

The Process of Knowledge Transfer: A Diachronic Analysis of Stickiness

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Even though intrafirm transfers of knowledge are often laborious, time consuming, and difficult, current conceptions treat them as essentially costless and instantaneous. When acknowledged, difficulty is an anomaly in the way transfers are modeled rather than a characteristic feature of the transfer itself. One first step toward incorporating difficulty in the analysis of knowledge transfer is to recognize that a transfer is not an act, as typically modeled, but a process. This article offers a process model of knowledge transfer. The model identifies stages of transfer and factors that are expected to correlate with difficulty at different stages of the transfer. The general expectation is that factors that affect the opportunity to transfer are more likely to predict difficulty during the initiation phase, whereas factors that affect the execution of the transfer are more likely to predict difficulty during subsequent implementation phases. Measures of stickiness are developed for each stage of the transfer to explore the predictive power of different factors at different stages of the process. A cross-sectional analysis of primary data collected through a two-step survey of 122 transfers of organizational practices within eight firms illustrates the applicability of the model and suggests several issues for further research. © 2000 Academic Press

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Interest has increased in the phenomenon of organizational learning, on how organizations create, retain, and transfer knowledge (Argote, 1999; Huber, 1991). One of the most surprising lessons from this attention to knowledge and learning is that mere possession of potentially valuable knowledge somewhere within an organization does not necessarily mean that other parts of the organization benefit from that knowledge. Organizations do not necessarily know all that they know. To a large extent, this is because internal transfers of knowledge, rather than fluid, are often “sticky” or difficult to achieve (Szulanski, 1994; von Hippel, 1994).

Although knowledge transfers are often laborious, time consuming, and difficult, research remains anchored on a basic conception of them as costless and instantaneous (Shannon & Weaver, 1949). As a consequence, the difficulty experienced in the process of knowledge transfer has received little systematic attention. When acknowledged, difficulty is seen as an anomaly rather than as a characteristic feature of the transfer.

One possible way to incorporate difficulty into the analysis of knowledge transfer is to conceive of transfers not as acts, as typically modeled, but as processes. A process view allows a closer examination of how difficulty evolves over stages of the transfer. It can also provide insight into the working of different organizational arrangements to transfer knowledge, inform managerial interventions and help design organizational mechanisms that support knowledge transfer.

To this end, this article offers a diachronic¹ analysis of stickiness based on a model of the transfer process of organizational knowledge. The model identifies different stages of the transfer process and possible predictors of difficulty for each stage.

Stickiness

Memory is attention in past tense.

Daniel Goleman, cited in (Gilovich, 1991)

Knowledge transfer is seen as a process in which an organization recreates and maintains a complex, causally ambiguous set of routines in a new setting. Stickiness connotes difficulty experienced in that process (Szulanski, 1996; von Hippel, 1994).

In a difficult transfer, problems are likely to escalate. Whereas some of the transfer-related problems will be diagnosed easily and resolved routinely by those directly involved with the transfer, other problems may transcend the resourcefulness of the organizational actor(s) who are normally affected by and routinely resolve transfer-related problems. This more complex level of problem is likely to require response in the form of additional deliberation, recourse to nonstandard skills, allocation of supplemental resources, and escalation of

¹ The term “diachronic” is borrowed from linguistics to suggest contrasts between earlier and later moments of an activity. See Barley (1990) for a discussion of the nuances of the differences in the meaning of the terms “diachronic” and “longitudinal.”

transfer-related decisions to higher hierarchical levels for resolution. Actors whose attention would not have been normally required, such as senior managers or consultants, are likely to be involved in efforts to identify and resolve this more complex level of problem. These actors will become involved on an exceptional basis to expedite the identification of possible solutions and to enable and coordinate their implementation.

This more complex level of problem is likely to be noticed more broadly because it interrupts the assumed flow of the transfer (Zeigarnik, 1967). In other words, this kind of problem is more likely to exceed the base rate of eventfulness of a typical transfer and thus is more likely to be noticed against a background of otherwise ambiguous and inconsistent organizational reality. This kind of problem is more likely to create a distinct moment of difficulty in the transfer (Gilovich, 1991) and thus is more likely to contribute to the overall perception of difficulty and to the intensity of efforts exerted to resolve the problem (cf. March & Simon, 1958). The assessment of the degree of difficulty experienced in a transfer is likely to reflect the number and intensity of those distinct moments of difficulty. Other things equal, a transfer is more likely to be perceived as difficult or sticky when efforts to resolve transfer problems become noteworthy.

Predictors of Stickiness

The incidence of transfer problems can be predicted to some extent by analyzing properties of the transfer. A useful starting point to classify predictors of stickiness is the signaling metaphor (Shannon & Weaver, 1949), which informs most of the actual research in knowledge transfer. This metaphor specifies the basic elements of a transfer: source, channel, message, recipient, and context.

One way to relate stickiness to characteristics of these elements in a systematic manner is to conceive of the transfer as an effort to create a partial or exact replica of a complex and causally ambiguous (Lippman & Rumelt, 1982) practice, that is, as a replica of a web of relationships connecting specific productive resources. Transferring complex and causally ambiguous knowledge typically requires reconstruction and adaptation at the receiving end (Attewell, 1992; Kogut & Zander, 1992). Consequently, resolving problems that arise during such a transfer may involve frequent comparisons of the replica being created with the "template" or benchmark after which it is modeled (Nelson & Winter, 1982). These comparisons entail exchanges of information between the recipient and the source of knowledge.

The effectiveness of such exchanges depends to some extent on the strength of the tie between them (Hansen, 1999), which is reflected in the ease of communication and in the "intimacy" of the overall relationship between source and recipient. An arduous relationship might increase the effort needed to resolve transfer-related problems.

The eventfulness of the knowledge transfer is also likely to depend on the dispositions and abilities of the source and recipient. The motivation of the source may be affected by an incentive to compete or collaborate with the

recipient and by the effort required to support the transfer. Furthermore, the source may not be perceived as reliable. A capable and trustworthy source is more likely to influence the behavior of the recipient (Perloff, 1993, see Chapter 6 for a review; Zander & Kogut, 1995).

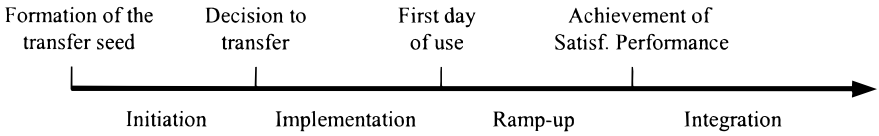
Likewise, the recipient may be more or less motivated to seek or accept knowledge from the outside. Lack of motivation may result in procrastination, passivity, feigned acceptance, sabotage, or outright rejection in the implementation and use of new knowledge (Hayes & Clark, 1985; Katz & Allen, 1982; Zaltman, Duncan, & Holbek, 1973). Recipients may also vary in their absorptive capacity—their ability to exploit outside sources of knowledge (Cohen & Levinthal, 1990, p. 128). Furthermore, to reap the rewards of a transfer, recipients must be able to discard old practices and sustain new ones. Evidence from studies of innovation (Rogers, 1983, p. 365), planned organizational change (Glaser, Abelson, & Garrison, 1983, pp. 221–251), and organizational learning (Argote, 1999) suggests that the challenge of abandoning old ways of doing things and of preserving new ones can be significant.

Finally, the organizational context where the transfer is embedded may affect the eventfulness of the transfer. Ultimately, the organizational context affects the willingness and ability of organizational subunits to complete transfer-related tasks. Its influence occurs through norm and value setting (Kostova, 1999), through fiat or incentives (Leonard-Barton & Deschamps, 1988), and through counsel and support (Attewell, 1992). An organizational context that facilitates the inception and development of transfers is frequently referred to as *fertile*. In contrast, a context that hinders the gestation and evolution of transfers is said to be *barren*. In a barren organizational context, transfer-related problems are more difficult to resolve.

Stickiness and the Stages of the Transfer Process

Current understanding of transfer processes suggests that there are four distinct stages in a transfer. A distinction is usually made between the initiation and the implementation of a transfer. Within the implementation phase, further distinctions are often made among (a) the initial implementation effort, (b) the ramp-up to satisfactory performance, and (c) subsequent follow-through and evaluation efforts to integrate the practice with other practices of the recipient. Initial implementation of a new practice and the subsequent ramp-up to satisfactory performance involve a two-step sequence of first “learning before doing” (Pisano, 1996)—either by planning (Argote, 1999) or by experimenting in a contrived setting before knowledge is actually put to use by the recipient—and then “learning by doing” which entails the resolution of unexpected problems that arise when new knowledge is put to use by the recipient (von Hippel & Tyre, 1995). Follow-through efforts typically aim at maintaining and improving the outcome of the transfer after satisfactory results are initially obtained. The resulting four-phase process is depicted in Fig. 1. Each of the four stages—initiation, implementation, ramp-up, and integration—can be difficult in its

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STAGE

FIG. 1. The process of knowledge transfer.

own way. The nature of difficulty at each stage and possible predictors are discussed in the next section.

The general expectation is that factors that affect the opportunity to transfer are more likely to predict difficulty during the initiation phase, whereas factors that affect the execution of the transfer are more likely to predict difficulty during subsequent implementation phases. In particular, the influence of the attributes of the source are expected to diminish as the transfer unfolds. The source's involvement and cooperation is most needed for the initiation and initial implementation of the transfer. However, once the recipient has obtained satisfactory results it needs progressively fewer interactions with the source. Conversely, attributes of the recipient are likely to become increasingly important as the transfer unfolds. Cool, Dierickx, and Szulanski (1997) found empirical support for this argument in the context of the diffusion of analog electronic switching within the Bell System. In the Bell System, easy access to the technology was found to impact the speed of diffusion before the adoption decision was made by the recipient but the traits of the recipient dominated once adoption had begun.

Initiation stickiness. Initiation stickiness is the difficulty in recognizing opportunities to transfer and in acting upon them. An opportunity to transfer exists as soon as the seed for that transfer is formed, i.e., as soon as a gap and knowledge to address the gap is found within the organization. The discovery of a gap may trigger problemistic search (Cyert & March, 1963) for suitable solutions. Alternatively, slack search (Cyert & March, 1963) may uncover superior practices, thus revealing a previously unsuspected gap or creating a new one (Glaser et al., 1983; Rogers, 1983; Zaltman et al., 1973).

The eventfulness of the initiation stage depends on how difficult it is to find an opportunity to transfer and to decide whether to pursue it. This becomes more demanding when existing operations are inadequately understood or when relevant and timely measures of performance as well as internal or external yardsticks are missing. Furthermore, the opportunity may need further scrutiny in order to understand why or how superior results are obtained by the source. The original rationale for a practice and its nuances are gradually reduced to taken-for-granted beliefs and entrenched habits. Yet, before the transfer can be undertaken, the practice may need to be documented, e.g., by

creating process maps or flowcharts, and its rationale reconstructed in order to select what needs to be transferred. The initiation of a transfer may consequently require substantial effort to delineate the scope of that transfer, select the timing, assess the costs and establish the mutual obligations of the participants (Ounjian & Carne, 1987, p. 198).

The search for opportunities and the decision to proceed with a transfer inevitably occurs under some degree of irreducible uncertainty or causal ambiguity. The source's mastery and ability to articulate a practice is often incomplete as is the recipient's ability to specify the environment where new knowledge will be applied. Measures of performance used to identify opportunities are often imprecise and subject to fluctuation. It becomes more difficult to assess the real merit of an opportunity and to act upon it. However, this uncertainty is reduced when there is evidence that the knowledge to be transferred has proven robust in other environments and that the source is reputable. When the source is not perceived as reliable, trustworthy, or knowledgeable, initiating a transfer from that source will be more difficult and its advice and example are likely to be challenged and resisted (Walton, 1975).

Implementation stickiness. Following the decision to transfer knowledge, attention shifts to the exchange of information and resources between the source and the recipient. Transfer-specific ties are established between members of the source and the recipient, and information and resource flows will typically increase and possibly peak at this stage. Efforts are made to preempt problems through careful planning (Pisano, 1996), especially to avoid the recurrence of problems experienced in previous transfers of the same knowledge and to help make the introduction of new knowledge less threatening to the recipient (Buttolph, 1992, p. 464; Rice & Rogers, 1980, pp. 508–509).

The eventfulness of the implementation stage depends on how challenging it is to bridge the communications gap between the source and the recipient and to fill the recipient's technical gap. Bridging the communications gap may require solving problems caused by incompatibilities of language, coding schemes, and cultural conventions. Closing the technical gap may disrupt the normal activities of both source and recipient. It may distract the source from its main mission (unless its mission is to support the transfer)—especially when supporting the transfer means generating additional documents, constructing dedicated equipment, lending or donating its own skilled personnel, or training the recipient's personnel. It may also temporarily disrupt the recipient's operations because existing personnel may have to be retrained or reassigned, new personnel may be hired and trained, infrastructure may have to be modified and upgraded, and consultants from the source unit or elsewhere may move temporarily to the recipient. Furthermore, when the recipient unit is large, transfer-related information may not reach all parts of the recipient, thus creating problems of coordination.

Further difficulty may also result from poor coordination between the source and the recipient, especially when the source or the recipient of knowledge deviates from agreed-upon responsibilities. The source or the recipient may do

more or less than it is expected from them, leading to situations where the recipient usurps roles of the source or where the source intrudes on the domain of the recipient (Leonard-Barton, 1990).

The true motivations of the source and the recipient are likely to be revealed at this stage. The recipient may increase difficulty by ignoring the source's recommendations out of misunderstanding, resentment, or to preserve pride of ownership and status (Rice & Rogers, 1980). The extent of difficulty can be mitigated through planning. However, the extent to which implementation activities can be planned depends on the depth of understanding of the practice, i.e., on causal ambiguity. Oversights during planning can be compensated through mutual adjustment. The effectiveness of planning, coordination, and mutual adjustments is likely to depend on the quality of the relationship between the source and the recipient.

Ramp-up stickiness. Once the recipient begins using acquired knowledge—e.g., starts up a new production facility, rolls over a new process, or cuts over to a new system—the main concern becomes identifying and resolving unexpected problems that keep the recipient from matching or exceeding a priori expectations of posttransfer performance. The ramp-up stage offers a relatively brief window of opportunity to rectify unexpected problems (Tyre & Orlikowski, 1994) where the recipient is likely to begin using new knowledge ineffectively (Adler, 1990; Baloff, 1970; Chew, Leonard-Barton, & Bohn, 1991; Galbraith, 1990) ramping-up gradually toward a satisfactory level of performance, often with external assistance.

The eventfulness of the ramp-up phase depends on the number and seriousness of unexpected problems and the effort required to solve them. Unexpected problems may surface because a new environment where the transferred knowledge is put to use reacts differently than expected, training of personnel turns out to be insufficient or incomplete, trained personnel leave the organization or prove unfit for new roles, or the new practices involve significant changes in the language system and in the shared norms and beliefs underlying the correct interpretation of work directives. Likewise, when the transition to the use of new knowledge is gradual rather than sharp, i.e., when a new practice coexists over time with the practice it was meant to replace, duplication of effort and resource contention is likely. Unexpected problems become more difficult to resolve the later they occur within the ramp-up stage because precarious versions of new practices may already have become habitualized and more difficult to modify. When new knowledge is put to use in broad scope, i.e., simultaneously rather than sequentially, the scope of incidence of unexpected problems will generally be broader.

Difficulty during the ramp-up stage is thus likely to correspond primarily to the degree of causal ambiguity of the practice. Unexpected problems are easier to resolve when cause–effect relationships for the new practice are understood and when it is possible to forecast and explain results. The absorptive capacity of the recipient, i.e., the ability to utilize new knowledge, depends on its existing stock of knowledge and skills. Thus the presence of relevant

expertise during the ramp-up stage, either from internal or external sources, is crucial to contain costs (Chew et al., 1991) and delays (Baloff, 1970).

Integration stickiness. Once satisfactory results are initially obtained, the use of new knowledge becomes gradually routinized. This progressive routinization is incipient in every recurring social pattern (Berger & Luckman, 1966, p. 53). Unless difficulty is encountered in the process, the new practices will blend with the objective, taken-for-granted reality of the organization (Berger & Luckman, 1966; Zucker, 1977). However, when difficulties are encountered, the new practices may be abandoned and, when feasible, reversal to the former status quo may occur.

The eventfulness of the integration phase depends on the effort required to remove obstacles and to deal with challenges to the routinization of the new practice. This involves maintaining a delicate and comprehensive truce in intraorganizational conflict (Nelson & Winter, 1982, p.110), i.e., a situation where members of the organization are "content to play their roles . . . [and where] . . . manifest conflict follows largely predictable paths and stays within predictable bounds." This truce may be disturbed by external events such as environmental changes, the arrival of new members, or the appearance of a clearly superior alternative (Goodman, Bazerman, & Conlon, 1980; Zaltman et al., 1973). Likewise, the truce may be disturbed by internal events such as individual lapses in performance, unmet expectations, unclear rationale for the practice, evidence of dysfunctional consequences of using new knowledge, or sudden change in the scale of activities. Each disturbance to the truce may compound difficulty because each time a contingency is resolved, the terms of the truce become more specific and likely to elicit some resistance.

Organizational subunits may differ in their ability to maintain routine operation. For example, they may differ in the quality of sensing mechanisms that detect incipient threats to the organizational truce and they may differ also in their ability to recalibrate situations once the threat is recognized (Goodman & Dean, 1982). The commitment of the recipient to specific practices will become evident during the institutionalization stage because each time the truce is disturbed the appropriateness of the new practice may be explicitly questioned and reevaluated requiring an affirmative "decision to continue." This decision may exact a social cost to the recipient (Berger & Luckman, 1966; Goodman & Dean, 1982, pp. 270–271; Nelson & Winter, 1982, p. 112; Tolbert, 1987). For example, preserving the use of new knowledge may require disciplining or removing disruptive individuals who do not accept the new power distribution or other organizational parameters of the new practice.

AN ILLUSTRATION: STICKY TRANSFERS OF BEST PRACTICE

One of the most prevalent and effective practical manifestations of organizational learning is the so-called transfer of knowledge and best practices within the firm (O'Dell, Grayson, & Essaides, 1998, p. 224). Upon discovering differences in the performance of similar units, firms multiply attempts to leverage existing knowledge through transfers of best practice.

Transfers of best practice are seen as dyadic exchanges of organizational knowledge between a source and a recipient unit in which the characteristics of the source and the recipient both matter. The expression *transfer of best practice inside the firm* connotes the replication of a superior internal practice within the organization that provides better results than any known alternatives. *Practice* refers to the organization's routine use of knowledge. The word "transfer" is used—instead of "diffusion"—to emphasize that the movement of knowledge within the organization is a distinct experience, not a gradual process of dissemination. The transfer of best practices provides a propitious setting to observe transfers of knowledge within organizations.

Sample and Research Process

Data were collected through a two-step questionnaire survey. The first step of the survey asked companies to provide a list of transfers for study which included sufficient detail about the parties involved in those transfers (i.e., respondents). More than 60 companies, with varying degrees of experience in the transfer of practices, expressed interest. Of that group, 12 were able to provide such a list. Of the 12, only 8 provided entries of sufficient quality to warrant continuation of their involvement in the research. The 8 companies were: AMP, AT&T Paradyne, British Petroleum, Burmah Castrol, Chevron Corporation, EDS, Kaiser Permanente, and Rank Xerox.

The second step of the survey was devised to analyze stickiness at specific transfers. The final sample consisted of 271 returned questionnaires, spanning 122 transfers of 38 practices,² for a response rate of 61%. To obtain a balanced perspective on each transfer, separate questionnaires were sent to the source, the recipient, and a third party to the transfer. The respondents were composed of 110 sources units, 101 recipient units, and 60 third parties. Average item nonresponse was lower than 5%. An average of 7.3 questionnaires were received for each practice studied.

To provide practices for study, companies were directed to search for transfers of important activities or processes that showed evidence of difficulty during the transfer and in the adaptation of the practice by the recipient.³ They were also instructed to rule out practices that could be performed by a single individual and to choose only practices that required the coordinated effort of many.

Construction of measures. The selection of items for the measures of stickiness—the dependent variables—is based on typical events expected at a particular stage of the transfer. These descriptors detect the incidence of *specific*

² The sample contained both technical and administrative practices. Examples of technical practices are software development procedures and drawing standards. Examples of administrative practices are upward appraisal and activity-based costing (ABC). Full disclosure of the practices studied is precluded by a guarantee of confidentiality.

³ In an effort to increase the variance in the dependent variable, this directive was necessary to counter the inclination of firms to report only successful transfers.

behaviors. The items for the predictors of stickiness—the independent variables—aim to capture *traits* of these basic elements of the transfer. The items constituting all constructs used in the study are described in Szulanski (1996).

Multiple-item scales were developed for all constructs to ensure the reliability and validity of the measurement system. Little empirical precedent was available to guide the development of the measures. A broad and thorough literature review informed the generation of the initial constructs and the a priori assignment of items to measure those constructs. In-depth clinical work, consultation with subject experts, and feedback obtained when piloting the questionnaire helped refine the choice of constructs, identify the most relevant items for those constructs, and select their proper wording given the empirical context. Some items were discarded, but not reassigned, after the full data set was obtained. The a priori assignment of items was preserved for all constructs.

For simplicity in scoring, a balanced and relatively straightforward 5-point Likert-type scale was used almost exclusively. Unless otherwise indicated, the scale used was: Y! = “Yes!”; y = “yes, but”; o = “no opinion”; n = “no, not really”; and N! = “No!” The construct scores were computed by adding the standardized item scores (Nunnally, 1978). Dependent variables were coded so that a larger numerical value represents a higher level of stickiness. Independent variables were coded so that a larger numerical value represents a higher barrier to transfer.

Table 1 summarizes the performance of the measurement model. Convergent validity (reliability and unidimensionality) was evaluated for each construct (Gerbing & Anderson, 1988). Cronbach’s alpha was used as a measure of reliability because it provides a lower bound for the reliability of a scale and is the most widely used measure (Nunnally, 1978). All but two scales had alpha greater than .70, thus providing an adequate level of reliability for predictor tests and hypothesized measures of a construct (Nunnally, 1978, pp. 245–246). The two least reliable scales scored marginally below that standard. The performance of the binary scales of both motivation measures is particularly noteworthy in that both scales qualify marginally for the Guttman criterion for scalability (McIver & Carmines, 1981). Unidimensionality was assessed through factor analysis and computation of the theta coefficient (Armor, 1974; Carmines & Zeller, 1979; Zeller & Carmines, 1980). The unidimensionality of all 10 scales was adequate.

Discriminant validity was evaluated for all construct pairs by examining the observed correlation matrix of the constructs. If the correlation between constructs i and j is 1, (i.e., if constructs i and j are perfectly correlated), the observed correlation should be $(\alpha_i^{0.5}) * (\alpha_j^{0.5})$ where α_i and α_j are the reliability coefficients for the constructs. In practical terms, testing for discriminant validity entails computing the upper limit for the confidence interval of the observed correlations and testing whether this limit is smaller than the maximum possible correlation between the scales as computed from their reliability coefficients. Table 2 reports the correlations for the independent variables. All construct pairs met the discriminant validity test at $p < .0012$.

In the design and administration of the questionnaire, several steps were

TABLE 1
Measurement Model

Construct	Description	Cronbach α	Items	Valid N	Average interitem correlation
Stickiness–Initiation	Difficulties experienced prior to the decision to transfer	.74	8	241	.27
Stickiness–Implementation	Difficulties experienced between the decision to transfer and start of actual use	.83	13	240	.28
Stickiness–Ramp-up	Unexpected problems from the start of actual use until satisfactory performance obtains	.77	9	236	.28
Stickiness–Integration	Difficulties experienced after satisfactory performance is achieved	.79	12	224	.25
Causal Ambiguity	Depth of knowledge	.86	8	250	.45
Unproven Knowledge	Degree of conjecture on the utility of the transferred knowledge	.67	3	251	.4
Source lacks Motivation ^a	Motivation of the source unit to support the transfer	.93	13	271	.5
Source not Perceived as Reliable	Degree to which the donor of the best practice is <i>perceived</i> as reliable	.64	8	210	.19
Recipient lacks Motivation ^a	Motivation of the recipient unit to support the transfer	.93	14	271	.48
Recipient lacks Absorptive Capacity	Ability of the recipient unit to identify, value and apply new knowledge	.83	9	252	.36
Recipient lacks Retentive Capacity	Ability of the recipient unit to support the routine use of new knowledge	.81	6	249	.43
Barren organizational Context	Degree to which the organizational context supports the development of transfers	.77	14	247	.2
Arduous Relationship	Ease of communication and intimacy of the relationship	.71	3	237	.46

^a These scales are composed of binary items. Both scales qualify marginally as Guttman scales.

TABLE 2
Correlations between the Independent and Control Variables^a

	1	2	3	4	5	6	7	8	9
1. Source lacks Motivation									
2. Source not Perceived as Reliable	.43								
3. Recipient lacks Motivation	.29	.37							
4. Recipient lacks Absorptive Capacity	.24	.43	.33						
5. Recipient lacks Retentive Capacity	.28	.44	.39	.51					
6. Causal Ambiguity	.40	.33	.36	.11	.16				
7. Unproven Knowledge	-.04	.25	.40	.08	.06	.36			
8. Barren Organizational Context	-.09	.19	.37	.17	.18	.19	.62		
9. Arduous Relationship	.18	.32	.43	.26	.35	.24	.16	.22	
10. Spontaneity	.11	.04	.11	.16	.19	.02	.08	.11	-.04

^a Pearson Product–Moment Correlation. Coefficients equal or larger than 0.16 are significant at $p < .05$.

taken to minimize measurement error (Nunnally, 1978). Formulated only after extensive fieldwork, the questionnaire was pretested with all the participating companies, with experienced academics, and with respondents who volunteered to record their reactions while completing it. Finally, the cognitive effort of the respondents was reduced by minimizing the number of scales to be learned and by translating generic terms like “source” or “recipient” into the specifics of a particular transfer.

Assumptions. Although there are no statistical tests to assess the validity of process models (Pentland, 1995), the behavior described by the model has been found to correspond to observed behavior at the level of abstraction described by the stages in terms of the expected temporal order of concerns (Szulanski, 1995, chapter 4). Statistical evidence of the distinctiveness of the four phases is provided by the discriminant validity tests for all six stickiness construct pairs.

Antecedent conditions are thought necessary but generally not sufficient for consequences to occur. However, the reversal of the sequence is considered highly unlikely. It is hard to imagine a practice being institutionalized before it has been implemented or being implemented before it has been identified.

Data were gathered to assess the validity of the model’s assumptions about sequence. The respondents were asked to specify the exact dates for each of the milestones of the transfer process. With few exceptions, the dates reported followed the progression one might expect from the specification of the process model. Further evidence for the sequence is provided by the motivation scales. These scales consist of binary items that identify specific events in an order derived from the process model. A test was conducted to see whether those scales qualify as Guttman scales, thereby providing empirical support for the validity of the assumptions about order of events. The scales for both source and recipient did qualify marginally as Guttman scales.

As a first approximation, predictors are assumed to remain invariant for the

duration of the transfer so that the timing of the measurement of the independent variables should not be critical. This assumption is deemed reasonable because most predictors typically change slowly. However, there may be exceptions such as the motivation of the source or the recipient and the nature of the relationship between the units that may be affected by the expected outcome of the transfer. Relationships between source and recipient subunits existed for at least 2 years prior to the beginning of the transfer.

Finally, in this study, all questionnaires were completed within a narrow band of 3.5 months, which started 5 months after the first day that knowledge was put to use by the recipient.⁴ Thus, all transfers in the study reached the institutionalization stage and were sampled at a defined and comparable point in time. Comparison across transfers is thus considered appropriate.

Analysis

The analysis purports to illustrate the relationships between predictors and stickiness at each stage. Several controls were included to account for unobserved heterogeneity. Spontaneity is a single-item variable that controls for whether the transfer was hierarchically imposed or spontaneous.

Results. Table 3 displays the findings from the regression analyses run separately on each measure of stickiness [Eqs. (1), (2), (3), and (4)]. The four equations have significant explanatory power ($\text{adj. } R^2 \geq .4$) for each of the process-based descriptors of internal stickiness.

Overall, the pattern of results is consistent with the general expectation that factors affecting the opportunity to transfer are more likely to predict difficulty during the initiation phase, whereas factors affecting the execution of the transfer are more likely to predict difficulty during implementation phases. Traits of the source unit such as *Motivation* and *Perceived Reliability* are significant in the first three stages of the transfer. Traits of the recipient unit, most notably *Absorptive Capacity*, become significant during implementation. *Causal Ambiguity* is significant at all stages of the transfer. *Causal Ambiguity* and the lack of recipient's *Absorptive Capacity* appear to be the most important predictors of stickiness.

Robustness of the results. Further analysis was conducted to confirm the stability of the coefficients. Missing data were handled in four different ways, with missing data deleted pairwise, using mean substitution method, replacing the missing indicators with the indicator's mean, once for independent variables only and again for both dependent and independent variables. Results remain stable also when company dummy variables are included in the four regression equations.

The results reported are based on an analysis in which each questionnaire

⁴ The average duration of the ramp-up process was 1.5 months with surprisingly little variation. Thus all transfers were sampled early on in the integration stage. Because the integration stage has been documented to last 1.5 to 2 years, a band of 3.5 months could be considered narrow.

TABLE 3
Regressions of internal stickiness for each stage

Variable	Standardized beta coefficients (<i>t</i> value)			
	Initiating (1)	Implementing (2)	Ramp-up (3)	Integrating (4)
Causal Ambiguity	0.20*** (2.74)	0.23*** (3.32)	0.24*** (3.39)	0.16** (2.50)
Unproven Knowledge	0.27*** (3.89)	0.11* (1.72)	−0.09 (−1.23)	−0.09 (−1.43)
Source lacks Motivation	0.07 (0.92)	0.17** (2.33)	0.16** (2.21)	0.06 (0.97)
Source not perceived as Reliable	0.27*** (3.59)	0.17** (2.25)	0.24*** (3.23)	−0.05 (−0.76)
Recipient lacks Motivation	0.10 (1.35)	−0.07 (−0.95)	−0.14** (−2.05)	0.19*** (3.07)
Recipient lacks Absorptive Capacity	0.11 (1.37)	0.47*** (5.87)	0.49*** (6.08)	0.45*** (6.07)
Recipient lacks Retentive Capacity	−0.01 (−0.10)	−0.03 (−0.46)	−0.43*** (−5.73)	0.01 (0.20)
Barren Organizational Context	−0.04 (−0.55)	−0.06 (−0.81)	0.21*** (2.86)	0.21*** (3.18)
Arduous Relationship	0.05 (0.70)	0.16** (2.38)	0.07 (1.12)	0.19*** (3.17)
Spontaneity	−0.16** (−2.53)	−0.10* (−1.71)	0.00 (0.06)	0.00 (0.03)
Residual (1)		0.17*** (3.04)	0.11* (1.90)	−0.10** (−1.99)
Residual (2)			0.30*** (5.22)	0.21*** (4.17)
Residual (3)				0.16*** (3.18)
<i>R</i> ²	0.46	0.54	0.56	0.68
Adj. <i>R</i> ²	0.42	0.51	0.52	0.64
<i>F</i>	15.88	14.6	15.88	20.62
<i>N</i>	166	150	158	142

* *p* < .10.
** *p* < .05.
*** *p* < .01.

from source, recipient, and third party pertaining to any one transfer is treated as a singular and discrete data point. Thus, each transfer—the unit of analysis—is sampled three times. This raises the problem of nonindependence of data. To confirm the stability and robustness of the findings, additional analyses were conducted. First, dummy variables were introduced to control for the affiliation of the respondent, i.e., source, recipient, or third party. Second, a single observation was created from the three questionnaires for the same transfer, first by averaging all questionnaires, then by averaging only those with high quality of responses, and finally by discarding all but the best questionnaire for each transfer (highest quality of response). In all these analyses,

the models remain highly significant, with sample sizes ranging from 77 to 98 observations ($\text{adj. } R^2 \geq .27$). The analyses revealed that with the exception of a single coefficient (unproven knowledge) in the *Implementation Stickiness* equation, results are otherwise stable, indicating the absence of major specification errors.

DISCUSSION AND CONCLUSION

Even though intrafirm transfers of knowledge are often laborious, time consuming, and difficult, current conceptions continue to treat them as costless and instantaneous. For example, Nelson (1981, p. 1049) notes that early studies of technological innovation assume that "... new technology instantly diffuses across total capital." Hansen (1996) reviews a large body of macro-organizational research which emphasizes the benefits of resource sharing while neglecting to analyze how knowledge sharing takes place. Attewell (1992) forcefully critiques the use of the signaling metaphor (Shannon & Weaver, 1949) to study the transfer of complex knowledge within organizations because such complex knowledge is largely inert; thus, knowledge transfer should be regarded as a process of reconstruction rather than a mere act of transmission and reception.

A conception of transfer as instantaneous and costless negates the possibility of difficulty. Thus, when acknowledged, difficulty is an anomaly in the way transfers are modeled rather than a characteristic feature of the transfer itself. The process approach to the study of transfer is often distinguished from a results, event, or variance approach. The latter focuses on describing and explaining results; however, such a focus obscures the decision processes involved and the nature of implementation problems.

The process model proposed and illustrated in this article is meant to provide a constructive way to incorporate difficulty in the analysis of knowledge transfer. By distinguishing between *Initiation Stickiness*, *Implementation Stickiness*, *Ramp-Up Stickiness*, and *Integration Stickiness*, the model provides one way to describe and to examine empirically the evolution of difficulty.

The empirical evidence illustrates a diachronic analysis of sticky transfers of best practice within the firm. The sample is drawn from a set of firms—reputed pioneers in best practice transfer as well as relative neophytes—that are aware of their own transfer activities and interested enough to supply high-quality responses. Sample selection bias occurs at the level of the transfers studied because despite a keen effort to the contrary most firms reported only transfers that reached the integration stage. The sample does not contain examples of transfers aborted during earlier stages.

Another limitation of the evidence is that its cross-sectional nature precludes strong causal inferences. Data collected through a cross-sectional survey can be valuable for a diachronic analysis, however, because longitudinal archival data is virtually nonexistent and most current longitudinal examinations of the process of transfer span a handful of transfers and a single firm. Furthermore,

observations taken through a fixed-interval periodic survey may not be comparable because the specific meaning of complex measures is sensitive to the stage of the transfer in which those measurements are taken. Thus such a survey may miss important dynamics when transfers are not synchronized, when the interval of sampling is long, or when a respondent's participation in the transfers is fluid. Analysis of a cross-sectional survey is not subject to these concerns.

The findings presented in this article merit consideration as an illustration of areas for further research. Overall, the pattern of results is consistent with expectations and supports the claim that the relative importance of predictors changes as the transfer unfolds. Thus, scrutiny of transfer processes seems warranted to improve the understanding of organizational mechanisms to support knowledge transfer and to inform managerial intervention.

Furthermore, two stable but unexpected findings are intriguing. One of them is the counterintuitive finding that a motivated recipient can intensify, rather than mitigate, the difficulty encountered during the ramp-up stage [see Eq. (3)] This finding is consistent with studies of the diffusion of innovations where highly motivated adopters have been found to exacerbate problems of implementation by prematurely dismissing outside help, expanding seemingly straightforward modifications into major projects, making unnecessary modifications to preserve pride of ownership and status or to let out hidden resentment (Rice & Rogers, 1980; Tyre & Orlikowski, 1994), or switching to new practices at a suboptimal moment because of unchecked enthusiasm (Baloff, 1970). This counterintuitive finding suggests the intriguing hypothesis that a highly motivated recipient can be a double-edged sword in that it may help initiate a transfer but also complicate its implementation.

The other stable but unexpected result is the negative coefficient on the lack of retentive capacity during ramp-up [see Eq. (3)]. This construct, which was expected to be significant during the integration stage, turned out to be significant only during the ramp-up stage and with opposite sign. This finding may therefore be an indication of the presence of unlearning barriers (Szulanski, 1996). Because questionnaires were administered shortly after practices had been implemented by the recipient, those practices were unlikely to have been fully institutionalized by the time measurement occurred (Lawless, 1987; Tyre & Orlikowski, 1994). Thus, to the extent that this construct measures the degree of institutionalization of a practice, a high score of institutionalization early in the integration stage must represent institutionalization of some *preexisting* knowledge. The more institutionalized preexisting knowledge is, the higher the effort required to dismantle it, i.e., the higher the unlearning barrier (Hedberg, 1981; see also Hamel, 1991). Such efforts to deinstitutionalize or "forget" prior knowledge are not likely to begin until new knowledge is first put to use, i.e., during the start-up stage, and will probably wane by the time satisfactory results are obtained using new knowledge. Thus, the unlearning interpretation is also consistent with the fact that the coefficient is significant only during the ramp-up stage. This finding implies that there may be a natural pace for organizational knowledge transfers to occur. If the pace is too fast,

changes may never get fully implemented. However, if the pace is too slow, practices may become institutionalized and more difficult to replace.

Students of organizational learning question how organizations learn to transfer knowledge, how they learn to learn. The process view of knowledge transfer developed and illustrated in this article suggests that organizations learn to transfer knowledge by making those transfers less eventful. People have a tendency to remember interrupted tasks better than those that have been completed (Zeigarnik, 1967). Interruptions of a transfer of knowledge occur when transfer-related problems impede further progress with the transfer. The lessons learned from solving those problems are more likely to be remembered and applied in a future transfer. Thus, an organization learns to cope with stickiness by drawing on the lessons of previous knowledge transfers. A dramatic account of this organizational learning process is offered by a systems analyst at Banc One Systems Corporation⁵:

At first, when a particular bank needed to be converted, all individual departments did it when they wanted. Applications were more independent, we didn't have so much interdependence. When the conversion management group was formed, they started coordinating across application areas. Conversions were done "in-sync." It was the first time I met other analysts, and that we started to work together, going to another bank. We began holding biweekly status meetings. In this way we became aware of the interdependencies. Thus we resolved interrelations during the conversion and not after. We became aware of how the system worked together, with a huge benefit to the conversion group. Every time we would run into a problem like that we would generate a task list. Then the problem became a check point and a task.

An organization that becomes more adept at transferring knowledge is likely to become better at preempting or resolving transfer-related problems during the next transfer. Dramatic reductions in the eventfulness of transfers can occur if problems are identified, solved, and cataloged. The process model offers a framework to classify transfer-related problems and the lessons from solving them. Process thinking offers the exciting possibility of learning to manage organizational learning, that is, to plan knowledge transfers more effectively and to "unstick" sticky transfers.

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⁵ Personal interview.

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