Multitasking: the Uncertain Impact of Technology on Knowledge Workers and Managers

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Abstract: While the productivity paradox has now been officially pronounced dead, the argument and the evidence for this assertion are both at a macroeconomic level. What has been less closely examined is the microeconomic impact of recent developments in ICT on the productivity of office and knowledge workers. There is an assumption, readily seen in many advertisements for mobile technology, that multi-tasking, WiFi connected laptops, Blackberrys, smart phones and so on are good for business and make people more effective and productive. This may be true some of the time and there is some (albeit limited) research which supports claims that these technologies increase productivity. However there are also emerging concerns that, in certain environments, these technologies may actually reduce productivity in both the short and the long term. This paper examines this problem and research to date and proposes a framework for further investigation of this phenomenon.

Keywords: multitasking, multicommunication, productivity, effectiveness, efficiency, ICT evaluation.

1. Introduction: Implicit assumptions

1.1 A multitasking world

In October 2007 a video entitled "*A Vision of Today's Students*" was posted on *Youtube*1. The video includes a series of views of students in a contemporary lecture theatre. As the camera turns to each student in turn, he or she holds up a card or a laptop showing a personal message such as "*I spend three and a half hours a day on-line*" or "*I will read 8 books this year*". One such card simply says "*I am a Multi-tasker*".

In another video in the same vein, a black and white photograph of an old fashioned classroom from early in the last century is shown. The accompanying text argues that the type of learning depicted was designed for people who would spend their lives working in a factory on a production line. A clear subtext in both of these videos (and many others readily found on the Internet) is that today's students will be working in a multi-career, multitasking world and that schools and universities need to re-invent their pedagogy in order to prepare them for this.

There are two aspects to the views proffered in these videos. First, it is implied that multitasking in the classroom with multiple media, computer enabled self and group learning is a better form of pedagogy than the traditional teaching approach where the entire class is required to focus on and attempt to absorb some of what the teacher is saying. Second, computer enabled self and group learning will develop young people's multitasking skills and that these are the skills they will need in today's and tomorrow's workplaces. These ideas reflect the view that multitasking is not only a trend in the workplace, but the assumption that multitasking is a better and/or more effective way of working than more traditional single-task-focused forms of activity.

This transition is readily visible within the computing era. Forty years ago green screens and dumb terminals tended to restrict those office or knowledge workers fortunate enough to have access to a computer at the time to a single task. The concepts of scientific management and work design proposed by Taylor (2003) back in the 1920s, which involved training workers in discrete tasks and supervising those tasks carefully, were adapted for the computer age. By the mid 1980s however, graphical user interfaces, through the metaphor of the desk, and later web browsers, facilitated multitasking in a variety of ways from having multiple windows open on screen at once to hyper linking and instant messaging. Several recent technologies including SMS texting, social networks and chat rooms have further facilitated this type of workplace behaviour. Many if not the majority of office staff now work with their e-mail systems active and an increasing number work with on-line messaging and chat rooms active as well. People commonly come to meetings and place their mobile 'phones on the table and/or open their laptops and connect to the wireless network. Anybody who has attended meetings where this happens, will have seen people texting (sometimes not even surreptitiously), reading their mail or 'chatting' while they are supposed to be attending

[1] http://www.youtube.com/watch?v=dGCJ46vyR9o

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to the business in hand. Students will openly admit to exchanging e-mails or even playing on-line games during lectures (Fried, 2008).

1.2 The impact of ICT?

Multitasking in the workplace long predates ICT, but ICT, if not a prerequisite for multitasking, is a significant enabler and amplifier of multitasking. From an ICT evaluation perspective, it is therefore pertinent to ask:

- Whether such modes of working (learning is a separate question) are better in some (or any) sense than monotasking? and
- When and if is multitasking a beneficial development in the workplace?

There is, as will be seen below, a body of research addressing the first of these questions, but little research which looks at the second. Furthermore, only a modest portion of this research is to be found in the IT evaluation literature (or in the wider IS literature). There is a embryonic body of research into the impact of multitasking on some specific types of work and this research is discussed below, but this is a topic that is worthy of more attention from the IT evaluation community than it has received to date. The purpose of this paper is to explore the impact of multitasking. In so doing, it will be argued that there are many different types of multitasking situation and that these have different characteristics which justify separate study. This is not so much a single question as a family of questions. This paper will propose a taxonomy of such situations and suggest a framework for further research in this area.

2. Defining multitasking

This paper is concerned with *conscious* multitasking and it is important, before engaging with this topic in detail, to distinguish between this and subconscious multitasking. The conscious mind can only focus on one task at any point in time. The subconscious, on the other hand, can cope with a number of simultaneous tasks[2]. A simple example of subconscious multitasking is driving a car and changing gear whilst turning a corner and listening to music on the car radio at the same time. The subconscious can control the movement of both feet on the pedals, one hand on the gear stick, one hand on the wheel and ears listening to both the music and the sound of the engine while both eyes focus on where the car is going. Only one of these tasks can have the attention of the conscious mind at any point in time. The subconscious can do the remaining tasks simultaneously because it has been trained to do them to the point where they have become routine. In certain circumstance, the conscious mind is not necessary in this process at all. Many readers will be aware of the experience of having been driving a car for some time without being conscious of driving and/or of letting their mind drift away from the act of driving whist still at the wheel.

As with any moderately complex task, the first time an individual drives a car it requires enormous concentration as the conscious mind has to attend to every necessary action. In time, and with practice, most of the actions required to control the car become programmed or automatic so that a driver does not have to think about the physiological mechanics of changing gear for example. His or her full attention can therefore be on the road. However if the driver's conscious is diverted by something else that requires its attention, such as a telephone call, this can be dangerous because, as noted above, the subconscious must now take over the non routine activity of watching the road. It was precisely for this reason that the use of hand held mobile 'phones while driving was outlawed in the United Kingdom in 2003[3]. The Royal Society for the Prevention of Accidents (2008) summarises the dangers of such distractions in one of its reports:

> *"When mental (cognitive) tasks are performed concurrently, the performance of both tasks is often worse than if they were performed separately, because attention has to be divided, or switched, between the tasks and the tasks must compete for the same cognitive processes. When a driver is using a hand-held or hands-free mobile phone while driving, she or he must devote part of their attention to operating the phone and maintaining the telephone conversation and part to operating the vehicle and responding to the constantly changing road and traffic conditions".*

It is interesting to note that in their efforts to eradiate the use of the mobile phone while driving, the UK law enforcement authorities in 2007/8 fined 165,000 drivers. This is thought to be a small fraction of those actually breaking the law. The fact that people are in jail because the law takes the dangers of multitasking while driving so seriously, is indicative of the importance of the impact of multitasking on task effectiveness when driving. If it affects driving, it will also affect many other types of activity.

[2] Typically from four to seven tasks.

[3] http://www.crimereduction.homeoffice.gov.uk/vehiclecrime/vehiclecrime38.htm

3. Multitasking in the office

While subconscious multitasking is common amongst workers engaged in manual occupations, it is not what is normally understood when applied to office or knowledge workers. What is meant here is carrying on several activities more of less simultaneously, all of which require the attention of the conscious mind. This type of multitasking involves continual switching of attention between tasks and devices/other people. An analogy with computers is helpful. A modern, single core processor simulates multitasking by switching between tasks so quickly that the user does not notice. On older PCs with early versions of Windows, this switching was sometimes noticeable; as the user moved from one window to the next, there was a visible delay. Humans switch their attention in a similar way and incur an analogous time overhead and delay in so doing. This switch may happen voluntarily, for example somebody may stop reading to look at their e-mail, or it may be interrupt driven such as when a user stops what they are currently doing to take a telephone call. If they are not suitably configured, computers that use multitasking to support multiple users or tasks can become overloaded. This phenomenon occurs when the switching activity takes up all or almost all of the processor's time, leaving no available capacity for application tasks. A term sometimes used by computer professionals for this is 'thrashing'. Humans, when they try too much switching, can experience an analogous phenomenon. So much time is taken with juggling tasks that little, if any, productive work takes place. Understanding the implications of this for organisational productivity requires an understanding of the nature of work in that organisation. The impact of multitasking on productivity will depend on the context. Some jobs are naturally interrupt driven[4] (managing is frequently cited as an example). However many jobs are most effectively done without interruption.

The problem of task interruption continues to be compounded by the emergence of new forms of interruption. While there is much research into multitasking (see section 4), the phenomenon has become steadily more complicated as both additional technologies appear and a generation which has grown up with these technologies moves into the workplace. The following is a list, in rough historical order, of some technologies which either facilitate multitasking and/or voluntary and involuntary interruption in the workplace:

- Land line telephones;
- Pagers;
- Conference calling;
- Video conferencing;
- e-Mail;
- Real time data streaming;
- Real time alerts;
- Graphical user interfaces (i.e. multitasking operating systems);
- Digital dashboards;
- Mobile telephones;
- SMS/text messaging;
- Digital cameras;
- Browsers (the Internet/Web);
- Chat rooms;
- On-line messaging;
- Social networking.

If one were to plot these on an historical graph, most of them would be concentrated in the last 20 years. Some, which have been around for a long time (such as e-mail and video conferencing (which dates back to the 1960s) have only come into widespread use in relatively recent times as costs have fallen and the infrastructure to support these activities has been laid down. Some of these are also more ubiquitous than others and what might be called *the business value to disruptive capacity ratio* of each varies. In more general terms, as Tang (2005, p1) puts it:

> *"… current trends in the deployment of ubiquitous computer lead to a world where computers pervasively vie for our attention".*

[4] A technical term used in computing to describe systems where processing of a given task may be interrupted by a higher priority task, but sometimes used as a metaphor for similar phenomena in the human world.

A parallel phenomenon is the growing emphasis on real time information such as that provided by digital dashboards (Malhotra 2005). To extend a point made above, ICT has not only increased people's ability to multitask, it has also created new forms of multitasking via such technologies as e-mail and mobile telephony. The pervasiveness of these technologies makes the nature of their impact on productivity and quality of life in the workplace an important issue to understand.

4. Research into multitasking

Research into multitasking can usefully be divided into a number of categories. First there research carried out in fields such as medicine and psychology into the neurological and mental processes involved. Secondly there is research into human multitasking generally, i.e. multitasking which is not necessarily IT enabled or driven. Thirdly there is research looking at the effectiveness of IT enabled multitasking as a productivity tool. Each of these literatures is briefly reviewed in this section.

4.1 Research in medicine and psychology

Research into how the brain processes material when it multitasks is relatively recent. It suggests that when the brain switches from a single task to multiple tasks, the locus of activity in the brain shifts from the hippocampus which stores and recalls information, to the striatum which takes care of rote or repetitive tasks (Kirn, 2007, University of California, 2006). The research suggests that when humans attempt conscious multitasking, the effectiveness of the brain is considerably reduced. In addition people engaging in multitasking become more fatigued, do not recall details of what they have been doing and exhibit raised stress and adrenaline levels. The evidence is summarised by Dzubak (2008, p11) who concludes that, while there is evidence that the ability to multitask improves with practice:

> *"…there is unequivocal evidence that depending on the task, degree of thinking, and the need for future application, we might want to do some things one step at a time, free of interruption, and do them well."*

In plain English, it takes more effort as well as more time to do three tasks simultaneously[5] than it does to do the same three tasks sequentially. There is ample empirical evidence for this effect (Dzubak 2008, Hembrooke and Gay, 2003). In general the findings of psychological research parallel or complement research in neuroscience. This research too supports evidence of greater fatigue as a result of switching. Rubinstein *et al* (2001) call this process of conscious switching, 'executive control'. A conscious switch is a decision to move from task A to task B. This is different from an unconscious switch where task B interrupts (a pager beeps for example). Meyer, cited by Lohr (2007), observes:

> *"Multitasking is going to slow you down, increasing the chances of mistakes. Disruption and interruption are a bad deal from the standpoint of our ability to process information".*

There is a compelling volume of research in the medical and psychological literature demonstrating that at the level of the individual, multitasking slows people down, reduces task effectiveness and takes more cognitive effort than monotasking. A full review of this is beyond the scope of this paper.

4.2 General multitasking research

While the neurology of multitasking is a relatively new research field, for over 40 years human multitasking has been the subject of extensive research in fields ranging from organisation theory to management science (González and Mark, 2004). One of the most striking and consistent findings from this research is the remarkably short time spent by what are called information (what might today be called knowledge) workers on a given activity before switching to another. As far back as the early 1970s, Mintzberg (1970, 1973) showed that managers carry out many tasks each day and sometimes spend less than a minute on a given task before they are interrupted. In their more recent research, González and Mark (2004, p119) state that:

> *"What somewhat surprised us was exactly how fragmented the work is. In a typical day, we found that people spend an average of three minutes working on any single event before switch to another event."*

[5] Performing tasks which require conscious attention simultaneously normally requires time-slicing. Time-slicing is a computing technique which involves doing small part of a task in a number of steps before transferring processing to another task. A number of steps in this second task are then completed before processing is switched to another task and so on. This differs from classic batch processing when one job is done at a time. While time slicing shares the computer's time resources more equitably between users (as opposed to everybody having to queue for the processor) the time spent in swapping jobs in and out of memory is a non productive overhead.

On the other hand, there are many knowledge based tasks where interruption is undesirable and where workers need to stay focused on one task. These range from writing computer code to giving a lecture. Between the person who has little or no control over the level of interruption, such as somebody working on a helpdesk, and the person whose work should ideally never be interrupted, such as a surgeon performing a complex operation, lies a large part of the working population, many of them office and/or knowledge workers. It is this group that is of most interest. For such workers, interruption and multitasking are often seen as a business necessity. It is at this group that so-called 'office productivity' and similar tools are aimed and, as already noted, traditional office equipment is now supplemented by a variety of emerging technologies. As far back as two decades ago, Reder and Schwab (1990) went so far as to suggest that:

> *"The multimedia approach to workstation design is definitely the right development model"*

More recently, Su and Mark (2008) have argued that so-called interruption management systems need to be designed to transform interruptions so that they are less stressful for workers and Galicia et al (2007) argue that ICT needs to be designed to support this type of work.

Nonetheless, the cost of interruptions is high. The US technology research organisation Basex Inc. (2005) claimed that:

> *"… interruptions take up more than two hours of the working day amounting to a cost of £588 billion a year to the US economy".*

While such numbers need to be regard with caution, it is indicative of a sizeable problem. At a micro level, Mark *et al* (2005) state that, following an interruption, it takes the average worker up to 25 minutes to refocus on a task that they were doing before the interruption. Clearly there is a trade-off here.

To complicate the picture even further, Reinsch *et al* (2008) examined the related phenomenon of multicommunicating. Multicommunicating, as the term suggests, is multitasking involving communications with several different people or groups. This, the authors argue, is the most complicated form of multitasking. In their analysis, they use structuration theory (Giddens 1986) to examine technology both as a stimulant and an enabler of behaviour. A key concept they propose is what they call *compartmentalization*. Compartmentalization is the ability of a technology to keep different lines of communication separate. Consider two simultaneous conversation between A and B on the one hand and A and C on the other. There are three possible situations (illustrated here with examples):

1. A, B and C are in the same room so both sides of both conversations are known to B and C.
2. A is on the phone to B and on a separate phone to C. Here B and C may be aware of A's part of the other conversation, but not the other part of that conversation.
3. A, B, and C are communicating by on-line messaging using separate windows. Here B may be unaware that there is another conversation taking place between A and C and C likewise unaware that there is a conversation taking place between A and B.

(There are other possibilities of course, but they are not of concern here). On-line messaging systems, like e-mail allow full compartmentalisation. Telephones and conference calls allow full or partial compartmentalisation. Face-to-face communication allows none, indeed Daft and Lengel (1986) suggest that the increased richness, typically associated with face-to-fact or video conferencing, is not always a good thing in multitasking situations when back channel or off-line conversations may be helpful. When it comes to communications therefore, there is a multiplicity of options which can be tailored to different situations and which may or may not enhance productivity, depending on the circumstances.

4.3 ICT and multitasking

While there is a reasonable body of research into general human multitasking, research into the impact of computer technology on human multitasking is still at an early stage. Spink *et al* (2002) claim that research into ICT and multitasking is a rapidly growing field and it is likely that knowledge of this phenomenon will grow. This may be so, but at the time of writing what is available remains limited. The reason for this may be seen by looking at a good example of the type of research that is required, namely the study by *Aral et al* (2007) of the impact of multitasking on productivity in an executive recruitment company. Multitasking was measured in terms of e-mail activity. Three findings emerged from this study:

1. Workers who multitasked more were more productive. Productivity was measured by individual financial contribution to the firm.
2. Workers who engaged in higher levels of multitasking were slower to complete projects. It is not clear from the research why slower completion was associated with higher productivity, but one explanation might be that such workers were working on more projects simultaneously.

3. The productivity impact of multitasking followed an inverted U curve. Productivity improved when workers moved from single tasking to multitasking. As the number of tasks increased, productivity levelled off and after a critical number of tasks was reached, productivity declined precipitously.

There are, as Manglesdorf (2008) points out in a review of this research, limitations in the research which constrain its generalisabilty. A critical limitation is that it was carried out in a single firm in a single industry and it used only one measure of multitasking. There are other, more subtle, problems which Manglesdorf does not discuss. The research shows correlation, but although it is suggestive of causality, there are other possible explanations for the phenomena observed. For example, it may be that staff who are more effective at selling tend to use the e-mail system more or that their levels of e-mail activity were higher because they had more contacts and therefore more prospects at any given time. While, therefore, the research is suggestive, it is not entirely convincing. The study also shows the challenges involved in measurement. The authors evaluated approximately 125,000 e-mails over a ten month period. To protect privacy, the content (but not the authorship) of each e-mail was encrypted which meant that behaviour had to be deduced from patterns in the data rather than from actual content. The research was only possible because of the availability of these data in an archive. All of this makes replication of this study difficult.

Nonetheless, this is a sufficiently important phenomenon to warrant further research. In the following section, a framework for such research will be proposed.

4.4 An evaluation perspective

From an IT evaluation perspective, an important question is whether multitasking is productive, counterproductive or neutral (i.e. the benefits broadly speaking match the costs/disbenefits)? The evidence from psychology and neuroscience is unequivocal – in terms of individual productivity, people are less effective and efficient at particular tasks when they multitask (of course change also relieves monotony which can aide productivity). On the other hand, there is some tentative evidence that at least some types of activity benefit from multitasking when measured at the level of organisational output. Furthermore, in certain circumstances, multitasking may have the advantage of occupying more time with productive activity. Downtime is a common problem with monotasking which is why, for example, work scheduling is such a critical aspect of production and project planning. The research challenge posed in the opening section may be focused as follows:

- The implicit assumption of many individuals is that multitasking is a better and more productive mode of work. Is this true, if so is it true in all circumstances and if not, is it true in specific circumstances?
- Multitasking operating systems could, and can continue to, avail of the growing processing and storage capacity of computers. Unlike machines, the processing capacity of humans does not change significantly over time. Is there some optimum level of multitasking and if so, how might it be identified?
- Is there a trade-off between single task efficiency and total productive output and, if so, on what basis should workers and organisations make this trade-off ?

Because conscious multitasking is tiring, there are, apart from immediate efficiency losses, also losses due to a decline in effectiveness resulting from fatigue. It does not follow, however, that multitasking is a less efficient form of work in terms of human time and effort (Iyer *et al* 2005). Multitasking can have the advantage of occupying more time with productive activity (Wasson 2004). A already noted, downtime is a common phenomenon when monotasking. A worker with a single task to do may have to wait for somebody to return a call or for the computer to respond to a complex query. Likewise, she may sit idle in a airport or spend 'non productive' time travelling between locations. So the fact that multitasking has drawbacks as a mode of working, does not automatically lead to a conclusion that serial monotasking is a better form of working even in those situations where it is practical (which is not in every situation).

Two further observations are worth making. First, many individual workers appear to assume implicitly that multitasking is a better and more productive mode of work and second, even if they do not make this assumption, many people multitask without ever considering whether or not this is what they should be doing. In the video referred to in the Introduction, the young woman who held up a card stating "*I read 8 books a year*", then held up a second card saying "*and look at 2,500 web pages*". Workers often complain of unproductive time and not having enough hours in the day. As people try to manage high workloads, the instinct is to juggle, to try to make some progress on all or several tasks rather than completing one before proceeding to the next. Often this is driven by external pressures. For many people, it is easier to say to a customer or a manager "*I am working on that*" than "*I have not started on that yet*". On the other hand, while a single task batch processing makes the most efficient use of raw computing power for the duration of a task, it may not be the most effective use of the machine's processor power, so from an organisational

perspective, monotasking may not be the most effective use of human resources. Consequently it is not self evident that multitasking is either a good or a bad practice in a given situation. In an extensive review paper looking at the impact of open office design, Roper and Juneja (2008, p19) say that:

> *"The research underpins the need for cost analysis of the impact that distraction have on knowledge workers".*

Applebaum and Marchionni (2008, p1313) argue that:

> *"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 organisational productivity"*

However their argument would appear to be based on the fact that (according to the authors) growth in overall productivity in the US economy has been averaging 4% over most of the past two decades. The fact that there may be many other contributions of ICT to productivity which are masking a possible negative effect of multitasking does not seem to occur to them.

In summary, there is little research to date which attempt to provide a meaningful evaluation of the impact of multitasking on organizational productivity or into the financial impacts of continual interruption and task switching. This is a significant gap in the research literature. Multitasking is an important phenomenon affecting, as it does, the working habits and patterns of a large number of knowledge workers around the globe. There is an often quoted saying in business, "work smarter, not harder". Unless the impact of multitasking is well understood, it will be hard to gauge what working smarter means. There is therefore a need for more research. The next section outlines a model that might be used in this task.

5. A taxonomy of multitasking

When it comes to work practices It is often useful, from an evaluation perspective, to categorise different forms behaviour. In order to analyse the impact of multitasking, it is helpful to break it down into a number of forms. Figure 1 shows what might be called the multitasking space, i.e. the various forms that multitasking and interruptions can take. This is a discrete space with 36 theoretical situations.

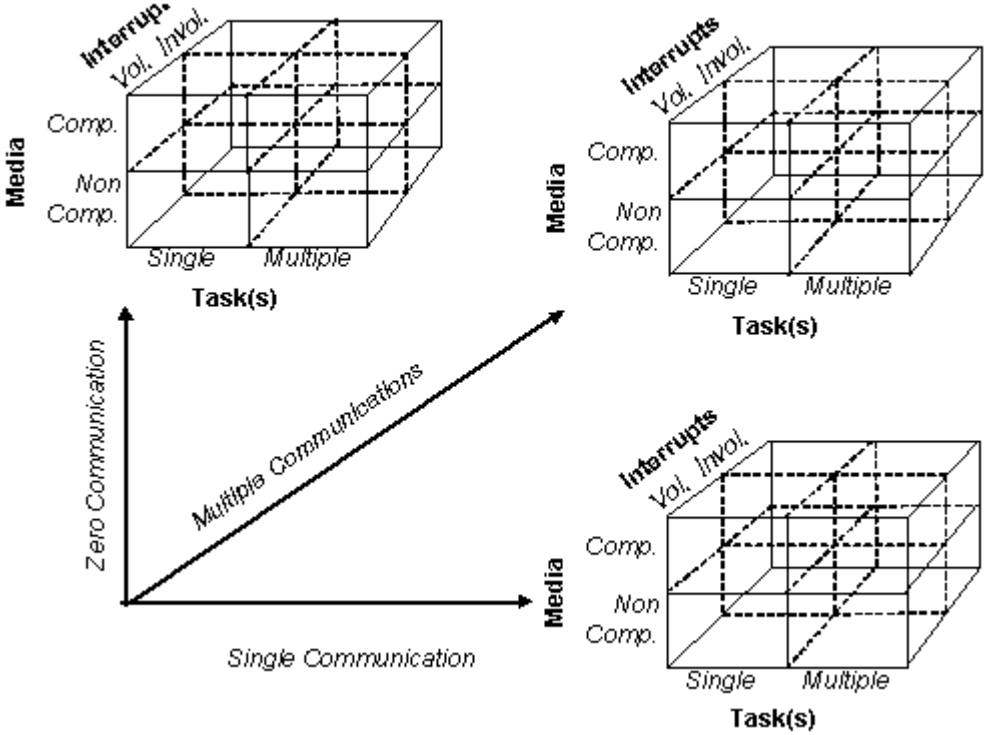

Figure 1: The multitasking space

The four dimensions of this space, with the number of possible values in parenthesis, are:

- Single or multiple activity multitasking (2);
- Zero, single or multiple communicating (3);

- Controlled (voluntary) or uncontrolled (interrupt driven) or both switching (3);
- Compartmentalised or non compartmentalised media (2).

(hence 2 x 3 x 3 x 2 = 36 possible situations). Not all of these situations are meaningful in practice as the nature of the media is not relevant in a zero or single communicating situation. In practice therefore many of these 36 possibilities may be collapsed into a single scenario. Furthermore, situations where a worker is subject *only* to involuntary interruption are likely to be rare. Most knowledge workers can and do involuntarily interrupt themselves, for example to think about another unrelated matter or to switch task. Consolidating and eliminating non relevant distinctions and unrealistic situations, there remain 20 possible different research scenarios which are illustrated in table 1.

Table 1: Analysis of real multitasking options.

			Communicating		
Type	Control	Media	Zero	Single	Multiple
Single	Voluntary	Compartmentalised		A	
		Non compartmentalised			
	Involuntary	Compartmentalised			X
		Non compartmentalised			X
	Both	Compartmentalised			
		Non compartmentalised			
Multiple	Voluntary	Compartmentalised			
		Non compartmentalised			
	Involuntary	Compartmentalised			X
		Non compartmentalised			X
	Both	Compartmentalised			B
		Non compartmentalised			

X	Rare or impractical
	Feasible scenarios

Two of the feasible scenarios are illustrated in the following examples.

- A worker may be engaged in single activity multitasking with single communication, voluntary interruption only and noncompatmentalized media. For example, an analyst is preparing a report with a colleague in a meeting room using a single laptop which is not networked, with no telephone in the room and a 'do not disturb' notice on the door. Here there is single line of communication and both workers may be using a word processor, a spreadsheet and a graphics tool where they may be changing numbers on the spreadsheet and then cutting and pasting the result into the document (or using hot linking to do the same thing). Switching is almost completely controlled. It is a non compartmentalised environment, but that is not relevant as there is only one form of communication. This situation is marked by the letter 'A' in table 1.
- Another worker may be in an environment where she is multitasking and multicommunicating with a number of other people by e-mail and telephone whilst, using two computers and being likely to be interrupted by calls from clients at any time. This form of working might be typical in areas such as share dealing, trading or sales. In this case, the business imperative may be to respond quickly to a rapidly changing external environment or to short term market opportunities. This is clearly a more complex environment than that in the preceding example. In such an environment, compartmentalisation may or may not be essential depending on the nature of the activity. 'B' in table 1 shows the positioning of such an activity for which compartmentalisation is necessary.

The nature of multitasking quite different in these two examples. Consequently the problem of evaluating the impact of this form of working on productivity is different in each case. While, in both of these examples, intuition suggests that these forms of multitasking will have a positive impact on effectiveness and output, if the environments were to be reversed, i.e. the first worker was trying to produce his report while simultaneously communicating with several other people on other matters, it is probable that his effectiveness would be considerably diminished.

A final factor, which might be considered a fifth dimension not shown in figure 1, is worker's ability to multitask. Research suggests that this skill varies by individual. For example Dzubak says that there is some evidence that multitasking capability improves with practice. Craik and Bialystock (2006) on the other hand suggest that multitasking ability disimproves with age (though in a rather interesting aside they suggest that this effect is less marked in bilingual people). Dzubak also claims that some young people are highly skilled at multitasking by the time they reach university level. To date, there is no convincing evidence that such people learn any more effectively than those who are less skilled at multitasking. Nonetheless, it is possible some people will be more effective at switching and multitasking than others. There are certainly people who are uncomfortable when faced with multiple tasks.

6. Evaluating multitasking

The above discussion leads to the proposed research framework in figure 2:

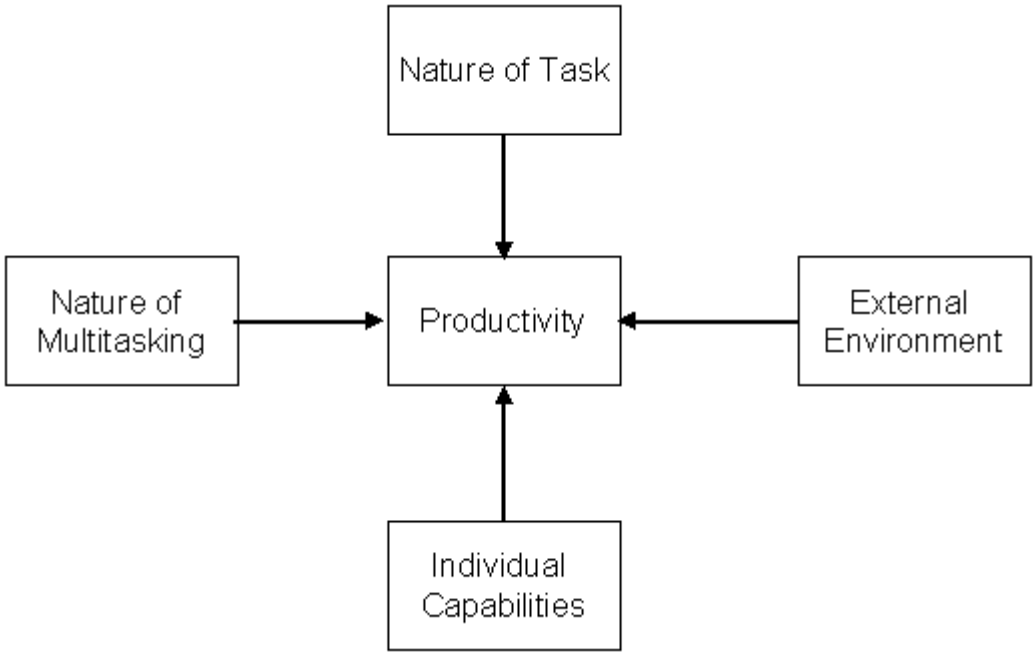

Figure 2: Research framework for multitasking evaluation.

While it may be possible to treat this as a multivariate analysis problem, this analysis suggests that generalised statements about multitasking may less useful than studies of specific work types and conditions/contexts. For example, the research by Aral *et al* cited above only looks at one of the 20 possible situations (multiple tasks, compartmentalised media, multicommunication and involuntary interruption – situation B in table 1). A researcher wishing to study multitasking will need to select which values on each of the four dimensions in table 1 (s)he wishes to examine even before considering individual capability. It may well be that findings for one scenario can be extrapolated into one or more other scenarios, but, *a priori*, this is not self evident.

7. Conclusion

As noted above in section four, while there is a large body of research into multi-tasking and worker distraction in other fields, there has been relatively little research to date into multitasking from an ICT evaluation perspective. There is evidence that the prevalence of multitasking as a style of working (and living) is increasing, although some claim that after a period of popularity, it may be about to go into decline (Kirn 2007). What is clear is that there is a need for research at several different levels into this phenomenon and how it impacts on the effectiveness of knowledge workers. The conjectures arising from this paper are, therefore, that:

1. Assumptions that are commonly made about multitasking and multi-communicating for knowledge and office workers are not necessarily untrue, but are not well founded;
2. There are considerable gaps in the ICT evaluation literature with regard to the impact of multitasking on productivity and
3. The research problem is complex with several dimensions. It is not obvious that findings in one situation are generalisable to others.

It is proposed that four types of research need to be considered:

1. The first is the type of case study carried out by Aral *et al*.(2006). There are several challenges that arise in this type of research. Not the least of these is that one needs an accessible and suitable set of data. This is only likely to exist for certain specific types of data (such as e-mails or maybe telephone calls). There may be little or no data on, for example, unscheduled interruptions hyperlinking or people 'digressing' while looking up something on the Web. Nonetheless, there is scope here if the right data can be found in a suitable organisation.
2. A second possibility is a longitudinal study. The problem is that for the purposes of comparison, data needs to be gathered before and after the introduction of the technology. If the pre-implementation data does not exist, such a study would have to take place in a situation where a technology was scheduled for introduction in the near future. The ethnographic approach used by Gonzáles and Mark (2004) falls into this category, but while their methodology was well suited to answer their research question (which was about how users 'blocked;' their work activities into what they termed 'working spheres'), it is hard to see how this could yield useful measurement of productivity impacts without the presence of an alternative model or control group.
3. A third possibility is set up an experiment with appropriate control groups. This would be the ideal solution, especially if groups of workers in the same organisation carrying out similar tasks could be used. This would require careful control to, for example, limit the tendency of workers to self interrupt. It would also be necessary to allow for different individual task efficiencies and individual's ability to concentrate. This could be done by, say, getting two groups to work in multitasking and monotasking (or low switch rate multitasking) modes and then switching them around after a certain period.
4. Fourthly, direct measurements of individual multitasking ability can be used (see, for example, Fisher et al (2003)).

A final complication is that in any study of the impact of ICT on knowledge workers, distilling out the impact of multitasking from other effects may be difficult.

Gezell (2007, p22), citing *Time Magazine*, notes that:

> *"Decades of research (not to mention common sense) indicate that the quality of one's output and depth of thought deteriorate as one attends to ever more tasks"*

Gezell advocates monotasking and the concept of a *point of concentration* (POC) which is something on which a worker should focus all of his or her attention for the duration of a task. It has been stressed in this paper that, whether widespread adoption of such a mode of working in knowledge organisations would prove more effective and productive over the long term is not self evident. There is a need for good empirical evidence and there are considerable opportunities here for well designed research.

This paper does not attempt to provide a definitive answer the questions set out in the opening section. What it tries to do is draw attention to the importance of this question and to provide a framework within which research into multitasking can be carried out. There is an implicit assumption by many businesses that multitasking and multicommunicating, even in situations that do not require it to achieve a single objective, is a good thing and that, if it has some drawbacks, then they are outweighed by the benefits. While this may be the case, it is by no means clear that it is so and the limited research to date has only considered highly specific conditions which are certainly not generalisable to the entire modern workspace.

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