The multi-tasking paradox: perceptions, problems and strategies

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Abstract

Purpose – The purpose of this article is to describe multi-tasking behaviour in the workplace; to link its cause to the increasing prevalence of low-cost information and communications technologies and to the changing organizational structures that have evolved to meet the demands and opportunities of these technologies.

Design/methodology/approach – This article is a presentation of the current literature on multi-tasking behaviour among knowledge workers with a selective bibliography addressing empirical research into the behavioural, managerial and technological aspects of this phenomenon. It then expands to comprehensive coverage of the literature on past and current thinking about task structuring, strategies for coping in a multi-tasking environment and the changing nature of work and organizations, which fuels the need to multi-task in response to these changes.

Findings – Among knowledge workers, multi-tasking behaviour appears to be an inevitable consequence of the presence of increasingly easy access to information. Despite the detrimental effect that multi-tasking has on specific task completion, the paradox is that this does not seem to have an effect on overall organizational productivity. For the USA at least, an average 4 per cent growth rate over the past several years of the late twentieth and early twenty-first centuries shows that productivity has increased in tandem with an increase in multi-tasking behaviour and information technologies.

Practical implications – Multi-tasking behaviour needs to be understood in the context of its manifestation as a variable that is at least partially dependent on the existence of relatively "cheap" information. In essence, in an information economy, task completion by knowledge workers to a set deadline may be counterproductive to the interests of the organization as a whole. This article describes certain strategies that can be used to minimize the harmful aspects of continuous task switching and to maximize the returns to experience that multi-tasking can bring to an organization.

Originality/value – Multi-tasking behaviour and its link to complexity theory may lead to a new understanding of organizations as highly fluid and variable entities that are impossible to design or maintain centrally and yet whose goals lead to the moment by moment creation of micro-organizational structures that accomplish tasks in a manner that engages the full resources of knowledge workers.

Keywords Communication technologies, Organization structures, Task analysis

Paper type Conceptual paper

Introduction

There is currently a perception and real problem among "knowledge" workers facing increasing amounts of fragmented, simultaneous activity, plagued with frequent interruptions and numerous inputs from their electronic gadgets; in other words, the problem of multi-tasking. Modern information and communication technologies are

Management Decision
Vol. 46 No. 9, 2008
pp. 1313-1325

0025-1747
DOI 10.1108/00251740810911966

seen as the main culprits in this proliferation of divided and limited attention spans. However, some workers also argue that the changing demands of the workplace make multi-tasking essential and unavoidable (Freedman, 2007).

The popular press (e.g. Wallis and Steptoe, 2006) has covered associated work-life balance issues and also the problems associated with multi-tasking at work such as the increased amount of stress, loss of focus and performance declines that multi-tasking workers are experiencing. To cite just two famous examples, Hallowell states that constantly switching tasks causes sub par performance at work and symptoms similar to Attention Deficit Disorder (Hallowell, 2005). Freedman also cites another study from a psychologist at King's College, London, who found that the constant stimulus by e-mail and other such communications technologies temporarily lowers IQ by ten points, the equivalent of not sleeping for one night, (Freedman, 2007).

However, contrary to what one might conclude from the above, there is a paradox: concurrent with the introduction of information technologies, productivity has increased markedly since the early 1990's and continues to increase to this day. As Freedman (2007) states in his article "What's next: taskus interruptus", a worker in the insurance industry could be expected to contribute $85,000 to his or her company in 1991, whereas today, with the ability to handle dozens of simultaneous case loads on the computer, such a person is expected to contribute $250,000 per year.

This article will explore the various perceptions and effects of multi-tasking as it is currently understood in the literature, including proposed causalities and empirical studies that are relevant to this phenomenon. Furthermore, we will explore how the current perceptions of multi-tasking as a necessary evil may not be the hindrance to productivity, as opposed to task completion, that one might conclude.

The increasing prevalence of multi-tasking in the workplace

It is common knowledge that multi-tasking is an increasingly sought-after skill in prospective employees, whether skilled or not. The following example illustrates this trend:

> Console requires multitasking with a fully integrated fire/trouble, burglar/trouble, panic/duress, intrusion/detection, and access control system (Yale University, n.d.).

This trend in employment recruiting is so common today, that an internet-based search of the terms "job description" and "multitasking", performed using Google, yielded over 1.2 million hits. Similarly, a search on the Monster.com (USA) website, using the search term "multi-tasking", yielded over 5,000 job positions (both searches, Oct, 2007).

Although most knowledge workers would agree that multi-tasking does increase task completion time, most will argue that the changing demands of the workplace make multi-tasking unavoidable. For example some fear that they might miss something: "don't let anything fall through the cracks", most will never let an email go unanswered (González and Mark, 2005).

The prevalence of multi-tasking: causes

The increasing phenomenon, since the 1990's, of multi-tasking behaviour among knowledge and other workers in member countries of the Organization for Economic Co-operation and Development (OECD) is undeniable. Most sources indicate that this is a necessary consequence of having to work within more flexible organizational forms

that are more suitably adapted to their acquisition and use of increasingly powerful information and communication technologies (ICT) (Boucekkine and Crifo-Tillet, 2003). It has also been demonstrated that organizations are more likely to benefit from increased productivity if they adapt their organizations and procedures to a more flexible model to accommodate the introduction of ICT (Boucekkine and Crifo-Tillet, 2003). These adaptations include: the " . . . flattening of organizational hierarchies . . . ", increased teamwork, unstable organizational structures, informal and vague job descriptions and the requirement that employees contribute to numerous, variable and non-standard tasks in semi-autonomous teams that are part of a network of interconnected teams, whether within or outside the organization (Powell, 2001).

Further proposed causes of the increase in multi-tasking behaviour include changes in worker preferences toward greater task variety and advances in "human capital" (from increased and continuous training) resulting in increased worker versatility (Lindbeck and Snower, 2000). More importantly, this development of "a new logic of organization" is seen as a response to the changing and less clear boundaries of organizations as they explore ". . . new technologies, new partners and new markets" (Powell, 2001).

The relatively new availability of cheap and abundant information, combined with the easier diffusion of ICT has increased "informational task complementarities", that is, the skills and tools used for one informational task and the concomitant experience gained by one worker can be applied to other similar tasks by the same worker (Boucekkine and Crifo-Tillet, 2003). An example of this includes the increasing demand on information workers to multi-task on multiple and parallel collaborations and on tasks of varying complexity in both collocated and geographically dispersed environments, and from job rotation situations, (González and Mark, 2005).

In the knowledge-based economy, shifting priorities, increasingly demanding customers, short product life cycles and rapid innovation oblige information workers to adopt a strategy of handling an increasing number of simultaneous projects, despite the consequent increase in time to completion (Leach, 2000) due to the fluidity of priorities and outcomes that are unavoidable in the current working environment, (Freedman, 2007). Additional observations of this phenomenon include the larger distribution of work once reserved for top-level managers, i.e. increases at the worker level in the variety and fragmentation of tasks, aggressive deadlines and constant interpersonal interactions (Lindbeck and Snower, 2000).

More negative explanations exist for the prevalence of workers who will accept multi-tasking as the norm. These explanations link the new conception of work and organizational structures with increasing job insecurity, the threat of downsizing and an increasing focus on performance evaluations based strictly on results and outcomes rather than seniority (Powell, 2001). A study on the causes of wage disparities in the US (Parama, 2003) has shown that workers who have entered the labour force more recently have a ". . . steeper experience-wage profile . . . " which may be due to their ability, through technology, to take on more (relatively substitutable) tasks, i.e. their ability to earn more, and faster, and is an incentive toward favouring a multi-tasking working environment with less emphasis on specialization.

More fundamentally, the nature of work itself has undergone a radical transformation; from the linear time notion that the organizational priority is to accomplish a "finished work" prior to moving on to the next task, to the current idea

that "... today's top priority is to immediately address whatever fraction of a vast, malleable range of tasks has become most critical – a just in time, networked work style [sic]" (Freedman, 2007).

This change that affects the organizational structure has been described as a change from a "Tayloristic" to a "Holistic" organizational model (Lindbeck and Snower, 2000). A good description of Taylor's approach is described as follows (Shingo, 1987):

> Taylor advocated three stages: (1) understanding the status quo from a time perspective, (2) improving operations through a rigorous study, and (3) using the standard performance times required for optimized procedures for production management as well.

At first, Taylor's approach, based on a specific focus on efficiency led to "... high productivity, high wages, and low cost ..." (Shingo, 1987), however, this approach was the first to contribute to the "... monotonous, fragmented jobs of traditional organizations ..." (e.g. assembly-line work) which have contributed in the past to worker resentment and to the existence of powerful trade unions and labour conflicts (Lindbeck and Snower, 2000).

In contrast, the Holistic approach includes a movement away from traditional organizations whose almost exclusive purpose is the coordination and promotion of highly specialized skills necessary for the well-defined and limited-scope of tasks, to a type of flexible organization that allows for the possibility of workers to expand their capabilities and to develop multiple aptitudes for multiple assignments (Boucekkine and Crifo-Tillet, 2003; Lindbeck and Snower, 2000). Thus the entrée and genesis of multi-tasking.

Multi-tasking defined

It is common knowledge that during any typical day most knowledge workers in the twenty-first century find themselves unable to complete the work they thought they were being paid to do. Since the early 1990's the ongoing changes in organizational structures described above were shown to require a multi-tasking model at the organizational level in order to capitalize on the benefits of ICT. On the employee level however, neat sequential transitions during job rotations or sequential task assignments within the same job are not the norm (Gonzalez and Mark, 2005).

Simply put, multi-tasking is the "ability to handle the demands of multiple tasks simultaneously" (Lee and Taatgen, 2002). Studies on human multi-tasking in the literature however, have been subdivided into two distinct typologies: task switching and Dual-tasking. Task switching or as originally named "mental set" by Jersild in 1927, can be defined simply as work fragmentation resulting from frequent switching between multiple and different activities (Pashler, 2000).

The notion of dual-tasking (also referred to in the literature as dual-task or multitask performance) is the actual process of performing two or more simultaneous tasks, for example, driving a car and talking on the phone (Pashler, 2000).

Related to dual-tasking is the new concept of "continuous partial attention". According to former Microsoft and Apple Computer executive, Linda Stone, "continuous partial attention" is quite simply "to pay partial attention – *continuously*". "Continuous partial attention" differs from multi-tasking only in the motivation that drives the behaviour. Individuals are motivated to multi-task out of a desire to be more productive, more efficient or both. Conversely, individuals pay

continuous partial attention out of fear that they will miss something (Stone, 2007). A good example of "Continuous partial attention" is student in-class internet surfing. Empirical data examining this critical issue will follow.

Empirical results on the effect of dual-task and multitasking on task completion

Past studies on dual- and multi-task performance indicate that a significant increase in the time required to complete tasks occurs when performing two or more tasks concurrently compared to when the tasks are performed independently (Pashler, 2000). One of the most widely held hypothesis addressing this limitation is that a "central bottleneck" occurs because cognitive processes do not allow for simultaneous cognitive operations (Oberauer and Kliegl, 2004). There is evidence supporting this hypothesis by performing experiments on visual search response times and errors in single and dual-task trials. In fact, this hypothesis has been the subject of much research over the last 50 years (Pashler, 1984).

However, inconsistencies have been observed suggesting that the hypothesis is flawed. In cases where individuals are highly skilled at both tasks, the decrease in productivity in dual-tasking is negligible (Lee and Taatgen, 2002). For example a recent experimental study on dual-task performance tested the hypothesis that with adequate practice, people can perform two cognitive functions without any notable reduction in performance. In this study six students "... practiced updating two items into working memory through two sequences of operations (one numerical, one spatial)...". The students were eventually able to perform the tasks simultaneously without any measurable drop in performance, although it took the students 24 practice sessions before this was achieved (Oberauer and Kliegl, 2004). A subsequent experiment also performed by Oberauer and Kliegl demonstrated that the tasks must actually be practiced simultaneously in order to eliminate any dual- task productivity loss. A new hypothesis is that "... there are no central cognitive limitations to parallel processing built into the cognitive architecture... " (Meyer *et al.*, 1995, Meyer and Kieras, 2003). According to the authors, the observed decrease in dual-task performance is attributed to the following three factors:

(1) "Peripheral interference due to common sensory or motor processes of the two tasks".

(2) "Lack of practice in combining the tasks".

(3) "Instructions that discourage simultaneous processing".

Therefore, individuals should be able to perform simultaneous cognitive operations without interference if the following three conditions are met:

(1) Motor or sensory overlap are eliminated.

(2) The individual is given sufficient practice at performing the tasks simultaneously.

(3) Instructions allocate equal priority to each task.

However, several experiments performed to test this hypothesis still identified a significant decrement in dual-task performance (Oberauer and Kliegl, 2004).

Empirical studies on partial attention and its effect on memory

As the concept of continuous partial attention is extremely new, no peer reviewed studies have been performed on the subject. Therefore, for the purposes of this article, we will provide applicable results from selected studies on multi-tasking to provide supporting information on the subject.

A recent study conducted by Basex Research, an IT market-research firm found that 55 per cent of workers open e-mail immediately or shortly after receiving it and 62 per cent of workers indicated that interruptions from friends during work are completely acceptable (Wallis and Steptoe, 2006). Furthermore, a recent study at Cornell University attempted to evaluate the effects of multi-tasking on students in the classroom also provides some crucial insight into the effects of partial attention. In the experiment, students from an upper level communications course were subdivided into two groups and tested immediately after a lecture. The first group was permitted to utilize laptop computers throughout the class, to browse the web or social network. The second group was not permitted to use laptop computers during the lecture. Tests results indicate that students permitted to use laptop computers "... suffered decrements on traditional measures of memory for the lecture content ..."(Hembrooke and Gay, 2003).

Multi-tasking and working spheres, an empirical study on task-switching and its management

More recently, multi-tasking in collaborative informational contexts has been investigated empirically by González and Mark (2004, 2005). Their findings indicate the very frequent need, on any given working day, for information workers to alternate between a multitude of different "working spheres" or "... collaborative contexts based on circumstances ..."

The working sphere description is seen as a way of distinguishing between collaborative relationships and the specific activities that the collaboration engenders, thus, a working sphere becomes a unit of work that involves three elements: a unique time frame, collaborative structure and a specific purpose, furthermore, distinctions were made between normal and urgent and central vs peripheral working spheres, with the latter two qualifying the degree or depth to which the worker is involved (González and Mark, 2005). In their study, 36 information workers or "informants" were shadowed by researchers that had the task of recording the details of any actions that were performed by the subjects while sitting with them in their cubicles for an average total time of 26 hours. All activities were recorded, including the use of ICT, note-taking and interpersonal interactions.

Three characteristics of multi-tasking were identified in the work of González and Mark (2005): to start with, "*Multi-tasking of working spheres is framed by the collaborations established with others*" (their italics), i.e. it was observed that collaborations with the same people can involve more than one working sphere (each one comprising a specific set of activities, goals and timeframe), thus, multi-tasking occurs when the total framework of working spheres must be managed with a single collaborator. Second, "*Multi-tasking often is characterized by spontaneity in the way that working spheres originate and are assigned to people*." Certain working spheres can arise spontaneously as emergencies, etc., and these sudden interruptions may require reassessing the entire set of priorities among other working spheres. Of equal

significance is the way that worker assignment to address these spontaneous events is given, i.e. at times without formal assigning by management (such as the use of project request forms and the necessary delay that goes with bureaucratic procedure). Finally, "... people *multi-task among collaborations and working spheres that have different levels of maturation*." More mature working spheres may have a complete and well-understood set of objectives, timeframe and activities; however, this does not mean that at any given time, all working spheres are as equally well-defined. The multi-tasking challenge arises from the need to manage (plan and obtain information on) different spheres at different levels of completeness. The results of this study by González and Mark (2005) are striking:

- The average number of working spheres per day (including all types described above) is 12.22 (s.d. 5.3).
- The average time spent in one continuous, uninterrupted segment on all types of working spheres before task switching (usually due to interruptions) was approximately ten and half minutes (s.d. 2.85 min.).
- The average total time per working sphere per day was: approximately 34 minutes (s.d. $\approx$ 12 min.).

The working sphere segments resulting from work fragmentation and interruptions are also divisible into a chain of discrete and concrete physical actions whose average duration was $\approx$ one and half minutes (s.d. 1 min. 25 sec); these actions included reading e-mail, phone calls and interpersonal interactions.

Strategies for managing interruptions

Further discoveries by González and Mark (2004, 2005) included the following three fundamental processes used by knowledge workers to manage the multi-tasking load as the working spheres evolve over time. First, there is a "... constant *renewal of overviews* of the working spheres ..." (author's italics), involving time spent, at times more than once a day, reviewing one's full set of working spheres and the status of each in terms of present priorities and local vs global perspectives. This may involve the use of prompting artifacts such as calendars and scheduling software to facilitate this process. Second, there is "... the adequate maintenance of a *flexible window of focus* over working spheres ...", that is, maintaining a certain portion of one's attention on the collective environment for cues in areas that are part of their assigned responsibilities, such as co-workers and their progress in order to allow adjustment of one's own work. This serves also to filter those distractions that may not be relevant to these responsibilities. Lastly, González and Mark (2004, 2005) include the "... management of transitions ..." which enables switching between working spheres. Distinctions were made between "natural transitions" and "forced transitions", the former resulting from a natural break in activity from one working sphere (waiting for an answer, etc.) and the latter resulting from interruptions. One strategy to deal with such interruptions involves a negotiation with the person interrupting to allow extension of the current working sphere to a natural transition point (such as finishing an e-mail and sending it prior to addressing the interruption). Other strategies included the preparation of physical prompts to facilitate the return to the task at hand. These empirical studies were significant and led to the following solutions to reconcile the multi-tasking paradox.

Considerations for the further development of technological solutions in support of multi-tasking behaviour

The majority of information technology tools and applications available today are designed to support individual tasks like preparing a document, spread-sheeting, data gathering or communicating (González and Mark, 2004). Several task management and personal information organization applications are available but there remains a general lack of applications that directly support human multi-tasking behaviour (Zacarias *et al.*, 2007).

Moreover, while computers themselves are able to run multiple applications, these applications do not address: information workers' tendencies to work on multiple collaborations, the fragmented nature of their work and the highly varied and continuously changing contexts of their multiple collaborations. New designs in IT should therefore address the following about *information workers* (González and Mark, 2005):

- They tend to "... switch between local and remote perspectives of their working spheres ..."
- They continually manage "... transitions between contexts due to interruptions".
- "... the states of awareness of their different working spheres ..." vary frequently.

Although still at the development stage, applications of information technology that address information workers' multi-tasking behaviours are being developed. For example, Microsoft® has begun working on an "intelligent office communication system" that can evaluate the relevancy and/or urgency of an incoming e-mail or instant message (IM). It then decides whether or not the e-mail or IM should be delivered immediately or delayed depending on the individuals' schedule that day, habits and relationship to the sender (interview with Czerwinski in Wallis and Steptoe, 2006). Other applications being developed include systems designed to limit the invasiveness of e-mails and IM. One proposed design involves an alert that appears on the corner of the screen providing the user adequate information for the user to decide if the interruption is worth responding to or not. This enigma requires a more flexible managerial system and organization.

The transformation to flexible organizations: managerial implications

As the continuing movement away from Tayloristic organizations to Holistic organizations continues, certain additional considerations at the managerial level must be taken into account. The boundaries between occupations have become more blurred; as a consequence, management must concern itself not only with performance but also with guiding the right worker on an appropriate learning/training program or on the job rotations that make optimal use of a worker's specific set of strengths. As hierarchies have flattened, decision-making is more and more left to those closest to the sources of relevant information (Lindbeck and Snower, 2000), i.e. to those workers who possess difficult-to-document "tacit" knowledge of a service, process or procedure (Laudon *et al.*, 2007). Managerial focus now also encompasses *ad hoc*, just-in-time team formations that address immediate organizational needs while allowing greater decision-making at the team level. As an example, job rotation is seen, not only as a means to further train an employee but to increase the "returns to experience" that

arise with the application of these new skills to multiple tasks (Boucekkine and Crifo-Tillet, 2003).

An added consequence arising from the decentralization of decision-making and greater information sharing that comes with the use of ICT and team work is that the supervision and control of workers, while still important, is becoming less focused on detailed and pre-set objectives and are therefore "... more closely associated with post-facto performance" (Lindbeck and Snower, 2000).Where does this data from empirical studies lead the complex and contemporary technological organization?

Discussion

While multi-tasking behaviour in the workplace has been increasing steadily since the early 1990's (Boucekkine and Crifo-Tillet, 2003), considerable disagreement persists, concerning the costs and benefits of multi-tasking behaviour to businesses (Zacarias *et al.*, 2007). As described above, empirical studies strongly suggest that multi-tasking (both dual-task and task-switching) decreases task performance by increasing task completion times (Pashler, 2000). In addition, a recent study by Basex Research, an IT market-research company found that the average (US) company loses 2.1 hours of employee productivity per day as a result of work interruptions and multi-tasking behaviour (Freedman, 2007).

The perception among some individuals however, is that because of changes in the nature of the workplace, multi-tasking is essential today. Customers, for example, are increasingly demanding. In an interview with David Freedman of Inc Magazine, Michael McLoskey, CEO of Front Range Solutions, customer-relationship management software and services provider gave the following scenario as an example: "If I'm in a price negotiation with a big customer ..." "... and they want an answer to a question, I better be able to get that answer ..." in a very timely manner. Any resulting decrease in productivity incurred by interrupted employees who switch tasks to meet the needs of the customer are justified (Freedman, 2007).

However, productivity in the United States has actually increased significantly since the early 1990's when workplace multi-tasking started to become more common (Freedman, 2007). In fact productivity increased approximately 4 per cent per year during the 1990's (Boucekkine and Crifo-Tillet, 2003)

The existing consensus is that information communication technology (ICT) was the driving mechanism behind the observed productivity growth, but considerable debate remains pertaining to the exact role of ICT. It is unclear whether "ICT-induced growth resulted from ICT usage or from increased capital expenditures on ICT during that period" (Boucekkine and Crifo-Tillet, 2003).

Multi-tasking behaviour and "continuous partial attention" can have negative effects other than delayed completion of tasks. Excessive multi-tasking and "Continuous partial attention" can increase stress levels and the frequency of error, it can also decrease a persons' ability to concentrate or think creatively and to make good decisions (Stone, 2007; McCartney, 1995). Excessive multi-tasking can produce feelings of "... never being finished, of always having to be on ..." which comes from the decrease in focus and performance that occurs when juggling multiple tasks and priorities (Gendreau, 2007). In fact, Hallowell (2005) has identified the psychological condition Attention Deficit Trait (ADT), characterized by distracted, rushed behaviour and loss of concentration due to an unmanageable task load. Increasingly, individuals

are also suffering from "techno stress", a term referring to stress stemming from the excessive use of multi-tasking technological devices (Appelbaum, 1990; Appelbaum and Primmer, 1990; Gendreau, 2007).Techno stress and ADT may be related although current research into these subjects is extremely limited.

To a certain degree excessive multi-tasking and "continuous partial attention" can also have social repercussions. Working on another task while someone is speaking to you for example can easily upset the other person if they realize you are not paying attention to them (McCartney, 1995).

Moreover, given the debate concerning the aforementioned general increase in productivity and the empirical results, the effect of multi-tasking on productivity and the detrimental effects of multi-tasking on individuals, many companies could benefit from reducing multi-tasking behaviour within their organization to a minimum level. Conversely, the company could also adopt measures to reduce its negative effects.

The pervasiveness of the idea that work is a linear one-at-a-time activity almost certainly has its roots in education. The idea of "task orientation" or the degree to which a child will remain "on-task" without distraction while seated during activities is a key factor in the evaluation of students' temperaments and their educational needs (Kauffman, 1997). Of course, no such formal evaluations of temperament are conducted to any significant degree at the adult level, yet this may explain the common perception that multi-tasking is a generally negative occurrence.

However, as Ogilvy (1995) in his book *Living without a Goal* states (in another context):

> ... universally agreed-upon Bad Things in social history have a funny way of promoting cures worse than the disease, viz., the Victorian and Puritan repressions of sexuality.

Ogilvy continues:

> But instead of calling for quarantine or cure we might do well to look more closely at the relationships between symptom and cause, and, second, at the implications of the diagnosis.

As Ogilvy states: in the information age, the nature of ownership and the conception of wealth as the accumulation of more and more physical goods gives way to an economy of experience. Property has inexorably shifted from physical things like real estate to "experiential" domains such as "... words and images, books and movies, art, travel ..."

The fundamental logic of information is that it "... does not inform unless it is received, it does not exist until it is consumed ... *information is intrinsically sacrificial.*" In other words, the logic of production is turned on its head. Henceforth, a knowledge economy can *only* produce through consumption (of information). What is called multi-tasking is in fact an immediate response to information from the environment, digital or otherwise, that constitutes the raw material of production. Henceforth, one's "work" is transformed from a series of completed tasks with a value attached to each, to a real-time readiness to apply one's skills and knowledge to informational situations that require immediate attention, thus creating value of an entirely different kind.

As workplace flexibility has increased, so has the complexity of the work system as a whole. The expansion of links and dotted lines to vastly more players within the many working spheres described above (Freedman, 2007) involves the creation of a "complex adaptive system", or CAS (Dum, 2001) where the characteristics of the components will evolve over time. From the descriptions above of the working spheres

within flexible organizations, one can find interesting parallels in the characteristics of CAS, as follows (Dum, 2001):

- "Diversity (heterogeneity) of CAS components ".
- "Interactions are adaptive: the system evolves (adapts) local connections until the desired global behaviour emerges".
- "Non-equilibrium situations are dominant".
- "Processes are taking place on many temporal and spatial scales".
- "Agents have limited (local) information of the system as a whole".
- "Such systems exhibit [sic] a variety of characteristics that often are not predictable from knowledge at the component level only. These systems often expose the limits of top-down thinking as their behaviour can neither be designed nor controlled in a hierarchical approach. Very often, rather than relying on pre-engineered shapes and functionality, the system components evolve and develop novel characteristics in an attempt to adapt to their environment. These systems scale-up easily because of a very effective management of the information flow between their components" (Dum, 2001).

One could conceive therefore that the vast network called the internet and its associated information and communication technologies are bringing us and our knowledge workers (or "components") toward a neural model of working wherein individual members are directly connected. As with synapses that relay apparently random signals as part of a complex pattern of neural signals in real-time; multi-tasking has become essential to deal with the fragmentary non-linear-time inputs from complex systems and to consume and re-combine the information into other more valuable forms of knowledge and experience.

Conclusion

In our investigation of the literature on multi-tasking, we discovered that considerable research has been conducted on the impact of multi-tasking on task completion. Studies on human behaviour under experimental conditions were designed to properly assign causes to the observed phenomena of reduced performance under multi-tasking conditions. While it is undeniable that multi-tasking has a negative impact on individual performance, it is equally undeniable that organizational productivity growth has not stopped since the phenomenon first became common practice. Therefore the question that remains is: to what extent productivity growth would be even greater in the absence of multi-tasking. Furthermore, new concepts like "continuous partial attention", Attention Deficit Trait and Techno stress could benefit from further research.

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