TITLE:

The Dynamics of Interrelated Routines: Introducing the Cluster Level

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Introduction

Routines are ever changing, not stable. In a nutshell, this is the surprising finding of recent research highlighting the endogenous dynamics of *single* routines (Feldman and Pentland 2003). However, organizational outcomes are brought about in a concerted effort that depends on *multiple*, interrelated routines. Whereas this seems to be beyond question, little is known about the implications and consequences of routine interrelatedness. Against this background, this paper seeks to address two research questions: First, how can we conceptualize interrelations between routines? And second, what are the dynamics of interrelated routines, and how do they unfold relative to the dynamics of single routines?

When setting out to study routine interrelatedness, it is important to distinguish between routines which closely interact and others which are more distant. Routines that closely interact in achieving a common task make up a distinct unit, which we will call a "cluster." Specifically, *a cluster consists of multiple, complementary routines, each contributing a partial result to the accomplishment of a common task*. The main point of this paper is that the dynamics of a single routine and the dynamics of a cluster of interrelated routines differ in significant ways. To elaborate this point, we draw on insights from research on interdependence and integration (Becker and Murphy 1992, Lawrence and Lorsch 1967, Puranam et al. 2012), modularity (Ethiraj and Levinthal 2004, Garud et al. 2003, Simon 1962) and the consequences of complementarities (David 1994, Levinthal 2000, Schmidt and Spindler 2002).

When addressing our first research question, we clarify how and why organizations develop multiple routines. This refers us to the fundamental principle of organization: the division of labor. Organization theory normally frames these issues in terms of differentiation and integration. Thus, understanding routine interrelatedness requires examining how organizations divide work into multiple, separate routines, whilst simultaneously securing a sufficient integration of efforts. This perspective leads to a coordination problem arising at the interfaces between routines. Interfaces between specialized routines are typically managed by means of programming. Programming interfaces coordinates multiple routines by means of performance objectives which make the results of each routine expectable for the actors that perform connected routines. This allows actors performing a focal routine to remain largely ignorant of the specific actions taken in other routines, even when there is task interdependence between these routines. In answering our first research question, we therefore conceptualize interrelations between specialized routines in terms of programmed interfaces which enable mutual anticipation of results.

Regarding the second research question, we will argue that division of labor and programming of interfaces bring about complementarities between routines. In the longer run, a system of interrelated and fine-tuned routines emerges: the routine cluster. Importantly, we will show that such a cluster develops its own dynamics in terms of distinct patterns of adaptation. These patterns emerge as the cluster is continuously being challenged by internal or external developments. Organizational actors regularly translate such developments into new routines which have to be integrated into the cluster to be fully operational. During integration, the new routines are examined in terms of fit and misfit respectively. We argue that in order to protect the already realized complementarities between established routines, fitting solutions (i.e. solutions with low misfit costs) will generally be preferred. In other words, our main argument in this paper is that, in contrast to the dynamics of single routines which are primarily driven by reflective action, dynamics on the cluster level are primarily driven by a logic of complementarities that builds up behind the backs of the performing actors. Over time, complementarities are likely to narrow the scope of viable changes in the cluster's development, amounting to a trajectory. The cluster will continue to change, but only along the emergent trajectory.

To illustrate this theoretical framework, we present a longitudinal, historical case study about CEWE, the European market leader in photofinishing. In this case study, we focus on a salient cluster of routines: the cluster of production routines at the core of this firm. To study this cluster's dynamics during the upcoming digital revolution (1990s), we first reconstructed how its routines were related to each other and then conducted an event-based analysis. We focus on two integration events and analyze how these two technological changes were translated into new routines pushing for integration. The analysis demonstrates how complementarities between established routines actually restrict the scope of viable adaptation and change at the cluster level. In sum, we can show that adoption and implementation of new routines largely depended on their (mis-)fitting with the well-oiled pattern of differentiation and integration that characterized this cluster.

Our findings contribute to extant literature on organizational routines in three major ways. First, we extend the theory of organizational routines by including the effects of interdependence, pointing out how routines are interrelated and form clusters. Second, we provide a conceptual framework for analyzing the dynamics of routine clusters. We show that, in contrast to the dynamics of single routines which produce continuous variation in action patterns, the dynamics of routine clusters are restricting and set limits to organizational adaptiveness. Third, by elaborating on these inverse dynamics, our findings contribute to a multi-level theory of organizational routines by adding the cluster level of analysis to the micro level analysis of single routine dynamics.

In the remainder of the paper, we proceed as follows: First, we review the literature on routine dynamics, highlighting how most of these studies focus on single routines. The fact that routines are regularly part of a system of interrelated routines awaits further exploration. For this purpose we introduce the cluster as a new level of analysis. After presenting our research design, methods and research site, we outline the case chronology of CEWE. Next, CEWE's core cluster of production routines as it was shortly before the digital revolution is identified as our primary unit of analysis. We will show how the routines were interrelated and what this meant for the evolution of the cluster. By comparing two selected innovation events at the beginning of the digital revolution (1990s), we aim at showing how established interrelationships were constraining the clusters development, amounting to a restrictive corridor for subsequent adaptive moves. The empirical analysis is followed by a discussion of the implications of our findings for theories of routine dynamics and organizational adaptation. We conclude by pointing out the limitations of this paper as well as possible directions for future research.

Revisiting Organizational Routines

A routine is commonly defined as a "repetitive, recognizable pattern of interdependent actions, involving multiple actors" (Feldman and Pentland 2003, 96). As such, routines have often been conceptualized as stable, even inertial patterns, accomplished rather mindlessly (Ashforth and Fried 1988, Gersick and Hackman 1990, Nelson and Winter 1982, Stene 1940, Weiss and Ilgen 1985). Along these lines of reasoning, a number of mechanisms have been identified which are assumed to contribute to inertia and over-stabilization (Schulz 2008). Opposing this conception of rather stable routines, more recent empirical research revealed a different picture. Routines proved much more dynamic than expected. Pentland and Rueter (1994), for instance, found routine-like work in a task unit characterized by high numbers of exceptions which required search and deliberation. Feldman (2000) reported on ongoing changes in supposedly stable routines and concluded that "[…] routines are not inert, but are as full of life as other aspects of organizations" (p. 626).

Inspired by this new understanding of routines and their inherent dynamics, subsequent empirical research on routines highlighted the role of agency in performing a routine (e.g. D'Adderio 2008, Howard-Grenville 2005, Lazaric and Denis 2005, Reynaud 2005, Turner and Rindova 2012, Zbaracki and Bergen 2010). Contrasting the view of rather mindless, habitual routine behavior, these studies point to the cognitive and motivational processes that shape routine performances (Parmigiani and Howard-Grenville 2011). Agents performing a routine will primarily be concerned with practical problems related to the enactment of some abstract idea in a dynamically evolving context (Feldman and Orlikowski 2011). As the resulting actions can and will have an impact on the idea they enact, these authors expect ongoing variation of actions and ideas over time (Feldman 2000; Pentland et al. 2011). This dual relation between the routine in principle and the routine in practice is conceptualized as the interplay between the ostensive and performative aspects of routines (Feldman and Pentland 2003). In this view, routines are conceived as action patterns that are subject to variation because actions are reflective of each other (Pentland et al. 2012). On these grounds, routines are sometimes even seen as a source of organizational change (Feldman 2000, Rerup and Feldman 2011).

What is common to these studies of routine dynamics is a focus on the evolution of single routines. An organization, however, does not represent an agglomerate of single routines. Rather, organizations have to be conceived of as a web of interrelated tasks and routines respectively (Nelson and Winter 1982, Simon 1962, Thompson 1967, Winter 2003). In the case of interrelatedness, the whole is more than (and different from) the sum of its parts (Levinthal 2000). This raises the question of how organizational routines are interrelated and what the implications are in terms of dynamics.

Interrelated Routines and their Dynamics

Only a very small number of publications hint at the importance of routine interdependence for our understanding of routines and organizations respectively. Turner and Rindova (2012), for example, find clues that task interdependence between two routines in a dyadic relation can amount to an important driver of consistency in the performance of both routines. Galunic and Weeks (2005) demonstrate that a relational view of routines in terms of ecologies can be a fruitful way to synthesize empirical results from different fields. Their synthesis also hints at the important role of managers in giving direction to the evolutionary trajectory of intra-organizational routine ecologies. Birnholtz and colleagues (2007) focus on a network of interdependent routines. They develop the concept of "organizational character" which refers to the dynamic reproduction of sameness on the level of aggregate behavior. However, a more systematic approach that helps understanding why and how routines are interrelated is still missing. This underexplored question will be addressed in the next section.

Routine Interrelatedness

Why and how are organizational routines interrelated? This question refers us to the basics of organizational theory and the elementary insight that organizations exist because of the benefits from the division of labor (Smith 1776). In this perspective, organizations divide a major task into subtasks (and subsequently subunits) to earn economies of specialization. Thus, work units are only concerned with parts of an overall, organizational task and are as such task-interdependent by implication (Adler 1995, McCann and Ferry 1979). Generally, we can speak of task interdependence "if the value generated from performing each is different when the other task is performed versus when it is not" (Puranam et al. 2012, 421).

Dividing an organizational task inevitably raises the problem of integration (Lawrence and Lorsch 1967). In any given organization, differentiation can take various forms, and the corresponding integration can be achieved in different ways (Lawrence and Lorsch 1967, Ouchi 1980, Srikanth and Puranam 2014). Focusing on routines, we are interested in the division of a complex organizational task into multiple specialized routines and how these are reconnected (or: integrated) in such a way that, eventually, each routine contributes a partial result to the accomplishment of the overall task.

This perspective draws our attention to the problem which inevitably arises at the "interfaces" (Simon 1996) between specialized routines. This integration problem of managing interfaces is often resolved through programming (Luhmann 1995, Simon 1977) – as opposed to ad-hoc coordination. Such programming of interfaces entails the normative prescription of the respective subtasks in such a way that the coordination requirements between routines are incorporated in the performance specifications for each routine (see also Schmickl and Kieser 2008). These performance specifications, or "programs" (Luhmann 1995, Simon 1977), normally encompass three parts: the triggering information, the major steps to program execution, and the expected output. For programming, the general design challenge is to divide the overall organizational task in a way "that minimizes […] externalities and consequently permits a maximum degree of decentralization of final decision to the subsystems, and a maximum use of relatively simple and cheap coordinating devices […] to relate each of the decisional subsystems with the others" (Simon 1973, 270).

Such type of integration offers important advantages in accomplishing complex organizational tasks. It saves time and costs, as performing a focal routine does not require the continuous observation of the performances of related routines. In contrast, programming interfaces builds on the advantages of creating semi-autonomous routines, or – put differently – modules (Baldwin and Clark 2003, Simon 1962, Srikanth and Puranam 2014). Actors can primarily focus their efforts on the continuous achievement of their predefined subtask and, thereby, realize the economies of specialization that lie at the heart of labor division (Becker and Murphy 1992).

To realize these advantages, it will be essential for organizational actors to distinguish those aspects of sub-task accomplishment that can be varied according to the contingencies of the situation from those aspects that have to remain constant – the results – in order to ensure expectability for others; which is a prerequisite for reliable integration of efforts (e.g. Baldwin and Clark 2003, Eppinger et al. 1994). In this way, programmed integration allows actors that are performing a focal routine to remain largely ignorant of "the specific actions taken by specific people at specific times" (Feldman and Pentland 2003, 101) that constitute the performances of *other* routines – even in situations when the tasks these other routines accomplish are interdependent with the task of the focal routine. Programmed integration does not, however, declass actions *within* a routine to mindless behavior. To reliably produce the prescribed results mindful actors that can vary their behaviors are of importance, as "variability in a process may help sustain the apparent stability of the outcomes" (Pentland et al. 2011, 1380).

Conceptually, this reasoning points us to the difference between a single routine with self-sustained coordination, i.e. an action pattern that emerges because actions are (made) reflective of each other (Pentland et al. 2012), and a set of multiple, interrelated routines where coordination relies on the expectability of pre-defined results and, therefore, actions only have to be selectively reflective of each other. This difference provides also the very reason why a whole organization should not be conceived as one complex routine: One would miss the essence of organized task accomplishment which builds on the advantages of operating with multiple, separate logics, and allows for partially ignoring the performances and complexities of adjacent routines during the accomplishment of a focal subtask.

To sum up, differentiation brings about task interdependencies and intermissions between routines. A preferred mode of integration is programming interfaces. Interrelated routines are integrated in terms of expectable results while at the same time allowing for variability of actions.

Clusters of Routines

In larger organizations, we will find a wide range of routines fostering internal complexity. At some point in the development of an organization, it will therefore become necessary to reduce this complexity to a manageable scope. A pivotal means to accomplishing this task is grouping routines into separate sections. We suggest calling such groupings routine clusters (following David 1994).

On the organizational level, internal differentiation is achieved by building specialized clusters such as production, marketing, research, finance or logistics (in large organizations, a sub-clustering may be needed in terms of different plants or various sales branches). By implication, routine clusters can again be conceptualized as partially autonomous behavioral units. As the results accomplished by these clusters again have to be integrated, differentiation into clusters has to be properly balanced with the reverse need for integration (Lawrence and Lorsch 1967).

Routines can be clustered in different ways. The actual form of such clustering depends on design decisions taken by (formally authorized or informally assigned) organizational agents. In the extant literature, a number of modes are discussed (e.g. Roberts 2004). One favors the grouping of routines along "objects" (e.g. products or customers); another may group along "activities" (e.g. producing, accounting, marketing). Whichever mode is chosen to group routines together, *within* a cluster the goal will be to exploit complementarities between interdependent routines: "Arguably, this is what organizations try to do: to create synergy by interweaving routines" (Galunic and Weeks 2005, 82).

Interweaving of routines is likely to result in a recognizable pattern of differentiation and integration that will characterize the cluster. The major point for our argument is that routines within such a cluster will somehow "fit," that is, complement each other (Galunic and Weeks 2005, Roberts 2004, Siggelkow 2002). As a consequence, "we [will] see broader assemblages of behavior emerge that result from complementarities among routines" (Levinthal 2000, 364). Obviously, complementarities figure prominently here. As will be shown below, their logic and dynamics are essential for understanding the adaptive behavior of clusters.

Dynamics of Routine Clusters

Routine clusters have to meet ongoing challenges of innovation and change. As a consequence, the question arises: How does a cluster respond to such challenges? What dynamics unfold on the cluster level? Furthermore, and in relation to our initial question: Do they substantially differ from single routine dynamics?

To study the dynamics on the cluster level, we suggest borrowing from theories of institutional evolution (North 1990, David 1994) which nicely fit with our focus on routines. Specifically, we propose analyzing the dynamics of a routine cluster by studying its reactions to change challenges. This means that changes, triggered by whatever development, eventually “arrive” at a cluster in the form of new, envisioned routines pushing for integration. As a consequence, the dynamics of a cluster result from the reactions to these new, at first only envisioned, and later possibly enacted routines.

New routines are challenging for an established cluster. The examination of and experimentation with new routines should not be imagined as a simple decision taken at a specific time. Instead, the adoption and integration of new routines is a complex endeavor that takes time and comes with uncertain results (e.g. Edmondson et al. 2001). The challenge is integrating a new routine into a “well oiled” cluster that exploits the complementarities between its established routines by means of programmed coordination. Routines are complementary to each other when „they fit together well, i.e. take on values that they mutually increase their benefit in terms of whatever the objective function or the standard for evaluating the system may be, and/or mutually reduce their disadvantages or costs” (Schmidt and Spindler 2002, 318-319).

At this point, an important, unintended side-effect of programmed coordination comes into play: The more task interdependencies between routines of a cluster have already been resolved by programming in the past, the more complex it becomes to reprogram the established interfaces in the future without losing the complementarities already realized (see also McKelvey 1999). That is, there will be increasing benefits for the cluster as a whole to stay with the established interfaces. As a new routine has to be integrated into these interfaces, upon arrival, new routines will be examined in terms of complementarity (fit) and perturbations (misfit), respectively (and not just for their own sake).

In line with this argument, broader theorizing on complementarities suggests that they will have important consequences for the cluster’s development in terms of momentum and direction. Because complementary elements mutually increase each other’s attractiveness and returns, the whole system will develop a momentum of its own which is likely to amount to a trajectory that gives direction to the cluster’s evolution over time (David 1994). Along a similar line of reasoning, research on modular design (e.g. Ethiraj and Levinthal 2004, Ethiraj et al. 2008, Garud et al. 2003) has demonstrated that, while modularization comes with important benefits in terms of organizational efficiency and effectiveness, it also implies certain adaptive limitations (Ethiraj and Levinthal 2004).

All this suggests that when a routine cluster is challenged by internal or external developments, the benefits of adaptation concur with potential disadvantages and perturbations resulting from misfitting new routines. In so far as skillful, concerted behavior of the cluster depends on the mutual expectability of the behavior/outcomes of specialized routines, misfitting routines pose a potential threat to the behavioral integrity of the cluster. Therefore, misfit costs are likely to represent a crucial criterion guiding the evolution of a cluster.

In summary, the evolution and dynamic shaping of a cluster largely depends on previously developed patterns of differentiation and integration. As these patterns exploit complementarities between routines, they build the critical frame for accepting or rejecting new routines, thereby restricting the scope of viable adaptations and creating a trajectory for the future shaping of the cluster. Therefore, for the development of a cluster, history matters (David 1985).

This proposition stands in an exciting contrast to the findings of the research on single routines. We obtain a picture of two reverse dynamics unfolding on two different, yet related, levels. While the endogenous dynamics of single routines can be expected to produce ongoing *variation* in the patterns of action that constitute these routines, the dynamics that unfold on the level of a routine cluster are likely to amount to a *selection* mechanism for organizational practice. It is the main argument of this paper that the established interrelationships between the routines of a cluster will affect the adoption and implementation of new routines, thereby introducing an endogenous, history-dependent limit to organizational change and the scope of single routine dynamics respectively (see Table I).

******* insert Table I about here *******

In summing up our argument, the conceptual answers to our research questions are as follows: Routine interrelatedness results when a complex organizational task is divided and integrated by means of programming interfaces between routines. The overall task is then accomplished by two or more specialized routines rather than by one (complex) routine. To manage internal complexity, interrelated routines are grouped into clusters. These clusters are characterized by emerging patterns of differentiation and integration that exploit complementarities between routines and, over time, amount to a trajectory which guides the cluster's future shape when challenged to adapt to new developments. Changes will largely be guided by examining whether the new routine fits with the cluster of complementary routines or, instead, evokes misfit costs, possibly even rendering the benefits of the historically developed architecture void.

In order to further explore and illustrate how these dynamics work in practice, we decided to conduct a case study on interrelated routines.

Research Design

The complex and underexplored character of interrelationships among routines and the necessarily longitudinal perspective on cluster dynamics made a historical (embedded) case study design the first choice (Kieser 1994, Pettigrew et al. 2001, Yin 2009). This design has proven to be a suitable choice in a number of previous case studies focusing on unfolding (non-)adaptive dynamics in organizations. Most of these studies cover a time period of more than 10 years (e.g. Burgelman 2002 [11 years], Danneels 2010 [21 years], Hall 1984 [20 years], Koch 2008 [8 years], Tripsas and Gavetti 2000 [18 years]). In sum, while being quite aware that using historical, retrospective data also comes with some drawbacks and limitations – which we will discuss at the end of the paper – there are also distinct advantages when studying the long term dynamics arising on the cluster level.

Research Site

Guided by our general study design, we looked for a suitable and informative case where the phenomena of interest are transparently observable (Pettigrew 1990). CEWE, the European market leader in photo-finishing, proved to be a good choice for our endeavor. It was a successful analog firm suddenly confronted with digital imaging. It is well known and well documented that digital imaging implied critical competence-destroying challenges (e.g. Benner and Tripsas 2012, Tripsas and Gavetti 2000). CEWE's history therefore provided the opportunity to observe the reactions of a well-established (analog) cluster when confronted with new digital routines.

Pursuing our theoretical framework, we first had to identify a suitable cluster within CEWE. As we were primarily interested in the dynamics of routine clusters, we first identified the major place where the company was first affected by the digital revolution. This proved to be the production department. As a board member put it, "At that time, CEWE was clearly a production company […] production clearly was the core and the heart of the company" (Interview SM2_1[1]).

While CEWE operated a number of production facilities all over Europe, it was the main plant where all the new digital devices were first tried during the 1990s. It served as a field of experimentation for the CTO who was the driving force behind many innovations. As he pointed out in one interview, "There I could see what works. And what works in our main plant should also work in our other production facilities. So, I always had a nice playground there that enabled me to learn where the true problems come from" (Interview SM4_1). The main plant, where during the peak of the analog era nearly 800 people worked in shifts, consisted of different lines/clusters, grouped along the different product types (b/w films, dia positive, etc.). The core line, however, was the production cluster for 35mm photofinishing. 35mm orders were responsible for over 80 percent of CEWE's total revenue in the late 1980s (Annual Report 1990), and the respective cluster excelled in productivity.

The 35mm production cluster turned out to be an excellent choice for observing a system of interrelated routines and their development. The developments at CEWE during the digital revolution enabled us to study the reactions to a broad scope of technological innovations, ranging from incremental innovations (new printing machines, new cutters, etc.) to radical changes (digital printing).

Data Collection

The data were collected over 16 months by the first author from May 2012 to August 2013. The study focuses on the period most relevant to the upcoming digital revolution (late 1980s – late 1990s). As already mentioned, the specifics of our longitudinal research design suggested the collection of retrospective data. After checking the archival data available at the firm, its fragmentary character made it quite obvious that we would have to collect our data primarily through retrospective interviews. These data were complemented with archival documents and direct observations.

We conducted in total 64 open-ended interviews with former and present members of CEWE's operational and strategic management as well as operative staff (30 min – 3 hours; see Appendix I for an exhaustive list). All were audio taped and transcribed. In the first phase, people from all parts of the organization were interviewed in order to reconstruct the case history and identify the most relevant routine cluster – i.e. the cluster that was first "hit" by the new digital initiatives. After the cluster was identified, subsequent interviews pursued primarily two objectives: (1) to reconstruct the cluster of routines, as it was at the beginning of our observation period (late 1980s) as well as (2) the reconstruction of the reactions to technological innovations. For reconstructing and comparing the reactions in greater detail, we selected four innovation events.

These interviews were not conducted in terms of classical interviewing, such as narrative interviews (Jovchelovitch and Bauer 2000). The specific reconstructive task required a more interactive setting. We asked our interview partners about the specifics of each routine, interrupted them to ask for more details and, in subsequent interviews, presented reconstructive figures asking them for confirmation etc. Eventually, the reconstruction turned out to be a joint effort.

Due to its fragmentary character, archival material only served for crosschecking and complementing data from interviews where that was possible at all. The available documents were very general in nature and did not specifically report on routines and changes. Interestingly enough, no written rules or routine manuals had been created. The company was in fact quite proud of not being as highly formalized as is usually the case for larger manufacturing corporations. The main archival documents were reports on the company's development since 1986, brochures of products such as the PhotoCD, folders for new employees describing the core processes, digital files describing some of the first digital workflows, press articles about important events in CEWE's history as well as infomercials produced over the decades by the company itself. While this material did not describe routines, it helped us in making refinements, crosschecking our understanding, and determining event sequences.

Direct observations during company tours guided by production managers at CEWE's main plant enabled us to acquire a more vivid understanding of the focused setting and its technology. While it was obviously not possible to directly observe the old routine cluster, the observations nevertheless helped in getting a better feeling for this production task, the sequencing of routines, and the typical details of routines in this unit. This was specifically the case for the analog routines of Sorting, Splicing and Film Development, which did not change significantly after the digital revolution. Also, some machinery of the analog Printing & Paper Development (e.g. machinery for paper development) as well as the Pricing & Shipping routines (e.g. machinery for transporting and sorting) was still in use.

Data Analysis

Analysis was guided by our theoretical framework. As suggested by Graebner et al. (2012), we used our qualitative data to illustrate and further refine our propositions derived from theory. We proceeded in four steps:

(1) In order to lay the foundation, we first identified the central routines of the cluster. Together with our interviewees, we reconstructed the programmed task to be accomplished by each routine as well as the typical

challenges in performing them. Drawing on our framework, we differentiated between three parts of the program: the triggering information, the steps in executing the program, and the expected output (see Table II). We thus split routines into parts rather than treating them as entities (see also Salvato and Rerup 2011). This proved particularly helpful in our next step.

(2) In the second step of our analysis, we looked for the interrelations among the routines in terms of programmed interfaces. We quickly found that our core routines were not just related to the preceding and subsequent routines, but were also coupled to other routines. Taken together, the interrelated routines amounted to what we call a cluster.

(3) The third step was to explore the nature of the cluster in terms of complementarities and common purpose. Our analysis showed that efforts focused on making the production more cost-efficient, faster, and of higher quality. This was giving the cluster a specific "character" (Birnholtz et al. 2007) in terms of its aggregate behavior. By implication, we differentiated between 3 distinct levels in our description of the routine cluster: (a) the cluster as a whole having a specifiable character in terms of aggregate behavior and constituted by (b) single routines that are (c) structurally coupled by programs in order to accomplish the given organizational task in a coordinated fashion. The results of the first three steps of our analysis are summarized in Table II.

(4) In the fourth step of our analysis, we focused on the cluster's evolution over time. We used the critical incident technique (CIT) as a guide to perform this part of the analysis. CIT is generally used to identify and analyze critical features in the relation between problem context, behavioral strategy, and outcome (Flanagan 1954, Chell 2004, Kain 2004). In our study, we specifically focused on understanding if and how the established cluster of routines influences the acceptance and integration efforts regarding different types of innovation. In executing this step, we first of all developed a list of innovation events in the period between 1980 and 2000 (see Appendix 2). While preparing this list, we were not specifically aiming at covering the cluster's full innovation history. Instead, we used purposeful sampling (Patton 2002) to find different types of innovations. We focused on the difference between incremental and radical innovations, as this difference is deemed to be critical for the question of acceptance or rejection of innovations (e.g. Tushman and Anderson 1986). We chose one representative innovation for each type. To analyze and better understand the related integration efforts, we used data on the relevant technology, the motivations to choose this technology, the derived new routines, the required changes of the established interfaces between the other routines of the cluster, as well as general performance outcomes.

We explored how new routines were drafted and which factors were considered most during this development process. Then, we investigated how these at first only envisioned routines were being enacted. Finally, in terms of consequences, we were interested in understanding the reactions of operators and management and how they were related to the acceptance or rejection of the new routines.

The Case of CEWE

During the first years of the German "Wirtschaftswunder," photography became an increasingly popular hobby for the masses. Color photography had become more affordable, and the use of black and white film declined. Concurrently, the task of photofinishing was becoming more complex. In contrast to the processing of black and white photographs, color photographs could not be developed easily in the backroom of photo shops. As a consequence, specialized photo laboratories were opened, accepting orders from photo shops lacking the equipment or the competencies needed for high quality color photofinishing.

One of these photo laboratories was CEWE. Founded in 1961 in West Germany with a capacity of 6,000 – 10,000 color prints per day, it rapidly grew from the very beginning. And in 1965, with the construction of its first industrial photofinishing site, CEWE had already become one of the five biggest laboratories in Germany. The expanding size allowed for the design of highly specialized routines. A number of production routines were differentiated, and considerable benefits from learning effects could be earned. Responding to the steady growth of the photofinishing market, CEWE decided to pursue a cost-leadership strategy (low prices at steady quality) which turned out to be very successful and pushed for further growth. In 1976, the continued technological and organizational advancement of its production system enabled the company to introduce the one day lab service allowing speed, next to price and quality, to become the third cornerstone of its competitive strategy. In the following years, CEWE, further speeding up its production processes, introduced an overnight service and expanded its production and sales facilities internationally. At the time of its IPO in 1993, the company already operated in 12 European countries, had a sales volume of over € 200 million, and printed 1.5 billion analog photos per year.

During its history, CEWE adapted its production system more than once, always aiming to benefit more from specialization and the continually advancing technology. Over time, the system of production routines became more and more attuned to one another – a 'well-oiled machine.' Eventually, CEWE became cost-leader, first in Germany, then in the European market for analog photofinishing.

In the 1990s, at the peak of CEWE's amazing success in analog photofinishing, a new era of imaging was looming on the horizon; the digital revolution had begun. This revolution, however, began silently and unobtrusively. Very early realizing the potential and danger of this new technology, CEWE's CTO was one of the few who was alerted and early on initiated experiments with digital photofinishing in his company. Even though CEWE's operational management was used to and even proud of constant innovation, digital photofinishing amounted to a hurdle. By the end of 1997, after years of intense experimentation, top management capitulated and stopped the adoption of digital imaging in the main plant. As we know by now, this could have easily been the end of CEWE. All firms that stuck with analog photofinishing and were hoping for an analog future disappeared from the market.

In this special case, however, top management decided to found a new digital subsidiary: CEWE Digital. Separate from analog personnel, the established operations and the analog plant, CEWE Digital was given the opportunity to develop new competencies for digital photofinishing. After some years of experimentation, this new venture turned out to be a huge success. Today, CEWE is a full-blown digital company; the former analog core has shrunk to a marginal specialties department at the main plant.

The most striking question from our point of view is that, given the long tradition of ongoing innovation and adaptation at CEWE's main plant, why was it not possible to integrate the routines for digital photofinishing? We try to answer this question by using our theoretical framework as outlined above, aiming to illustrate and substantiate our argument.

<u>Organizing the Complex Task of Industrial Photofinishing</u>

As a first step, we will contextualize and describe our unit of analysis – the cluster for 35mm photofinishing at CEWE's main plant – as it was in the late 1980's, just before the digital revolution.

At CEWE's main plant, in the course of continuous growth and advanced division of labor, a number of production routines were developed. Each was responsible for the accomplishment of a part of the overall task: industrial photofinishing. In the late 1980s, shortly before the advent of the digital revolution, the production facility was differentiated into several production lines for different film types (e.g. b/w, slide film, etc.). We decided to analyze the line for processing 35mm photographic film in detail. It was considered the most important one as 35mm orders covered more than 80 percent of the company's total revenue in the late 1980s (Annual Report 1990). Generally, this line – or in our terms: this cluster of routines – was perceived to represent the core of the company. It operated at a high speed and cost efficiency while reliably fulfilling high quality standards. We will now proceed with our analysis by reconstructing this cluster as it was in the late 1980s in terms of (1) its routines, (2) its interrelationships and (3) the thereby realized complementarities.

(1) Routines

At CEWE's main plant, the industrial photofinishing of 35mm film was divided into a series of 7 subtasks. Our historical reconstruction of these tasks yielded that each of them was enacted as an organizational routine in its own right. In line with our theoretical arguments, we considered two routines as distinct in so far as a complete iteration of one routine could be completed without information about the current state of performances in the other.

The Film Development routine can serve as an example. We will first describe its program and subsequently how it was enacted. The program prescribed the sub-task of film development as follows: Film Development starts upon the arrival of a trolley. Coming from Splicing, this trolley contains expectable specifics: A light-tight cassette of no more than 100 orders spliced onto one roll, empty photo bags in color-coded boxes and a batch card. Some cues, representing the program's trigger, help operators to quickly recognize the relevant specifics of the batch (i.e. the orders to be processed within one complete performance of the routine). The easily visible color codes on the boxes enable prioritizing of time-critical orders. The information on the batch card enables the straightforward determination of the machine settings appropriate for the batch. After interpreting and identifying the incoming information, program execution starts. For Film Development, this generally means (1) to load the appropriate developing machine with the film roll, (2) develop the film, (3) notch the developed film, and finally (4) transport the processed material on a trolley to the Printing & Paper Development area. In executing these steps, the operators are expected to bring about a prescribed outcome. In this case, that means reliably providing properly developed films that have special notches on every negative image as well as producing this output at a certain speed while keeping film losses at an absolute minimum.

From the perspective of the film development team, these performance objectives (i.e. this program) had to be enacted in a given situation. This enactment was neither achieved passively nor "mindlessly." Often, the actors performing this routine had to make small adjustments and improvise in order to keep the process reliable and results expectable for subsequent units. During Film Development, for example, the operators had to be specifically alert to the danger of film losses and actively had to monitor the chemical process for any unexpected disruptions. Operators were led by a floor manager who had to assign and reassign his/her team members to work stations, oversee program execution, and, in case of exceptions, re-prioritize incoming orders or make other adjustments. He/she generally had to assure that “[…] there are no congestions. That work flows easily. And when there are bottlenecks, to check if it’s critical or where bottlenecks absolutely have to be avoided” (Interview PR1_2). In sum, it was obvious that in order to successfully enact the routine, actors varied the task to cope with the contingencies of the situation at hand without, however, neglecting the result expected by subsequent routines.

(2) Interrelationships

We considered two routines to be related to each other, insofar as their respective performance objectives were prescribed (i.e. programmed) specifically in order to resolve task interdependencies between them. This can be demonstrated with the Splicing routine. By producing a specific result, this routine solved many problems for subsequent routines –also involving routines that were not immediate neighbors in terms of the workflow (see Table II). The proper task was to splice photographic films needing the same development process (e.g. in terms of chemicals) onto one roll. The size of the roll as prescribed in the program of the routine, however, did not have anything to do with the task of splicing itself. Rather, it was mainly the speed of the paper development machines (the main bottleneck of the cluster) which provided the rationale for defining the optimal size of one roll. Similarly, the stickers with order numbers applied to the photo bag and the film during Splicing did not fulfill any purpose for the task of splicing itself, but rather were necessary in order to reduce mix-ups during Cutting & Packaging. Finally, the same was true for the batch cards which had to be filled out during Splicing. They did not support the task of splicing – in fact, they made it more complicated – but rather provided easily recognizable triggering information for the actors performing the routines Film Development, Printing & Paper Development, and Cutting & Packaging.

The example of the Splicing routine illustrates how interfaces between routines were programmed with the whole cluster in mind. By taking a cluster-level perspective, many task interdependencies between the routines could be managed through specifying performance objectives for each routine (instead of relying on ad-hoc coordination). As a consequence of this program architecture, instead of being related just in terms of workflow, the routines were interrelated with almost all other routines of the cluster through a network of mutual anticipations. The programs had numerous “references” to the other routines of the cluster, and each routine presupposed certain aspects of other routines (in terms of results) in its own performances (see Table II).

As a result of programming interfaces, operative actions only had to be selectively reflective of each other. Instead of having to keep in mind each aspect of the overall task of industrial photofinishing and relying on ad-hoc coordination with hundreds of people to perform the overall task (35mm photofinishing), the actors could focus their attention on the complexities of enacting their respective program (e.g. Splicing), gaining ever more experience with this specific subtask.

(3) Complementarities

As outlined in our theoretical argument, complementarity is an important feature of the routines of a cluster in terms of common purpose and fit. The following part of our analysis illustrates which complementarities arose in the course of dividing tasks and programming interfaces against the backdrop of the constantly evolving analog market.

Our analysis showed that in the late 1980’s – shortly before the age of digital photofinishing dawned –, the cluster as a whole was streamlined towards three strategic goals: (1) cost leadership and (2) high speed in (3) reliably delivering a certain quality standard. The success of the whole company very much relied on the performance of this cluster which in turn very much relied on the working of the interfaces between its routines.

(1) Increasing cost effectiveness became ever more important as the industry matured. For the 35mm cluster, this meant, for example, (re-)designing the interfaces to reduce mix-up of the different parts of an order and enable automation in order to minimize the average unit cost by earning economies of scale. How much the related growth in volume has shaped CEWE’s history is indicated by two numbers: In 1965, the maximum capacity of the main plant was at around 70,000 photos per day. In the early 2000s, it reached its peak daily capacity of about 3,000,000 analog photos.

(2) Accelerating production processes was of strategic importance as well. In the analog era, customers were eager to quickly cast a first glance at their developed photos. Consequently, market shares were to be gained not only by producing at low cost (and low prices), but also with fast delivery times. Over the years, the standard decreased from over three days per order down to less than twelve hours for the overnight service that became

increasingly popular during the 1980s. Amongst other measures, this was achieved by programming interfaces specifically to resolve bottlenecks and enable prioritizing of time-critical orders.

(3) Photo quality was the third cornerstone of CEWE's market strategy. As CEWE was producing at an industrial scale, the primary challenge was to design the cluster in a way that assured reliable accomplishment of the quality standards expected by retail and customers respectively. This was done, for example, by programming interfaces in a way that enabled the automatic configuration of machinery and establishing quality checks at critical points in the workflow.

Overall this illustrates the critical role the programming of interfaces – that is, the specification of performance objectives for each routine in a way that takes into account task interdependencies with other routines – played for the collectively achieved results of the cluster. For reaching these three strategic goals, fine-tuning of all routines and their connections in the cluster was of paramount importance.

The results of this part of our analysis are summed up in Table II. There, we detail all seven routines and illustrate how the integration of efforts was achieved by means of programming (table headings in italics): For performing its *task*, each *routine* was expected to rely on a specific input as a *trigger*. Subsequently, when executing the *steps to program execution*, it was paramount to reliably produce an *expected output* which was a *partial result* of the overall task to be accomplished: the processing of 35mm photographic film. In managing task interdependencies between specialized routines, the programming of interfaces served as the basic *means of integration*. The interfaces were programmed in accordance with certain *specifications*. Each specification resolved particular task *interdependencies* between the focal routine and other routine(s), thereby referring to the *strategic goals* of becoming cheaper and faster while reliably producing high quality. As a result of this form of programmed coordination, our cluster of routines converged to a tightly integrated behavioral entity. Sometimes, the programs also referred to task interdependencies with routines in other clusters (e.g. clusters of the sales or accounting department). This indicated to us the linkages between clusters (which we do not discuss here). In sum, thus, the cluster formed a coordinated, quasi-autonomous whole with an identifiable "character" (Birnholtz et al. 2007) in terms of aggregate behavior.

******************insert Table II about here******************

Cluster Level Dynamics: The Advent of New Routines

After having reconstructed the cluster and having identified the complementarities realized by means of programming interfaces, we were interested in the cluster's developmental dynamics. This part of our analysis illustrates when and how the cluster adopted new routines during collectively enacted integration processes following change-inducing events. For this purpose, we identified in total 41 change-inducing events between 1980 and 2000 (see Appendix 2). In the following we will provide a detailed description of two critical innovation events as representative examples for how the cluster evolved dynamically in reaction to different types (incremental vs. radical) of innovation challenges.

Generally, our data illustrates that the cluster's reactions resulted neither solely from formal design activities nor were they realized in an instant. Instead, these changes were collectively enacted by various actors during implementation processes that took from several months (event 1) up to several years (event 2).

For each innovation event, we will first provide a short description of the change-inducing event (in our case new production technologies) and the implied new routine. Then we will describe how this new, at first only envisioned routine was received in terms of *anticipated* benefits and/or problems of misfit. Next, we looked at subsequent actions on the cluster level fostering actual integration or rejection. These were very much driven by *realized* benefits and/or misfits. The following analysis illustrates how these acceptances (or rejections) followed a historical and endogenous trajectory foreshadowed by the cluster's architecture which limited the cluster's change potential.

Critical Event 1: The Advent of the PhotoCD (incremental innovation)

The first genuinely digital production technology at CEWE was needed for producing the so-called PhotoCD in 1991 (essentially an invention by Kodak). The "Photo CD Transfer Service" (Product Folder, 1993) was a service for digitizing scans from photographic films and recording them on a CD. From a strategic point of view, this product was added to the existing portfolio in order to signal that CEWE already had the capabilities necessary to produce digital products.

The new technology arrived in the form of a new digital (Kodak) workstation. This technology called for the design of a completely new routine. Building on this workstation, the new routine would have to (1) scan (already fixed) negatives. These digital scans were then (2) to be burned to CD and (3) used to make an index print. As the workstation needed fixed film negatives as its input, this could have suggested a direct coupling with the Film

Development routine. At an expected average speed of about 10 orders per hour per workstation, however, the envisioned routine would have been far too slow for the speed of the already established cluster (e.g. Printing & Paper Development routine: ~ 500 orders per hour per workstation).

Operational management anticipated a serious misfit: A direct integration would threaten the overall production speed and thus the cost-effectiveness of the whole cluster; the low speed of this work station would have diminished the benefits of the well-coordinated system of routines dramatically. While the 35mm cluster as a whole processed around 8,000,000 orders per year at that time, only a tiny fraction of these orders was expected to arrive with an additional PhotoCD order. A full integration of the new routine therefore was discarded. Operational management didn't want to lose the decisive advantages of their well-oiled cluster.

Therefore, instead of adapting the cluster to the anticipated needs of the envisioned routine, the new routine had to be adapted to the needs of the cluster. They searched for a possibility which interfered much less with the well-integrated cluster of established routines. As depicted in Figure 1, largely separating it from the workflow was deemed a workable solution.

**************insert Figure 1 about here**************

From a cluster level perspective, the primary challenge was to program an interface which would feed the workstation at the heart of the PhotoCD routine with the necessary input, developed film, and then feed its output back into the workflow *without disrupting the cluster*. The only place in the cluster where developed film was an outcome directly accessible without having to interfere with the established workflow was right in-between the Cutting & Packaging and the Pricing & Shipping routine. At this place, the respective orders could easily be separated out, processed by the PhotoCD routine, and then fed back to the Pricing & Shipping routine (see Figure 1).

This placement of the PhotoCD routine ensured that none of the existing routines had to be adapted significantly in order to integrate the disruptive new digital routine into the general workflow. The only necessary adaptations were some reprogramming of the Sorting (adding a new sorting criterion) as well as of the Pricing and Shipping routine (adding a new price category).

For the standard program of the PhotoCD routine as suggested by technology (i.e. workstation) and task, however, this type of integration required significant (re-)design efforts. First, the outcome of Cutting & Packaging – the photo bag complete with cut film strips and photos of one order – had to be brought into a form processable by the workstation. Consequently, the first step in the new program was to (1) re-splice strips of developed film on a roll, then (2) scan the negatives, (3) burn the CD, and (4) print the index. Finally, to assure that the Pricing & Shipping routine could process the output of the PhotoCD routine, it was necessary to (5) re-cut the photographic film and then re-package everything into the photobag again.

This solution ensured that the PhotoCD only meant very little disruption for the standard work flow. By and large, the new routine was kept apart from the established operations. This was a feasible solution because only a small share of the customers asked for this new CD, the rest stayed with the standard order. The troublesome reprogramming of the interfaces illustrates how much the re-design efforts on the cluster-level were guided by the power of misfit costs that arose for the cluster as a whole (instead of being guided by dynamics that originate from practicing the new routine).

Critical Event 2: Digital Photofinishing (radical innovation)

In the mid-1990s, the first digital pocket cameras for the amateur market were introduced. Top management, quite aware that the new digital cameras had the potential to change the whole analog world, was motivated to adapt the cluster to the necessities of the new digital world. The transformation from analog to digital photofinishing, however, turned out to be huge for them. The technology at the core of this transformation was the IT necessary to convert digital orders and the digital printers necessary to print photos from digital data.

These technologies implied a new routine: Digital Printing & Paper Development. To print a digital photo, it would be necessary to (1) convert the digital order into a file format readable for the digital printers, (2) print the data on photographic paper and – as usual – (3) fix the still light-sensitive paper using chemical development processes.

From a cluster level perspective, however, the most important feature of the envisioned routine was that it would require a new form of input and produce a previously unknown type of output. The input for the envisioned routine would be quite different from photographic film. It was digital data. Also, the expectable output would have an unusual form. Digital orders came with no upper limit in terms of pictures per order and potential variations in picture size within one order. This, of course, was radically different from the usual analog orders consisting of 12, 24, or 36 single-sized pictures per order. Even more complications were to be expected from the fact that digital photos had a standard aspect ratio of 3:4 instead of the usual 2:3 of analog photos. The unusual form of the input as well as the output of these new envisioned routine rendered it incompatible with the established interfaces of the cluster. That is, none of the established routines was ready to either deliver the input for or receive the output of this routine.

Consequently, direct integration of the Digital Printing & Paper Development routine was expected to produce serious misfit problems with all other routines: The least problematic adaptation was expected to be the implementation of a new sorting category in the Sorting routine. The other anticipated adaptations, however, seemed far more challenging. First, there was simply no standardized output available which could provide the envisioned Digital Printing & Paper Development routine with the necessary new input – digital orders. The preceding routines Splicing and Film Development, which normally provided the analog Printing & Paper Development routine with its input, were, of course, rendered useless. It was unclear how the digital orders (in the form numerous and diverse data storage devices) coming from Sorting could be transformed into digital batches (i.e. systematized chunks of data to be processed during a full iteration of the Digital Printing & Paper Development routine). At the same time, problems were anticipated in terms of the output to be expected of a Digital Printing & Paper Development routine. The established Cutting & Packaging routine was by far not prepared to process the high variability to be expected from the digital routine. The Cutting & Packaging routine was designed in a way that heavily relied on single variety batches in terms of picture size and the 2:3 aspect ratio of the analog photo. The output to be expected from the Digital Printing & Paper Development routine, however, called for a Cutting & Packaging routine that could flexibly adapt to an ongoing stream of photos of different sizes and process the 3:4 aspect ratio of the digital photo. Furthermore, as the digital orders did not have any limitations in terms of order size, misfit costs were also to be expected for the Pricing & Shipping routine. There, most of the necessary sorting and transportation was done using a fully automatic transportation system. The vessels used to store the orders before transportation, however, were built for orders of a maximum size of about 70 pictures per order. Orders that were above this limit – a potential result of the envisioned new routine – would therefore lead to disruptions. Finally, the Quality Control routine would have to be recalibrated to digital photos as the established standards in terms of photo quality were set far too high to be accomplishable.

**************insert Figure 2 about here**************

In sum, adapting the established cluster to the needs of the new digital routines would have required many changes (see Figure 2) that were expected to jeopardize the high performance in terms of all three strategic goals achieved by the cluster's established pattern of integration and differentiation. The underlying reason was that the established interfaces were neither ready to provide such a routine with the necessary input, nor were they prepared to process the output to be expected. The even more complex changes necessary to integrate the envisioned Digital Printing & Paper Development routine seemed to bring about inacceptable disturbances of the well-oiled workflow and losses in terms of speed, unit costs, and quality. Consequently, when considering the operative incompatibilities from the cluster level perspective, in our case advocated mainly by the operations management of the main plant, anticipated misfit costs seemed far too high to allow for integration.

Despite this negative evaluation by operations management, the CTO, anticipating the upcoming digital revolution, further pushed for integration. Therefore, increased efforts to develop a more integrable solution were made in the following months. Soon it was clear, that next to the Digital Printing & Paper Development routine it would be necessary to design a completely new Digital Cutting & Packaging routine. This additional routine was needed to mitigate the most pressing integration problems and incompatibilities related to the unusual form of output the Digital Printing & Paper Development routine would produce.

Despite the efforts to develop a more integrable solution, the actual integration of these two routines for digital photofinishing resulted in realized misfits. The misfits arose in part because of the specific requirements of the interface connecting the Sorting with the Digital Printing & Paper Development routine. At this point in the workflow digital data had to be processed. For this, costly specialists had to be hired. The new Digital Cutting & Packaging routine was adding to these problems. At its interface with the Digital Printing & Paper Development it had to be able to cope with the highly unusual format of the new digital prints (4:3 instead of 3:2) as well as the high variability of order sizes (see above). This rendered the machinery available for the tasks of cutting and packaging useless. It had been constructed with the specificities of analog orders in mind (i.e. a limited number of pictures per order, single variety output in terms of picture size, different aspect ratio). Therefore, a lot of manual – that is, slow and costly – work was necessary during Digital Cutting & Packaging. Put differently, the management of these interfaces could no longer profit from solutions already available – as was the case for example with the PhotoCD routine (see above). This further increased the realized costs of misfit. Finally, while performing these new routines for digital photofinishing was unusually challenging, the quality of the digital prints was still quite low. The main reason for this misfit-problem was the poor picture quality of the available digital amateur cameras. This led to even more resentments in the production department as nobody believed that a technology unable to produce quality prints could ever become a serious alternative to analog photofinishing. Accordingly, any investment of time or money into these new routines was considered wasteful.

Obviously, many of the problems related to the efforts of integrating these misfitting digital routines were not abstract or somehow used as an excuse by people generally opposed to innovation, or even “mindless.” The opposite was true. After long and mindful consideration by actors that had a long history of experience with innovation on the cluster level, the new routines from digital photofinishing appeared too disruptive a solution, specifically when taking into account the expectable losses relative to the basic strategic orientation – the “character” of the cluster – and the previous performance of the cluster as a whole.

From the perspective of the established cluster, therefore, rejection of these new, troubling routines made perfect sense. However, as top management was a powerful advocate of digital photofinishing, resistance did not take the form of an open rebellion. Instead, as the CTO of this time reports, the resistance against digital photofinishing was more subtle, “Yes, those are critical questions, and, to speak frankly, there was hidden glee when something went wrong. The thinking was pretty much: 'Didn't I tell you this isn't gonna work?' […] They were less concerned with trying to find solutions than describing the problems” (Interview SM4_2). In 1997, therefore, after continuous struggle, top management capitulated and stopped implementing digital imaging. Eventually, they came to the conclusion that integration of the new routines into the established cluster was not feasible. From a present day perspective, it is quite obvious that this capitulation could have been the end of the proud company CEWE. At least, this was the case with many other imaging firms who were not able to adopt the new digital technology (see e.g. Benner and Tripsas 2012).

Luckily for CEWE, however, top management was stubborn. They canceled integration, but they did not give up on digital photofinishing altogether. Instead, they founded a new, separate company for digital photofinishing in terms of corporate venturing. CEWE Digital was launched, “[...] completely free […] from the classical and old ideas and currents. [A company] that has complete freedom to attend to all things digital“ (Interview SM4_1). This spin-off, free from the demands of the established cluster, proved able to further develop a new digital cluster without considering existing routines and their functionality. At CEWE Digital, the new routines could prosper in a different architecture specifically designed to explore the potentials of this radical innovation. A member of the founding team of CEWE Digital summed it up for us, “We did it differently. Because it was something different” (Interview PR5_1).

Discussion: The Logic of Complementarities

The most obvious result of our empirical study is that the cluster showed different reactions to different types of innovation challenges (see also Benner and Tushman 2002, Benner and Tushman 2003, Henderson and Clark 1990). In case of an incremental innovation (event 1) the actors eventually succeeded in integrating the new routine. The program architecture of the cluster remained more or less unimpaired. This was different with the second event. There, the integration of radical new routines required a basic reorientation of the established cluster; the whole program architecture was called into question. As a result of the high misfit costs, the routines for digital photofinishing were rejected in the end.

The theoretical argument we have proposed in the first part of our paper helps understanding these powerful dynamics on the cluster level. The observed dynamics were primarily driven by a specific *logic of complementarities* which directs the selection of new routines by a cluster. If and how new routines are accepted and integrated very much depends on the resulting misfit costs for the cluster *as a whole*. Importantly, the misfit costs do not result from the technology per se, but instead from the costs (incl. the risk of ripple effects) of developing new routines and integrating them *into* the interfaces established by an integrating program architecture. The interfaces have been programmed specifically in order to realize complementarities in the analog era. Adapting them to the needs of new digital photofinishing routines would have meant destroying the fine-tuned network of fitting routines. In line with our theoretical argument, we showed how the rejection as well as the adoption of new routines was shaped by the active pursuit of keeping the cluster as a whole intact (i.e. avoiding misfit-costs).

In short, thus, the higher the misfit costs, the higher the probability that new routines are rejected. The misfit-costs amounted to a selection mechanism in organizational practice. One operational manager summed it up, “One is not generally opposed to new things. But when it comes to achieving one’s goals, namely to productively fulfill one’s tasks, keeping your discard rates under control, that above all, you never lose sight of quality and production deadlines. And when some process pops up that makes all of this considerably more difficult, then, especially for operational management, […] this becomes a nuisance" (Interview PR4_1). Throughout the integration processes, it was the anticipation as well as the recognition of such "nuisances" – or as we would say: misfit-costs – which implicitly build a trajectory defining the (long term) boundaries of adaptation for the cluster and its routines.

Our results are supplemented by the study of Edmondson et al (2001). While we are primarily concerned with explaining how the cluster dynamics establish an endogenous limit to organizational adaptiveness, Edmondson and her colleagues were mainly concerned with the question of how to best deal with the resulting problems for integration. They developed a normative process theory of how a new technology should be transformed into an integrable routine.

Theoretical Implications

Our argument brings to the fore the relevance of interrelations between routines. Our major conclusion holds that the dynamics of the routine cluster we observed were clearly distinct from the dynamics to be observed on the level of single routines. Building on this insight, we contribute to the literature in two ways: First, we argue that routine clusters have a specific morphology and highlight the differences between a single routine and a set of interrelated routines which have often been ignored in previous research. This morphology of interrelated routines forms the basis for our second contribution, the explanation of the dynamics of routine clusters. These limiting dynamics result from the binding forces of complementarities which in turn result from the (successful) programming of interfaces between specialized routines. In the following, these contributions shall be discussed in more detail.

The Morphology of Interrelated Routines

The attempt to comprehensively describe a set of interrelated routines confronted us with some highly relevant, but previously ignored conceptual questions. The answers we have developed are of importance for empirical research on organizational routines because so far most studies do not distinguish between a single routine and multiple, interrelated routines. Following our argument, this might be a mistake and could even lead to biased results.

When conducting empirical research on routines, how can we know if the actions we observe are part of a single routine or actually constitute a set of interrelated routines? Reflecting on our research and that of others, we find that a suitable solution to this problem is to define *one* organizational routine as “a repetitive, recognizable pattern of interdependent actions, involving multiple actors” (Feldman and Pentland 2003, 96) that strives to accomplish a “day-to-day operational task” (Rerup and Feldman 2011, 584) and emerges as actions become reflective of each other (Pentland et al. 2012). Actions are reflective of each other if the occurrence of one action changes the probability distribution of the occurrence of the others *within the same iteration of the routine*. Thus, during that iteration, “as each action is taken it is more or less likely that other specific actions will follow” (Pentland et al. 2012, 1490). This implies ad-hoc coordination of actions and therefore, within one routine, we would expect to see the exchange and processing of real-time information between the performing actors. Conversely, if there is no exchange and processing of real-time information between two performing actors, they do not contribute to the same routine. Thus, we can empirically distinguish multiple specialized routines from a single routine by asking whether the actions we refer to a) strive to contribute to the same operational task and b) are reflective of each other.

The relations between actions within one routine also differ significantly from the relations between multiple routines. Actions within one routine are directly relate to each other as they are reflective of each other (see above). Routines, however, are related in a much more indirect manner: they anticipate each other in their respective performances. That is, one routine performs *as if* the other routine would be performed in a certain way (without checking in real-time). Building on theories about programmed coordination and modularity in organization design (March and Simon 1958, Simon 1962, Luhmann 1995, Garud et al. 2003), we argue that such relations between routines will be formed mostly by the programming of interfaces. Programming interfaces refers us to the *normative prescription of what can legitimately be expected of a complete performance of a routine by others* – what we call the routine’s “results.” Importantly, by “results” we do not just refer to material outputs, but also to other features such as timing, and reliability. The defining aspect of a programmed interface is that certain aspects of the coupled routines’ performances are mutually and legitimately expectable. In this way, task interdependencies can be accounted for without having to rely exclusively on ad-hoc coordination of actions.

Finally, *actions on the cluster level (i.e. programming interfaces) are not constitutive parts of the routines they address*. Following our definition of one routine, claiming otherwise would imply that programming is based on real-time information about what is happening right at the moment of programming in the addressed routine(s). Instead, in organizational practice, performance objectives are typically (re-)defined based on some kind of observational data regarding a possibly great number of *past* iterations of *multiple* routines and some hypothesis on the causal structure behind this data. While being mindful of how the addressed routines generally work and how they might influence each other, such programming is *not* reflective of the actions *currently* taken within these routines.

The importance of the conceptual distinction between the actions that constitute a routine and the actions on the cluster level that address this routine must not be underestimated. These two types of action will strive to accomplish different – possibly even conflicting – goals (ongoing accomplishment of a day-to-day operational task vs. resolving interdependencies between multiple tasks) and take into account different time horizons (short term vs. longer term).

<u>The Dynamics of Routine Clusters</u>

The significance of the morphological differences between a single routine and a routine cluster are emphasized by the surprising finding that the dynamics of clusters seem to evolve on a different time frame and go in the opposite direction from the dynamics of single routines.

Observing the dynamics of routine clusters requires a prolonged "observation interval" (Zaheer et al. 1999). Our empirical analysis focuses on a decade and its changes in several routines. We would not have come to the same conclusions, had we conducted a, for instance, 6 month participant observation of interactions within a single routine of the same cluster. The dynamics of routine clusters evolve over years rather than within months and between rather than within routines.

The cluster dynamics we observed also head in different directions than the dynamics of single routines. Owing to the interplay between the ostensive and the performative aspects, researchers have observed endogenously produced variability at the level of single routine performances (Feldman 2000, Feldman and Pentland 2003, Pentland et al. 2011). However, the same routine will often be part of a routine cluster and its overarching dynamics. In this respect, our analysis illustrates how the "character" (Birnholtz et al. 2007) of a cluster, being the result of a history of connecting routines by means of programming (and reprogramming) interfaces, guides the dynamics of routine clusters. As the dynamics on the cluster level will unfold over years rather than within months, actors within the organization – while producing them through their everyday actions – might not be aware of them to their full extent. On the other hand, when trying to change the cluster, these same actors will immediately experience the practical implications of these dynamics. The enacted interfaces, programmed to solve problems of integration prevalent in the past, represent an important part of the reference base for present actions on the cluster level. Put differently, the "logic of complementarities" resulting from the pattern of differentiation and integration unfolding on the cluster level will amount to a selection mechanism when confronted with new routines. *Fitting solutions are preferred to misfits*.

Self-reinforcing Processes and Path Dependence

Theoretical arguments from economic and institutional theory (David 1994, Milgrom and Roberts 1995, Schmidt and Spindler 2002) suggest that complementarities between the routines of a cluster can trigger self-reinforcing dynamics. While our data does not allow for illustrating this point in detail, it seems plausible that the developmental logic of complementarities in our case is also driven by self-reinforcement. Task interdependencies between routines are managed by programming interfaces, amounting to an overall program architecture. As a result, the different routines fit – that is, complement – each other. This creates advantages in terms of aggregate behavior and integrated results (in our case in terms of unit cost, speed, and quality). The more these complementarities are reflected in the way the programmed interfaces couple routines, the more benefits can be earned (positive feedback). This, in turn, motivates the earning of further benefits. As a result, the couplings between the routines of a cluster become ever more specific – reinforcing the standards of fit – until the cluster amounts to a 'well-oiled machine.' Organizational actors will be ever more motivated to focus their search efforts for innovations in areas that are complementary to the established cluster and let implementation efforts be guided by the standards of fit.

These self-reinforcing dynamics of complementarities are therefore likely to bring about a trajectory over time. Or, as Paul David (1994) put it, "Historical precedent [...] can become important in the shaping of the whole institutional cluster, simply because each new component that is added must be adapted to interlock with elements of the pre-existing structure" (p. 215). In other words, under a regime of self-reinforcing dynamics, systems are likely to become path dependent and may eventually suffer from a lock-in (David 1985, Schmidt and Spindler 2002, Sydow et al. 2009). By implication, the dynamics of a routine cluster do not favor radically new variations and changes. Instead, the reverse seems to be true: It narrows the scope. There will still be some leeway for cluster development, but only along the emerging path or trajectory.

Dynamics on the Cluster Level and Technological Discontinuities

The general phenomenon we focus on here is also accounted for by theoretical and empirical studies on technological discontinuities (e.g. Anderson and Tushman 1990, Suárez and Utterback 1995, Utterback and Acee 2005). However, the 'logic of complementarities' explanation put forward in this paper explains a different, previously unexplored aspect of this complex, multi-level phenomenon.

In their classical paper on technological discontinuities and dominant designs, Anderson and Tushman (1990) aim at explaining the effects technological change has on whole industries. They focus on technological breakthroughs and the subsequent era of fermenting which culminates in the emergence of a (new) dominant design *of a technology* (e.g. AC vs. DC power generation systems). In essence, they therefore point to overarching industrial dynamics specifically referring to dynamics that arise *between organizations*. In contrast, our research focused on hurdles to adopting new technologies in terms of new routines on the cluster level, focusing on dynamics *between routines*. In sum, while our case study also addresses a technological discontinuity, we explain a different aspect of this multi-level phenomenon.

Dynamics on the Cluster Level and Competency Traps

Another related conception is the competency trap (e.g. Levitt and March 1988) which, like ours, addresses internal dynamics and organizational hurdles in adopting innovations and new routines. The argument builds on the general insight that the utility of an alternative (e.g. a routine) does not just depend on the alternative itself, but also on the competence in practicing it. As this competence is itself a variable largely explained through the accumulation of experience, "a competency trap can occur when favorable performance with an inferior procedure leads an organization to accumulate more experience with it" (Levitt and March 1988, 322). In other words, an organizational member or an organization stays with the established experiences, the accumulated competence, and its benefits (decreasing cost through learning effect) and refrains from changing to new processes. The switching costs are perceived as being too high. This explanation of organizational conservatism focuses on different dynamics as compared to our approach. Our explanation is focused on the dynamic consequences of knowledge accumulated *between routines* in terms of a pattern of differentiation. That is, our primary explanans is the programming of interfaces between routines reflecting complementarities *between routines*. In contrast, the primary explanans of the competency trap argument is accumulation of experience *within a routine*. While both are located within an organization, the focused dynamics are clearly distinguishable and explain different aspects of a multi-level phenomenon.

Limitations and further research

We have illustrated our theoretical arguments with a longitudinal historical case study. Our research design choices as well as the specificities of the data accessible to us come with certain limitations that must not go unmentioned:

While collecting retrospective data has important strengths when studying the long term dynamics of routine clusters, it also has several weaknesses and limitations. We primarily rely on retrospective interview data as a source to develop descriptions of routine programs and integration processes. As is well known, this type of data can be biased due to "hindsight bias" (Fischhoff 2012), cognitive limitations (Nisbett and Ross 1980), and social desirability (Huber and Power 1985). Additionally, it is generally very difficult to determine cause and effect from retrospective data because of rationalization tendencies (Leonard-Barton 1990) or misattribution of insignificant events as causes (Huber and Power 1985).

We tried to counterbalance these weaknesses by several measures. To acquire a more comprehensive picture of the change processes and core routines, we conducted interviews across all hierarchical levels, with different functional roles as well as with present and former staff of CEWE (see Appendix 1). Thus, we gathered multiple perspectives on each of the focused routines as well as on each of the analyzed integration events and relevant environments. This increased the chance to offset individual biases. We also tried to counteract possible memory lacks by conducting one extended group interview (194 minutes) specifically concerned with the description of the core routines where interviewees (current and retired members of operational management) could actively complement each other's memories.

Our empirical research was not inductive but clearly theory-guided. We aimed at demonstrating the viability of our theoretical argument using original empirical data. While this does not remedy the shortcomings of retrospective data, it reduces their significance for our research endeavor.

The data available to us was hardly sensitive to the performative dimension of our routines. We couldn't retrieve non-reactive performance data for the core routines CEWE's main plant in the relevant time period. While such measures (e.g. data on failure rates) did exist, the company does not archive them systematically for more than a few years into the past. We tried to counterbalance this weakness by specifically asking our interviewees about daily challenges and problems in accomplishing the prescriptively defined (sub-)tasks (and how this was related to other subtasks). It is these *systematic* exceptions that refer to the problems of *routine* interdependence.

Apart from the limitations of our specific design choices and the data available to us, some limitations derive from the specific case we selected and our analytical focus. These limitations also point to four general directions for further research on routine interrelatedness and cluster level dynamics:

(1) Although our case example can be taken as a typical example of a cluster of interrelated routines, in other clusters the density of structural relations between routines might vary considerably with potentially significant influence on the cluster's dynamics. Two important avenues for further research can be derived from this: First, it would be important to specify where, when, and why routines tend to become more or less interrelated. Generic arguments would suggest that, for example, the distance to the organization's core (Thompson 1967) as well as the age of the cluster (March et al. 2000) could make a systematic difference. Second, it would be important to learn more about the different implications when accounting for various densities of structural relations between routines (i.e. how many routines are coordinated with the same interface). Again, generic arguments suggest that this could have significant implications for the respective dynamics of routines and clusters of routines (e.g. Weick 1976).

(2) Also, we only consider relations between routines within one cluster and focus on the adaptive implications for this cluster. Of course, there will also be relations between clusters. It would be a promising avenue for future research to explore how routine clusters are related to each other (Galunic and Weeks 2005). Which kind of governance guides these interrelationships? And what are the implications in terms of dynamics for routines, clusters, and organizations?

(3) Our study is primarily concerned with the dynamics emerging on the cluster level. In future studies, it would be important to shed light on how the endogenous dynamics of single routines affect and are affected by routine interdependence. This also hints at the question of whether single routine dynamics affect the outcomes and practice of creating coordination mechanisms (Jarzabkowski et al. 2012) meant to couple *other* routines – or as we would say: a routine for programming interfaces between routines (see also Adler et al. 1999).

(4) Finally, it would be important to elaborate on the situations of lock-in and path dependence in organizations. Combined with established general research designs for path dependence analysis (Sydow et al. 2009, Sydow et al. 2012), a cluster level perspective encourages empirical research on the conditions of rendering interrelations

between routines path dependent. And while the general assumption can be made that complementarities between routines will stabilize the cluster, we should realize that this is a dynamic stability based on task interdependence and programming rather than a static stability based on assumptions of mindlessness or endogenous rigidity. Also, discussing path dependence implies thoughts on breaking an organizational or cluster path. Our case provides some insight into path breaking as well: Top management was not able to break the developmental path of the analog cluster from inside, but from outside. They created a new environment for the digital routines (venture) allowing for developments beyond the beaten tracks of analog routines and their interrelations. It seems worthwhile to further explore this avenue of breaking cluster stability.

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[1] All quotations from data are the authors' translations from German to English.

Figure 1: Buffering the PhotoCD routine

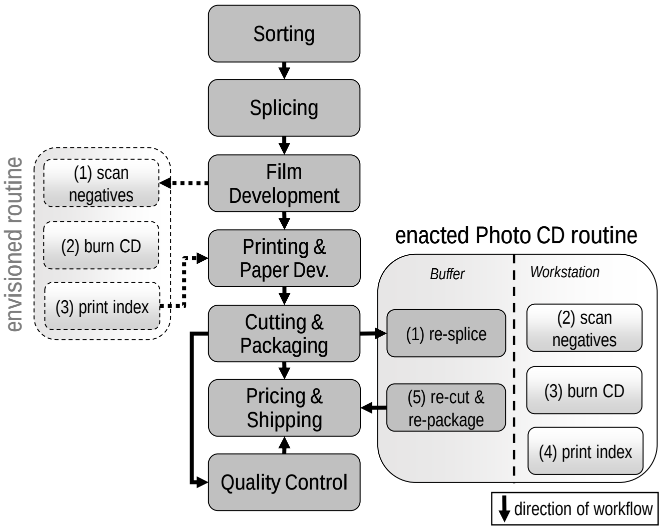

Figure 2: Rejecting Digital Printing & Paper Development

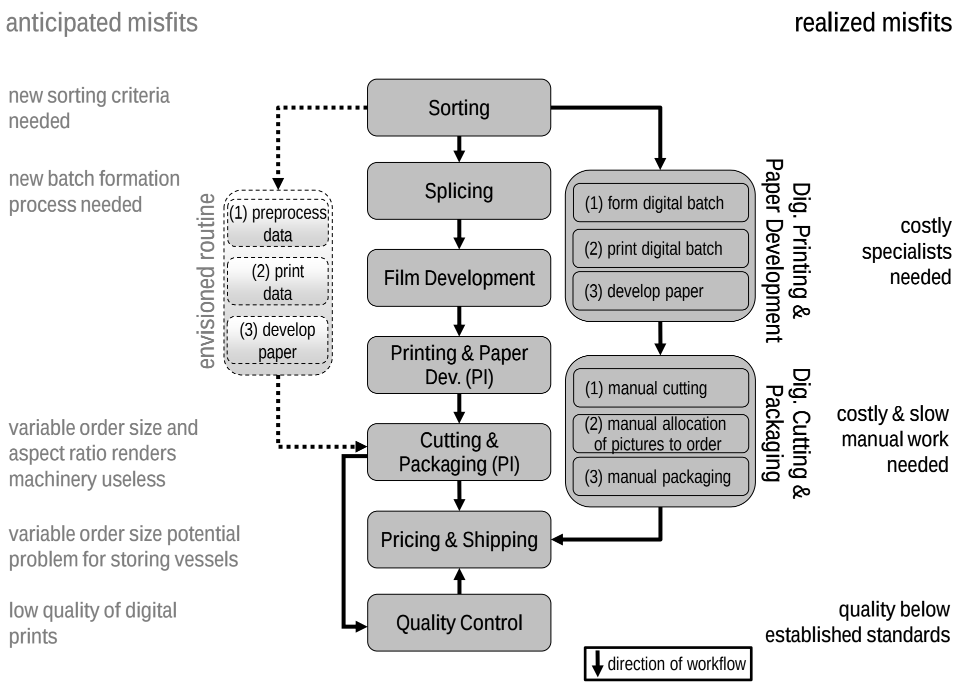

Table I: Single routine vs. routine cluster

	Single Routine	Routine Cluster
Unit of analysis	An organizational routine is a "repetitive, recognizable pattern of interdependent actions, involving multiple actors" (Feldman and Pentland 2003, 96) that emerges as actions become reflective of each other (Pentland et al. 2012) and is oriented towards the accomplishment of a "day-to-day operational task" (Rerup and Feldman 2011, 584).	A cluster is a system of complementary routines, each contributing a partial result to the accomplishment of a common task.
Dynamics	The dynamics of a single routine will be characterized by continuous variation of action patterns over time as they are primarily driven by reflective action (Feldman 2000, Pentland et al. 2011, Pentland et al. 2012)	The dynamics of a routine cluster are restricting as past solutions to problems of differentiation and integration become important for the utility and acceptance of an adaptive move in the present.

Table II: Interrelated routines

N°	Routine	Task	Program part	Means of Integration	Specifications	Interdependencies with (Routine N°)	Strategic Goals
1	Sorting	sorting of incoming orders in a way that provides the production routines with input material for only one product type	trigger	arrival of photo bags	special layout of photo bag enables easy and fast recognition of order information	environment (sales dpt.)	/
			steps to program execution	1.) new orders in photo bags are transported to sorting area 2.) multi-phase sorting according to expected output criteria 3.) boxes with single variety orders are transported to splicing area		/	
			expected output (partial result 1)	boxes with single variety orders	color codes on boxes enable easy recognition of time-critical orders	2	speed
				standards for failure rate	sorting failures below defined threshold	2, 7	productivity
				sorting criteria	sorting criteria are defined depending on product differences minimizing change-over times for machines used in other routines	3, 4, 5	speed
				output quantity	providing each product line with enough orders to work efficiently and without interruption	2, 3, 4, 5	speed
2	Splicing	splicing of photographic films that need the same development process on one roll	trigger (partial result 1)	arrival of boxes	color codes on boxes enable easy recognition of time-critical orders	1	speed
				film cartridges	codes on film cartridge enable control for purity of variety in boxes delivered by Sorting routine	1	productivity
			steps to program execution	1.) inserting films into splicer 2.) applying sticker with order number to photo bag 3.) splicing all films in one box on one roll 4.) filling out batch card 5.) checking film roll for physical integrity with "checker" 6.) transporting trolley (with film roll, batch card, and photo bags) to film development area		/	
			expected output (partial result 2)	trolley with processed material for one batch	flow of material (necessary input for following routine)	3	speed
					size of batch adapted to capacity of the following routines	3, 4, 5	productivity
					film ruptures below defined threshold	3, 7	quality
				batch card	specific order information on batch card enables operators of other routines to determine next steps	3, 4, 5	speed
				order numbers on each photo bag	order number facilitates control for mix-up at Cutting & Packaging and IT-supported pricing and shipping	5, 6	productivity
				order numbers on each film	order number facilitates control for mix-up at Cutting & Packaging	5	productivity

Table II (ctd): Interrelated routines

N°	Routine	Task	Program part	Means of Integration	Specifications	Interdependencies with (Routine N°)	Strategic Goals
3	Film Development	multi-phase chemical development process for photographic film	trigger (partial result 2)	arrival of trolley	prioritizing of time-critical orders enabled through easily visible color codes on transport boxes	1	speed
				batch card	information on batch card enables determination of appropriate machine settings	2	speed
			steps in program execution	1.) mounting cartridge with film roll onto appropriate film development machine 2.) developing photographic film 3.) notching of developed film with film notcher 4.) transporting notched film roll (incl. batch card & photo bags) to printing area		/	
			expected output (partial result 3)	trolley with processed material for one batch	flow of material (necessary input for following routine)	4	speed
					limiting failed development processes to an absolute minimum	7	quality
				notches on film	special notch provides machines at Printing & Paper Development and Cutting & Packaging with readable marks on every negative image	4, 5	productivity & quality
4	Printing & Paper Development	printing and fixing negative image on photographic paper	trigger (partial result 3)	arrival of trolley	prioritizing of time-critical orders using information on colored card	1	speed
				batch card	information on batch card enables determination of appropriate machine settings	2	speed
				notches on film	Printer uses notches on film roll for self-configuration	3	productivity & quality
			steps in program execution	1.) (re-)configuring and equipping printer with paper roll 2.) mounting notched film roll onto appropriately configured and equipped printer 3.) printing negatives on paper roll 4.) transporting printed paper roll to Paper Development 5.) equipping Paper Development machine and mounting printed paper roll 6.) developing paper roll 7.) quality control of developed photos 8.) feedback for recalibration of printer 9.) transporting developed paper roll (incl. batch card, film roll, and photo bags) to cutting area		/	
			expected output (partial result 4)	trolley with processed material for one batch	flow of material (necessary input for following routine)	5	speed
				marked pictures	pictures of insufficient quality are marked	5, 7	quality
				order numbers on back of every photo	helps operators at Cutting & Packaging with clearly visible visual signs to control for mix-up	5	speed & quality
				cutting marks on every photo	during printing, paper is perforated with marks that provide cutter with information about where to cut	5	productivity & quality

Table II (ctd): Interrelated routines

N°	Routine	Task	Program part	Means of Integration	Specifications	Interdependencies with (Routine N°)	Strategic Goals
5	Cutting & Packaging	cutting of rolls of developed photographic film and developed photographic paper & packaging of cut photos and film into photo bag	trigger (partial result 4)	arrival of trolley	prioritizing of time-critical orders using information on colored card	1	speed
				batch card	information on batch card enables determination of appropriate machine settings	2	speed
				notches on film	cutter uses notches on film for self-configuration	3	productivity & quality
				cutting marks on photo	cutter uses marks on paper for self-configuration	4	productivity & quality
				order numbers on back of every photo	checking for mix-ups of film, photo, and photo bag using order numbers printed on photo, film, and photo bag ("*Tri-Check*")	4	productivity & quality
				order numbers on photo bag	checking for mix-ups of film, photo, and photo bag using order numbers printed on photo, film, and photo bag ("*Tri-Check*")	2	productivity & quality
				order numbers on film	checking for mix-ups of film, photo, and photo bag using order numbers printed on photo, film, and photo bag ("*Tri-Check*")	2	productivity & quality
				marked pictures	pictures of insufficient quality are removed	4	quality
			steps in program execution	1.) mounting paper and film roll onto appropriately equipped cutter 2.) cutting of paper and film roll 3.) applying paper strips to cut pieces of photographic film 4.) packaging cut film and photos into photo bag 5.) putting boxes with completed orders on transport system to Pricing & Shipping area		/	
			expected output (partial result 5)	boxes with completed orders	flow of material (necessary input for following routine)	6	speed
				paper strips	paper strips are applied in order to make follow-up orders more convenient	environment (sales dpt.)	/
6	Pricing & Shipping	pricing and sorting of finished orders according to shipment areas	trigger (partial result 5)	arrival of boxes	identification of order enabled through order number	2	productivity
			steps in program execution	1.) identifying customer 2.) pricing of finished orders using pricing information for specific customer 3.) sorting of orders according to customers in pre-specified shipping regions		/	
			expected output (result)	bags with all finished orders of one customer sorted for shipping regions	shipping regions specified in reference to the existing logistical network	environment (logistics dpt.)	/
				bills in each bag	pricing with final prices for end consumer	environment (sales dpt.)	/

Table II (ctd): Interrelated routines

<table>
<tr><th>N°</th><th>Routine</th><th>Task</th><th>Program part</th><th>Means of Integration</th><th>Specifications</th><th>Interdependencies with (Routine N°)</th><th>Strategic Goals</th></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Quality Control</td><td rowspan="5">systematic quality controls according to certain quality criteria</td><td>trigger
(partial result 5)</td><td>boxes with completed orders</td><td>flow of material (provision with necessary input from Cutting & Packaging routine)</td><td>5</td><td>speed</td></tr>
<tr><td>steps in program execution</td><td colspan="2">1.) taking pre-specified portion of finished orders from Cutting & Packaging and transporting to Quality Control area
2.) checking photos regarding specific quality criteria
3.) checking film regarding specific quality criteria
4.) checking for mix-ups of photos, film, or photo bags
5.) transporting checked orders to Pricing & Shipping area
6.) providing responsible division with feedback on output quality</td><td colspan="2">/</td></tr>
<tr><td rowspan="3">expected output</td><td>boxes with checked orders</td><td>flow of material (necessary input for following routine)</td><td>6</td><td>speed</td></tr>
<tr><td rowspan="2">feedback to other routines</td><td>feedback to other routines includes specific information about type and assumed origin of quality problem</td><td>1, 2, 3, 4, 5</td><td>quality</td></tr>
<tr><td>controlling processes indirectly to efficiently detect quality issues regarded as problematic for customers</td><td>environment (customers)</td><td>/</td></tr>
</table>