The SECI model of knowledge creation: some empirical shortcomings

Stephen Gourlay

Kingston Business School

Kingston Hill

Kingston upon Thames

KT2 7LB

UK.

sngourlay@kingston.ac.uk

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Nonaka's theory of organizational knowledge creation, centring on the SECI model, is probably the most widely cited theory in knowledge management. It is the contention of this paper that the empirical basis for the model is highly unsatisfactory, and thus that the model itself may be seriously flawed.

1. Introduction

This paper presents a critique of key empirical aspects of Nonaka's model of knowledge creation. If, as is now widely accepted, it is important to manage knowledge for a variety of reasons, then it is equally important that we have good models to assist this process. Nonaka and his colleagues' model, in particular the SECI matrix of knowledge conversion, is increasingly being cited by authors in a widening set of disciplines, and has evidently achieved something like a paradigmatic status. However, as I shall argue below, it is not supported by empirical evidence, and some of the conversion modes are not coherent. The paradigmatic status of this theory may thus be unwarranted.

The theory of organizational knowledge creation developed by Nonaka and his colleagues (Nonaka 1994; Nonaka et. al. 1994; Nonaka & Takeuchi 1995; Nonaka et. al. 2000; 2001a; Nonaka & Toyama 2003) originated in studies of information creation in innovating companies (Imai et. al. 1985; Nonaka 1988a, 1988b, 1990, 1991b, Nonaka & Yamanouchi 1989; Nonaka & Kenney 1991) and appears to have undergone two phases of development.

Initially a two dimensional theory of knowledge creation was proposed (Nonaka 1994: 16-17; Nonaka & Takeuchi 1995: 57-60). The first, or "epistemological", dimension is the site of "social interaction" between tacit and explicit knowledge whereby knowledge is converted from one type to another, and new knowledge created (Nonaka et. al. 1994: 338; Nonaka 1994: 15). Four modes of knowledge conversion were identified (Figure 1): tacit to tacit (Socialization); tacit to explicit (Externalization); explicit to explicit (Combination), and explicit to tacit (Internalization). After Internalization the process continues at a new 'level', hence the metaphor of a "spiral" of knowledge creation (Nonaka & Takeuchi 1995: 71-2, 89) often referred to as the SECI model.

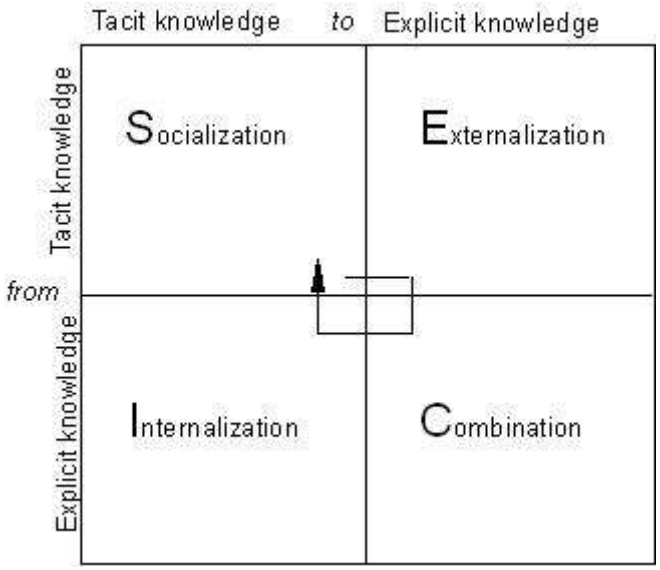

Figure 1: The 'engine' of knowledge creation

(adapted from Nonaka & Takeuchi 1995, pp. 57, 62, 71)

While knowledge conversion is a social process its effects in the "epistemological" dimension appear to be on the individual since the second ("ontological") dimension depicts the passage from individual to inter-organizational knowledge via group and organizational levels (Nonaka & Takeuchi 1995: 73). Through this process an individual's knowledge is 'amplified' and 'crystallized' "as a part of the knowledge network of an organization" (Nonaka 1994: 17-18). This is the process of organizational knowledge creation and it too is described as a 'spiral'. The SECI components reappear at this level although in a different order (Nonaka et. al. 1994: 342; Nonaka 1994: 17; Nonaka & Takeuchi 1995: 73, 89-90, 235-6).

Recently the two dimensions have become three elements or levels (Nonaka et. al. 2000; 2001a; 2001b). The SECI processes remain a key element but "*ba*", or shared context of knowledge creation, and "knowledge assets" have replaced the "ontological" dimension (Nonaka et. al. 2001b:16). Knowledge creation, a "self-transcending process by means of which one transcends the boundary of the old self into a new self" (Nonaka et. al. 2001b: 16) clearly, if somewhat mystically, indicates a strong individual and subjective focus (see also Nonaka & Toyama 2003). The focus of this paper is the "engine" of knowledge creation - the SECI processes - so other elements of their model will not be discussed.

Although the theory was first fully described in 1994 (Nonaka 1994; see Nonaka 1991a for some key elements) it has attracted little systematic criticism. Adler (1995) argued that it suffered from too static a contrast between tacit and explicit knowledge which he felt was inadequate for a dynamic model of tacit-explicit knowledge inter-relatedness (Adler 1995: 110-111). He also noted that several of the SECI modes had been studied by other disciplines, something Nonaka appeared to have overlooked (Adler 1995: 111). Jorna (1998) reviewing *The Knowledge-Creating Company* (Nonaka & Takeuchi 1995) argued that since the four phases of 'knowledge conversion' concern a change of signs from one form to another a semiotic framework for dealing with signs is required, but is absent. He also noted the omission of many important philosophers, of learning theory, of earlier discussion of tacit and declarative knowledge, and the misreading of important organizational writers. Engeström noted Nonaka and Takeuchi's accounts suggest teams took as given the problem

to be worked on. His research, however, led him to conclude that formulating, analyzing and systematically locating the problem are key innovation processes (Engeström, 1999: 380, 388-90). Others have pointed to important contingent factors to the SECI processes: Becerra-Fernandez and Sabherwal (2001) show that each of the SECI modes is dependent on the presence of appropriate task characteristics while Poell and van der Krogt (2003), treating the modes as forms of learning, also report that work type influences how workers learn.

These are serious criticisms that anyone wishing to use Nonaka's theory must take into account. The argument I propose to develop in this paper is that the evidence for the processes is weak or non-existent which thus calls into question the SECI model itself. Since this remains at the heart of the overall theory, flaws in the SECI model will also affect the wider theory.

2. The empirical basis for the SECI model

There are two principal sources of empirical grounding for the SECI model. First a survey of Japanese managers that Nonaka and his colleagues claimed validated the model. Second, the case study data, particularly that presented in *The knowledge-creating company* (Nonaka & Takeuchi 1995). I will deal with those two sources in turn.

2.1 The survey of managers[1]

In 1993 Nonaka and his colleagues surveyed a convenience sample of Japanese managers to test the emerging theory of knowledge creation (Nonaka et. al. 1994). The questionnaire comprised 185 items, 38 of which concerned "the content of organizational knowledge creation", as measured by the amount of time spent on specific activities (Nonaka et. al. 1994, pp. 342-3, 350). While they cautioned that this was the first time that the survey had been used, that generalization to other cultures remained questionable, and that more qualitative data would have been useful (Nonaka et. al. 1994: 350), they nevertheless concluded that the survey validated the four modes of knowledge conversion (Nonaka & Takeuchi 1995: 91; see Nonaka et. al. 1994).

This claim can be questioned on several grounds. First, it is doubtful whether processes as complex as knowledge conversion can be identified through self-completion questionnaires, at least, not without considerable prior research to validate measures of the concepts. Second, at that time no studies of knowledge conversion had been undertaken from which measures of the process could have been derived. Indeed, until the early 1990s Nonaka had been occupied with studies of *information* creation (see e.g. Imai et. al. 1985; Nonaka 1988a, 1988b, 1990, 1991b, Nonaka & Yamanouchi 1989; Nonaka & Kenney 1991) some of which were clearly the source for data on the knowledge creation modes. Third, the SECI model is a process model, but the questionnaire only measured "content", so the claim to have validated a process model cannot be sustained. Finally, while the percentage of variance explained through confirmatory factor analysis did reach acceptable levels for socialization and combination such levels were not reached for the other two modes. At best, it seems, the survey validated two of four hypothesized modes of information creation.

1 I am grateful to Andrew Nurse, Research Associate, Kingston Business School, for permission to draw on an unpublished paper for this section.

2.2 The case study evidence

Nonaka and his colleagues also provided illustrative case study evidence for each of the the SECI processes. This material is *illustrative* in the sense of having been selected to exemplify a point and as has already been indicated, much if not all the data came from previous studies of information creation. Nevertheless, it is worth evaluating just what the data shows in the light of the model and associated theory.

The SECI model claims that knowledge conversion begins with the tacit acquisition of tacit knowledge by people who do not have it from people who do, a process Nonaka and his colleagues named socialization. They give three examples of this process (Nonaka 1991b: 98-9; Nonaka 1994: 19; Nonaka & Takeuchi 1995: 62-4; Nonaka et. al. 2001b: 17) of which the best documented study concerns the development of the automatic bread-making machine showing "how a tacit technical skill was socialized" (Nonaka 1991b: 98-9; Nonaka & Takeuchi 1995: 63-4, 100-109).

An early prototype machine failed to produce tasty bread, the problem focused on in the second phase of the project (Nonaka & Takeuchi 1995: 63, 102-3). For some unreported reason the team felt that the secret lay in the kneading process. Since a master chef could not 'tell' them what they needed to know, a software engineer apprenticed herself to him to learn the appropriate tacit skills. We are told that one day she "noticed the baker was not only stretching but also "twisting" the dough" and for reasons not reported the team decided to try to replicate this action. Since the new prototype was successful they concluded that they had found "the secret for making tasty bread." (Nonaka & Takeuchi 1995: 64, 104-5).

This appears to provide a convincing and unusual case of tacit-to-tacit knowledge transfer, or socialization – the software engineer learned from the master baker by working with and observing him. There are, however, some critical technical difficulties with this account. First, it is not clear what the observed 'twisting' motion actually referred to, whether to part of the motion of hand-kneading, or to aspects of the final process of shaping the dough prior to baking. What is clear, however, is that they focused on the manipulation of the raw dough by the baker. This is the source of a second and crucial difficulty: kneading and manipulation does not affect the *taste* of bread. Taste (apart from being subjective) is influenced by the raw ingredients, the dough maturation process (which produces the complex chemicals that are further changed during baking), and by the baking process itself (Barfield [1947]: 33, 84, 95-8, 193, 207, 212; Reinhart 2001: 62-4, 94-5). It would thus appear that the team solved the taste problem accidentally. Collins' studies of scientists' work shows that failure to understand how a goal was actually achieved is not uncommon and may not even be realised by those involved until others try to replicate their achievements (Collins 1974, 2001). The team clearly did not 'know' how to make tasty bread (unless we extend the meaning of the word 'know' to include ignorance of effects caused by actions) since they did not understand what actually influenced the taste of bread. To suggest that such events illustrate the transfer of 'knowledge', even if qualified by the adjective 'tacit' both stretches the meaning of 'knowledge' beyond useful bounds, and conflates knowledge with the effects of experience. It is therefore difficult to accept this as illustrating 'socialization'.

Nonaka and Takeuchi's account of the bread-making case is in fact ambiguous. While the question of taste is emphasised, we are also told that the second prototyping stage focused on how to knead bread dough properly (Nonaka & Takeuchi 1995, pp. 63-4, 103-5). From this perspective their account seems to provide a better example of 'socialization'. Thus they tell us that the developers learned how to knead bread, under the supervision of the chef, and

subsequently were able to reflect on that experience to think about how to mechanize the process. In this context someone came up with the idea of a 'twist', and when they replicated that the result was a better tasting product. However, it does not seem necessary to invoke the notion of some mysterious kind of knowledge being transferred by an equally mysterious process to account for what happened here. People learn physical skills both with and without the assistance of an expert. Once people have learned a skill, they can reflect on it, and may perhaps succeed in producing some kind of description – in this case, the description was in engineering terms explicitly connected with the need to develop a new bread-making machine. While apparently a better example of 'socialization', since this data is open to other and simpler explanations, there is no need to invoke the idea of 'socialization' here. We are thus left without any convincing or unambiguous evidence for this mode of conversion.

Externalization, the next step in the knowledge conversion process, involves converting tacit into explicit knowledge, and holds the key to knowledge creation as new concepts are formed here (Nonaka 1994: 24; Nonaka & Takeuchi 1995: 66). Several cases of new product development are offered as examples of this process. The best documented case describes how managers set up a young team charged with producing a new car that was inexpensive but not cheap (Nonaka & Takeuchi 1995:11-13, 69-70, 76-8, 86-7). When novelty proved difficult to achieve a team leader stimulated their creativity with his idea of "Automobile Evolution". Using this and other similarly incongruous phrases ideas about what a new car might look like were generated and subsequently developed into a formal proposal for a new car.

The lack of detail precludes much comment on this example, but it seems to be an interesting example of the application of standard creativity techniques. So far as "externalization" is concerned, however, the principal difficulty here is the complete lack of any evidence for tacit knowledge that was made explicit by the creativity process. Had Nonaka and his colleagues claimed that the team leader had "foreknowledge", in the Polanyian sense, of the new product, then, despite the obvious difficulties of this notion, the product development cases could be read as examples of tacit-to-explicit knowledge conversion. Polanyi claimed "we can have a tacit foreknowledge of yet undiscovered things." (Polanyi, 1966:23), and wrote that the "true meaning of the heliocentric system was discovered by Newton, but it was anticipated 140 years earlier by Copernicus." (Polanyi, 1969:133). In so far as human knowledge grows in part by 'standing on the shoulders of giants' we might have to conclude that cave dwellers had 'foreknowledge' of space technology. However, the notion of 'foreknowledge' was not invoked, and in any case seems one of Polanyi's more mystical ideas. The phenomenon Polanyi described – that one person draws inferences from another's ideas that the latter did not anticipate – can be explained by reference to different individuals operating in different situations, and does not require a notion of 'foreknowledge' implying some kind of predictive powers. Thus we are forced to conclude that no evidence is actually offered for tacit-to-explicit knowledge conversion by these studies.

The bread-making case seems to provide a more convincing example. Thus we are told that one of the design team "was able to transfer her knowledge [of making bread] to the engineers by using the phrase "twisting stretch" to provide a rough image of kneading" (Nonaka & Takeuchi 1995: 104). The team was able to use this metaphor to think about how to replicate the motion in a machine. Externalization is also exemplified here in that the team were able to put their newly acquired tacit knowledge into a form of words and ultimately machine specifications that enabled them to produce the desired effects. This appears very like the processes Collins (1974, 2001) described – people who could do something but were

not able to fully describe how they could do it worked hard at developing a description when it became necessary, and when it was apparent that they could not describe what they did in such a way as to enable someone else to do the same thing. Externalization does appear to be an important process, albeit one that is more complex than Nonaka's accounts would suggest. Moreover, as has already been suggested, it must be questioned whether it is useful to stretch the meaning of 'knowledge' to include what otherwise might be called 'ignorance'. In so far as 'knowledge' is generally assumed to imply some kind of understanding, and that neither the software team nor Collins' scientists fully understood how they had achieved their results then it would be better not to refer to this lack of understanding combined with ability to do something as 'knowledge'.

The next step in the SECI model is *combination* – the process of "systematizing concepts into a knowledge system" (Nonaka & Takeuchi 1995: 67), which happens when people synthesize different sources of explicit knowledge into, for example, a report (Nonaka 1991b:99), or "through ... meetings and telephone conversations" and exchange of documents (Nonaka 1994: 19; Nonaka & Takeuchi 1995: 67). We are also told that an MBA education is "one of the best examples" of combination (Nonaka & Takeuchi 1995: 67), and that modern computer systems provide a "graphic example" (Nonaka 1994: 19). Finally, combination also involves the 'embodiment' of knowledge into products (Nonaka 1991b:99; Nonaka et. al. 1996: 207-8).

Combination thus apparently consists of three (or four) kinds of activities: using language (talking, listening, reading, writing) to produce a synthesis; some unspecified aspect of computer functioning; and the 'embodiment' of knowledge into material goods. In so far as formal education involves language activities it can be subsumed under the first category, but it could also be separated out as learning/teaching, and thus constitute a fourth category of 'combination' activities. It is impossible to take seriously their claim that higher education simply or even largely involves 'exchange' of explicit knowledge (Adler, 1995). More significantly, none of these examples were discussed or described in ways that revealed their common properties as examples of the 'combination' of explicit knowledge, and no descriptions of 'combination' processes were offered.

What might be involved in 'reordering explicit knowledge'? If we take the case of creating a new document from existing ones (Nonaka 1991b: 99) 'reordering' implies first that the document(s) are read. There are a number of theories of reading (Smith 1994). Some treat a document as a channel along which messages pass to the reader but this application of the mathematical theory of communication to human communication has long been criticized as inappropriate (Cherry 1966; see also Garavelli et. al. 2002). Other reading theories treat the process as an interactive constructive one. Rosenblatt, for example described reading as "dynamic, fluid process" and "an interdependent relationship in time between a reader and part of the environment, a text." (Rosenblatt 1998: 887-8; see also Rosenblatt 1994: 17-19; Goodman 1996; Smith 1994; Gourlay 2001). Brent (1992) has drawn attention to similarities between Rosenblatt's view, and those of others studying the reading and writing processes.

If reading and writing are interactive dynamic processes this implies, to use Nonaka's terms, that they involve explicit-to-tacit, tacit-to-explicit, and probably also tacit-to-tacit transformations as readers/writers try to make sense of the text they are 'consuming'/producing. As Adler (1995: 111) noted, pursuit of combination appears to require "an important dose of tacit knowledge". If what has been said about reading extends to all language processes these would appear to involve aspects of 'socialization', 'externalization', and 'internalization' and can thus hardly be introduced as examples of

combination! As for computer functioning and 'embodiment' processes, these might be viable candidates for a distinct 'combination' process, but as they have not been described, it is impossible to know what was intended. We have to conclude that the notion of 'combination' is far from coherent despite having been validated by a survey (Nonaka et. al. 1994). It is therefore not surprising that there is no clear empirical evidence.

The final cell of the matrix is labelled *internalization,* described as "a process of embodying explicit knowledge into tacit knowledge". It is "closely related" to "the traditional notion of learning", and to "learning by doing" (Nonaka et. al. 1994: 340-41; Nonaka 1994: 19; Nonaka & Takeuchi 1995: 69) although somewhat confusingly they also say that internalization is 'triggered' by learning-by-doing (Nonaka et. al. 1996: 208). Individuals can also internalize experiences by creating and reading documents: "Documentation helps individuals internalize what they experienced ... documents [help] ... people ... experience the experiences of others indirectly" (Nonaka & Takeuchi 1995: 69). 'Documentation' is an ambiguous word that can mean 'writing' or reading. Books by business leaders, for example, are seen as a useful way of sharing mental models (Nonaka & Takeuchi 1995: 70). Finally, internalization also involves, or is achieved through, the dissemination of explicit knowledge throughout an organization (Nonaka 1991b: 99; Nonaka et. al. 2001b: 19).

Their description of 'internalization' is thus also a little confusing since so many activities appear to be involved in this process. Moreover, we are not given any indication as to what they understand by, for example, 'embodying' of explicit knowledge, or 'the traditional notion of learning'. It appears, however, that they envisage it to involve three distinct routes or processes: learning by doing, through reading, and through writing. Learning by doing is exemplified by team members who enriched their tacit knowledge through the experience of creating a new product (Nonaka 1991b: 99), and workers who learned what working reduced annual hours 'meant' by working at the new annual rate for a month (Nonaka & Takeuchi 1995, pp. 70, 117-20). The annual hours example indicates that the workers 'felt' what the shorter working hours 'meant', suggesting internalization is about acquiring a subjective sense of meaning. In so far as tacit knowledge is subjective and personal then this would appear to illustrate the acquisition of such knowledge but it is difficult to see what the explicit knowledge of how many hours were to be worked as distinct from the experience of actually working shorter hours contributed to 'internalization'.

No examples of internalization from or through reading or writing are given, and the difficulty with regarding reading simply as a transmission channel has already been discussed. While those comments concerned explicit knowledge I see no reason why they should not also apply to tacit knowledge. If, as Nonaka and his colleagues claim, language and texts 'contain' mental models then on the assumptions of the 'communication model' they would be transmitted simply by reading. But if reading is an interpretive process, such transmission is unlikely, unless the reader is already attuned in some way to the writer's tacit 'message'. Like 'combination', 'internalization' has not been clearly described, and the examples are far from convincing.

3. Conclusion

This paper has examined the empirical data on which the SECI model, central to Nonaka's theory of organizational knowledge creation, is based. Three points stand out. First, much if not all the data for the survey and case studies actually came from earlier studies of *information* creation. Nonaka has made much of the difference between information and

knowledge (Nonaka 1991b; 1994, pp. 15-16; Nonaka & Takeuchi 1995, pp. 57-9), and while his earlier studies were of semantic (as distinct from syntactic) information creation (see Nonaka 1991b), he has not produced an argument to show the equivalence of knowledge and semantic information. His theory might therefore at best be regarded as a theory of *semantic information creation* rather than of knowledge creation.

Second, the claim that the model (whether of knowledge or information creation) was validated by a survey cannot be sustained. The survey only found support for two of the four modes (socialization, and combination) one of which is conceptually incoherent. Indeed, the fact that such an incoherent notion was validated by the survey raises further concerns about the measures used in that study. Even if they were to be justified, the survey concerned the "content" of the processes, and not the processes themselves. The SECI model is a process model, and its validation must therefore require validation of processes, not simply 'content'.

Third, the detailed case materials reveal that the notions of combination and internalization have not been clearly described, and are multi-activity processes involving activities between which no common features have been demonstrated. There is no convincing evidence for either of these modes, nor for socialization. There is however some evidence for the production of descriptions of processes or activities that people could previously do but not describe – which Nonaka and his colleagues call 'externalization'.

The SECI model has thus never had a sound empirical grounding, which must call its status into question. Consideration of its theoretical soundness is beyond the scope of this paper, but we can note, for example, that Nonaka's key distinction between tacit and explicit knowledge, and his conceptualization of tacit knowledge, have been called into question (McAdam & McCreedy 1999; Tsoukas 2003) suggesting that there may also be important theoretical shortcomings.

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