Supporting organisational knowledge work: Integrating *thinking* and *doing* in task-based support.

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1. Introduction

Over recent decades there has been increasing acknowledgement of the importance of "knowledge-work" and "knowledge-workers" in our society. Improving knowledge worker productivity is now recognised as being the biggest challenge for management in the 21st century (Drucker, 1999; Newell et al, 2002; Davenport, 2005). Numerous scholars and practitioners have taken up this challenge, and in doing so have provided many new insights into the nature and complexity of knowledge work. Of particular note is Davenport's (2005) classification scheme based on two significant dimensions of knowledge work: (i) the level of interdependence – whether the work is performed by individuals or groups; and (ii) the complexity of work – the degree of cognitive activity such as interpretation and judgement required to perform the work (see Figure 1).

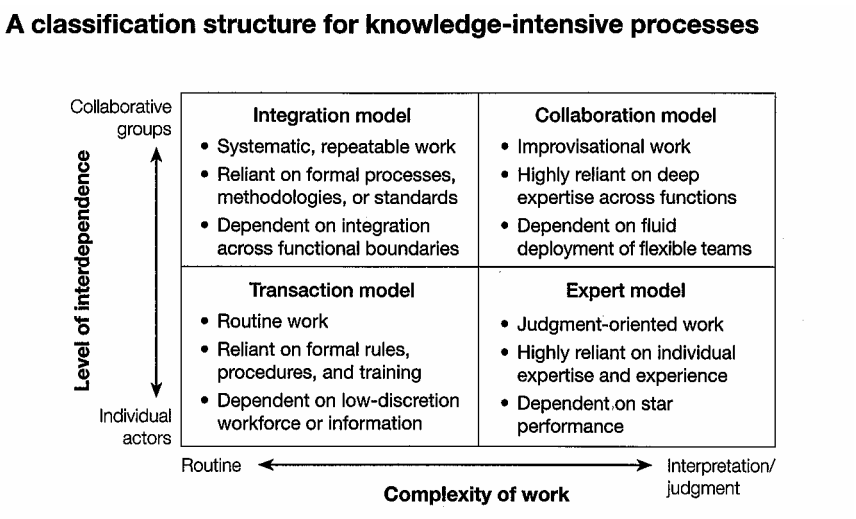

Figure 1: Davenport's classification structure. (From Davenport 2005)

This table provides a very useful way of classifying different forms of knowledge work. This form of classification then provides a basis for guidance as to how best to engage with each form of knowledge intensive process (Davenport 2005).

However, this form of classification has significant weaknesses. Implicit in the table is the assumption that a particular form of knowledge work is situated solely at one position in this matrix. In other words, this model assumes that knowledge work must exclusively break down to one of these four categories. But as this paper shows, some complex forms of collaborative knowledge work do not fit this model very well, not only crossing the boundaries of the above table, but being composed *simultaneously* of opposing quadrants of this model.

This paper focuses on what Davenport (2005) terms the *Integration Model* of knowledge work: relatively routine collaborative knowledge work. The main purpose of this paper is to look at the requirements for supporting this form of work, which we term *organisational knowledge work*. This type of knowledge work involves groups of participants working together on particular, well-defined collaborative tasks. These tasks are routine in the sense that they accord with Davenport's description: they involve systematic, repeatable work; they are reliant on formal processes; and they are dependent upon integration across organisational boundaries. However, as this paper shows, work that falls into this category may still be cognitively demanding, may involve complex and precise technical judgements, and may involve a high degree of professional expertise. As such, although organisational knowledge work may initially seem to be routine, since it follows a fixed schedule and accords with strict standards, it may in fact involve a high degree of individual expertise and experience and a high level of judgement-oriented work. Thus, elements of Davenport's *Expert model* may also be required for describing this form of collaborative work.

This study focuses in detail upon a particular organisational knowledge work setting that exemplifies this form of knowledge work. It draws principally from a series of empirical studies into knowledge work settings conducted at the Australian Bureau of Meteorology, looking in detail at the production of weather forecast products.

These studies show that the work of weather forecasters involves a complex interplay between collaborative-routine (*Integration model*) work and individual-interpretation (*Expert model*) work. The work routine of the weather forecaster is regulated by a formal work schedule that adheres to strict protocols, relies on formal processes, and depends upon integration across functional boundaries – we refer to this aspect of task performance as the ***doing***. It thus seems to be a classic case of work that follows the *Integration model*. However the formal, routine work of the weather forecaster is just one dimension of the complete activity undertaken required to perform the task of forecasting. As well as the routine work, a forecaster is continually engaged in expert judgement-oriented work, which required a high degree of expertise. This involves the constant monitoring of the evolving weather system by individual forecasters, repeated checking and interpretation of guidance data, and highly skilled judgement regarding the application of this data – we term this aspect of task performance as the ***thinking***. The studies revealed that the forecaster's work involves integrating both the *doing* and *thinking* dimensions of the forecasting task, and as such involves the exercising of complex judgements within the parameters of routine task performance. The classification scheme of Davenport (2005) is thus incomplete with regards to organisational knowledge work, since it essentially separates these two dimensions and fails to recognise the complexity of the way individuals perform when they are involved in technical collaborative tasks.

The main conclusion of this paper builds on these empirical results, by emphasising that effective knowledge work support must involve the integration of the *doing* and *thinking* dimensions of knowledge work activity. Knowledge work support must therefore effectively support both the productive and cognitive dimensions of knowledge work.

2. The Task-based Approach

The approach adopted here is built on the theoretical framework of the Task-based Knowledge Management (TbKM) approach pioneered by Burstein & Linger (2003, 2005). The TbKM approach focuses on *knowledge work*, not *knowledge* as the object of knowledge management, and is characterised by the following elements:

- a task focus – a focus on actual work practices in the context of task performance
- a task based model of knowledge work – conceptualising knowledge work in terms of a task-based focus
- a community of practice – the basis of collaborative task performance in an organisational context
- an organisational memory – a central component of a knowledge work support system, necessary for collaborative task performance and organisational learning
- task outcome – including both the tangible and intangible results of task performance
- knowledge work support – the primary goal of TbKM

(Burstein & Linger, 2005)

In following the TbKM framework this paper adopts an approach somewhat different to the standard approaches of KM discourse. Rather than focusing on the *management* of knowledge in an organisation, as most KM strategies tend to, the focus of the Task-based approach is on *supporting* knowledge work in an organisational setting. This distinction is significant, in that the emphasis is on supporting human task performance, rather than on the management *per se*.[1] The approach here also contrasts with much of the literature on knowledge work. For example, Newell *et al* (2002), one of the most thorough recent accounts of the issues surrounding knowledge workers, almost entirely concerns the *management* of knowledge work, and as such embodies quite a different attitude to knowledge work to that adopted here.

The distinction between support and management here is subtle, but crucial, for it turns on fundamentally different conceptions of knowledge. The traditional approach to KM tends to focus on the management of knowledge as a *resource* or *commodity* that can be codified, captured, stored, and henceforth managed, in the same way that many other resources can be managed. In contrast, the approach here views knowledge as a *process* rather than as a commodity. The focus is thus on supporting and enhancing this process, by supporting expertise and enhancing capabilities. Rather than being concerned with the traditional problems of KM, such as definitions of knowledge, the tacit/explicit

[1] In this sense the "KM" part of the label TbKM is clearly inappropriate – it should perhaps be called Task-based Knowledge-work Support (TbKwS). However since much of the work that this study is based on refers to this approach as TbKM we shall maintain that terminology here.

distinction, the storage, retrieval, and sharing of knowledge, etc. this approach is concerned with more pragmatic questions concerning task performance in an organisational setting. By putting human processes at the centre of our approach, rather than knowledge, we can focus on the specifics of task support, leading to a more practical, and ultimately, more effective way of enhancing knowledge work.

The TbKM framework focuses on knowledge work as a *collaborative activity* (Iivari & Linger 1999). As such it applies best to organisational contexts that involve collaborative knowledge work. The definition of knowledge work adopted by the framework follows from Iivari and Linger (1999), who characterise knowledge work as having the following characteristics:

- it is based on a body of knowledge,
- entails working on representations (data) of the objects of work
- stipulates typically a deep understanding of the objects of work, and
- the outputs of which entail knowledge as their essential ingredient.

This paper adopts this approach to defining knowledge work, and knowledge workers. The form of knowledge work of interest here involves all of these components, is a collaborative activity involving communities of practice, and knowledge workers are those engaged in such knowledge work.

The TbKM framework is built around the task-based model of knowledge work illustrated in Figure 2. This framework conceptualises the task of knowledge- work activity as being composed of two levels: the *pragmatic* and *conceptual* levels. The framework integrates two levels of understanding of the task as the central component of the activity system:

- The *Pragmatic* level, representing actual work practice and the work that needs to be done.
- The *Conceptual* level represents a more generic, abstract perspective on the task expressed in terms of the overall objectives of the task performance process and related concepts and structures.

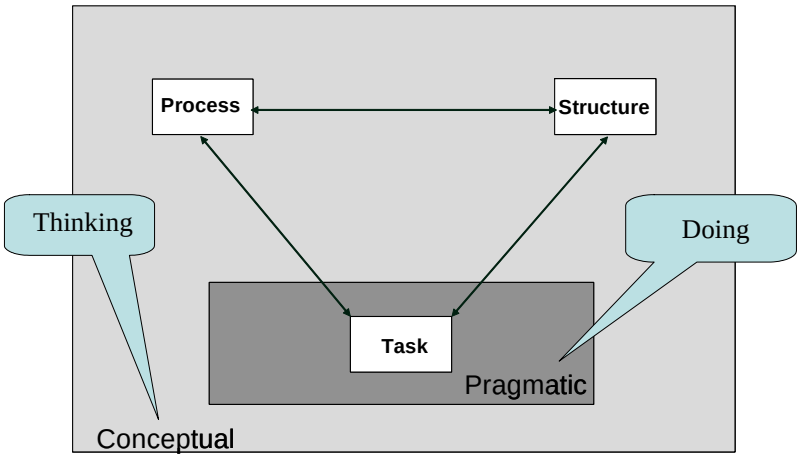

Figure 2: A task-based model of work (adapted from Burstein & Linger, 2003)

One of the key insights of the TbKM approach is that it emphasises the importance of integrating *thinking* and *doing* in task performance (Linger and Burstein, 2001). The TbKM approach conceptualises this clearly in its theoretical model of knowledge work by embedding the *doing*, the performance of a task, as a pragmatic layer within a broader conceptual layer that encompasses the *thinking* dimension of the task.

According to the TbKM approach, building a knowledge work support framework requires comprehensive study of the work activity system in question, focusing on the knowledge work task performance. The approach then builds from the bottom-up, developing a rich conception of the knowledge work task from this detailed investigation into collaborative task performance in the work activity system. Only once this conception has been derived is it possible to establish the requirements for knowledge work support.

In effect TbKM is essentially an implementation of a *knowledge work support system (KWSS)* that systemically preserves knowledge of each instance of the task in a dynamic memory system. In order to support knowledge work, this memory includes the pragmatic outcomes as well as the knowledge created through task performance. Effective utilisation of this memory is facilitated by TbKM functionality such as reasoning, memory aids, explanation facilities and learning capability. Moreover, the TbKM approach is consistent with reflective practice in that actors are encouraged to reuse and create knowledge through learning as an integral part of the task (Schön, 1991).

3. The case study – knowledge work in the Australian Bureau of Meteorology

The case study drawn from here was part of a knowledge management project conducted by researchers at Monash University in collaboration with key personnel from the Australian Bureau of Meteorology (Linger *et al*, 2001). Broadly, this project aims to improve meteorological services through the application of knowledge management to the forecast process (Ryan, 2003). The TbKM approach was applied in this case to develop a model that incorporates the forecasters' explicit, tacit and experiential knowledge, and allows forecasters to share knowledge and learn from their collective experience. As part of this broader project a series of field studies were undertaken in regional offices of the Bureau of Meteorology, investigating the details of the task of weather forecasting.

Following the TbKM approach in the case of weather forecasters entailed a need to understand how the details of the forecasters' working routine contributed to the overall aims of their profession. This essentially involved identification of the *task*, the primary object of their work, which forms the central component of the TbKM approach. This includes observing the how forecasters actually work, and how weather forecasts are written, thus providing a detailed understanding of how forecasters, as knowledge workers, perform and achieve their professional goals. The approach taken was a form of ethnographic study of a knowledge work setting (Schultze 2000), involving observational data collection, informal conversation, formal interviews, questionnaires, and feedback sessions.

Typically the studies both looked at *how* a particular tool was being used by a forecaster, and inquired as to *why* she was using that tool for the particular activity. This form of analysis involved a larger degree of interpretation, appealing to theories of sensemaking (Weick, 1995) and inscriptions (Latour 1990), delving into the cognitive and organizational processes that underlie the pragmatic performance of activities. As such, this approach provided a deep insight into the nature of the task being undertaken, because it revealed the reasons and purposes underlying each particular activity. An analysis of *interactions* between the forecaster and other actors was also important here, because the questions resolved by the interactions provided insights into the sorts of underlying processes that the forecaster was engaged in. These empirical studies thus

provided immense detail as to how the forecasting task is performed. Some of the key findings included the following:

- the evolving ‘mental picture’ of the weather system in the forecaster’s head is of paramount importance to forecasting
- the interactions between forecasters is a significant factor in the forecast process
- forecast products continue to be time consuming activities as an enormous amount of time was spent manually editing products, even though this is now done online: it is a very slow process of retrieving the previous version of each product and typing the edits to form the updated product
- the forecast process is consistently disrupted, including external phone calls and the need to produce non-standard forecasts
- the forecaster’s ‘expert knowledge’ of their domain, including their knowledge of local geography and topology, is a key element in forecast construction
- the forecaster’s expertise is an expression of their training and extensive experience rather than the volume and diversity of data

(Linger & Aarons, 2005)

The studies thus showed that forecasting is not only dependent on data but is a complex socio-technical activity that is also knowledge intensive.

As a result of these studies a conceptual model of “the task” of forecasting was defined (Aarons et al, 2005). What the studies ultimately revealed was that the forecasting task can be perceived in two different but intricately related ways:

1. a *product* based view (pragmatic - *doing*): focusing on the outcome of each activity, the particular forecast product that is output at the end of each work-phase; and
2. a *cognitive* based view (cognitive - *thinking*): focusing on the underlying group activity of the forecasters, involving the continuous maintenance of their understanding of weather and guidance data (this is referred to as the *forecast policy*, and this activity is referred to as *policy maintenance*).

Rather than being seen as two different activities, these two views should be seen as being two different aspects of the same overall task, much like two sides of the same coin.

These two dimensions of the forecasting task correspond to the *pragmatic* and conceptual layers of the task-based model of work adopted by TbKM (as in Figure 2). Both of these conceptions can be illustrated with reference to the observational data, by plotting the various activities undertaken throughout a forecasting shift as in Figure 3. This form of data presentation reveals how each activity contributes to each particular component of the task, and shows how the two conceptions of the forecasting task relate to each other.

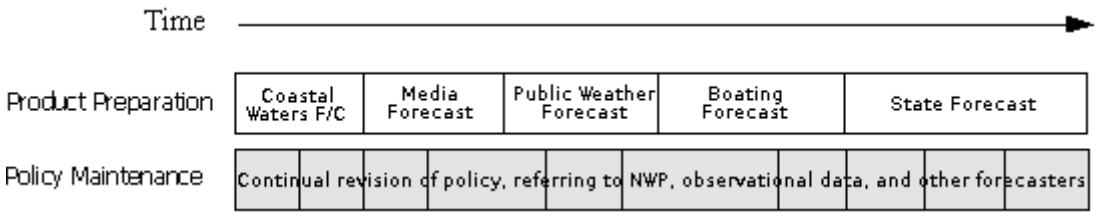

Figure 3: Two conceptions of the forecasting task (From Aarons *et al*, 2005)

For example, in writing a particular forecast, such as a Coastal Waters Forecast (which is issued every 6 hours) the forecaster goes through a series of fairly routine steps, looking at certain guidance data, using particular forecasting tools, and issuing a forecast following a standard template. However, when preparing such a forecast the use of a particular tool, such as looking at a satellite image, contributes to that particular product, but also contributes in a broader way to updating the forecaster's general understanding of the weather system. Many forecasting activities were seen to contribute to both product preparation (*doing)* and policy maintenance *(thinking).* Some activities seemed to play a role in only one conception – for example, the hand sketching of synoptic charts does not contribute directly to product preparation yet is definitely an integral part of the way forecasters develop their mental model of the weather system.

The studies also revealed that the *thinking* dimension of the forecasting task was often overlooked in the forecaster's own understanding of their work. The forecasters themselves generally conceived of their own work as being entirely routine as per Davenport's *Integration Model*. They thought of themselves purely as forecast writers, and had no conception of the importance of many of the difficult cognitive activities they were engaged in while writing the forecasts. As a result, the cognitive *thinking*

dimension of forecasting work is still not very well understood, and is often invisible in formal accounts of the forecasting process. In contrast, the *doing* dimension – the *product based* view, which focuses on the pragmatic details of product preparation – is well understood, and has been described and documented in previous studies (Bally 2001; Linger & Burstein 2001).

A further consequence of this was that the emphasis of system development was on supporting the *doing* dimension of the forecasting task, while largely ignoring the *thinking* dimension. This was most clearly apparent in the way that the new forecasting tools were configured for the forecaster to work with. Although the new tools could produce excellent forecast products, including both the traditional forecasts as well as a whole new range of graphical products, they were not well configured to accommodate the way forecasters actually constructed these forecasts. As a result, forecasters tended to write forecasts using their traditional tools, then import these forecasts into the new forecasting systems, effectively doubling the amount of work required to write a forecast rather than reducing it as the new systems were designed to do. Thus the new tools failed to become accepted amongst forecasters, and ultimately failed to replace the more traditional systems.

Interestingly, the few cases in which new tools were developed successfully they tended to be built explicitly to support the *thinking* aspect of the forecasting task, while still being of clear applicability to the *doing* dimension of forecasting. The most spectacular example of this was the development of a meteorological data viewer known as "Kenny". Kenny, who in the early stages of development tended to die once every day, was a small unofficial side project of a small number of forecasters, that spread like a virus through the organisation. Its success was mainly due to the fact that it was built to do exactly what the forecasters wanted to do – view a lot of data through a unified interface with a very quick response time. Its design mirrored the way forecasters thought about their work, and thus was readily adopted by forecasters. It is now an essential part of all forecasters' work, and plays a central role in both the *thinking* and *doing* aspects of the forecasting task. In essence, Kenny has become a superb knowledge work support tool, since it provides excellent support to the forecasters in both the pragmatic and cognitive aspects of their task.

In summary, what the Bureau of Meteorology case study showed with respect to knowledge work support is that, in this case, the knowledge work task involves both a pragmatic (*doing*) and cognitive (*thinking*) dimension, and that effective knowledge work support must incorporate and integrate both of these dimensions. It also showed how easy it can be for the cognitive (*thinking*) dimension to be invisible to both the knowledge workers themselves, and to those who provide support for them.

4. Conclusions

What this study confirms is the importance of recognising the two dimensions of knowledge work, and of addressing both these dimensions in knowledge work task support. It also shows the applicability and utility of the Task-based KM framework in a collaborative knowledge intensive organisational environment.

One question that is raised concerns the broader applicability of the results of the case study: Is the case study of weather forecasters unique in the way that knowledge work consists of two dimensions, or is this fairly typical of organisational knowledge work settings? Without further empirical investigation into a range of different settings it is difficult to give a definitive answer to this question. However, based on the experience from a number of case studies in areas such as defence, lexicography, immunology, epidemiology, and banking (as summarised in Burstein and Linger, 2003), it is clear that the TbKM framework has broad applicability to a wide range of organisational knowledge work settings, and that each of these settings can be conceptualised according to the TbKM task-based model of work as illustrated in Figure 2.

The more general upshot in terms of the TbKM conception of knowledge work tasks is that the *doing* and *thinking* aspects of these tasks should be seen as two sides of the same coin, and that ignoring one of these dimensions entails an incomplete view of the knowledge work activity. What this entails is that effective knowledge work support thus must involve the successful integration of these two dimensions, in order to fully support knowledge work tasks.

All of this reveals a crucial weakness with Davenport's (2005) influential characterisation of knowledge work. It is clear that Davenport's characterisation of the *Integration Model* is at best incomplete, and at worst fatally flawed. For this paper has

shown that work that accords with the *Integration Model* is far more complex than Davenport's scheme allows for – thus his model incomplete. But also, this paper has shown that the separation of routine-collaborative work and expert-individual work into opposing quadrants does not make any sense for the sort of organisational knowledge work discussed here. Thus there seems to be a fundamental problem with Davenport's classification scheme.

Of course, Davenport is well aware that his classification scheme is far from perfect, as he makes abundantly clear:

> "I have tried for years to develop the "perfect matrix" for distinguishing amongst knowledge workers, and have come to the conclusion that it doesn't exist. There are simply too many important ways in which knowledge work differs to reduce the variations to two dimensions." (Davenport, 2005: 26)

To defend Davenport, just briefly, the classification scheme in Figure 1 does provide a useful taxonomy of the different forms of knowledge work. As a tool of *classification* it seems pretty good, even taking into account Davenport's own reservations. However as a tool of *analysis* it is deeply problematic, since it obscures the true complexity of knowledge work contexts. In particular, Davenport's scheme gives no account of the relationship between the pragmatic and cognitive dimensions of knowledge work (let alone integrate them), and gives a flawed account of the relationship between individual and group knowledge work in cases of collaborative activity.

In closing, it is worth emphasising that the sort of organisational knowledge-work discussed in this study has largely been overlooked in the knowledge-work literature to date. There seems to be a bit of a blind spot as far as this form of work is concerned. The emphasis of much of the present material on knowledge-work is on individual knowledge-work, and much of the material on knowledge-work support places a huge emphasis on personal knowledge management (PKM). Even in cases where collaborative organisational-based knowledge work is discussed, it is rarely investigated in much detail. Yet this form of work is not only extremely common, it is also one of the most significant forms of knowledge work in our society. Thus it clearly warrants a lot more attention than it currently receives.

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