1 Making Sense of Managing Knowledge

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In the late-1990s, many people were taken aback by the rapid diffusion of knowledge management (KM) initiatives. Burgeoning markets for new trade journals have encouraged knowledge-related titles (*Knowledge Management, KM World, KM Review, The Journal of Knowledge Management, The Journal of Knowledge Management Practice* and *The Journal of Intellectual Capital*). Major consulting firms have KM specialists and new KM marketing organizations. Pressure to follow the KM fashion has been an important influence on information technology expenditure and has given rise to new job titles, such as 'Chief Knowledge Officer'. The recent explosion in the academic literature seeking to make sense of the KM terrain and its messages for practitioners has matured into handbooks (Choo and Bontis, 2002; Easterby-Smith and Lyles, 2003; Holsapple, 2003). So how does this collection of original chapters and readings fit into an already crowded picture?

KM has become important, not least of all, because important people have taken it seriously and allocated big budgets to projects that attempt to 'manage' knowledge. Yet, there are signs that the achievements of such initiatives often fall short of expectations. Amid rapidly growing interest in KM, John Storey and Elizabeth Barnett won the *Journal of Knowledge Management's* 'Best Paper of the Year Award' with a perceptive assessment entitled 'Knowledge Management Initiatives: Learning from Failure' (reproduced in this volume as Chapter 10). When John Seely Brown and Paul Duguid sought to challenge some of the extravagant claims made in the name of information, they felt that publication of their book *The Social Life of Information* in March 2000, at the height of the dot.com boom, was a case of unfortunate timing. A year later, the dot.com bubble had burst, while interest in the book surpassed the authors' anticipations, as they noted in the preface to the second edition (Brown and Duguid, 2002: ix–x).

Notwithstanding the KM hype, Brown and Duguid appeared to echo the *Economist* magazine's judgement that the term is merely a 'buzzword': another light-weight managerial fad:

> *Certainly much about knowledge's recent rise to prominence has the appearance of faddishness and evangelism. Look in much of the management literature of the late 1990s*

> *and you could easily believe that faltering business plans need only embrace knowledge to be saved. While it's often hard to tell what this embracing involves, buying more information technology seems a key indulgence. (Brown and Duguid, 2002: 118)*

To the extent that KM offers 'information' (in the form of so-called 'explicit knowledge'), it adds a new dimension to the dramatic advances in Information Communication Technologies (ICTs) that have transcended traditional boundaries between organizations and nations. Access to cyberspace provides previously unimaginable amounts of information but, as the philosopher Ludwig Wittgenstein (1889–1951) demonstrated in his *Philosophical Investigations* (2001), no amount of information can account for its own interpretation. Each interpretation would itself require an interpretation; implying a regress into infinite explanation. Access to information is not the same as the capacity to render that information meaningful. Nor is information about doing something the same as knowing how to do that thing in practice (Ryle, 2000: 26–60; Tsoukas and Mylonopoulos, 2004: 6). Although enthusiasm for measuring intangible assets and accounting for Intellectual Capital (IC) rocketed in the 1990s, as Daniel Andriessen (2004a, 2004b) explains in Chapter 11, 'IC Valuation and Measurement: Classifying the State of the Art', there is considerable disagreement about how to measure what and the extent to which such measurements might be regarded as useful.

One of the problems to be faced when making sense of *managing knowledge* stems from the sheer breadth and diversity of interests that have identified with management and business knowledge. Suddenly, many well-established areas of study have appeared eager to demonstrate their knowledge credentials. Moreover, unlike easily forgotten management fashions, knowledge and knowing are important subjects in their own right.

Whereas a national flag or a tombstone might *denote* a great country or the life of a great person, the objects themselves (as pieces of cloth or stone) are of rather less intrinsic interest (Polanyi and Prosch, 1977: 72); their significance lies in the integration of a vast range of subsidiary details. Flags and tombstones from an era that has been lost to history fail to integrate emotions in the way that they might once have done. In the fast-changing and fickle world of management fashion, the symbolism of fads such as business process reengineering, quality circles and management by objectives seems to have become associated with past eras. In contrast, the knowledge fashion is double-edged: it combines the capacity to integrate thoroughly positive connotations associated with the word 'knowledge' (the fashion element of its brand image) with an intrinsically interesting subject that has fascinated history's brightest minds – a side of the blade that is less likely to become blunt. In this respect, J.C. Spender's specially written contribution to this reader (Chapter 6, An Overview: What's New and Important about Knowledge Management? Building New Bridges between Managers and Academics) is worthy of special mention being an attempt to integrate the practice and conceptual edges.

On occasions, KM might be seen as being a high-profile accessory to the managerial tool kit: a new solution of the type that is often presented with PowerPoint slides, designer mineral water and fashionable mints in imitation cut-glass containers.

And failure to pay sufficient attention to know-how embedded in established practices can create problems. As Storey and Barnett's study of KM failure (Chapter 10) notes, even the generous provision of organizational resources and an apparent commitment from top management is not necessarily sufficient to overcome the power embodied in established practices. In an additional chapter especially written for this volume (Chapter 9, 'Human Resource Policies for Knowledge Work'), John Storey explains how Human Resources Management is often expected to facilitate KM, while at the same time being intertwined with the very processes that it is trying to shape.

Meanwhile, the philosophical dimensions of knowledge and knowing are serious subjects that are deeply embedded in human practice. Myths and legends are the stuff of history. Stories are an essential part of sensemaking and communication: they exploit information about history or events in other places to make sense of the here-and-now and speculate on imagined futures. Metaphors and analogies provide powerful tools for explaining one thing in terms of another. Indeed, storytelling techniques are becoming an increasingly popular part of the management and business literature (Brown et al., 2005; Denning, 2001). Even though scientific stories are told according to strict rules, they are still stories that can be used to make a case and influence people. In all their various forms, stories are a valuable device for soliciting the intelligent cooperation of others and stimulating creativity – along with the emotional force of factors such as love, fear or money. Ultimately, effective management is about aligning the capacity to imagine a difference with knowing how to make a difference: the practice of power. But how does the new and fashionable KM paradigm relate to these long-standing questions?

The sections that follow introduce some key themes in the evolution of recent interest in management and business knowledge. Although problems with the practical implementation of KM often stem from misunderstandings that fuel overly optimistic expectations, these disappointments should not distract from the substantial insights that can be achieved by developing a better appreciation of how knowledge relates to the active process of 'doing things' in practice. Such issues frame the arrangement of this book, which is explained at the end of the chapter.

The Seeds of Misunderstanding

As Chapter 15 ('Tacit Knowledge, Communication and Power: Lessons from Japan?') argues, the KM paradigm appears to blend at least two areas of misunderstanding: (a) Michael Polanyi's concept of tacit knowing; (b) and the assumption that practices situated in Japan's company-as-family workplace organizations can be divorced from their institutional context and used as a guide for managing knowledge in other contexts. The connection between these themes arises from the colossal influence of Nonaka and Takeuchi's (1995) book, *The Knowledge-Creating*

Company: How Japanese Companies Create the Dynamics of Innovation. The book was written specifically for the Anglophone market. Veteran management guru, Peter Drucker, has described it as a 'classic' (Takeuchi and Nonaka, 2004: ix). And its success has helped to propel Michael Polanyi's work on tacit knowing into the managerial mainstream.

Michael Polanyi (1891–1976) was born in Budapest, gained degrees in medicine and the physical sciences, before achieving recognition as an outstanding chemist, first in Germany, where his work included scientific exchanges with Einstein, and later in Britain (as an aside, his son, John, was joint winner of the 1986 Nobel Prize for Chemistry). In the later decades of his life, Polanyi turned to philosophy, publishing his magnum opus *Personal Knowledge* in 1958, after nine years devoted almost exclusively to its preparation (Polanyi, 1974: ix). Notwithstanding prevailing expectations that 'true knowledge' should be deemed objective and impersonal, he demonstrated that *Personal Knowledge* was not a contradiction in terms.

Polanyi's philosophical work developed the idea that there was an inexpressible tacit coefficient that enabled every thought and action. For example, we can recognize our friend's face from one in a thousand or, indeed, one in a million. The tacit integration of subsidiary information 'clues' is achieved in an instant – it is an instantaneous 'gestalt' perception in which, what we perceive as an organized whole, is greater than the sum of its parts. When we watch a movie, we see the flow of moving pictures, as opposed to individual frames of film. Similarly, we integrate information clues to recognize our friend in an instant, but we cannot say which clues we attended to, nor how we integrated them. We know 'how to do it in practice', but we cannot articulate what it is that we know: '*we can know more than we can tell*' (Polanyi, 1983: 4, italics in the original). After the event, we might attempt to construct an explanation of how the information clues could have been related to each other; but this is merely speculation and per force historical. If we were to give such an account to a stranger, we might not be confident that he or she would be able to pick out our friend instantaneously and unambiguously from a face among a thousand or a million candidates. Yet, a central theme of Nonaka and Takeuchi's (1995) model of knowledge creation turns on the claim that tacit knowledge can be converted into explicit knowledge (information) and moved from one context to another.

As the chief editor of the prestigious journal, *Organisation Studies*, Haridimos Tsoukas (2003; reproduced here as Chapter 5) has pointed out Nonaka and Takeuchi's (1995) book has been instrumental in the institutionalized misunderstanding of 'tacit knowledge' in management studies:

> *Ever since Nonaka and Takeuchi (1995) have published their influential The Knowledge-Creating Company, it is nearly impossible to find a publication on organizational knowledge and knowledge management that does not make a reference to, or use the term 'tacit knowledge.' And quite rightly so: as common experience can verify, the knowledge people use in organizations is so practical and deeply familiar to them that when people are asked to describe how they do what they do, they often find it hard to express it in words ...*

> *... My argument will be that popular as the term 'tacit knowledge' may have become in management studies, it has, on the whole, been misunderstood. (Tsoukas, 2003: 412)*

Tsoukas (2003: ch. 4) goes on to explain that tacit knowing is essential to every thought and action, but it cannot be converted into information (so-called 'explicit knowledge') and 'managed'. If you tell me something, I might *learn*, yet your knowledge will not be diminished or 'converted' into something else. The capability to know is possessed by people: short of brain transplant, it stays with the knowing subject.

The Danish science writer Tor Nørretranders (1999: 125) suggests that human sense perceptions deliver more than 11 million bits of information per second (at least 10 million bits of which come from the eyes) but consciousness can only process 40 bits of information per second – at best. Moreover, consciousness comes some time after sense perceptions are delivered to the brain. Drivers can brake as much as 0.5 seconds before they are conscious of seeing the child run in front of the car. Fortunately, from the point of view of accident statistics, they can act in advance of consciousness. They do not have to wait for tacit–explicit knowledge-conversion. Parallel processing enables our brains to leap to conclusions before we are consciously aware of what the problem might be.

Malcolm Gladwell (2005) has popularized the concept of 'knowing more than we can tell' in his recent book, *Blink: The Power of Thinking without Thinking*. This highlights the importance of what psychologists call 'adaptive unconsciousness' Gladwell (2005: 11) – people can take a look and, in a blink experience emotions, intuitions and hunches that race ahead of conscious thought. In a similar vein, Guy Claxton's (2005) *The Wayward Mind: An Intimate History of the Unconscious*, begins by marvelling at his mind's capacity to exercise a 'mind of its own':

> *It wanders off while I'm trying to concentrate. It refuses to stop churning over the day while I'm trying to get to sleep. At night it creates movies that range from the exceedingly tedious to the embarrassingly bizarre. It comes up with tunes and phrases that I didn't intend, and often didn't want. It tells me that someone has come into the room when I've got headphones on and my eyes shut and I'm miles away – and often it's right. It forgets well-known names at crucial moments. It feels hurt or angry out of all proportion. It is a royal pain in the ass sometimes. But apparently it's the only mind I've got. (Claxton, 2005: vii)*

The capacity of the tacit dimension to act as an unseen 'mental butler' is an integral but unknowable part of every thought and action. It's not possible to observe yourself thinking, or 'see' the mental processes that enable and constrain thoughts and actions, any more than you can expect to leave your body and meet yourself as an object. Much of the time the mental butler might be a loyal servant – but not always, as Claxton points out. There are occasions when consciousness is accompanied by regret, for example, when you realize that emotions have overruled your intentions.

Metaphorically speaking, the tacit dimension might be represented as a 'tool of knowing' in the way that spectacles represent a 'tool of seeing'. And, as Polanyi commented, you cannot use your spectacles to scrutinize your spectacles (Polanyi and Prosch, 1977: 37). We can only point to the tacit dimension because of the fact that we can self-evidently do whatever it is that we do and think whatever it is that we think. On this account, tacit knowledge is unknowable in any abstract sense – 'We must be forever unable to give it an explicit specification' (Polanyi and Prosch, 1975: 62) – but its existence is implied by our ability to 'do things' in practice.

Learning from Japan?

At the height of Japan's miracle economic growth, many Westerners were eager to learn the secrets of its success. However, in contrast to the other G7 economies, Japan's traditional values owe almost nothing to Mediterranean origins – and the lack of common reference points can mask misunderstandings.

As Chapter 15 ('Tacit Knowing, Communication and Power: Lessons from Japan?') explains, the assumption that Japan's workplace organizations are roughly similar to the Western counterparts overlooks, among other things, the processes by which Japanese organizations have emerged in tandem with power relationships mediated by Japanese institutions. Nobel Laureate, Douglass North (1990), has famously defined institutions as the 'rules of the game'. Throughout history, institutions have created order and reduced uncertainty in exchange: they enable and constrain what can and cannot happen in any given context (North, 1991: 97). For North, institutions comprise informal constraints (sanctions, customs, traditions and codes of conduct) and formal rules (constitutions, laws and property rights). He argues that they exist on a continuum, which stretches from the informal to the formal. Thus, economic development and the change from less to more complex societies represent a unidirectional move (albeit lengthy and uneven) from unwritten customs and traditions to written laws that underpin specialization and the division of labour (North, 1990: 46). However, the implication that economic progress is a march towards liberal individualism, impersonal transactions and the logic of Anglo-Saxon market-rational capitalism, misses the point that no rule can account for its own interpretation.

The reflexively automatic practice of power, mediated by highly aligned tacit knowing among insiders, in any tightly bounded collective, shapes what can and cannot happen in ways that are not even apparent to the insiders themselves. Here-and-now gestalt tacit integrations that guide behaviour cannot be articulated – yet, they shape what does and does not happen. Etiquette guides for visitors to Japan outline the rules of play for almost every social occasion, but they cannot account for how Japanese people themselves think and act *in situ*.

In Japan, employee loyalty, long working hours and work-before-family attitudes are not so much an achievement of coercive corporate rules, but a reflection

of the way that organizations are embedded in Japan's wider social order. Sustaining obligations to the group in Japan's group-oriented society, and *esprit de corps* that is generated by repeat transactions, reinforce the status quo: group affiliation and appropriate introductions are essential to getting things done and ostracism (*mura-hachibu*) can have serious consequences. Within the organization, close community relationships reduce the marginal cost of information transfer, enabling insiders to retaliate against and ostracize those who break their code. Insiders (us) are differentiated from outsiders (them) and develop high levels of *esprit de corps* that facilitate breathtaking levels of coordination and flexibility. Meanwhile, the organization, as a collective entity, is fixed in web of repeat transactions with other organizations (such as regular suppliers and customers). Organizational insiders have a clear sense of 'the way that things should be done around here'. This relies on a facilitative and disciplinary power that operates through obligations arising from being a member of Japanese society in general, and any given company as family workplace organization, in particular. Many organizational practices are facilitated by expectations that are deeply embedded in Japanese society.

Foreigners who go to work in a Japanese organization might stumble over even the most basic rules of play and never come close to thinking and acting in the manner of an insider. Although they might take comfort in legal frameworks and formal rules that appear broadly similar to those found in Japan's Western counterparts, disciplinary authority turns on the power mediated by highly aligned tacit knowing among members of the relevant collective – whether it be Japanese society in general or a specifically organizational matter. Belonging to a Japanese organization involves demonstrating commitment to the organizational cause through voluntary overtime, not going home before the boss and after-hours socializing: one should 'be there' (even in the absence of essential work) to lend emotional support to one's colleagues. And holidays should be short. Consider the case of the foreign employee (FE), in discussion with their division chief (DC), of a Japanese organization who wanted to take his full entitlement of three week's holiday all in one go.

FE: I have three week's holiday and I should like to take them.
DC: Japanese people do not take so many holidays in one go
FE: But I'm entitled ...
DC: Sit down, have some green tea, have some rice crackers ...
FE: Thank you. [Accepting the green tea and a rice cracker]
DC: Why didn't you take all the rice crackers?
FE: Well, I didn't want to appear greedy ...
DC: And so it is with holidays! We offer you these holidays as a gesture. Only a foreigner would fail to see that it's greedy to take them all! What would your colleagues think?

Eventually, the story had a happy ending: the division chief learned that the employee had to return to his home country to sort out affairs after a family

bereavement and sent him on an expenses-paid business trip to that country with no apparent work to do. The spirit of friendly paternalism can be warm and embracing; but only if the principle of commitment to the organization is observed. On this point, the Japanese American Dorinne Kondo's (1990) ethnographic study of life in a small family-owned Japanese factory offers some fascinating insights into the practice of facilitative and disciplinary power.

Nonaka's Model of Organizational Knowledge Creation

Nonaka, who had studied in the United States, was struck by the American respect for information processing of the type developed by Nobel Laureate, Herbert Simon. He felt that Simon's model of 'organizations as information-processing machines' overemphasized the logical aspects of human reasoning (see Nonaka and Takeuchi, 1995: 37–9). As Nonaka and his colleagues (2000; reproduced here as Chapter 2) argue, Japanese organizations are able to include care, love, security, energy, passion and tension among their organizational assets: such values spring naturally from close community relationships associated with being part of the organizational 'family'. But how do you communicate these taken-for-granted aspects of life inside a Japanese organization to outsiders who expect that there will be formal rules and levers that can be pulled to control cause and effect relationships? Western social science places considerable emphasis on the 'scientific' and finding causal mechanisms for all phenomena – yet, if insiders themselves are unclear about why and how they 'do what they do', what authority would outsiders have for making such judgements?

Whereas Polanyi insisted that the tacit dimension was, by its very nature, inexpressible, Nonaka's concept of knowledge-conversion turns on the idea that, given sufficient effort, aspects of the tacit dimension could be converted into information (which he called 'explicit knowledge') and communicated around the organization if it is first: 'converted into words or numbers that anyone can understand' (Nonaka and Takeuchi, 1995: 9). Thus, the tacit knowing that enables practice is objectified: knowledge becomes a transferable commodity and communication is presented as if it were a form of conveyance. For Nonaka, the challenge is to: 'express the inexpressible' (Takeuchi and Nonaka, 2004: 36). As a grand gesture, this is not without theatrical impact. Nonaka offered the Anglophone management world a new type of rice cracker and the Western appetite for new fashions seems to have relished the opportunity to consume everything on offer: oriental oracular mystique appeared to inspire Western managers to pursue new dreams with big budgets. Yet, Japan itself seems remarkably immune to the craze for KM crackers. Takeuchi has, for example, noted that there has not been any sign of a Western-style KM boom in Japan.

The emotional glue or *esprit de corps* that binds insiders together in Japan's company-as-family organizations generates group-level knowledge of the type that

Cook and Brown (1999; reproduced here as Chapter 3) argue is qualitatively different to individual knowledge. For example, the collective dimension of a particular language is qualitatively different to what a particular person might have said in that language. Medical knowledge about a disease is different from the individual doctor's diagnosis that a particular patient is suffering from that disease. Similarly, tacit knowing possessed by a group is distinct from the tacit knowing of each individual member. Thus, the collective tacit knowing possessed by a football team that plays together regularly cannot be reduced to the individual skills of its members; individual players who move to another team can take their individual skills with them, but not their previous team's *esprit de corps*.

In a book first published in 1959, Edith Penrose (1995: 78) touched on something similar in her conception of a 'free resource', which is knowledge learned by one firm that is not immediately available to other firms. This collective capacity to know cannot be traded, but it has value in the services that it can render to insiders. Once this collective know-how has been mastered, it can be reused at no extra cost. Indeed, far from being consumed by its use, the resource is strengthened in the process. In this respect, Penrose pioneered a dynamic resource-based view of the firm that proved to be well ahead of its time – although renewed interest in her work prompted publication of a second edition in 1995. The cover carried a warm endorsement from Nonaka, although he appears to differ with Penrose on the individual-collective issue.

Nonaka adopts the view that 'knowledge is created only by individuals' (Nonaka and Takeuchi, 1995: 239). Accordingly, the individual – collective distinction is presented as a continuum. In a graphical representation of their famous knowledge-creating 'spiral' Nonaka and Takeuchi (1995: 72–3) plot tacit–explicit knowledge conversion (on the y-axis) against an ontological continuum (the x-axis) that stretches from the individual to the collective, passing through group, organization and inter-organizational boundaries. The creative individual's original idea is modified and expanded in the process of being repeatedly converted into 'explicit knowledge' and reinterpreted by an expanding community of interaction. Ultimately, it is speculated, such a process might render the secrets of Japanese knowledge-creation 'universal' (Nonaka and Takeuchi, 1995: 246). But is it reasonable to assume that only an individual can create knowledge? And can that creative individual's 'explicit knowledge' eventually become 'universal'? Does this 'universal' refer to 'universal truth' or merely information that is circulated widely? For example, in the manner of a sensationalist headline that whizzes around international media even though it has no basis in 'truth'. What is the intended relationship between information, 'explicit knowledge' and 'truth'?

Whereas occidental philosophy has tended to treat the subject and object as discontinuous entities ('true knowledge' has to be independent of the knowing subject and represent a knowable reality 'out there' in a more or less veridical fashion), tacit–explicit knowledge-conversion has provided (if unwittingly) scope to blend the two. Tacit knowing could be converted into 'explicit knowledge' (information) and combined with objective knowledge (also expressed as information) and 'managed'. Thus, knowledge-conversion implies that it is possible to be subjective and objective at

the same time. As Nonaka et al. (2000: 7/Chapter 2) put it: 'we adopt the traditional definition of knowledge as "justified true belief". However, our focus is on the "justified" rather then the "true" aspect of belief'. Thus, the Western expectation that knowledge has something to do with objectively determined 'truth' is blurred to accommodate other forms of information – yet, this is not merely mundane-sounding information, but re-branded as 'explicit knowledge'.

Albert Einstein famously observed that: 'Knowledge is experience. Everything else is just information'. Thus, experience is afforded a centre-of-stage role. In contrast, Nonaka's concept of tacit–explicit knowledge-conversion provides a device for separating 'knowledge' from knowing subjects by converting their capacity to know into information or 'explicit knowledge'. However, this road leads to abstraction. It abstracts information from the here-and-now processes by which people think and act in any given context. For Michael Polanyi (1969: 195), all of knowledge is either tacit or rooted in tacit knowledge, hence: 'The ideal of a strictly explicit knowledge is indeed self-contradictory; deprived of their tacit coefficients, all spoken words, all formulae, all maps and graphs, are strictly meaningless ... The false ideal of a strictly explicit knowledge was pursued with the greatest zeal in the twentieth century by modern positivism.'

In Western cultures, science has been equated with an attempt to reveal eternal 'truth' that transcends human experience. However, as Ernst von Glasersfeld (2002) and other radical constructivists have argued (see Chapters 6 and 15), unless we claim some form of direct mystical revelation of an eternal truth (such as a message from the gods) all of human knowing – including scientific information about a supposedly independent reality – is constructed. And to the extent that these constructions are articulated, they are represented as *information*.

Consider, for example, the race to decode the human genome. These advances build on the development of knowledge about the structure of deoxyribonucleic acid (DNA) that was published in the top-ranking scientific journal *Nature* in 1953, by James Watson and Francis Crick, who went on to win the 1962 Nobel Prize for Medicine. The entire paper – it only covers about a page – is reproduced in Figure 1. In some respects, it might be seen as one of the 20th century's most important scientific breakthroughs: but is the paper knowledge, information or something else? To Watson and Crick's peers and rivals, the publication was a potent and highly meaningful symbol of the knowledge that had been mastered. In KM terms, its cogent presentation might be a textbook example of 'explicit knowledge' – but what does this knowledge mean to you? For those who possess the capacity to read the paper in a meaningful manner, it might be of great interest. It might also be of interest to those who are curious to note how the style of academic publishing has changed over the last half-century. However, those who lack the necessary background knowledge could struggle to make sense of the information contained in the paper. And even if the paper was explained, for example, with hypertext annotations, these annotations could not explain themselves without recourse to more annotations. Meaning can only be generated in the mind of the knowing subject. Someone who has never seen the artifacts of today's society might struggle to differentiate a scientific paper from a railway timetable or wallpaper.

equipment, and to Dr. G. E. R. Deacon and the captain and officers of R.R.S. *Discovery II* for their part in making the observations.

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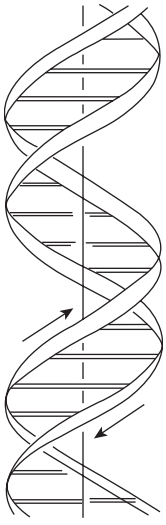
MOLECULAR STRUCTURE OF NUCLEIC ACIDS

A Structure for Deoxyribose Nuclei Acid

WE wish to suggest a structure for the salt of deoxyribose nucleic acid (D.N.A.). This structure has novel features which are of considerable biological interest.

A structure for nucleic acid has already been proposed by Pauling and Corey[1]. They kindly made their manuscript available to us in advance of publication. Their model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons: (1) We believe that the material which gives the X-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms it is not clear what forces would hold the structure together, especially as the negatively charged phosphates near the axis will repel each other. (2) Some of the van der Waals distances appear to be too small.



This figure is purely diagrammatic. The two ribbons symbolize the two phosphate—sugar chains, and the horizontal rods the pairs of bases holding the chains together. The vertical line marks the fibre axis

Another three-chain structure has also been suggested by Fraser (in the press). In his model the phosphates are on the outside and the bases on the inside, linked together by hydrogen bonds. This structure as described is rather ill-defined, and for this reason we shall not comment on it.

We wish to put forward a radically different structure for the salt of deoxyribose nucleic acid. This structure has two helical chains each coiled round the same axis (see diagram). We have made the usual chemical assumptions, namely, that each chain consists of phosphate di-ester groups joining β-D-deoxyribofuranose residues with 3', 5' linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fibre axis. Both chains follow right-handed helices, but owing to the dyad the sequences of the atoms in the two chains run in opposite directions. Each chain loosely resembles Furberg's[2] model No. 1; that is, the bases are on the inside of the helix and the phosphates on the outside. The configuration of the sugar and the atoms near it is close to Furberg's 'standard configuration', the sugar being roughly perpendicular to the attached base. There is a residue on each chain every 3.4 A. in the *z*-direction. We have assumed an angle of 36° between adjacent residues in the same chain, so that the structure repeats after 10 residues on each chain, that is, after 34 A. The distance of a phosphorus atom from the fibre axis is 10 A. As the phosphates are on the outside, cations have easy access to them.

The structure is an open one, and its water content is rather high. At lower water contents we would expect the bases to tilt so that the structure could become more compact.

The novel feature of the structure is the manner in which the two chains are held together by the purine and pyrimidine bases. The planes of the bases are perpendicular to the fibre axis. They are joined together in pairs, a single base from one chain being hydrogen-bonded to a single base from the other chain, so that the two lie side by side with identical *z*-co-ordinates. One of the pair must be a purine and the other a pyrimidine for bonding to occur. The hydrogen bonds are made as follows: purine position 1 to pyrimidine position 1; purine position 6 to pyrimidine position 6.

If it is assumed that the bases only occur in the structure in the most plausible tautomeric forms (that is, with the keto rather than the enol configurations) it is found that only specific pairs of bases can bond together. These pairs are: adenine (purine) with thymine (pyrimidine), and guanine (purine) with cytosine (pyrimidine).

In other words, if an adenine forms one member of a pair, on either chain, then on these assumptions the other member must be thymine; similarly for guanine and cytosine. The sequence of bases on a single chain does not appear to be restricted in any way. However, if only specific pairs of bases can be formed, it follows that if the sequence of bases on one chain is given, then the sequence on the other chain is automatically determined.

It has been found experimentally[3,4] that the ratio of the amounts of adenine to thymine, and the ratio of guanine to cytosine, are always very close to unity for deoxyribose nucleic acid.

It is probably impossible to build this structure with a ribose sugar in place of the deoxyribose, as the extra oxygen atom would make too close a van der Waals contact.

The previously published X-ray data[5,6] on deoxyribose nucleic acid are insufficient for a rigorous test of our structure. So far as we can tell, it is roughly compatible with the experimental data, but it must be regarded as unproved until it has been checked against more exact results. Some of these are given in the following communications. We were not aware of the details of the results presented there when we devised our structure, which rests mainly though not entirely on published experimental data and stereo-chemical arguments.

It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material.

Full details of the structure, including the conditions assumed in building it, together with a set of co-ordinates for the atoms, will be published elsewhere.

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(Continued)

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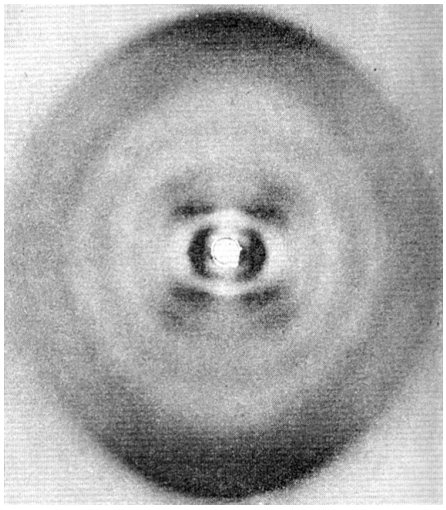

Figure 1.1 The structure of DNA

Cook and Brown's Generative Dance

Amid the surge of interest generated by Nonaka and Takeuchi's (1995) path-breaking work, Scott Cook and John Seely Brown's (1999/Chapter 3) *Bridging Epistemologies: The Generative Dance between Organisational Knowledge and Organisational Knowing* offered arguments for reinterpreting Nonaka's insights in a way that shifted the spotlight of attention towards the active process of 'knowing as action'. Cook and Brown retained Nonaka's distinction between tacit knowledge and explicit knowledge, but insisted that it was not possible, under any circumstances, to convert one into the other.

They also insisted that not every aspect of what is known by a group can be usefully or meaningfully reduced to the actions of an individual. For example, the English language is possessed, as a tool that is held-in-common by English language speakers, irrespective of whether you tell me what you did last night. If my bus breaks down and has to be towed off the highway, it will not change the collective dimension of the Highway Code. Conversation and the conventions associated with road traffic regulations are group-level 'tools' that enable communication, safer highways and other factors that contribute to knowing as action. Clearly, this group-level issue is important in enabling what you can and cannot do. If you travel from Britain to France, the institutional 'rules of the game' change – and failure to adapt can have consequences. Yet, when people move from one organization to

another, they might fail to notice that they are using the wrong language and 'driving' on the wrong side of the road (for example, by asking to take their holidays in ways that offend against the prevailing rules of play).

In Cook and Brown's 'generative dance', all four types of knowledge (tacit and explicit, possessed by individuals and groups), 'mutually enable' the active process of knowing as action. However, if tacit knowing is unknowable in any objective sense, is it viable to insist that it comes in two types? Can groups reproduce the unknowable gestalt tacit integrations, which are associated with individual experience, in a synchronized manner? Arguably, all that we can do is point to the collective experience (for example, the moment when everybody broke into spontaneous laughter) and infer that tacit knowing among members of the group was in some way aligned. When we are in the company of close friends, we might act and think as if there is an unambiguous alignment of tacit knowing: but there is always scope for the occasional surprise.

In Polanyi's approach, tacit knowing is reflexively automatic: you cannot consciously turn it off (anymore than Polanyi could scrutinize his spectacles through his spectacles). People are no more conscious of tacit knowing that a healthy person is conscious of his or her bones. Yet, aspects of Cook and Brown's reflect a distinctly transitive flavour. Take, for example, their comments about riding a bicycle:

> *If you ride around using your tacit knowledge as an aid to discovering which way you turn [to keep upright], when you ultimately acquire the explicit knowledge you still possess the tacit knowledge, and you still use it in keeping upright. (Cook and Brown, 1999: 385/Chapter 3)*

In the above excerpt, tacit knowledge becomes the object of the transitive verb 'to use'. So, where is Cook and Brown's 'you'? Where is the person-behind-the-person wielding the individual tacit knowledge and group-level tacit knowledge 'tools'? Who is this meta-person who can apparently scrutinize his or her spectacles through his or her spectacles?

Nested and Overlapping Collectives

Social learning, working and innovating of the type that takes place within Japan's company-as-family workplace organizations is evident in the Western concept of communities of practice. For example, one of its pioneers, Etienne Wenger (2003: 80) has written about a *shared repertoire* of communal resources – language routines, artifacts, tools, stories and so on – that emerge from practice and are possessed by practitioners as tools of practice.

> *Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area*

> *by interacting on an ongoing basis. Engineers who design a certain kind of electronic circuit called phase-lock loops find it useful to compare designs regularly and to discuss the intricacies of their esoteric specialty. Soccer moms and dads take advantage of game times to share tips and insights about the subtle art of parenting. Artists congregate in cafés and studios to debate the merits of a new style or technique. Gang members learn to survive on the street and deal with an unfriendly world. Frontline managers running manufacturing operations get a chance to commiserate, to learn about upcoming technologies, and to foresee shifts in the winds of power. (Wenger et al., 2002: 4)*

In the course of daily life, people are simultaneously members of many nested and overlapping collectives. As Wenger (2003, p. 91) has pointed out, you do not cease to be a parent because you go to work; you do not cease to be a nurse because you step out of the hospital – the responsibilities of childcare exist in parallel with work and other responsibilities. Even so, some collectives are more important than others. And power, mediated by prevailing institutional rules of practice, has a profound effect on the way that collectives, situated in different institutional contexts, operate and achieve insider–outsider distinctions. For example, Japan's institutional rules of practice militate against 'horizontal' collaboration and self-organizing communities of practice – as Nonaka et al. (2000/Chapter 2) imply:

> *However, the knowledge creating process is not confined within the boundaries of a single company. The market, where the knowledge held by companies interacts with that held by customers, is also a place for knowledge creation. It is also possible for groups of companies to create knowledge. If we further raise the level of analysis, we arrive at a discussion of how so-called national systems of innovation can be built. For the immediate future, it will be important to examine how companies, government and universities can work together to make knowledge creation possible. (Nonaka et al., 2000: 30/Chapter 2)*

Practice within Japan's tightly bounded company-as-family workplace organizations is a matter for insiders; self-organizing horizontal networking by individuals lacks legitimacy. However, in the US, UK and other societies, institutional rules of practice legitimize liberal individualism, employee mobility and a labour market for specialists. Accordingly, responses to the question that Haridimos Tsoukas and Efi Vladimirou (2003; reproduced here as Chapter 4) pose, in 'What Is Organizational Knowledge?', might vary considerably according to power relationships that are mediated by the prevailing institutional rules of practice.

In the US, UK and other leading Western economies, traditional professions (such as law and medicine) and organizational professions (for example, managers and administrators) are being complemented by the rise of so-called knowledge workers. As May, Korczynski and Frenkel (2002; reproduced here as Chapter 8) point out, new occupations such as financial and management consultants, information technology analysts, project engineers and computer are often assumed to be free agents who can create special 'market niches' for themselves. However,

these workers might be more intimately connected with their organizations than is commonly assumed: knowledge-based perspectives provide a potentially valuable tool for revizing simplistic assumptions about alliances, networks and partnerships.

The boundaries of Western organizations tend to be ambiguous and attempts to work out who is allied with whom on what issue can reveal tensions between formal statements about what lies in the organization's interests and individual ambitions. In an original chapter produced for this volume, Paul Quintas has addressed the challenging topic of 'Managing Knowledge and Innovation across Boundaries' (Chapter 12). This is an important theme that highlights issues in the two subsequent chapters.

In Chapter 13, 'The Human Resource Architecture: Towards a Theory of Human Capital Allocation and Development', David Lepak and Scott Snell assess four modes of soliciting the intelligent cooperation of employees: home-grown internal development (in the manner of Japanese company); acquisition of key personnel on the labour market; contracting out specific tasks; and alliances. The viability of each mode depends on generating intelligent cooperation of knowers (the people who possess the capacity to do what your organization believes it wants done) and each carries its own costs and benefits. Effective communication and cooperation depends on social processes. Yet, the importance of the social dimension only becomes apparent when somebody does something that offends against the institutional rules of practice. The social dimension is a vital, but frequently under-acknowledged, tool of effective management. On this account, Mark Lengnick-Hall and Cynthia Lengnick-Hall's 'HR's Role in Building Relationship Networks' (2003; reproduced here as Chapter 14) is of particular interest. It explains how HR professionals can orchestrate six types of relationship that enable the pursuit of competitive advantage. Effective communication depends on alignment of tacit knowing: the capacity to read information signals in a similar way. Building effective relationships is a vital part of coming to appreciate what other people know and extent to which their knowledge might be of interest to you.

Can you Tell Me How to be Smart?

Dorothy Leonard and Walter Swap sound as they are a smart couple: they are respected US academics – she is a professor at Harvard Business School, while he holds a chair at Tufts University – and they are married to each other. Moreover, they have written a book *Deep Smarts: How to Cultivate and Transfer Enduring Business Wisdom* (Leonard and Swap, 2004a) and an article in *Harvard Business Review* (2004b; reproduced here as Chapter 7) that deal with the problem of transferring business expertise to other people. What they call 'deep smarts' (a deeply smart insight), is not the sort of thing that can be transferred in a series of PowerPoint slides or by downloading data:

> *When a person sizes up a complex situation and comes to a rapid decision that proves to be not just good but brilliant, you think 'That was smart.' After you've watched him do this a few times, you realise you're in the presence of something special. It's not raw brainpower, though that helps. It's not emotional intelligence, either, though that too is often involved. It's deep smarts, the stuff that produces that mysterious quality, good judgement. (Leonard and Swap, 2004: 88)*

To be sure, it's hard to argue against the importance of good judgement: but how is this mysterious quality to be nurtured and managed with regard to organizational and other activities? An instruction manual that merely says, 'Work out what good judgement is and be sure to apply it at all times' would not be much help. Calls to identify and use 'best practices', or managerial edicts to ensure that employees always aspire to 'best practices', can be irritating. Moreover, these bland slogans often dodge the tricky question of how to define 'best' in concrete, measurable terms. What sense is a manager to make of a trusted colleague who suddenly fails to meet expectations? Is it reasonable to assume that he or she is simply having a bad day or does the problem run deeper? Have that person's circumstances changed (for example, as a result of non-work commitments), or is there some change in the nature of the job that undermines the value of yesterday's 'best practice'? A person might be doing his or her best in changed conditions that require new or different practices and fresh thinking. Without a clear understanding of the person and the various contexts that shape his or her capabilities, aspirations and problems, it is difficult to make an informed judgement.

A part of the manager's problem is that what Leonard and Swap call 'deep smarts' – the capacity to act and think in a wise and insightful manner – are difficult to imagine in the abstract: you have to be familiar with the context in which a particular person was being smart. To the uninitiated spectator, skilled practice enabled by 'deep knowledge' can be more or less indistinguishable from mediocre or downright poor performance. A casual or uninformed glance might not be sufficient to differentiate between the skilled action of the expert and the lucky guess of a novice. Even the most well-intentioned or heroic attempt to 'rise to the occasion' might, if it is taken out of context, come across as a bungled, last-minute scramble. Separating 'snapshots' of actions from their appropriate context can seriously misrepresent what those snapshots meant to people at that particular time and place. What appears to be smart today might turn out to be less impressive tomorrow, and vice versa.

Intuition, hunch and 'gut feeling' all represent the type of knowledge – born from experience – that might help people to 'read' the signs and respond appropriately. For example, an experienced doctor's 'inspired guess' can be a lot more useful than the novice's 'hard information' – even if the latter is supplied in huge quantities. As insiders come to know 'what is what' in a particular context, they develop a 'sixth sense' of what might happen next and, in normal circumstances, are rarely surprised. In contrast, novices who have only grasped part of the picture might be entirely confident until a 'killer fact', which they have hitherto overlooked, forces them to reassess their position.

In an effective example of what KM might miss, Flyvbjerg illustrates how focusing on the rules of practice can conflict with the skilled execution of practices based on those rules:

> *Some years ago in the USA, an experiment was conducted on a group of paramedics. Video films were made of six persons administering cardiopulmonary resuscitation (CPR) to victims of acute heart failure. Five of the six were inexperienced trainees just learning CPR, while the sixth was a paramedic with long experience in emergency life-saving techniques. The films were shown to three groups of subjects: paramedics with practical experience, students being trained in this field, and instructors in life-saving techniques. Each subject was asked the following question: 'Who of the six persons shown in the films would you choose to resuscitate you if you were the victim of such an accident?' Among the group of experienced paramedics, 90 percent chose the one experienced paramedic from the films. The students chose 'correctly' in only 50 percent of the cases. Finally, and perhaps surprisingly, the instructors in resuscitation had poorer results than either the experienced paramedics or the students, choosing the experienced paramedic in only 30 percent of the cases.*
>
> *What form of rationality led the instructors to achieve such a poor performance? And what mechanisms lay behind the experienced paramedics' well-developed ability to choose correctly? (Flyvbjerg, 2001: 10)*

Flyvbjerg makes the point that the experienced paramedics are 'experts' who have a familiarity with the task in hand. Competent practice involves tacit knowing: one practitioner can recognize the expertise of another without being able to say exactly what it is that he or she is recognizing. Practice cannot be reduced to rules and undue attention to rules can distract from the 'flow' of competent performance. For example, people who become preoccupied with why it is not possible to detect individual frames in the movie that they are watching, might be distracted from subtle nuances of plot.

The Readings

The remainder of this book is divided into two principal sections: Part 1: Key Concepts and Part 2: Knowing in Practice. Part 3, entitled Revising the Agenda, comprises an extended chapter that reprises the Japan theme that underpinned Ikujiro Nonaka's influential work on tacit–explicit knowledge-conversion. Chapter 15 'Tacit Knowing, Communication and Power: Lessons from Japan?' emphasizes potential insights that might be gained by paying appropriate attention to Michael Polanyi's original work on tacit knowing and considers how these might be related to communication, meaning and the practice of power. It concludes that the KM agenda has embraced some unfortunate misunderstandings of the type that have been outlined above. Arguably, more account should be taken of how the capacity

to 'know how to do things' and imagine a difference is aligned with the power to make a difference.

Broadly speaking, the readings in Part 1 reflect two distinct themes in the development of management and business knowledge. First, Japanese propositions – advanced by Nonaka and his colleagues – that 'tacit knowledge' could be converted into 'explicit knowledge' and communicated from one context to another (Chapter 2). If this were the case, experience of 'how do things in a particular context' (practical know-how, judgement, intuition, gut feelings, and so on) could be converted into 'explicit knowledge' and managed. However, a second theme, which embraces conceptual aspects of knowing-in-practice, is evident in Chapters 3–6; albeit with different twists that reflect the evolution of debates since the late-1990s.

The readings in Part 2 reflect different aspects of the human dimension to managing people who know things. Throughout human history, knowing how to do things and change things has been intertwined with the practice of power. However, the advent of the bureaucratic organization and expectations that social science should be 'scientific' or 'as objective as possible' have tended to overshadow the crucial issue of knowing how to make a difference. Take, for example, the economic theory of perfect competition: there are a large number of buyers and sellers, everybody knows everything about everyone else and there is only one price – nobody can change anything. As McNulty (1968: 640) has argued, the perfection of this model of competition is achieved by separating competition from the verb 'to compete'. KM has enjoyed some success is establishing a preference for the noun 'knowledge' as opposed to the verb 'to know'? But should this be regarded as progress?

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