



The Marks are on the Knowledge Worker

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ABSTRACT

A study of twelve knowledge workers showed that their defining characteristic is that they are changed by the information they process. Their value lies in their diversity - companies exploit the fact that these people make different sense of the same phenomena and therefore respond in diverse ways. Knowledge workers do not carry much written information with them when they travel and rarely consult their filed information when working in their offices. Their desks are cluttered and seemingly function as a spatial holding pattern for current inputs and ideas. My explanation is that once informed (ie. given form) by some written material, these workers have no particular need to retain a copy of the informing source. However, if a piece of written material has not yet informed them, then they cannot sensibly file it anyway because its subsequent use or role in their world is still undetermined. I conclude that the valuable marks are on the knowledge worker rather than on the paper or on the electronic file and suggest how computer support for knowledge work might be better targeted on the *act of informing* rather than on passively filing large quantities of information in a "disembodied" form.

KEYWORDS: Knowledge workers, information appliances, writing, memory.

INTRODUCTION

Peter Drucker, the distinguished commentator on organisation and management, has popularised the term "knowledge worker" to describe the role of a growing percentage of employees in business organisations: *"The manual worker is yesterday.... The basic capital resource, the fundamental investment, but also the cost centre for a developed economy is the knowledge worker who puts to work*

what he has learned in systematic education, that is, concepts, ideas and theories, rather than the man who puts to work manual skill or muscle." [5]. Unfortunately, Drucker does not characterise the distinguishing behaviour of these workers clearly enough for us to see how to develop computer tools which would make them more effective in their work. Using Drucker's description, I therefore identified twelve knowledge workers in a range of U.S. and European companies. Their job functions included: design, advertising, marketing, management consultancy, broadcasting, law, finance and research. I interviewed each for 2-3 hours, covering the worker's objectives, value to the organisation, work and communication patterns, use of information and paper and use of computer tools. The interviews were all taped and analysed from the point of view of why the workers behaved the way they did and how they had an effect on their organisations. In this paper, I report some of the main findings of this study, offer an explanation for the distinctive behaviour of these workers and discuss the ramifications of these results for computing tools which support knowledge work.

CHARACTERISTICS OF KNOWLEDGE WORKERS

The results of the study suggest that the defining characteristic of knowledge workers is that they are themselves changed by the information they process.¹ So, the workers interviewed saw their value to an organisation being to understand a body of knowledge and generate new information from this understanding which changed either the organisation or its customer in a direct way. Consequently, they all described their personal work objectives in direct relation to the objectives of their company. These results seem to validate and refine Drucker's original concept [5].

Going beyond the work of Drucker, I identified three particular characteristics of knowledge workers which challenge established views on computer support for office work.²

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¹ To some extent, this is true of any human being. What distinguishes knowledge workers is that this is their primary motivation and the job they are paid to do.

² In the rest of this section, wherever I say "knowledge worker", I strictly mean only the small set I sampled. However, I am choosing to take the



Diversity of Output

Companies value knowledge workers for their diversity. Faced with the same phenomena, each knowledge worker provides a different output and it is this variation which is their key benefit to the company. As one person expressed it: *"I guess I am the product in our business - it's a bit like oil painting really, my colleagues use different paints and get different effects - but we're all doing essentially the same job..."*. Knowledge workers solve problems and generate outputs largely by resort to structures internal to themselves rather than by resort to external rules or procedures. In other words, each knowledge worker develops a different internal "configuration" based on changes wrought in their thinking and outlook by the situations they have encountered, the information they have absorbed and the particular way they have made sense of these - *"You can't train someone to do this job - you have to learn it through experience."* They are highly motivated (and indeed are often paid) actively to learn and change their thinking throughout their careers. This means that if the individual doing a job changes, then the company gets a different product as a result. This is not true for other kinds of workers.

Unfortunately, many corporate software programs aim to level or standardise the differences between individual workers. In supporting knowledge workers, we should be careful to provide tools which enable diversification of individuals' outputs. Word-processors satisfy this criterion; tools which embed a model of a knowledge worker's task in the software do not.

Low Dependence on Filed Information

Knowledge workers do not carry much written information with them when they travel. Most of those interviewed carried simply a diary, an A4 notepad and a few selected papers or brochures relevant to the current business. They claimed that most of what they needed on such visits was in their heads. Knowledge workers also rarely consult their filed information when in their offices. They do make a lot of notes, both in meetings and when trying to sort out their thinking on their own but many of these notes are discarded once the ideas have been worked out or translated into a proper report. A typical comment was: *"I take a great many notes but I very seldom use them. It helps me understand what's going on to rephrase and condense what I hear."* Another study of 28 research workers reported that, whilst 64% kept their notes for years, 44% of these claimed that they rarely referred back to any of them [9].

Ironically, computer tools have long been focussed on the electronic storage and retrieval of vast quantities of information and similar tools for

personal information storage have naturally followed. Meanwhile, even the latest notepad computers offer relatively poor surfaces (in comparison with paper) for easy note-taking or scribbling. We may have been fooled into thinking that knowledge workers write things down because they need an external memory store, whereas in many cases, it may be the graphological act itself which is important [4, 14].

Importance of Spatial Layout and Materials

Many knowledge workers have extremely cluttered desks and floors and yet are seriously disrupted by changes made to this apparent "muddle" or by needing to move offices regularly. This supports earlier studies of office work [10, 11]. It seems that this apparent "muddle" plays a number of important roles for them in their work:-

As a Holding Pattern:-

It seems that knowledge workers use physical space, such as desks or floors, as a temporary holding pattern for inputs and ideas which they cannot yet categorise or even decide how they might use [12]. Filing is uncomfortable for them because they cannot reliably say when they will want to use a particular piece of information or to which of their future outputs it will relate - *"I can cover as much flat space as there is, to be honest, I think it's because I don't want to decide up front what to do with it, but I don't want it to disappear ... if I had acres of desk to wander around, I could spot a bit of information and think 'ah, I could use that'. I think it's a visual thing."* Once they have finished a report or developing an idea, then they might file the inputs or possibly simply throw them away. Filing is certainly not their goal.

In designing electronic notebooks for portability, the displays are getting ever smaller. Unfortunately, small displays force you to classify your notes immediately you receive or generate them. The study suggests that knowledge workers may be uncomfortable with these devices as note-takers except for non-primary aspects of their work such as noting a telephone number, a diary date or a short message for a colleague. In these cases, users can classify the note's subsequent use before they start to write it. In contrast, if knowledge workers are using such a notebook to jot down an idea they have just heard, they will be forced to classify the inherently "unclassifiable" and it is unlikely to inform them later as it will have disappeared for ever into the bowels of the device. Maybe this is why the A4 pad or notebook is an old-favourite of knowledge workers whose functionality will be hard to match.

As a Primitive Language:-

It also seems that knowledge workers may use pieces of paper or the marks on them as a material correlate

risk of generalising to all knowledge workers as the behaviour described flows naturally from their primary characteristic of being changed by the information they process. I am on the look out for counter-evidence.



of a model of the world which they are in the process of constructing in their heads. It is like a primitive language for them - *"I can get the ideas out serially but then I need to look at them, move them around..."*.

As Contextual Cues:-

Many of the workers reported that first thing in the morning, or after any interruption in their thought (like a phone call), they have the *"where was I?"* problem in a complex and ill-defined space of ideas. The layout of physical materials on their desk gives them powerful and immediate contextual cues to recover a complex set of threads without difficulty and delay, *"this is my whole context, these are my personal piles"*.

As Demonstrable Output:-

Piles of papers on desks are also important as tangible objects to which workers can point to show others how much progress they have made. One of the problems for a knowledge worker is that their productivity is difficult to measure and often their end-effect on the company is intangible, so they seem to use paper as a tangible record of their contributions, *"I think a key thing for me is that I like information to be tangible - I like to say 'this is what I presented to whoever' and I can actually touch it and move it around as I want"*.

OTHER CLASSES OF OFFICE WORKER

Given limited data on other kinds of office worker [6] combined with informal observation, my tentative, working hypothesis is that knowledge workers can be distinguished from two other broad categories of office worker: communications worker and clerical worker.

- **Communications Worker** - these people are tuner amplifiers for information which they collect from other sources (e.g., knowledge workers, magazines or conferences) and pass on. Their value to a company is in finding and connecting to sources of information and then tuning this information in order to bring about changes in *other* people's understanding, beliefs, behaviour rather than in their own. Their personal motivation comes from forming relationships and influencing others. Indeed, unlike knowledge workers, they are often happy to adjust ideas or lines of reasoning in order to achieve the effect they want on another person. The knowledge worker is more likely to stick faithfully with the idea and attempt to change the person or find someone different who will listen! Because communications workers use material to inform others, they may be able to classify incoming material according to how they want to use it. Computers to date have not been a very valuable tool for these people. Fax machines have and I believe these people may

well be the most promising market for the upcoming Personal Digital Assistants (PDAs).

- **Clerical Worker** - these people apply information which is extrinsic to them and which does not change (ie. inform) them, e.g., company policies. This means that variation between the end-products of different workers is relatively low. Their value to the company is knowing which information to apply in different circumstances and applying it in a way which produces a consistent output. Their personal motivation comes from being indispensable to the smooth and efficient running of an office. Computers have traditionally been the most valuable as tools for this class of people.

Obviously, no person's work belongs totally to one category rather than another, so it could be argued it is the work which should be classified rather than the person doing it. However, I believe that classifying the person is more appropriate because the above characterisations reflect different ways in which two people might deal with exactly the same information or indeed the same job. This, in turn, seems to reflect different mainsprings of motivation for people at work.

AN EXPLANATION OF KNOWLEDGE WORKERS' BEHAVIOUR

The study identified three distinguishing characteristics of knowledge workers: they are valued for diversity rather than consistency between their individual responses, they do not rely heavily on information once it has been filed and they do rely heavily on using their desks and floors as a spatial holding pattern for paper-based inputs and ideas - *"my desk is my live workspace"*, as one interviewee expressed it.

The first two characteristics can be explained by the fact that once a piece of written information has informed a knowledge worker (ie. given form to their thinking or outlook) then it has discharged its value and the paper on which it was written can be discarded or passed to another (who might be differently informed by it). Filing information for personal re-use may actually be a redundant and resource-wasting task for knowledge workers. The marks which can make a difference to their organisations are on the knowledge workers *not* on the pieces of paper. This is what it means to *inform* - to change the form of a person or a device such that they act differently (ideally more effectively) on their environment. And, as we have seen, each knowledge worker is differently informed and therefore acts differently on the environment. In contrast, whilst information is held in a book, in a filing cabinet or in a database, its value is not realised. That only happens when it is embodied in a device whose actions are directly determined by its internal form. My office cabinets and my PC do not behave usefully



differently from yours as a result of all the information I have filed in them.

This might not sound very radical but the mindset in Computing for the past 20 years has been on the value of storing information in large databases for selective retrieval. And because computers have opened up a new way to store vast amounts of "information" in a disembodied state and ship it around over faster and faster networks, people have come to believe that the more information you can store or ship, the better off you or your organisation are. We have confused what we can write down with what we usefully know and compounded the error by supposing that because computers can help us write down more they can obviously help us know more.

Computers have also provided the dominant metaphor for understanding human memory as sets of relatively independent data, stored passively in some identifiable location and then searched for and retrieved in order that a particular datum can have its effect on an event or action [15]. As such a passive storage device, human memory compares miserably with its computer equivalent. This is because we have lost sight of humans as highly-tuned learners and actors whose internal form is constantly changing in order to refine their ability to act on the world. Again we have confused the ability to recall facts with the ability to think and act effectively and expect a Von Neumann computer, which is good at the former, to be an effective aid for the latter.

The characteristic of knowledge workers having cluttered desks might be explained thus: whilst a piece of written information is in the process of informing a knowledge worker, then they cannot sensibly name it and file it because its subsequent use or role in their world is as yet undetermined. In contrast, the information filed in a PDA can only inform the kind of action which they could determine in advance that it would inform. Whilst useful for vital administrative and communication tasks, this cannot be described as knowledge work.

Also, during the *act* of informing, a knowledge worker needs structures which are both flexible in their semantics and generative in nature. There is evidence that spatial relationships are powerful in this regard at a pre-linguistic stage of reasoning, ie. objects and their spatial relations provide a primitive means for creating, exploring and changing structures which can inform us in novel ways. Unfortunately, computer tools continue to provide users with storage and retrieval facilities which force filing-by-naming, ie. their structures are persistent and preservative in nature, rather than generative.

We are starting to explore ways of storing and re-displaying arrangements of visible marks or materials as a way of visually stimulating the recovery of an earlier mindset for a knowledge worker. We have noted how people sometimes use whiteboard copies not to retrieve a specific fact but to

cue themselves back into a line of reasoning they were engaged in.

STORED INFORMATION - A NEED TO CHANGE OUR APPROACH

Drucker has predicted the rise in importance of knowledge work in modern organisations [5]. If we are to support these workers, the data reported in this paper suggest we should re-consider computer support for human information processing in the office. I suggest that the approach taken by those with an ecological perspective on psychology may prove fruitful because of its focus on the tight relationship between humans as perceivers and actors and their environment.

Human (or any other animal's) knowledge is there to improve this relationship. Shaw and Bransford [15] argue that the process by which past experiences affect current perceptions need not involve contact with previously stored traces. Rather, previous experiences constantly attune the framework by which we perceive and assess the significance of current experiences.

This makes the popular notion of a passive computer information store acting as a useful extension to human memory to support a person's (or even an organisation's) current reasoning or action a very odd notion. For a start, it depends on a person's current model of the world and their set of known facts about that world being somehow separable entities. They have to be separable for the facts (or any knowledge which *can* be recorded on paper or in a database) to stand as passive, un-changing units which can be retrieved to affect directly a current action.

Our model of knowledge workers suggests instead that when these people are informed by a new fact, then, by definition, their model of the world is reformed. Maybe the fact can then only be re-generated as a side-effect of operating the improved model. Certainly, humans are relatively poor at regurgitating facts to order; but ecologically this is a highly unusual behaviour for them to be called upon to perform anyway. Acting from their latest, optimised model of the world is what they are designed to do.

Embodying information (genuinely changing your internal form) is only achieved at a high cost of time and effort to the person concerned. The advantage is that there is no capacity limit for this and, most importantly for the knowledge worker, it can reliably affect *any* future (and as yet undetermined) action. Plato recognised this point. In the *Phaedrus*, he introduces the myth of Theuth, the Egyptian god who invented calculation, number, geometry, dice and script. Theuth comes to the king, Thammuz, to introduce his various arts, most of which were well received, except for writing. Theuth claimed that writing was "a recipe for memory and wisdom". Thammuz was sceptical, claiming that it had



nothing to do with memory at all, but only with reminding and was therefore merely the semblance of wisdom and not the real thing. The danger in it was that men might begin to rely on writing instead of truly learning things by imprinting them on memory first [3, 7].

So, if there is no passive store of facts in the brain, when does such a passive store, held externally, help you? It works for clerical tasks where you can apply information without internalising it because its purpose is not to affect you but to affect some pre-determined action, artefact, procedure or even another person. Examples include: logarithmic tables, diary schedules, telephone numbers, PIN numbers and the information recorded in a driving licence. In these cases, you can apply such information equally effectively whether you "know" it or are reading it off a piece of paper. This type of information is, in fact, particularly costly to remember because you have to develop some contrived model of the world which will re-generate this arbitrary fact for you. We believe PDAs should excel in supporting the storage and use of precisely this class of information - for any kind of worker.

SUPPORTING KNOWLEDGE WORK

If the characterisation proposed in this paper is correct, then true knowledge work, cannot be automated. At the points where it apparently *can* be automated, then it is no longer true knowledge work. Given the growing proportion of knowledge work in organisations, this is an ambivalent discovery for a computer company to make. Our approach at Hewlett Packard is to try to understand how we would design computer tools differently if they were focussed on supporting the *act* of informing people, rather than on storing or processing information on peoples' behalf. Here are some of the ways in which that leads us to think differently:-

1. Avoid trying to help knowledge workers in ways which involve the tool in "understanding" the information it is holding or predicting what the user wants to do with it. Only the knowledge worker can give meaning to the marks on the paper or on the screen and they do not know and cannot predict what this meaning is until they have been informed by it.
2. Concentrate on capturing and *reproducing* the appearance of marks made by knowledge workers rather than interpreting them. These marks made on paper, screen (or indeed any other physical surface from cave wall to whiteboard) is *how* people change their environment in order to carry information from place to place or time to time [13, 16]. They are also used to externalise their own thinking - a type of scaffolding whilst they are in the process of informing themselves [1, 2]. Changing these marks or their arrangements may not do the knowledge worker a service when it comes to cueing the re-call of

their current understanding of an issue or their intent to inform another.

3. Use electronics to mimic and extend the ability of the physical environment to inform an individual worker or an organisation of such workers. Hutchins' work on ship navigation provides a powerful example of the physical environment being used as a holder for distributed information whilst a team of people collectively compute it [8]. The key here is seeing *people* as the primary computing devices and the technology as providing a flexible environment for presenting a problem in ways which make it readily accessible to human computation. Current tools tend to treat presentation as a side-effect of *their* computation rather than their primary goal. Indeed, the devices which do this part of the work today are called (and generally considered to be) "peripheral", i.e. they are peripheral to the main job which is seen to be "computing". Turning these so-called peripherals (e.g. printers, scanners, disks and displays) into independent, informing appliances which are useful in their own right, is a primary goal of our laboratory.
4. Remember that knowledge workers cannot predict what will inform them or how it will inform them. The dream of providing such workers with an "electronic encyclopaedia in the sky" only satisfies those cases where someone can predict what they need to know.
5. Knowledge workers are in the business of labelling things in new ways. They cannot do this until they have been informed. It is hard today to keep information electronically without labelling it. The smaller PDA displays get, the more necessary labelling becomes.
6. Don't encourage organisations to think that storing information is an alternative to being informed by it.
7. Beware of the assumption that forgetting is a *bad* thing for humans and that we should design computers to cover for this "weakness" in our make-up. Forgetting is at the heart of new concept formation.

CONCLUSION

Humans are informed (ie. given form) by perceiving their environment and act more effectively in relation to the environment as a result. The primary role of knowledge workers in organisations is to inform themselves so that they can, in turn, reform their organisations to behave more effectively in relation to the environment.

When the human race invented the written mark as a carrier of information, this simple modification of their physical environment radically enhanced its



capacity to inform them because it broke, for the first time, the physical constraints of time and space.

We are anxious to improve the capability of computing technology to support this act of informing. The rise in importance of knowledge workers in modern organisations makes this even more important because these peoples' entire value to their organisation rests on how effectively they are informed not on how large their databases or filing cabinets are.

Von Neumann computers have been the dominant metaphor for understanding human knowledge for the past 20 years - equating it with retrieving data from a passive store in order to affect a current action. This has guided much of the work on office support tools and downgraded the perception of humans as powerful information processors which has seriously de-railed our thinking on how humans actively change as they perceive and change their environments.

Our approach to information appliances is based on re-evaluating the ancient breakthrough of making written marks in the context of modern computing and communications. We think we can profitably exploit electronics to extend the physical environment's capacity to inform knowledge workers and their organisations by breaking a new set of physical constraints of time and space. We would be content if our contribution had even a tiny fraction of the impact of the first written marks made on stone.

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REFERENCES

- [1] Bolter, J. D. *Writing Space: The Computer, Hypertext and the History of Writing*. Lawrence Erlbaum Associates: Hillsdale, New Jersey, 1991.
- [2] Campbell, J. *Grammatical Man: Information, Entropy, Language and Life*. Simon & Schuster, Inc.: New York, 1982.
- [3] Carruthers, M. *The Book of Memory: A Study of Memory in Medieval Culture*. Cambridge University Press: Cambridge, 1990.
- [4] DiVesta, F. J. and Gray, G. S. Listening and Note Taking. *Journal of Educational Psychology*, 63, 8-14, 1972.
- [5] Drucker, P. F. *Management: Tasks, Responsibilities and Practices*. Harper & Row: New York, 1973.
- [6] Frohlich, D. M. A Survey of Office Work Practice. *Hewlett Packard Technical Report HPL-92-121*, 1992.
- [7] Hackforth, R. *Plato's Phaedrus*. Cambridge University Press: Cambridge, 1952.
- [8] Hutchins, E. The Technology of Team Navigation. In Galegher, J., Kraut, R. and Egido, C. *Intellectual Teamwork: Social and Technical Bases of Cooperative Work*. Lawrence Erlbaum Associates: Hillsdale, New Jersey, 1989.
- [9] Kahn, F. A Survey of Note-taking Practices. *Hewlett Packard Unpublished Report*. 1992.
- [10] Lansdale, M. The Psychology of Personal Information Management. *Applied Ergonomics*, 19, 1, 55-66, 1988.
- [11] Malone, T. W. How Do People Organise their Desks? Implications for the Design of Office Information Systems. *ACM Trans. Office Info. Systems*, 1, 1, 99-112, 1983.
- [12] Mander, R., Salomon, G. and Wong, Y. A Pile Metaphor for Supporting Casual Organisation of Information. *Proceedings of Human Factors in Computing Systems CHI'92*, pp 627-634, 1992.
- [13] Norman, D. A. *The Psychology of Everyday Things*. Basic Books, Inc.: New York, 1988.
- [14] Ong, W. J. *Orality and Literacy: The Technologizing of the Word*. Methuen: London, 1982.
- [15] Shaw, R. and Bransford, J. *Perceiving, Acting and Knowing: Towards an Ecological Psychology*. Lawrence Erlbaum Associates: New Jersey, 1977.
- [16] Williams, P. M. *Hewlett Packard Unpublished Report*. 1992.