichotomy and the dynamics that arise from it to support both parts at the same time. This new way of understanding a dichotomy, the EQM paradigm, can be used also for different solutions developed under the other three approaches. According to this paradigm, the dichotomy is always present, even in a subunit that has specialised in one part of it. The four different approaches to dealing with dichotomies are thus complementary.

Some organisations may still choose to focus on only one part of the dichotomy, as in the suppression approach. Others may choose to have special departments for the beginning and end of development processes, as in the sequential approach. Especially radical product and production system development are competence-demanding activities; thus, it is often wise to have special departments for them. But the EQM paradigm changes the understanding of the other three other approaches. For example, under the EQM paradigm, it is proposed that the R&D department of a traditional sequential approach should enable the co-existence of individual exploration with structures for co-creation to be able to exploit the competence of entire departments in development projects. Similarly, production employees should be encouraged, trained and given possibilities to be explorative and creative in their production work to enable the co-existence of their exploitative tasks (see the chapters Yamamoto (Chap. 5) and Melkas et. al. (Chap. 6)). Furthermore, structures for making use of the creativity of employees must be in place to take full advantage of this emergent possibility of production system development. Even if a department is specialised in exploration or exploitation, it will function better if it co-exists with and enjoys synergy between these two types of activities.

References

Adler, P., Goldoftas, B., & Levine, D. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota production system. *Organization Science, 10*(1), 43–68.

Adler, P. S. (1999). Building better bureaucracies. *The Academy of Management Executive, 13*(4), 36–47.

Adler, P. S., & Boris, B. (1996). Two types of bureaucracy: Enabling and coercive. *Administrative Science Quarterly, 41*, 61–89.
Adler, P. S., & Cole, R. E. (1993, Spring). Designed for learning: A tale of two auto plants. *Sloan Management Review, 34*(3), 85–94.
Anderson, N., Potocnik, K., & Zhou, J. (2014). Innovation and creativity in organizations: A state-of-the-science review, prospective commentary, and guiding framework. *Journal of Management, 40*(5), 1297–1333.
Andriopoulos, C., & Lewis, M. W. (2009). Exploitation–exploration tensions and organizational ambidexterity: Managing paradoxes of innovation. *Organization Science, 20*(4), 696–717.
Archer, M. S. (1995). *Realist social theory: The morphogenic approach*. New York: Cambridge University Press.
Backström, T. (2013). Managerial rein control and the Rheo task of leadership. *Emergence: Complexity & Organization, 15*(4), 76–90.
Backström, T., & Döös, M. (2008). Relatonics–a key concept for networked organizations. In G. D. Putnik & M. M. Cunha (Eds.), *Encyclopedia of Networked and Virtual Organizations* (Vol. 3, pp. 1367–1374). Hershey, PA: Idea Group, Inc.
Backström, T., Moström Åberg, M., Köping Olsson, B., Wilhelmson, L., & Åteg, M. (2013). Manager's task to support integrated autonomy at the workplace. Results from an intervention. *International Journal of Business and Management, 8*(22), 20–31. doi:10.5539/ijbm.v8n22p20.
Backström, T., & Söderberg, T. (2016). Self-organisation and group creativity. *Journal of Creativity and Business Innovation, 2*, 65–79.
Benner, M. J., & Tushman, M. (2003). Exploitation, exploration, and process management: The productivity dilemma revisited. *Academy of Management Review, 27*, 238–256.
Berger, P. L., & Luckmann, T. (1966). *The social construction of reality. A treatise in the sociology of knowledge*. New York: Doubleday & Company.
Burgelman, R. A. (2002). Strategy as vector and the inertia of coevolutionary lock-in. *Administrative Science Quarterly, 47*, 325–357.
Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Boston: Harvard Business School.
Cooper, R. G. (1990, May–June). Stage-gate systems: A new tool for manageing new products. *Business Horizons, 33*(3), 44–54.
Cooper, R. G. (2011). Perspective: The innovation dilemma: How to innovate when market is mature. *Journal of Product Innovation Management, 28*(S1), 2–27.
Ekvall, G. (1996). Organizational climate for creativity and innovation. *European Journal of Work and Organizational Psychology, 5*(1), 1005–1123.
Gell-Mann, M. (1994). *The quark and the jaguar—Adventures in the simple and the complex*. London: Little, Brown and Company.
Ghoshal, S., & Barlett, C. (1994). Linking organizational context and managerial action: The dimensions of quality of management. *Strategic Management Journal, 15*, 91–112.
Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Cambridge: Polity Press.
Gumusluoglu, L., & Ilsev, A. (2009). Transformational leadership, creativity, and orgazational innovation. *Journal of Business Research, 62*(4), 461–473.
Gupta, A. K., Smith, K. G., & Shalley, C. E. (2006). The interplay between exploration and exploitation. *Academy of Management Journal, 49*(4), 693–706.
Hagström, T., Backström, T., & Göransson, S. (2009). Sustainable competence: Reproduction and innovation in a bank. *The Learning Organization, 16*(3), 237–250.
Haken, H. (1996). *Principles of brain functioning. A synergetic approach to brain activity, behavior and cognition*. Berlin: Springer.
Hazy, J. K., & Backström, T. (2013). Human interaction dynamics (HID): An emerging paradigm for management research. *Emergence: Complexity & Organization, 15*(4), i–ix.
Kotter, J. P. (1996). Leading change, Boston: Harvard Business School Press.

Lavie, D., Stettner, U., & Tushman, M. L. (2010). Exploration and exploitation within and across organizations. *The Academy of Management Annals, 4*(1), 109–155.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal, 14*, 95–112.

Lewis, M. W. (2000). Exploring paradox: Toward a more comprehensive guide. *Academy of Management Review, 25*(4), 760–776.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87.

Martins, E. C., & Terblanche, F. (2003). Building organisational culture that stimulates creativity and innovation. *European Journal of Innovation Management, 6*(1), 64–74.

Miron, E., Erez, M., & Naveh, E. (2004). Do personal characteristics and cultural values that promote innovation, quality, and efficiency compete or complement each other? *Journal of Organizational Behavior, 25*(2), 175–199.

O'Reilly, C. A., & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in Organizational Behavior, 28*, 185–206.

Peschl, M. F., & Fundneider, T. (2014). Designing and enabling spaces for collaborative knowledge creation and innovation: From managing to enabling innovation as socio-epistemological technology. *Computers in Human Behavior, 37*, 346–359.

Pot, F. D. (2011). Workplace innovation for better jobs and performance. *International Journal of Productivity and Performance Management, 60*(4), 404–415.

Schein, E. H. (1985). *Organzational culture and leadership—A dynamic view*. San Francisco: Jossey-Bass.

Smith, W. K., & Tushman, M. L. (2005). Managing strategic contradictions: A top management model for managing innovation streams. *Organization Science, 16*(5), 522–536.

Solé, R., & Goodwin, B. (2000). *Signs of life—How complexity pervades biology*. New York: Basic Books.

Taylor, A., & Helfat, C. (2009). Organizational linkages for surviving technological change: Complementary assets, middle management, and ambidexterity. *Organization Science, 20*(4), 718–739.

Teglborg-Lefevre, A.-C. (2010). Modes of approach to employee-driven innovation in France: An empirical study. *Transfer, 16*(2), 211–226.

Westerman, G., McFarlan, F. M., & Iansiti, M. (2006). Organization design and effectiveness over the innovation life cycle. *Organization Science, 17*(2), 230–238.

Xu, Q., Chen, J., Xie, Z., Liu, J., Zheng, G., & Wang, Y. (2007). Total innovation management: A novel paradigm of innovation management in the 21st century. *Journal of Technology Transfer, 32*, 9–25.

Chapter 10
Conclusions

Tomas Backström, Anders Fundin, and Peter E. Johansson

In this concluding chapter, each of the previous chapters are reflected upon based on the emergent quality management paradigm presented in Chap. 9 by Backström. That the production system is heavily dependent on employees' knowledge, commitment and innovation capacity in order to have high-quality production is something of a foregone conclusion that most agree with. Yet this is what the traditional quality paradigm does not take into consideration seriously enough. What is still taught is that exploration and exploitation can be managed independently, and they are treated as different systems that can be looked at separately. A consequence of this is the view that it is possible to separate, on the one hand, exploration, which gives employees new knowledge, commitment and innovation capacity, and, on the other hand, exploitation of the organisation's resources in high-quality production.

In Chap. 5 Yamamoto provides a fine illustration of this fallacy. The chapter starts with Kaikaku, described using analytical terms as a linear process (Fig. 5.1). Management and staff perform exploratory work in the initial phases where radical change is designed and planned. The last phase, *implementation*, constitutes the exploitation of these plans, including the training of employees in the new systems and processes. A classic example of how to handle duality is through the use of separation. The final part of Yamamoto's chapter, however, gives a completely different picture of Kaikaku, now described as a spiral process (Fig. 5.3). He discusses how Kaikaku is often carried out with the participation of all employees and that it is important to divide the process into several incremental small projects because this makes it possible to build on ideas received during the process and continuously expand the competence of the staff to take part in the change process. Management still initiates and decides the direction of change by the use of an extended, demanding and, for many, motivating goal, but the pathway is determined iteratively as you

T. Backström (✉) • A. Fundin • P.E. Johansson
School of Innovation, Design and Engineering, Mälardalen University, Eskilstuna, Sweden
e-mail: tomas.backstrom@mdh.se

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8_10

go and is influenced by the experiences and ideas that arise while working towards the goal. The ability to reach the target grows over time. There is a dependence between employees' work with exploration and the success of the exploitation process. The idea that they could be separated and the plan changed in advance then becomes obsolete.

All the chapters describe the various dualities that must be addressed to achieve a high-quality production system. Some chapters focus on dualities and demonstrate the importance of being able to handle them. In Chap. 2, Fundin et al. describe five dualities, and in Chap. 3 Wiktorsson et al. describe four more. Between the lines these chapters still make an assumption that the dualities can be separated from each other and that one must consciously pay attention to both sides, so that they can complement each other, in order for both to be in use simultaneously. However, history shows that acute and short-term profitable exploitation is often given priority in practice, even though management might have the knowledge, opportunity, insight and will to carry out explorative activities as well. That the two complement each other is not enough. For it to be necessary that both are used, they must dependently improve each other, since they are necessary for one another. In other words, exploration and exploitation must demonstrate a symbiosis with each other.

Fundin et al. describe two constructive dilemmas, two examples of organisations that successfully embraced dilemmas. For Toyota it seems to be part of company culture. Phrases to characterise the company include that it "thrives on paradoxes" and "harnesses opposing propositions to energise itself". This can be seen as the goal of the new paradigm. We believe that we ourselves construct the problem with the dilemma with our schooling in analysis. When we overcome the need to separate the parts of a dilemma, the problem disappears, and it is even hard to see what it was, but for most organisations this point is located far in the future. In the other example, Intermountain Healthcare has implemented a system for developing practices in which guidelines are continually constructed and reconstructed by the practitioners themselves. In this way, a continuous exploration of new ways to work forms the groundwork for exploiting the organisation's resources. Is it possible that standards that have not been changed the last month have now become irrelevant for today? If so, exploitation has become dependent on exploration on a daily basis.

Fundin et al. point out in their chapter the importance of the possibility of making use of the knowledge and methods of the old paradigm, obviating the need to start from scratch with the new paradigm. This seems possible because quality management approaches support both kinds of activities, exploration and exploitation. However, much work will be required to tightly integrate them to unleash the potential of the methods in current quality management programmes. Identifying and describing how methods of exploiting similar activities will require methods for exploring similar activities, and vice versa. It should no longer be possible to use only one type of method.

Wiktorsson et al. show in their chapter the importance of staff knowledge. If you only wish to exploit in terms of automation processes, you risk losing the knowledge that you then need. Information and knowledge are key factors in the new paradigm.

In Chap. 4 Johansson deepens the discussion about knowledge needed for staff to take an active part in change processes suggested by the emergent paradigm. First he notes that at the individual level, it takes experience to be able to combine exploration and exploitation: "for a novice the two orientations of exploitation and exploration are likely to be kept separate in order to make them meaningful". Then he suggests guidance or coaching as organisational solutions for workplaces with inexperienced personnel. These solutions also include opportunities for staff to learn to acquire enough experience to combine dualities.

In the new paradigm, activities for exploration and exploitation must be closely intertwined and dependent on each other. One cannot run production for any length of time unless employees also perform exploration activities. It makes no sense to plan a change project if staff are not committed to it. The chapters by Yamamoto (Chap. 5), Melkas et al. (Chap. 6), Chirumalla (Chap. 7) and Schaeffer (Chap. 8) focus on the tools and methods to use to approach this ideal. The chapters by Yamamoto and Melkas et al. involve activities, Kaikaku respectively innovation sessions and research-based theatre methods, that management can initiate to spur development of the ability to do both exploration and exploitation; this includes representatives from an organisation's staff and stakeholders. Two other chapters (Chirumalla and Schaeffer) are devoted to showing how activities for both exploration and exploitation can be brought together in daily quality work using videos to transfer results from exploration or by allowing physical spaces for both exploration and exploitation to emerge in the production system.

The Kaikaku approaches described by Yamamoto show that exploration work contributes to people's personal development: "The more people are able bring about such improvements, the more difficult challenges they will be able to address." One important result from his research is that people develop their capabilities for both exploration and exploitation by taking part in a Kaikaku event. The Kaikaku is defined as a large-scale fundamental change in operations performed over a specified time period. Still, it should be performed in smaller projects, step by step, because then people both increase their competence for each step and see more improvement opportunities. The Kaikaku event is initiated by top managers and serves as a major motivation because it reflects a need to attain a higher pace of improvement. For experienced Kaizen companies motives like Kaizen has stagnated, and it has been proposed that employees should be encouraged to become more innovative in improvement work. Yamamoto characterises the Kaikaku as an "exploration effort for everyone". Everyone's participation, team work, an evolutionary approach, and the motivation and mindset of employees are seen as important factors for success. Also, more innovative thinking and acting from managers are needed. This includes a challenging spirit, a give-it-a-try mentality and the ability to unlearn: "It seems that companies used the word Kaikaku as a way to make managers and employees be aware of this mental mode toward exploring." Companies that have performed Kaikaku activities believe that abilities have developed not only on individual and group levels but also on an organisational level, for example by a change in the organisational culture. Iteration in improvement cycles is mentioned as an important mechanism for development, and Yamamoto develops a model of a learning cycle for abilities that enable exploration and exploitation.

Melkas et al. also describe how certain methods—innovation sessions and research-based theatre—can be used when top managers experience a profound need to develop their company or to increase employee involvement in changes. They "emphasize that making practices...visible and voicing various views are essential if organizations want to exploit the potential hidden in everyday working life". Their methods involve learning and interacting for knowledge-sharing, integration, reflection and co-creation. The authors see a need for new managerial practices where analytical exploitation-like processes are based on interpretive processes with an explorative polyphony and multi-voice sketches of possibilities. As one consequence, these methods widen the focus from an initial small single problem involving few people, to involving employees, experts, customers and others in a process where new opportunities are created in an iterative transition between exploration and exploitation.

A video tool with seven steps, for lessons learned practices, developed by Chirumalla, shows how exploration and exploitation orientations can be integrated into one tool and as such become more dependent on each other. The capture of everyday experiences and learning is introduced by Chirumalla as a third function of importance for operations management, complementing production system operations and production system design. Chirumalla approaches the problem with new knowledge explored in day-to-day practices, which seldom is exploited by companies; this implies that the ability to organise, structure and systematise new knowledge through organisational routines is crucial for successful exploitation.

Finally, rooms need to be transformed to support a new emergent quality management paradigm. Schaeffer talks about how traditional lean production requires spaces with a clear structure that is clearly subdivided among different functions and explicit expressions. The new paradigm requires spaces that support unplanned communication, reflection and learning. Schaeffer formulates seven different kinds of spaces for the new paradigm based on an empirical investigation using input from several employees about which places support innovation. In Schaeffer's chapter, two more important lessons for the new paradigm are presented. First is the risk that over time it will become routine and be transformed into procedures and standards without explorative content. Second is the idea that the new thinking must be implemented in a manner consistent with the paradigm itself, that is, not as a linear process planned by management but as a process in which the employees themselves find paths to achieve the management objective specified.

To conclude, our book introduces four processes: innovation, production, knowledge creation, and value creation processes. It is emphasised that companies must prioritise and develop all four of these processes to survive and prosper. Throughout the book, dichotomies associated with these processes have been elaborated on and discussed. Historically, these dichotomies have often created dilemmas owing to the current understanding of their relations. However, as suggested in this book, alternative perspectives can be used in a constructive way to resolve these potentially high-impact dilemmas. Recognising the dichotomies as mutually dependent gives further possibilities for the development of production systems. Because the dilemmas have been known to the research community and been a part of company

practices for a long period of time, our aim with this book was to shed new light on them through the introduction of a new paradigm that theoretically could resolve production system dilemmas. Additionally, the book offers guidance and practical solutions on how to manage and organise work processes to overcome several kinds of dilemmas. This new paradigm is in its infancy, and we hope that the book has inspired readers to take on the challenge of continuing its further development.

Index

T. Backström et al. (eds.), *Innovative Quality Improvements in Operations*,
International Series in Operations Research & Management Science 255,
DOI 10.1007/978-3-319-55985-8