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An Account of Writing as Creative Design

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This chapter attempts to answer the question "how do we write?" by looking beyond writing as a problem-solving process to consider the writer as a creative thinker and a designer of text. The aim is to take a step towards a general account of the processes of writing, and to resolve some of the seeming contradictions in studies of writers, such as:

- writing is a demanding cognitive activity, yet some people appear to write without great effort;
- most writing involves deliberate planning, but also makes use of chance discovery;
- writing is analytic, requiring evaluation and problem solving, yet it is also a synthetic, productive process;
- a writer needs to accept the constraint of goals, plans, and schemas, but creative writing requires the breaking of constraint;
- writing is primarily a cognitive activity, but it cannot be performed without physical tools and resources.

I shall call on theories of cognition and creativity from Boden (1990; 1994a), Gelernter (1994), and Karmiloff-Smith (1990), and descriptions of how designers think from Lawson (1990) and others. These will form the basis of an account of writing as creative design.

The central part of the account is that writing is an open-ended design process, mediated by tools and resources. The way that a writer generates new material, and also manages the proliferation of possible next actions, is by imposing appropriate constraint. The constraints come from a combination of the given task, external resources, and the writer's knowledge and experience. Implicit constraints guide the writing process, and a writer re-represents some of these as explicit conceptual spaces.

Creativity in writing occurs through a mutually promotive cycle of engagement and reflection, both guided by constraint. A session of engaged 'knowledge telling' generates written material for consideration. Reflection involves reviewing and interpreting the material as a source for contemplation. Contemplation generates new ideas which are explored and transformed, producing plans and constraints that drive a further period of engaged writing.

This basic creative mechanism supports a variety of writing strategies, depending on the timing and relative emphasis given to reviewing, contemplation, planning and engagement.

Writing as design emphasises the writer as a user of tools and a creator of cognitive artefacts. A writer is a thinker in a self-constructed environment which affords, constrains and mediates the writing process. Writing as design emphasises the use of a primary generator (a 'guiding idea') in inspiring and guiding the entire task. As a writer's thoughts become externalised in sketches, notes, drafts and annotations, so these designs become source material for the iterative process of interpretation, contemplation and re-drafting.

Writing is not an isolated mental activity, but is closely linked to other creative design tasks such as drawing and music composition. The skill develops spontaneously from oral language production through a general cognitive mechanism whereby a thinker re-represents knowledge that was embedded in automated processes into an explicit form.

Although the account is far from complete, it can form a bridge between the more detailed cognitive models of a writer as thinker and the broader theories of writing in a socio-cultural setting.

Writing and Creativity

All writing is novel in that it generates phrases and sentences that have never been composed before. Most writing is appropriate, fitting the demands of the task and audience. And some writing displays such radical originality that we call it creative. A general account of the writing process needs to distinguish between novelty, appropriateness and creativity, and to go some way towards describing the psychological mechanisms underlying creative writing.

Boden, in her analysis of cognition and creativity (1990; 1994a), starts by separating out the great historic acts of creativity (H-creativity) from psychological creativity (P-creativity).

> A valuable idea is P-creative if the person in whose mind it arises could not have had it before. By contrast, a valuable idea is H-creative if it is P-creative *and* no one else, in all human history, has ever had it before. (Boden, 1994b, p. 76)

It follows from this definition that there can be no solely psychological explanation of H-creativity. It can only be analysed by reference to the society and culture in which its creator lived. But H-creative ideas are, by definition, also P-creative, and P-creativity *is* amenable to a psychological explanation. So, in this account of the psychology of writing, we shall restrict ourselves to P-creativity as a mental phenomenon and leave H-creativity to the biographers and literary critics.

Constraints and Conceptual Spaces

What is it that distinguishes P-creativity from novelty? The sentence "A pink rainbow flooded into my cup of steaming coffee" is certainly novel, but does it qualify as P-creative? To answer that question we need to look at the structures and constraints within which language is produced. Language, as a system, is generative in that people who follow the rules of grammar are able to produce well-formed sentences many of which have never been uttered before. By selecting the grammatical structures that form sentences and slotting in words with the correct parts of speech one can generate sentence after sentence of the kind given above. The prose may be novel and grammatically correct, but it would also be mostly nonsensical and would

certainly be inappropriate to any writing task. So as well as being novel, writing must also be appropriate to the task and to the audience, otherwise it degenerates into a ramble of nonsense.

We arrive at appropriateness by imposing constraint. This is key to an understanding of creativity in language. The generative system of grammar provides a framework for the production of language, and onto this framework a writer imposes schemas of knowledge and rhetorical structures, appropriate to the task and audience. These constrain the generative system to form what Boden describes as a 'conceptual space'. The dimensions of a conceptual space are "the organizing principles that unify and give structure to a given domain of thinking" (Boden, 1994a, p. 79). A conceptual space eases the mental burden of writing by limiting the scope of search through long term memory to those concepts and schemas that are appropriate to the task. Thus, a conceptual space can be restrictive, invoking a flow of conventional, predictable ideas. But it also provides the source material for creativity.

The paradox is that constraint *enables* creativity. By constraining the generative system into an appropriate conceptual space, a writer gains a conceptual structure that can be systematically explored and transformed. A conceptual space can be explored by testing the bounds of the existing constraints. For example, Sterne in *Tristram Shandy* mocks the conventions of narrative form through exuberant digressions; Shakespeare takes the language of officialdom to the extreme in the pompous pronouncements of Malvolio; and Dickens (cited in (Boden, 1994a, p. 79)) pushes at the boundaries of the English adjectival phrase by piling on adjectives to describe Scrooge as "a squeezing, wrenching, grasping, scraping, clutching, covetous old sinner".

Conceptual spaces can also be given a slight modification or a wholesale transformation. Creative thinking involves, in part, calling on general-purpose processes and applying them to conceptual spaces (see (Perkins & Salomon, 1989) for a discussion of general and specialized methods of problem solving). The psychiatrist Albert Rothenberg (1976) carried out numerous interviews with creative people and found evidence for general creative processes, such as "Janusian thinking" (the "simultaneous conceptualization of opposites") and "homospatial thinking" (actively conceiving two or more discrete entities occupying the same space). The experimental language of James Joyce, Walt Whitman's abandonment of the ordinary rules of prosody, and Ted Nelson's development of hypertext with its multiplicity of paths and readings, are some notable examples of the transformation of literary structure. Lesser minds are still able to perform conceptual transformations during everyday problem solving, by applying general operators such as "consider the negative", "remove a particular constraint", "substitute one structure for another", and "reconsider from a different viewpoint". The hard part is, first, to become aware of our own conceptual spaces, and, second, to see how to transform mental structures that we are accustomed to taking for granted.

In short, we can distinguish creativity from novelty in that creativity involves setting appropriate constraints to form a conceptual space that is relevant to the writer's purpose, bringing aspects of that conceptual space into conscious awareness, and then deliberately exploring and transforming it to create an original and valuable product. Of course, not all explorations and transformations will be valuable, and very few of them will lead to a great work of literature. But this does appear to be one technique used by experienced writers, as is shown in the following verbal protocol from an experienced writer who has been asked to write a short story on "A Night at Luigi's":

> Now let's say Luigi runs the restaurant and, er, he wants to create an image of, er, good image, so he wants the customers, he wants them to come back, he wants them to talk about Luigi's, so how would he do that, OK. Now let's say somebody orders wine and, er, he tastes it. OK. So, if the wine's not good they send it back. So that's no story in there. But there is a story if the wine is good and it goes back. Would be even more of a study, story, if Luigi tastes it himself and takes it back. OK. I think we've got a story. (Sharples, 1985, p. 24)

The writer begins by setting a general goal (Luigi the restaurant owner wants to create a good image) invoking a restaurant schema. The schema covers a set of conventional activities that might be performed in a restaurant, such as: order wine; waiter brings wine to the table; customer tastes the wine; if wine is bad then customer sends it back; otherwise customer drinks wine. The writer chooses a part of the schema (ordering wine) and considers the condition ("if the wine's not good they send it back"). Realising that this would not make an interesting story, he tries a negation operator ("if the wine is good and it goes back"), and then a substitution ("Luigi tastes it himself and takes it back"). He ends up with a plot (which he later turns into a draft story) about a restaurant owner who impresses his customers by publicly tasting and rejecting his own wine.

Some successful writers have developed the transformation of entire story spaces into a lucrative craft. Umberto Eco (Eco, 1982) wrote a penetrating essay on The Narrative Structure in Fleming . He showed that Fleming's James Bond novels are built around a series of contrasts between characters and values, such as Bond – M, Bond – Villain, Villain – woman, love – death, luxury – discomfort, loyalty – disloyalty. He set out fourteen of these 'oppositions' which, Eco suggested, include all the narrative ideas of Ian Fleming. For example, in the contrast between Bond and his boss 'M' there is a "dominated-dominant relationship which characterises from the beginning the limits and possibilities of the character of Bond and sets events moving" (Eco, 1982, p. 245). The plots of all the Bond novels can be seen as games with the 'oppositions' as opposing pieces, governed by fixed rules and moves. The invariable scheme of moves is as follows:

A. M moves and gives a task to Bond.
B. The Villain moves and appears to Bond (perhaps in alternative forms).
C. Bond moves and gives a first check to the Villain or the Villain gives a first check to Bond.
D. Woman moves and shows herself to Bond.
E. Bond consumes Woman: possesses her or begins her seduction.
F. The Villain captures Bond (with or without Woman).
G. The Villain tortures Bond (with or without Woman).
H. Bond conquers the Villain (kills him, or kills his representative or helps at their killing).
I. Bond convalescing enjoys Woman, whom he then loses.

Although the scheme is fixed, in the sense that all the elements are always present in every novel, the order may change. In *Dr No* the order is A.B.C.D.E.F.G.H.I., but for *Goldfinger* it is B.C.D.E.A.C.D.F.G.D.H.E.H.I.

As Eco concludes, it is clear how the James Bond novels have attained such a wide success. They translate the purity and order of epic stories into current terms, and transform a network of elementary associations into new but familiar patterns.

> "In the novels of Fleming the scheme follows the same chain of events and has the same characters, and it is always known from the beginning who is the culprit, and also his characteristics and plans. The reader's pleasure consists of finding himself immersed in a game of which he knows the pieces and the rules – and perhaps the outcome – drawing pleasure simply from following the minimal variations by which the victor realises his objective." (Eco, 1982, p. 259).

Fleming clearly understood how to create and transform plot structures and exercised this skill for all its considerable worth.

Representational Redescription

Before moving on to the processes of writing, we need to make an important distinction between regular activity and explicit knowledge. We can produce regular, grammatically correct language without being able to recite the rules of grammar. But to explore and transform conceptual spaces we must call up constraints and schemas as explicit entities, and work on them in a deliberate fashion. This requires an ability to re-cast the regularity of implicit language production as explicit mental structures.

Karmiloff-Smith's theory of 'representational redescription' (Karmiloff-Smith, 1990) states that as a natural part of skill development we become able spontaneously to re-represent knowledge that was previously embedded in effective procedures. A young child can create a simple story by recalling some episode from the past or by summoning up a train of ideas governed by implicit schemas and constraints. But only when the child develops cognitive awareness is she able to re-represent that episode in a form that allows her to insert new events, or alter it to provide a new conclusion.

In more general terms, the mind exploits knowledge is has already stored (both innate and acquired), by re-representing tacit procedures as explicit structures. Representational redescription provides us with the means to reflect on experience. It allows us review an activity, re-cast it as a mental schema, and use this to probe long term memory, recall related schemas, integrate the new knowledge with the old, and explore and transform it.

The transition from tacit knowledge to deliberate cognition is not easy. Although re-representing tacit knowledge is a natural part of skill development, even in adults it is muddled and incomplete. Reflective understanding alone may be inadequate to drive the writing process: bringing tacit knowledge into conscious awareness is no guarantee of being able to understand or control it. We have no everyday vocabulary to describe our mental processes to ourselves. The increased mental burden of trying to reflect on one's own thinking can cause cognitive overload and this, combined with the attempt to work on incomplete schemas, can lead to a drop in the general quality of writing. It is at this point that learners need help to develop a coherent mental framework of plans, operators, genres and text types that can guide the process of knowledge integration and transformation.

The Component Processes of Creative Writing

The exploration and transformation of conceptual spaces is part of the process of writing, but by no means all of it. Very little of everyday writing qualifies as P-creative by Boden's definition. Boden's analysis of creativity helps to explain creativity in writing, but it leaves open

the more general issue of how a writer goes about the everyday business of composing novel, appropriate, and sometimes creative, prose.

A writing task starts with a given set of constraints. These may be external, such as an essay topic, previously written material, or a set of publisher's guidelines. They may also come from within the writer, as the schemas, inter-related concepts, genres, and knowledge of language that form a writer's conceptual spaces. The task is also constrained by the tools a writer employs and by the context in which the writing occurs. These constraints act together to channel mental resources and to frame the activity of writing.

Scardamalia and Bereiter (Scardamalia & Bereiter, 1987) describe two fundamental processes of writing, which they term 'knowledge telling' and 'knowledge transforming'. Knowledge telling is where the writer creates ideas by a process of association. One idea is generated which contains aspects or features that prompt another idea to be recalled, and so on along a chain of conceptual relations. When this is carried out as a purely mental activity then we call it 'daydreaming' or 'free associating'. But it is also an effective way of writing. Each concept is translated into words that are set down on paper and these act as an immediate prompt for further association and writing. In children, this appears in text as a 'what next' sequence of propositions, linked by simple 'and' or 'but' connections:

> one day in the street a sale was on and a little girl was gowing to school and hur mum said take this dinner munny but she knew that it was to much and she spent sume of it. wen she got to school the teacher said where have you been the girl said nowhere sorry. at home time she took the toy rabbit home and her mum said go to bed . The End . [Story written by seven year old child]

In adults, knowledge telling can range from a loosely-controlled 'stream of consciousness', to the seemingly controlled but effortless writing of some experienced novelists:

> The thing develops as I write. (Aldous Huxley, cited in Chandler, 1991)
>
> Suddenly words are there, and there with an imperious insistence which brooks no delay. They must be written down immediately. (Amy Lowell, cited in Ghiselin, 1954, p. 112)

Success comes from the way in which the knowledge telling is guided by constraint. A successful writer is able to invoke just the right schemas and text structures to create an appropriate 'story world' in which the knowledge telling can be performed. Knowledge telling is particularly suited to narrative fiction writing, where the writer retells an event or creates a scene and allows imagined characters to act it out.

Knowledge transforming appears to be similar to Boden's description of the processes governing P-creativity. The writer forms initial states of knowledge appropriate to the task. These constrain and drive the writing. During drafting the writer monitors the text in relation to the constraints and, if they diverge, revises the text or the plans to keep them in harmony. Scardamalia and Bereiter characterise knowledge transforming as an interaction between two problem spaces — content and rhetoric — with the content space being the writer's beliefs about the writing topic and the rhetorical space containing the writer's knowledge about the text and writing goals. But there seems to be no good reason to stop at two knowledge spaces. In general, a writer as thinker will be working with multiple overlapping areas of knowledge, drawing analogies between related concepts in different spaces and using problems encountered in one knowledge space as goals to be achieved in another.

High and Low Focus Thinking

Having set out the two component processes of knowledge telling and knowledge transformation, the next question is how do these processes fit together? To understand this, we need to go back to more general theories of creativity.

In an analysis of creative thought, Gelernter (Gelernter, 1994) offers the notion of a spectrum of cognitive activity, from 'high focus' thinking where ideas are constructed and manipulated, to 'low focus thinking' characteristic of daydreams, where whole episodes from memory are blended and linked together by a common flow of emotion. Rather than seeing these as two separate modes of thought, he suggests that they form a continuous spectrum, so that a person might come out of a daydream of low focus thought into a more controlled bout of analytic thought, abstracting common features from the memories to produce new mental concepts. To substantiate his claims, Gelernter summons up quotations from the Romantic poets, Freud's accounts of dream-thought (although, inexplicably, he does not refer to Freud's only direct account of the creative process: *Creative Writers and Daydreaming* (Freud, 1976)) and passages from the Scriptures, in an attempt to show a connection between creative daydreaming, childhood memories, and ancient thought.

There are problems with the details of Gelernter's theory. He proposes that low focus thought consists of memories bound together by shared emotion. But a sound (remembered or external), a colour, an object, or a word can also be the link between one dreamlike episode and the next. Dream thoughts may often evoke emotions, they may also be influenced by emotions, but there is no good evidence that emotion is the indispensable force that binds the creative imagination. Gelernter also claims that low focus, affect-linked thinking provides the solution to "the most significant unsolved problem of cognition", that of analogical thinking and creativity. Creativity, Gelernter claims, boils down to the discovery of new analogies, which occur when one thought sparks off another one related to it only by a deep bond of emotion. But this is at odds with Boden's account of creativity arising from deliberate mental explorations and transformations.

We can reconcile these claims by proposing that high and low focus thinking both contribute to creativity. One way in which they can combine is through the deliberate re-creation of emotional experience in the mind, until it wells up and drives composition. The poet Wordsworth described this process as "emotion recollected in tranquility":

> … the emotion is contemplated till, by a species of reaction, the tranquility gradually disappears, and an emotion, kindred to that which was before the subject of contemplation, is gradually produced, and does itself actually exist in the mind. In this mood successful composition generally begins, and in a mood similar to this it is carried on. (Wordsworth, cited in Owen & Smyser, 1974, p. 148)

The emotion appears to act as both a generator and a filter of thought, prompting and combining ideas that have, in the past, been associated with that same mood.

Where Gelernter's theory is most useful — at least to an understanding of writing — is in seeing low and high focus thinking as being parts of a continuous spectrum of cognition. When a person sits back and thinks, there is no barrier between the free association of ideas and the controlled transformation of mental spaces or the solving of problems. Indeed, all these aspects of thought combine and support each other, with contemplation summoning up emotion, and ideas generated by dreamlike thinking becoming the raw material for deliberate analysis. Freud

captures this process by describing the creative writer as someone who moulds his own wish-fulfilling fantasies into a form that is pleasing and attractive to others (Freud, 1976, p. 48). If low and high focus thinking are directed towards producing text then they become the processes of knowledge telling and knowledge transforming.

The Externalization of Cognition

Even cognitively mature writers can find it difficult to mould fantasy into attractive prose, as this protocol of an inexpert adult writer shows:

> Well I first thought of a basic structure in my head. Going to a restaurant. Getting some food. Food leading to some sort of problem, ending in mayhem, was the basic structure. Right at the beginning. But then there was how to get from step to step, as we went along. (Sharples, 1985, p. 26)

Although he was aware that he should structure his writing, his knowledge of story schemas and how to explore and transform them was inadequate to drive the production of text.

Expert writers can call on a large stock of remembered plans and schemas, built up through a long apprenticeship in the craft of writing. But an inexpert writer has less of this pre-compiled knowledge and so must construct plans to order, calling on everyday experience and guided by a general knowledge of how to design artefacts, transform mental structures, and solve problems. Even an accomplished writer will sometimes need to call on these general methods if faced with a new type of rhetorical demand.

One way to overcome the difficulties of performing such complex knowledge manipulation in the head is to capture ideas on paper (or some other external medium such as a computer screen) in the form of external representations that stand for mental structures. So long as ideas, plans and drafts are locked inside a writer's head then modifying and developing them will overload the writer's short term memory. By putting them down on paper (or some other suitable medium) the writer is able to explore different ways of structuring the content and to apply systematic transformations, such as prioritising items, reversing the order, or clustering together related items. Writing creates external representations and the external representations condition the writing process.

Cognition is not simply 'expressed' or 'amplified' through the use of external representations, but rather the nature of thought is determined by the mind's dialectical interaction with the world as constructed by human beings (Kuutti, 1991; Wood, 1992). Notes, sketches, outlines, tables, topic lists, concept maps, and argument structures are both representations of mental content and things in themselves, new stimuli dissociated from the moment of their production and available for reinterpretation. To take our account further, we need to look beyond the writer as a disembodied mind and consider the role that the external environment plays in mediating cognition by considering writing as design.

Writing as Design

There are striking similarities between studies of cognition in design and the cognitive theories of creativity in writing that we have discussed in the previous section. For example, Lawson's influential book on *How Designers Think* (Lawson, 1990) contains a chapter on 'Creative Thinking' and he basis his model of the design process around the creation and manipulation of appropriate constraints. But rather than concentrating on the similarities between theories of design and theories of creativity, we shall look at some aspects of design that might help to

extend our understanding of writing. Lawson describes the following properties of design problems and processes (Lawson, 1990, pp. 90–93), all of which apply to writing.

Design problems are open-ended and cannot be fully specified. They are not like the classic problems studied by cognitive psychologists, such as chess or the Tower of Hanoi, with a fixed set of goals and a sequence of steps each of which can be evaluated in terms of its nearness to a goal. The number of actions that a designer might take at any stage is uncountably large, and there is no simple function to evaluate each step in the process.

The design process is endless. A designer is faced with an inexhaustible number of possible solutions, and the end of the design process is a matter of judgement. It follows that a designer is rarely pleased with the product, but stops when it no longer seems worth the effort of trying to improve its quality, or when halted by some external factor such as running out of time or resources.

There is no infallibly correct process of design. There are many different and equally successful approaches, and good designers are able to control and vary their strategies according to the task.

The process involves finding as well as solving problems. The design process does not consist of a neat sequence of stages leading up to a finished product, and much of a designer's time is spend in identifying and refining the problem. "It is central to modern thinking about design that problems and solutions are seen as emerging together rather than one following logically upon the other." (Lawson, 1990, p. 91) This rejection of stage models in favour of a more integrative analysis mirrors the development of research in writing, beginning with the insight of Flower and Hayes that "the act of writing is best described as the act of juggling a number of simultaneous constraints. This is in contrast to seeing it as a series of discrete stages or steps that add up to a finished product." (Flower & Hayes, 1980, p. 31)

Design inevitably involves subjective value judgement. A designer asks questions that are value-laden and produces products that can only be judged by a subjective assessment of quality.

Design is a prescriptive activity. Unlike the process of scientific discovery, where the aim is to describe the world, design is concerned with what might, could, and should be. It prescribes and creates the future, and so demands both ethical and moral scrutiny.

Designers work in the context of a need for action. Design is a process that will result in some change to the environment. The environmental impact of writing is less obvious than in engineering or architecture, since writing changes the landscape of thought. We can easily produce cases, such as *The Communist Manifesto*, where texts have incited great actions, but this hides the fact that all writing performs speech acts (such as informing or persuading), and all writing can act as the inspiration and source material for further writing activity.

Now that we have established writing as a design activity, at least in so far as it fits the essential properties of design as given by Lawson, we can look at aspects of how designers work that might contribute to our understanding of how people write. The three aspects that are most useful to our analysis are: primary generators, the fusion of analysis and synthesis, and the use of tools and external representations.

Primary Generators

A primary generator is some powerful but easily stated idea that a designer summons up early in the task, to prompt and guide the activity. The term is due to Darke (1978) who interviewed British architects about their intentions when designing local authority housing. She found that

the architects tended to latch on to a relatively simple idea very early in the design process. That idea narrowed down the space of possible solutions and acted as a framework around which to create the design.

Accomplished novelists, when describing what initiated their writing, often talk in terms of primary generators:

> With me a story usually begins with a single idea or memory or mental picture. The writing of the story is simply a matter of working up to that moment, to explain why it happened or what caused it to follow. (Faulkner, cited in Plimpton, 1958, p. 121)

> I had an idea of what I wanted to do, but here was something missing and I was not sure what it was until one day I discovered the right tone — the tone that I eventually used in One Hundred Years of Solitude. It was based on the way my grandmother used to tell her stories. She told things that sounded supernatural and fantastic, but she told them with complete naturalness. When I finally discovered the tone I had to use, I sat down for eighteen months and worked every day. (Garcia Marquez, cited in Plimpton, 1985, p. 323)

For academic writers, a primary generator may come in the form of a research question or an organising schema (such as a thesis proposal). These early ideas can influence the entire writing process and in academic writing are sometimes stated explicitly in the introduction to the text.

However, designers can also gain insight into the problem as the design progresses and this may lead them to reject or modify the primary generator. A primary generator can cause great difficulties if it presents an insuperable hurdle, but if the designer succeeds in overcoming such difficulties and the original ideas were good, we are quite likely to recognise this as an act of great creativity (Lawson, 1990, p. 36).

The Fusion of Analysis and Synthesis

In an experiment with experienced designers, Eastman (1970) set the task of redesigning a bathroom. He recorded what the designers did and how they described what they were doing. These protocols showed no meaningful division between analysis and synthesis, but rather that designers learned about the problem through a series of trial solutions (Lawson, 1990, p. 33).

In other areas, such as software design, it is recognised that design is an iterative process, with the intermediate products acting as generators of new ideas.

> One thing we always experience during design is a need to shift constantly between two kinds of design activity, *analysis* and *synthesis*. During analysis we test the design to determine whether it is meeting our targets for usability and software quality. During synthesis we shape the design, drawing on fresh ideas and on solutions to similar problems that have worked well in the past. (Newman & Lamming, 1995, authors' emphasis)

Iteration is also a fundamental part of the model of writing developed by Hayes and Flower (1980), where the synthetic process of translating ideas into prose can be interrupted by the analytic process of editing, which may in turn lead the writer into a new sequence of planning, translating and reviewing.

Tools, External Representations, Media and Resources

A cognitive model of writing is concerned primarily with the writer as a thinker and problem solver. It does not address such questions as: What purposes are served by written notes, plans and outlines? Why do writers prefer one tool over another? Which types of media are suited to which writing tasks? An account of writing as design takes a broader view. A designer is a thinker who works within a carefully constructed material world, surrounded by books, files, notes, drafts and drafting tools. The designer, the artefacts, and the setting form a rich inter-operative system. Each artefact conditions the activity, assisting certain operations while restricting others, and an analysis of a writer's use of tools, external representations, media and resources plays an important part in an understanding of writing as design. Writing *tools* include pencils, pens, erasers, computers and dictating machines. They create, erase or modify marks on *media*, such as sheets of paper, file cards, computer displays, and audiotapes. The marks act as signifiers, to form an inter-related system of *external representations* that can convey meaning to the writer and others. A writer also calls on external *resources* such as databases, reference books and colleagues for information and support.

Tools

The skills of design are learned not in the abstract, but through the continued use of a system of tools. Tools have intrinsic properties, such as size and portability, but their qualities as components of design are not inherent in their structure, they only arise through usage. A pencil is a pencil not because it is a stick of graphite surrounded by a sheath of wood, but because it can be employed as a particular type of writing implement. While we are writing with a pencil it is no longer a separate object but a conduit for ideas. As observers of a writer we may reflect on the properties of the pencil and how the writer holds it, but for the person engaged in the flow of writing it does not exist as a distinct entity. Its 'pencilness' only becomes apparent if there is a breakdown in the writing activity, for example if the point snaps.

Thus, the properties of a tool only become apparent to its user when the tool ceases to be an extension of the self, in the event of some breakdown in its action. This insight is due to Heidegger, and its relation to design is discussed by Winograd and Flores (1986). The most immediate implication is that we need to consider not only the intrinsic properties of tools, but also how a tool is experienced by its user, and how its structure is revealed through breakdown.

A writer's choice of tool is not just a matter of selecting the best implement to perform a particular task, but is an expression of an apprenticeship and an approach to the craft. Some writers report having strong, even ritualistic preferences for particular tools:

> For years I have looked for the perfect pencil. I have found very good ones, but never the perfect one. And all the time it was not the pencils but me. A pencil that is right some days is no good another day. (John Steinbeck, cited in Chandler, 1995, p. 136)

A discussion of the resonances (such as Freud's depiction of writing as "making a liquid flow out of a tube onto a piece of white paper") and the aesthetic appeal of writing tools is beyond the scope of this chapter, but for a rich account of the phenomenology of writing see (Chandler, 1995).

Tools become apparent to their users when there is a breakdown in normal activity. When the point of a pencil snaps the writer turns from transcribing ideas as text, to considering the construction of the pencil and how to repair it. In this case the repair is simple and there is no

need to delve into the chemical composition of graphite or the structural properties of wood. But when writing by computer breaks down a writer is confronted with a series of interlocking 'system images'. A system image (Norman, 1986) is the guiding metaphor that a computer system shows to the user. Depending on the type of breakdown, a word processing program may present different, possibly conflicting, system images: the electronic typewriter, the filing system, the desktop. Some breakdowns display layers of embedded systems, down to the level of the computer operating system.

Dealing with breakdowns of all kinds is an integral part of the writing process and one aim of recent research in writing has been to look beyond the untroubled flow of words. The contribution of the cognitive approach has been to portray the writer as a problem solver, coping with the need to satisfy rhetorical demands, retrieve appropriate material from memory, and juggle multiple constraints. Sometimes these become unsatisfiable or overwhelming, leading to coping strategies or writer's block. Writing as design shows the writer as a user of tools. These support the writing process, by providing a means to express plans and ideas as they occur, but the tools themselves may be contexts for other types of cognition and action, from displacement activities to breakdowns in which the tool rather than the writing becomes the focus of attention.

External Representations

External representations serve multiple purposes. First, they act as an external memory, so that ideas, intentions, and plans can be kept for future reference and not forgotten. For example, a writer can glance at a list of previously-written topics to recall ideas and to see whether the text is heading in the intended direction. One of the writers studied by O'Malley (1988) annotated her draft text with terse reminders (such as asterisks) to indicate parts that were incomplete or needed revision.

Second, they act as a mediation between different people, and between the designer and herself at another point in time. By sketching out a complex idea as a diagram it is possible to gain an overview of a complex set of relationships and to present it in a compact form. A simple ad-hoc sketch can indicate intentions that are too fluid to express easily in words. In his studies of pairs of collaborating authors, Wood (1992) describes how one author drew a large funnel shape to represent the overall structure of the paper, and later both writers referred to places in this shape when talking about parts of the paper.

Third, external representations are a means of capturing intermediate products in a form that is intermediate between mental schemas and a finished text. Notes Networks (Sharples, Clutterbuck, & Goodlet, 1994; Trigg & Suchman, 1989) and Mind Maps (Buzan, 1989) are intended as 'intermediate representations' allowing a writer to visualise associations between mental concepts, before committing them to text. Similarly, by setting down a plan as a table, a writer can gain an overview of the relationships between items, and can check that all the relevant dimensions have been explored.

An external representation is a fixed point in the design process, indicating both previous cognition and the form of the product under design.

Media

The media on which external representations are formed have their own intrinsic properties, resonances and breakdowns. For example, a word processor with a standard 20 to 24 line

display makes it difficult to gain an overview of a long document or a good 'sense of the text' (Eklundh, 1992; Haas & Hayes, 1986). A full analysis of writing media would follow much the same path as a study of tools. But the essential function of a writing medium is to be a carrier of signs and one way to understand the influence of media on the writing process is to consider the relationships between media and external representations (Sharples & Pemberton, 1992). We have mapped five common writing media — computer screen; sheets of paper; file cards; dictating machine; sticky notelets; white board — against the following, generally beneficial, properties of external representations:

- *Entire document*. An entire document of medium length can be held on the medium.
- *Usable in end product*. The material can be used directly in the final document, without the need for transcribing or rewriting.
- *Portable*. The material is easy to carry around.
- *Overview.* The writer can rapidly gain an overview of a large document
- *Allows reordering*. The items can be easily reordered.
- *Allows non-linear organisation*. Items can be grouped spatially, or by means of explicit links, into networks, tree structures, tables, etc.
- *Permanent*. The material can be kept permanently available, for reuse in other documents.
- *Allows annotations*. The items can be annotated with memo notes, highlights, etc.
- *Indexable*. Items can be accessed rapidly by means of an index created on the same medium.
- *Re-representable.* One type of representational structure can be transformed automatically into another type, for example a document can be presented as an outline.

Figure 1 sets out the properties of a number of different media according to their normal usage (whiteboards, for example, could be made portable, but normally are not). No medium has all the desirable properties. Sheets of paper, file cards and the computer screen all score well, with sheets of paper offering the benefit of full text readability, file cards supporting non-linear organisations, and the computer giving the ability to change representations. The limitations of the computer are all surmountable and new computer systems are being developed that provide portability, non-linear organisation, annotation and overviews of text.

But even if a computer can offer the facilities of other media, even if it permits input by handwriting, it is still provides the writer with a different experience, and a different set of breakdowns, to a pen and paper or a white board.

	Computer screen	Sheets of paper	File cards	Dicta-phone	Sticky notelets	White board
Entire document	√	√	**?**	√		
Usable in end product	√	**?**				
Portable	**?**	√	√	√	√	
Overview		√	**?**			√
Reordering	√		√		√	√
Non-linear organisation	**?**	**?**	√		√	√
Permanent	√	√	√	√	**?**	
Annotations	**?**	√	√		√	√
Indexable	√	√	√	**?**		
Re-rep-resentable	√					

Figure 1. Media and their properties

Resources

External resources form part of the wider world of work in which a designer is embedded. When resources are both appropriate and ready to hand then they become absorbed into the design process. An online thesaurus, for example, is just another part of a writer's toolkit. But if they are separated, physically or by function, from the main task then work with the resources is interleaved with design. So design becomes one activity within a complex working environment.

The writing environment is changing rapidly, as the physical and social resources of the writer are being drawn into the computer. A journalist can now browse the Internet for leads, search online databases for source material and conduct interviews by email. New technology offers a wealth of resources on the desktop. It can also fracture social contact and confine research to a self-referential infosphere. Instead of muddying his boots, the modern Wordsworth need only call up a CDROM of the 'Lakeland experience'. For a survey of the changing environment of writing see (Sharples & van der Geest, 1996).

In summary, writing as design emphasises the writer as a user of tools and a creator of cognitive artefacts. A writer is a thinker in a self-constructed environment which affords, constraints and mediates the writing process. Writing as design emphasises the use of a

primary generator in inspiring and guiding the entire task. As a writer's thoughts are externalised in sketches, notes, drafts and annotations, these designs become grist for an iterative process of interpretation and re-drafting.

A Theory of Writing as Creative Design

The previous sections have re-conceptualised writing as a process that combines creativity and design. This section weaves together these two strands into a single fabric.

A writing episode starts not with a single goal, but with a set of external and internal constraints. These come as some combination of a set task or genre (such as a college essay), a collection of resources (for example information on company performance to be pulled together into a business report), aspects of the writer's knowledge and experience, and a primary generator (or 'guiding idea'). A primary generator is particularly important to imaginative writing, as it provides a mental construct around which to form the text. When novelists describe the inspiration for their writing in terms of such a construct, it can seem as though they had thought out the entire text in advance. But the skill of a great writer is to create a generator that is manageable enough to be realised in the mind, yet sufficiently powerful to spawn the entire text.

As the writing progresses, constraints provide the tacit knowledge to guide the writing process. The writer may re-represent some of them in a more explicit form, as a conceptual space to be explored and transformed. The movement between engaged writing, guided by tacit constraint, and more deliberate reflection forms the cognitive engine of writing (see Figure 2).

Engagement

An engaged writer devotes full attention to creating a chain of associated ideas and turning them into text (as notes or fully fleshed-out prose). Working memory is entirely devoted to the task, and the only other deliberative mental activity that the writer can perform while engaged in text creation is to speak the words out loud. We think *with* the writing when we are producing text, but we cannot think *about* the writing (or about anything else) until we pause. In the terms used by Karmiloff-Smith (Karmiloff-Smith, 1990), a writer cannot simultaneously enact a writing procedure and re-represent it. In order to reflect on the text it is necessary to stop writing, and the result is that periods of engaged knowledge telling are interleaved with periods of reflection.

Reflection

Reflection is an amalgam of mental processes. It interacts with engaged writing through the activities of reviewing, contemplation, and planning. Reviewing involves reading the written material, while carrying out minor edits. Through a process of interpretation the writer re-represents the procedures enacted during composing as explicit knowledge which can then be integrated with an existing conceptual space.

This leads to contemplation. Contemplation may involve the high focus thinking of deliberate knowledge exploration and transformation of conceptual spaces. Or it may involve low-focus thinking: calling up trains of associated and analogous thoughts, linked by some common emotion, theme or experience.

Planning takes the results of contemplation as the source for creation of plans and intentions to guide a further period of engaged writing.

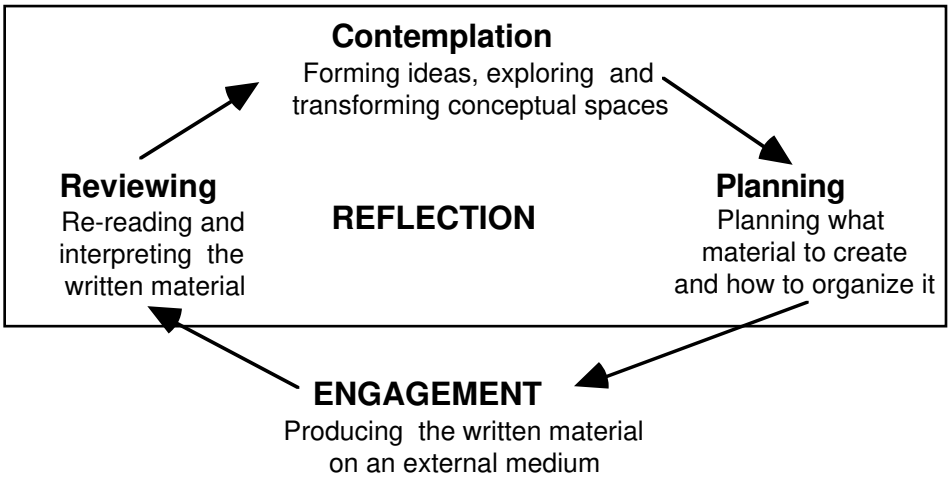

Figure 2. The Cycle of Engagement and Reflection

Writing as a creative mental process consists of a regular movement between engagement and reflection. An engaged writer is devoting full attention to the task of creating text (whether it be notes or fully fleshed-out prose). Reflection consists of 'sitting back' and reviewing all or part of the written material, conjuring up memories, generating ideas by association, forming and transforming ideas, and planning what new material to create and how to organise it.

It is usually engagement in the production of text that is described as being creative, "It is the act of writing that produces discoveries" (Mandel, 1978). But Boden has argued that creativity arises also from the reflective exploration and transformation of conceptual spaces, and Gelernter proposes that it wells up from a process of analogical association. The suggestion here is that it is the entire cycle of engagement and reflection that pushes composition forward, with engagement providing new material for consideration, and reflection offering a re-interpretation of the material, and new plans to be enacted.

The cycle of engagement and reflection sets up distinctive rhythms that characterise the processes of writing. The period of these rhythms may be short, as when a writer looks back over each sentence as it is written, or long, when a writer re-reads an entire piece of writing and plans a major revision. At the most general level, the writing process can be described in terms of how these rhythms are affected by the writer's approach to the task, the tools a writer employs, and the types of representation on which they operate.

> The rhythm of the pen is slow and enhances the deliberation time which goes into writing, Contrarily, the typewriter composer, if the rhythm of the instrument is to be maintained, finds almost as soon as the thought occurs it appears on the paper. (Ihde, 1979)

In a statistical study of the writing process, van Waes (1992) used cluster analysis techniques to uncover profiles of writing. He first selected twelve variables to describe the writing process. These included 'share of revisions in the first phase [of the task]', 'total number of revisions', 'duration of initial planning (seconds)' and 'degree of recursivity [in terms of formulating followed by revision]'. He then set 40 people the task of writing two

short reports (some on a computer and some using pencil and paper) and used video observation combined with automatic logging of the computer keystrokes to compile a record of each writing episode in terms of the twelve variables. He found five basic clusters, or profiles, of activity. These types of writing activity are described below, using the labels given by van Waes, but they have been cast in terms of the cycle of engagement and reflection.

Profile 1: Initial planners

This process is characterised by an initial phase of reflective planning, followed by a drafting and a relatively small number of revisions to the text. This is typical of a pre-planning approach to writing, with the engaged writing driven by a tight set of constraints.

Profile 2: Average writers

This can be seen as a middle way, with average values for each of the variables.

Profile 3: Fragmentary first-phase writers

Initial planning is brief. There are a large number of revisions concentrated in the first phase of the writing process. It can be seen as a rapid cycle of engagement and reflection, with the writer making continual adjustments to keep constraints and text in harmony.

Profile 4: Second-phase writers

The writers do some initial planning and then, once they have started drafting, pause infrequently for long periods. Revision is concentrated in the later phase of writing, with attention given to changes above word level. This can be seen as a longer cycle of reflection and engagement, with the writer creating a loose set of constraints to guide a session of engaged writing, followed by a period of major readjustment.

Profile 5: Non-stop writers

These writers spend little time on initial planning. They revise least and pause less often than the other groups. These are writers who appear able to engage with the text for long periods, without stopping for reflection.

The profiles found by van Waes give an indication of how differences in approach to engagement and reflection produce different types of observed writing activity. For a more detailed analysis that includes the writer's disposition, the text type and the type of representation see (Sharples, 1994).

Validating the Account

How can we judge the worth of the account of writing as creative design presented in this chapter? There are a number of ways in which it can be validated and applied, and this section does no more than suggest some possible approaches.

First, the account is testable. We can study the verbal protocols and self-reports of writers to look for evidence of primary generators and of the types of creative thinking proposed by Boden and Gelernter. We can carry out studies of children, inexperienced adult writers and experts (similar to studies by Karmiloff-Smith of drawing ability) to investigate whether their writing abilities conform to the account of representational redescription (see, for example, (Bereiter & Scardamalia, 1987; Sharples, 1985)). We can also look for similarities between

writing and other design tasks, by comparing the use of tools, media and external representations. Studies of this type include (Wood, 1993) and (Medway, 1996).

Second, the account can be matched against other general theories of writing. The description by Scardamalia and Bereiter (1987) of the knowledge telling and knowledge transforming processes of writing matches Gelernter's distinction between high and low focus thinking, with knowledge transforming corresponding to Boden's (1994a) analysis of creativity occurring through the mapping, exploration and transformation of conceptual spaces. The account extends the cognitive model of writing proposed by Hayes and Flower (1980, this volume) while proposing a different emphasis. It shares with Hayes and Flower a stress on the setting and manipulation of constraint and on writing as an iterative process, with intermediate products acting as a prompt for new ideas. The component processes are similar, but with the addition of contemplation as an activity separate from planning. It gives more stress than Hayes and Flower to the essentially cyclical nature of the writing activity, with the process of review and interpretation providing an explicit re-representation of enacted procedures, leading to contemplation, planning and re-engagement. But the emphasis of this account is not on writing as problem solving but writing as design, with the task environment not just influencing performance, but mediating and extending cognition. The account relates writing to other productive, creative activities, and to the writer's physical and social environment. It is much closer to the new model of cognition and affect in writing set out by Hayes in this volume which incorporates visual/spatial representations, and replaces revision by text interpretation and planning by reflection.

Third, the account resolves the apparent contradictions set out at the start of the paper:

- *Writing is a demanding cognitive activity, yet some people appear to write without great effort.* Writing involves both engagement (the direct recording of conceptual associations) and reflection (the deliberate and cognitively demanding process of re-representing embedded processes and exploring cognitive structures). An engaged writer who has created an appropriate context and constraints can be carried along by the flow of mental association, without deliberative effort.
- *Most writing involves deliberate planning, but also makes use of chance discovery.* The products of engaged writing become source material to inspire and constrain deliberate planning.
- *Writing is analytic, requiring evaluation and problem solving, yet it is also a synthetic, productive process.* Analysis and synthesis are not in opposition, but form part of the productive cycle.
- *A writer needs to accept the constraint of goals, plans, and schemas, but creative writing requires the breaking of constraint.* Constraints serve a dual purpose: they act as a tacit generative framework, but an experienced writer is also able to represent constraints as explicit structures and can apply general-purpose procedures to explore and transform them. This transformation breaks out of the original framework, and in so doing creates a different conceptual space and set of constraints.
- *Writing is primarily a cognitive activity, but it cannot be performed without physical tools and resources.* It is not possible to write a long piece entirely in the head, because of the limitations of short term memory. A writer needs to record the intermediate products and this act of recording requires tools, which both assist and restrict the process.

Last, it can inform the practice of writers, writing instructors, and the designers of new writing technology. Because it relates writing to design, the account can apply to new activities that combine writing with other types of design, for example the design of on-line documentation, help systems, and hypermedia. It suggests that general theories of creativity and studies of design might be of value to teachers of writing. For example, writers might be taught ways to re-represent their implicit schemas and constraints as explicit knowledge that can be shared and discussed with a teacher. They might also be helped to develop general-purpose operators and techniques for the exploration and transformation of conceptual spaces.

Earlier versions of this account of writing have provided requirements for a new computer writing environment (Sharples, Goodlet, & Pemberton, 1992). The Writer's Assistant is designed for people who create complex documents as part of their professional lives. One aim of the system is to support cognition, by providing the writer with explicit text structures, constraints, and external representations such as notes networks and document structures, all of which can be viewed, altered and transformed.

Conclusion

The account of writing as creative design complements and extends previous models of writing as problem solving, providing an analysis of how creativity occurs, and of the relationship between writers and their environment.

Writing is certainly a cognitive activity — it involves setting goals, planning, and organizing ideas. But it does not fit the mould of traditional problem solving activities. The writer is always faced with an uncountably large set of choices, with no simple means to evaluate each possible action. There is no set search space, the problem must be generated as it is being solved. Writing is creative and, like other creative activities, has no simple goal. It involves the exploration of experience through reflection (or in the more elevated words of William Wordsworth "passion recollected in tranquillity"). Writing also has much in common with the practices of architects, composers, engineering designers, and graphic designers. A writer as designer is dependent on tools and resources and is embedded in a community of practice, following guidelines of style and structure, and building on the work of others. Lastly, writing is developmental, and Karmiloff-Smith's theory of representational redescription provides a means to understand the development of writing abilities and the acquisition of new skills.

The account given here is still far from complete. It does not cover motivation or writers' habits. It does not reach the level of detailed cognitive processing provided by the accounts of Hayes and Flower or Scardamalia and Bereiter. It has little to say about individual approaches to writing, or specific techniques such as brainstorming or outlining that a writer can employ. It needs to say more about types of representation and about interactions between cognition and the external world. And it only covers single person writing, yet more and more writing is done in collaboration. But despite the limitations it offers the basis for a greater understanding of writing and, by calling on studies of creativity and design, it situates writing within in a wider spectrum of mental and physical activities.

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