

Paper title: Unlocking seeds in path-dependence processes

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Unlocking seeds in path-dependence processes

Abstract

A large amount of organizational activity – that goes under the label of performance programs (March and Simon, 1993: 163) consists of routinized activities that are performed without any significant problem-solving effort. In this paper, the analysis is restricted to the programmed activity, more precisely to the dynamics by which programmed activity emerges. These dynamics are also identified by Nelson and Winter (1982: 104) as *routinization*. On the one hand, it is important to understand what makes these processes path-dependent. For this purpose, the main reference is the theoretical framework proposed by Sydow, Schreyögg and Koch (2009) to define organizational path-dependence and the paper reviews the empirical data produced by the experimental literature on organizational routines.

On the other hand, it is also important to analyze and understand those conditions that may trigger some unlocking processes, by generating self-reinforcing dynamics that contrast and eventually overwhelm the original path. By analyzing the evidence produced by experimental data, this paper identifies some sources of unlocking behavior that allow organizations to depart from path-dependent routinization.

Introduction.

A large amount of organizational activity – that goes under the label of performance programs (March and Simon, 1993: 163) - consists of routinized activities that are performed without any significant problem-solving effort. In this paper, the analysis is restricted to the programmed activity, more precisely to the dynamics by which programmed activity emerges. These dynamics are also identified by Nelson and Winter (1982: 104) as *routinization*. On the one hand, it is important to understand what makes these processes path-dependent. For this purpose, the main reference is the theoretical framework proposed by Sydow, Schreyögg and Koch (2009) to define organizational path-dependence and the paper reviews the empirical data produced by the experimental literature on organizational routines. On the other hand, it is also important to analyze and understand those conditions that may trigger some unlocking processes, by generating self-reinforcing dynamics that contrast and eventually overwhelm the original path. By analyzing the evidence produced by experimental data, this paper identifies some sources of unlocking behavior that allow organizations to depart from path-dependent routinization.

Sydow, Schreyögg and Koch (2009) structure the organizational path-dependence dynamics in three stages (preformation phase, formation phase and the lock-in phase) and, following Arthur (1989), they identify four major sources of path-dependence within organizational contexts: Learning effect, coordination effect, adaptive expectation effects, and complementary effect.

All these effects act as self-reinforcing mechanisms that progressively lock organizations in their initial choices, generating strong history-dependence and context-dependence, since each of these mechanisms exerts its own effect on specific problems and situations that organizations deal with in the every-day life. As a final result, initial accidental experience (small accidents) eventually affects the subsequent dynamics, and ultimately the future path of the organizational life.

Besides these mechanisms, the literature identified also other sources of path-dependence, such as for instance power, legitimacy and conformity (Beyer 2010).

Despite the cumulative effect of multiple sources of path-dependence, some organizations exhibit strong ability to unlock themselves from their expected destiny, and thus suggesting, “path-dependent development is susceptible to fundamental change, the end of a path being within the realms of possibility” (Beyer 2010: 6).

Literature on organizational routines (Feldman 2000; Feldman and Pentland 2003) already discussed and theorized the apparent oxymoron, i.e. the tension between stability and change,

which intrinsically characterizes the meaning of this concept (Feldman and Rafaeli 2002). This paper further elaborates on this matter, and explores under which conditions organizations can unlock existing and self-reinforcing paths. For this purpose, the analysis and the discussion are based on empirical evidence obtained in a experimental setting specifically developed by Cohen and Bacdayan (1994) to study organizational routines. Following Cohen and Bacdayan (1994: 554) routines are qualified as organizational when routines a) involve more than one individual (multi-actor) and they can be regarded as b) interlocking sequences that c) can be reciprocally triggered. A micro analysis of experimental data shows how organizational routines emerge, and how organizational behavior departs from routines. This paper findings show that organizations have the possibility to break out of routines when interruptions interfere the predictable execution of quasi-automatic sequence of actions. A various repertoire of routine interruptions are identified and analyzed in order to understand what makes the interruptions able to interfere with the routinization, and if interruptions may become a source of a novel lock-in. The consequences of theses findings are discussed with respect to the concept of organizational capabilities and, more precisely, with the possibility to intentionally develop dynamic capabilities.

1. Organizational routines and path-dependence

Being interested in organizational processes that are strongly affected by path-dependent dynamics, the concept of organizational routines as “*regular and predictable behavior*” (Nelson and Winter 1982:15) comprises very well all these elements. The concept is introduced here in a very broad sense, “to include the relatively constant dispositions and strategic heuristics that shape the approach of a firm to the nonroutine problem it faces”. Routines are the result of a process of organizational evolution, by which problem-solving activity (*problemistic search*) turns into repeated patterns of actions triggered by stimuli. The four mechanisms of path-dependence (i.e. learning, coordination, expectation adaptation and complementarity) are also drivers of routinization.

In fact, during the process by which organizational routines emerge (*routinization*) organizations evolve trying to deal with a very specific situation or problem: they create artifacts (e.g. individual and organizational memories, roles, languages, tools) and an operative environment (i.e. contexts, beliefs, coordinated actions) that are situated and therefore history-dependent. On the one hand, the routinization is the result of a problem-

specific learning effort. On the other hand, the higher is the marginal investment that has to be done by a bounded-rational organization to explore any further alternative solution, the more the organization is locked-in the existing solution, even in spite of its sub-optimality.

One clear example of lock-in due to a routinization is what Levitt and March (1988:322) call competency traps: successful routines (it can be either actions or choices) tend to be proposed even when they are not adequate to deal with the current situation. The cumulated experience with a specific routine can be so strong that an inferior routine may perform better than a superior untested solution. Therefore, the strength of a learning effect can be so high to restrain the organizations from adopting novel alternatives.

In general terms, organizational routinization produces path-dependence to the extent it requires the acquisition and the development of idiosyncratic resources and capabilities that are differentiated (i.e. context-dependent).

2. The Experimental research of organizational routinization and path-dependence

There is a long tradition of experimental research that analyzes how problem-solvers can be locked-in one solution and are not able to move back to the search phase. Luchins (1942) outlined an experimental setting where the task is to solve a volume-measuring problem; his main result, also known as *Einstellung effect*, is that the solution initially discovered and successfully implemented is later adopted to solve new volume-measuring problems for which more efficient alternatives are accessible and feasible.

Cohen and Bacdayan (1994) developed an experimental setting to study organizational routines and the process of routinization. To solve the task (i.e. TTT - a card game), pairs of individuals need to coordinate their activity in a consistent way, since various alternative solutions are usually available.

The particular trait of the stream of research based on this laboratory experimental design is to provide rich and controlled data to observe and to analyze organizational behavior, without asking the subjects to elicit what they are thinking, as it is done by the thinking aloud approach (Ericsson and Simon 1993). Since one of the main features of organizational routines is the tacit dimension of knowledge they incorporate, the possibility to analyze the routines, without asking the subject any question, is very much appropriate.

In Cohen and Bacdayan's experimental design, the object of study is the simplest possible form of organization that still preserves some fundamental traits: pairs of individuals who are required to coordinate their interdependent actions in order to accomplish a task. In the base

line version of the experiment no communication takes place among the individuals, but they can see and remember their partner actions. This task is a problem solving activity: playing a card game. During the experiments the pairs of subjects are given a sequence of problems to solve. The way the cards are dealt in the board defines the initial conditions of each problem. By controlling the initial conditions, the experimenters control the type of problems assigned to the subjects, since not all the problems can be solved in the same way (i.e. through the same sequence of actions). In general terms, the problems are not all the same: the sequence and the minimum number of actions required to accomplish the task (i.e. the final goal is to move the Two Hearts into the Target position in the board) differ from problem to problem, likewise the initial endowment of resources (cards) given to each individual, and the set of information that is initially shared by the subjects. In other words, problem after problems these tiny organizations learn how to perform tasks that are not exactly identical. The payoff is negatively correlated to the number of actions that the organization undertakes to solve all the sequence of problems. Moreover, the same payoff is given to each member of the pair, regardless her role and individual performance; therefore, organizational members have strong incentive to collaborate in order to increase the final reward. In their paper, Cohen and Bacdayan (1994) studied how pairs of subjects solve two series of 40 problems; doing so, they analyzed more than 12,000 actions, looking for patterns and measuring the time needed to decide each action. Subjects are not allowed to communicate during the experiment. Cohen and Bacdayan's findings can be summarized as follows: i) organizations learn how to coordinate and to solve the problem through patterns of actions that progressively become recurrent; ii) organizational learning is mainly implicit, and it is persistent even though organizational members are not able to articulate and explain why they do what they do (procedural memory); iii) organizations adopts patterns of action even though they are suboptimal; iv) speed increases when patterns of actions are subsequently repeated. In other words, by observing how organizations learn how solve problems, and by showing that organizations solve the problems in a repetitive, semi-automatic way (i.e. routines), their experiment setting allows studying the routinization process.

By applying the same experimental design, Egidi and Narduzzo (1997) investigated the path-dependent nature of the routinization process that takes place when organizations play TTT. Each TTT problem can be solved in two fundamentally alternative pattern: subject A creates the conditions that allow subject B to accomplish the task, or, viceversa, subject B sets the conditions, and subject A completes the task (Egidi 1996). A distinct division of labor between subject A and B characterizes each of the two alternative patterns. Organizations are

able to solve problems when their members coordinate with each other, and choose to apply the same pattern. If they do not coordinate with each other, they can hardly solve the problem as they move the cards without progressing towards the end of the game. The analysis of the theoretical problem space shows that some problems can be efficiently solved only through the first pattern, others are efficiently solved by means of the second pattern and, finally a third group of problems is indifferent, in the sense that the two patterns were equally efficient (Egidi 1996).

Based on this analysis, Egidi and Narduzzo (1997) created two new sequences of problems that differ from each other in the following way: the first 15 problems of each of the two sequences were filled by problems that can be efficiently solved only one pattern that is the same for the all sequence (and different from the other sequence). The subsequent 27 problems include all the three types of problems: those that are efficiently solved through one pattern, those that can be efficiently solved through the other pattern, and those that can be efficiently solved by applying any of the two patterns of actions.

These two decks define two experimental conditions; each pair of subjects undertakes only one experimental treatment, and the structure of the data analysis will be a comparison between groups with regard to their behavior in the last 27 problems that are identical for the two groups.

One first result of this study was to recreate and observe the *Einstellung effect*, even at the organizational level. In this experiment the initial learning process is path-dependent by design; later on, most of the organizations were not able to search a novel more efficient solution pattern; those who tried to explore another solution, exposed themselves to coordination failures. In this particular case, an important dimension of the learning effect is related to coordination and coordinated action. The solution patterns that organizations initially learn and routinely apply to solve the problems are essentially coordination routines. Most organizations are locked-in the coordination routine they learned and they apply it all the time, even when its sub-optimality becomes apparent. The third driver of path-dependence that is in play here is the adaptive expectation effect. Any attempt that organizational members do to search for alternative solution patterns decreased the possibility to anticipate in the right way the partner's actions, resulting in poor performance and frustration. So, the more organization performance depends on adaptive expectation, the lesser will be the temptation of departing from regular and predictable behavior.

Complementarity, the fourth path-dependent mechanisms outlined by Sydow, Schreyögg and Koch (2009), is certainly relevant in this experimental setting, since the role of the

organizational members, the actions that they can perform, and the adopted reward system are based on an idea of being complementary. Nonetheless, this dimension was not tested by any experimental treatment done with TTT, so we do not have evidence of the impact of complementarity on path-dependence.

3. Unlocking paths

To rephrase what the experimental evidence shows us about the path-dependent dynamics of organizational routinization we can take advantage of the formulation proposed by Feldman and Pentland (2003) that distinguish between the ostensive and the performative aspects of a routine. As soon as a coordinated action triggered by a particular situation results in a positive outcome, organizations tend to focus their attentions on that performance and the features of that particular situation, in a way that the repetition of similar conditions is expected and the past behavior is replicated. Routinization emerges as the cumulative effect of these two constitutive and mutual-reinforcing aspects that amplify the path dependence from the initial conditions.

Based on such representation, it is reasonable to wonder if and how it is possible to escape from lock-in conditions. A convincing answer can be found within the literature on organizational routines, as soon as the notion of routines is reconsidered and enriched by incorporating the agency role (Feldman 2000). Through this inclusion routines can legitimately and consistently regarded as a source of change.

In a complementary way, we wish to exploit the experimental setting provided by TTT to focus our attention on those situations of change that in principle may unlock the organizations from their predictable path. In other words, we are interested in situations where organizations perform actions that represent a discontinuity of the regular sequence of actions. As Cohen (2012:1384) pointed out, routines (as well as habits) are based on two fundamental psychological capacities: 1) procedural memory (or non-declarative memory), and 2) action-specialized perceptual capability.

Therefore, discontinuities in the context of this analysis can be referred to change in the action-specializes perceptual capability: something that was previously ignored is brought to our attention by the situation at hand. These changes can be traced back as interruptions in the regular flows of choices and action. Two main dimensions can be observed and assessed: first, the time that organizational members take to decide their next action, as soon as they realize

was the partner just made. Second, the analysis of break-down of sequences of actions. In this paper we focus on the latter.

4. Data and Methods

To study under which circumstances organizations can resist to the amplifying effect of path-dependence, resist to the implementation of existing routines and to unlock their path, we analyze the behavior of organizations (pairs of subjects) playing TTT.

Data were collected by replicating the Cohen and Bacdayan's original experiment. Subjects are University of Trento students who undertook the experiments; they received a monetary reward that is identical for each subject of a pair. Reward is negatively correlated to the number of actions that the organization performs to solve all the problems, and to the time spent to solve all the problems.

5. Findings.

Learning effect is neither smooth, nor monotonic

Problem #38 and #8 are equivalent (initial conditions and initial information available to the subjects in the two problems are identical), but some organizations that solved Problem #8 in with no mistakes, later on are not able to apply the same solution pattern. Despite the fact that organizations already successfully solved almost forty problems, what happens when dealing with Problem #38 is quite surprising. 32 organizations out of 40 solve Problem #38 in 24 different ways. This is a clear sign that organizations fail to easily apply in a semi automatic fashion the routine already experienced and retained. A more careful analysis of the organizational behavior shows that most of the organizations fail to decide what to do basing on the initial conditions of the problem, and they rather start to perform a sequence of actions that were previously successful, even though in a radically different problem. While most of the previous problems can be solved by a coordinated action performed by the two organizational members, one subject alone can solve Problem 38, as long as the other subject does not interfere. As mentioned, 32 organizations did not recognize the fact that P 38 is not exactly the same they were used to.

Break down created by missing differences among subsequent problems

Empirically, the following observations are based on comparison between the first action performed to solve two consecutive problems For instance, Problem #14 and Problem #15 seem to have similar (but not identical, in an important aspect) initial conditions, and one

third of the organizations (10 out of 32) try to apply the latter the same successful solution that they used to solve the former. The behavior of these organizations is consistent with the hypothesis that organizational member perception memory is highly selective and retains a limited number of information. This circumstance, on the one hand, exposes organizations to mistakes and extra costs due to inefficiencies; on the other hand, the same circumstance allows the organization to take the initiative and to depart from the existing routine and to subtract itself to the path-dependence produced by routinization. As a consequence of such surprising failure, organizations react by increasing the number and the type of information they look at in order to decide how to solve a problem and, in some cases, to explore new alternative solutions, the first step of any unlocking path.

Another clear example is the use of the action Pass, discussed also by Cohen and Bacdayan (1994). Eventually, almost all organizations learn to use this action to communicate the following message “I will be able to solve the problem, as soon as you set me the proper conditions”. On the other hand, in some problems, the same Pass action blocks any possible solution. Since the same action produces inconsistent results, organizations are pushed to questions their condition-action behavior and to search for alternative solutions.

Break down created by wrong expectations on the partner’s next move

Empirically, this findings are based on various sources of observations, besides the actual actions performed by the subjects, such as the position of the mouse that is ready to make a move, but that is suddenly moved somewhere else as soon as the partner reveals her move. We analyze in the Table 1 a sequence of Problems, where the move Pass makes impossible to solve the problem. As we see, even in this case we do not observer a monotonic learning process, since the number of useless Pass is higher in Problem #30 than in Problem #19 and #21.

Table 1. Action “I Pass” inhibits any problem solution

Action\Problem #	5	10	17	19	21	30
I set up	13	18	20	28	28	24
I pass	19	12	11	4	4	8

First, organizations may repeatedly incur in mistakes, since they try to adopt solutions that are not feasible. These findings show that experimental subjects do not learn in a stable way how to deal with such problems, and they insist in repeating the same mistake.

Please, focus your attention to the Table 1, and in particular to the change that takes place between Problem 17 and 19. What happened in between these two Problems? What type of problem is # 18? Interestingly enough Problem #18 can be efficiently solved through the action Pass, but this case Pass should be performed by the other subject. Interestingly enough, even in Problem #18 some organizational members do not pass, and because of this they block an easy solution of the problem. In other words, Problem #18 offers a unique, “educational” experience to witness the use of Pass action. This education effect of Pass is produced even if Pass action is not performed, as soon as the consequences of this choice become evident.

Table 2 shows the history of Pass actions performed by the 8 pairs of subjects where the wrong implementation of Pass. As it is clear by observing the use of Pass action made by the listed pair of subjects in the selected problems, learning process is not monotonic and stable, and it is possible that pairs are not able to replicate the proper pattern on actions already executed.

Table 2. Pass move performed in an inappropriate way

Pair ID\Problem #	5	10	17	19	21	30
I	P	P	P			P
II	P					P
III	P	P	P			P
IV	P	P	P	P	P	P
V	P	P	P			P
VI	P	P			P	P
VII	P	P	P	P	P	P
VIII		P				P

To solve Problem #30 the organizations need to coordinate their action, given the initial information set.

Break down created by coordination failure

Data also show what happens when one action performed by one organizational member creates ambiguity about the solution pattern that is going to be applied. In principle, it is possible that the same action a) allows the subject to prepare the conditions for the final conclusion, as well as, b) becomes a means to wait that the partner is going to complete. In such situations, the data shows that organizations get lost, since each organizational member starts to implement her own solution pattern.

In general, coordination failure, this case, is caused by inability to develop right expectations about partner's next move. Sometimes this is due to ambiguous set of information; some other times, the inability to develop right expectation depends on the inability to understand on which basis the partner decides her move: does she base her action on her endowment, or rather on the final goal that need to be reached?

In any case, the final result is that under these conditions organizations may derail from the repeated behavior and unlock novel paths.

Results

Experimental evidence suggests that while learning effect, coordination effect, adaptive expectation effect and complementary effect act as mechanisms of path-dependence, as proposed by Sydow, Schreyögg and Koch (2009), a) interruptions in the learning process, as well as b) break down of operational routines due to misperception of the situation at hand, c) to coordination failure, or d) to wrong estimation of partner adaptive expectations may create the conditions to departure from the path-dependent regular behavior and to unlock novel paths of experience.

Discussion

The experimental literature on organizational routines shows that emergence of routines indicates that organizational capabilities to solve problems and accomplish task are developed through a process of trial and error. As demonstrated by Cohen and Bacdayan (1994) such organizational capabilities are stored as procedural memory and their evidence is given by the patterns of actions that are executed to solve recurrent problems. Along this line of reasoning, organizational routines lead to stability and organizational capabilities are associated to fixed contexts.

As a further step, the same literature on organizational routines has conceived routines also as a source of change (Feldman 2000; Pentland and Feldman 2003; Feldman 2004) and flexibility that organizations may use in their adaptive response to new, different situations. In other words, this wider perspective entails not only the path-dependent dynamics that lead to routinization and to a locked-in system of organizational capabilities, but also the co-existing unlocking tensions that support adaptation and change. This paper identifies some of the sources of this unlocking tensions that lead to divert from the path. One significant contribution of this wider perspective is to reconcile the usual contraposition between

organizational capabilities and dynamic capabilities as if they are apart, characterized by intrinsically different nature, or belonging to two separate hierarchical systems (Teece, Pisano and Suen 1997; Eisenhardt Martin 2000; Winter 2003). This wider perspective provides a general evolutionary framework that encompasses both the stability of routinization and the adaptability of change. The prize to pay is to abandon the idea that routines are mindless, automatic responses to identical stimuli, and to acknowledge that agency is a fundamental part of the analysis that cannot be separated and detached by the routinized activity.

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