Computer-aided constrained writing

S.J. Driver

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Department of Literature, Film and Theatre Studies
University of Essex

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Abstract

How can computers aid human creative processes without impinging on human creativity? I enjoy writing poetry, and I do not want to be made obsolete by an artificial poet. But what if computers could help rather than replace me? I want creative control over my work. All the creative decisions are to be mine, but creative choices alone do not make a poem. Choices must also be implemented.

In this thesis I shall explore the role of computer-aids within a creative workflow, specifically when employing writing constraints, such as those defined by the *Ouvroir de Littérature Potentielle* (OuLiPo).

I am approaching this topic both as a creative writer and a computer scientist. I shall investigate the *how* of constrained writing and the *what* of computer-aids through practical experimentation and observation. From these foundations I shall argue that computers need not impinge on human creativity and that a human:computer partnership may take advantage of the strengths of each while mitigating the weaknesses of the other. I shall discuss *what* must be considered when designing such computer-aids and explore *how* this could be implemented within a software application.

Acknowledgements

A part time PhD is a marathon inside a maze. The way is not always clear, there are many dead ends, and more un-walked paths. The end is always just over the wall. I write this page as I leave that maze. It is the last text I type in my thesis, for all that it appears at the beginning. Looking back on my marathon I have many people I would like to thank.

There is my technical team; those who ensured I had the right running shoes and training to make it through this maze. I thank my supervisors Prof Philip Terry and Dr David Lyons. I thank Dr Christopher McCully who chaired my supervisory panel.

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government's Disabled Students Allowance. I have particularly benefitted from being mentored by Dr Caroline Henderson, Amanda Charleston and Shirley Dow and from having access to further advice from disability specialists within the University of Essex. The funding for such disability support is precarious, both locally and nationally. I am deeply saddened that while I was somewhat protected as a continuing student, I have witnessed higher education becoming less accessible. I feel as if a chasm has been opened in the maze and I only just escaped being on the wrong side of it.

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Overview

Introduction

i: Background and motivation

I experimented unwittingly with constrained writing as a teenager. I had become frustrated at my lack of success with writing poetry for a school assignment. Every year selected pupils would read their poems at a school 'Theme Evening'. My poetry was never chosen; it was lacking something, but I did not know what.

I wanted my poem to be selected. I might not have known why the reviewers did not like my writing but I did have examples of the types of poetry they considered to be *good*. What I needed, I reasoned, was a poem that was almost identical to one found within our class anthology, but yet was also unique and *mine*. I decided that I would chose a poem from an established poet and then change as little as possible while fitting it to the required theme. I hoped that the intangible *magic* element within the published poem would transfer across into mine.

I took my favourite childhood poem, *Silver* by Walter de la Mare,[1] and changed it to fit the required theme. I checked that the original poem would be familiar to my audience. They would see the connection.

Silver begins:

> Slowly, silently, now the moon
> Walks the night in her silver shoon;
> This way, and that, she peers, and sees
> Silver fruit upon silver trees….

Which became in *Dusty*:

> Slowly, silently, now the digger,
> Works the yard in its luminous glimmer,
> This way and that it turns the ground,
> Dusty rocks with a dusty sound….

I copied some words while substituting others. Both poems open with `Slowly, silently` but in the second line `Walks the night` becomes `Works the yard`. The structure of both poems is similar but not identical. The syllable count differs between `moon` and its replacement: `digger`, but the words that linked with `moon` needed that same connection to `digger`. Where `moon` was matched with `shoon`, my version has `digger` matched with `glimmer`. The extra syllable introduced into the first word requires an extra syllable in the second to reproduce the structural link between the two lines. The internal structures of the two poems are congruent despite the differences between their rhythms.

With hindsight, I realise that *Dusty* was a piece of constrained writing. I had used a writing constraint, consistent with those formalised by the *Ouvroir de Littérature*

[1] Walter de la Mare, ‘Silver,’ in *A Junior Anthology of Poetry* (Madras: Macmillan India Ltd, 1989), 83.

Potentielle (OuLiPo)[2], or in English, *The Workshop of Potential Literature*. I had applied the Oulipian Measure to *Silver*. I had 'measured' the syllables in the original poem and had applied those measurements to my own composition. My approach had been driven by my acknowledgement that the poetry selectors were looking for something that I could neither understand nor recognise. I had examples which contained this unidentified quality, but no step-by-step guide to creating it. By using an Oulipian Measure, I had not only copied enough of this *magic* to compose an acceptable poem, but I had come in close contact with that intangible poetry ingredient.

I regarded de la Mare's poem as a model answer. My first academic love was mathematics and I have a tendency to fall back on mathematics when I 'get stuck'. I am accustomed to learning new mathematical procedures by working through pre-existing examples. As my confidence with the procedure grows, I add complexity, changing the variables and moving further and further away from that model, towards a unique problem and its solution. This is similar to how I used *Silver* to address my poetry conundrum.

Working through the model also increased my familiarity with the intangible concept which I wished to emulate. Just as when learning a mathematical procedure, I moved away from the model by making my own changes. Evaluating the success of those changes deepened my understanding of the intangible concept. I am not claiming that subsequently I wrote good poetry, and only good poetry, but my understanding of poetry did improve.

[2] A glossary of abbreviations is included at the end of this part.

This experience predisposed me to be attracted to constrained writing. As is the wont of teenagers, my attention then drifted elsewhere. I trained as a software engineer and became particularly interested in assistive software, including Computer Aided Learning (CAL) and accessibility software for disabled users. I tutored literacy and computer skills, focusing on working individually with pupils who had additional needs. The predominance of science and mathematics in my life had made me feel off balance and in response I returned to creative writing. This only made me feel imbalanced in the other direction. It was in constrained writing that I found my long-sought equilibrium, since through it, I could combine scientific experiments and creative explorations. Constrained writing felt familiar due to my experience with *Dusty* as a teenager, but I embarked on this project because it was a unique opportunity to combine my science with my art.

My formal encounter with writing constraints began with a MA Creative Writing module on Oulipian Practice. We discussed writing constraints and literature which employed them. We applied Oulipian constraints and invented new ones. Our learning outcomes focused on the *what* of constraints and the *what* of the works that employed them. *What* is that constraint? *What* work employed that constraint? *What* affect did it have? Yet as novices in constrained writing, the question of *how* was immediate and was also much discussed during these seminars. *How* do we write to this constraint? Do we write first and then edit for compliance, or should we check compliance as we write? *How* do we test for compliance with each specific constraint? Can methods be reused? My experience with software engineering caused my approach to diverge from that of

the other participants. Where they were checking compliance manually, I saw *how* as a question of having the appropriate technology. I began programming.

My first attempted to write to an Oulipian Sequence[3] was so frustratingly inefficient that I almost discontinued it altogether. I found myself counting the letters in each word as I scribbled them down, making slow but steady progress only to realise later that I had misspelt a word. Unless I could find a close synonym that also met the length requirement, all my work from that point onwards would then have to be revised. With frequent backtracking to correct such errors, the flow of my thoughts was interrupted. I lost the sense of what I had been intending to write. It was this experience that first led me to consider the process of constrained writing more closely. If only I could make the process more efficient and less frustrating, if only I could stay in the flow of my writing without being distracted by backtracking, then I might persevere to the end of the piece and actually complete a constrained writing composition.

It was natural for me to turn first to software to assist my writing process since I had the required skills and equipment. I implemented a simple tool in C#[4] that counted letters as I typed them and warned me if the two did not reconcile with a preset sequence. Receiving such instant feedback greatly improved my writing process and reduced my frustration. I began to enjoy writing to the sequence. I feel certain that my enjoyment was beneficial to the outcome, if for no other reason than it did indeed mean that I persevered until my Oulipian Sequence composition was complete.

[3] The Oulipian Sequence is where a numerical sequence prescribes some aspect of the text, for example the number of letters in successive words could correspond to the digits of pi (see also Constraint Glossary).
[4] C# is a programming language. As with constraints, a brief description of each software application or programming language is given at its first mention and a glossary is included at the end of this document.

As I used my sequence software tool, I revised it to better aid my writing process. I modified the display to improve its clarity. The countdown had been monochromatic. I adjusted it to change colour when it reached the final two letters of each word. This use of colour made it easier to recognise that the threshold was approaching since the number itself did not need to be in focus. I could recognise the colour change out of the corner of my eye without losing sight of the text I was typing. Later, I added a retrospective display to match the whole text against the sequence, not just the word at the cursor position. This highlighted words which did not match and allowed for compliance checking after writing as well as during the process.

When I discussed my work with my colleagues I realised that our writing processes varied. We worked with the same *what* (the constraint definition) but my *how* was just one of many possible *hows* since our writing preferences differed. Not all my peers were comfortable composing text directly into software, but instead wanted to work in longhand. My experience showed me that developing technology to assist with the constrained writing process could be done through an iterative prototyping. With each prototype being both a refinement and an extension of its predecessors, writing preferences could be considered one by one.

Finding one possible *how* led to others. My sequence *how* involved software, but many elements from it could be presented in a physical form. Each medium has strengths and weaknesses, but so does each writer. Writers also have preferences for working styles and media. I naturally turned to software for help, so a software solution suited

me, but for a writer who preferred longhand drafting, a paper-based tool could be preferred. Similarly those who find it hard to sit still and concentrate might find a kinaesthetic 'how' more accessible than a written task. For example, a primary school class might get on well when writing poetry by physically moving letter tiles, but be less enthusiastic when presented with a blank sheet of paper.

My experience with the Oulipian Sequence prompted my initial research question; "How can one write under constraint?" It also gave me an initial methodology. To find *how* I needed to experiment. If I wrote using constraints while prototyping methods and tools, I could refine my tools and perhaps create a framework for developing other tools. From this starting point I investigated existing constrained writing tools and set out the scope of this project. The scope reflects the title and has been derived from non-specialist terms as illustrated in the breakdown which follows.

ii: Project title and scope

Computer: The computer is not a modern invention, but the term is is currently considered as synonymous with the digital computer. The Oxford English Dictionary (OED) entry begins: "1. A person who makes calculations or computations… Now chiefly [historical]" before stating that in current usage, a computer is a "device or machine for performing or facilitating calculation."

Historically, computers could be mechanical or human. According to Alan Turing: “A computer… was a mathematical assistant who calculated by rote, in accordance with a systematic method.”[5] In ancient times, there were mechanical tools such as the Antikythera Mechanism which could perform calculations.[6] Turing goes on to explain that at times, a *human* computer, might be aided by a *mechanical* computer:

> A computing machine [of the early twentieth century] was in effect a homunculus, calculating more quickly than an unassisted human computer, but doing nothing that could not in principle be done by a human clerk working by rote. For a complex calculation, several dozen human computers might be required, each equipped with a desk-top computing machine.[7]

The modern personal computer (PC) is a ubiquitous part of every day life. Every telephone call, train journey and supermarket shop involves computers. It is a computer which connects the call, opens the ticket barrier and calculates how much the groceries cost. There are also more obvious computers in daily life, the ones we actually call ‘computers,’ such as laptop computers and desktop computers. Smart phones and tablets are also computers which, while less customisable than their larger peers, are extremely portable and easy to use.

Over the course of this project, PCs have developed and changed and so has their role within our lives. When this project was conceived in 2011, the tablet PC was in its infancy, with the first iPad only released the previous year.[8] Those first tablet PCs were far from self-sufficient, running reduced versions of applications from their larger

[5] Alan Mathison Turing, *The Essential Turing: Seminal Writings in Computing, Logic, Philosophy, Artificial Intelligence, and Artificial Life, plus the Secrets of Enigma*, ed. B. Jack Copeland (Oxford: Clarendon Press, 2004), 40.
[6] Lloyd Miller II, ‘Ancient Computer Is Older Than Previously Thought,’ *New Historian*, 2 December 2014, https://www.newhistorian.com/ancient-computer-older-previously-thought/2289/.
[7] Turing, *The Essential Turing*, 40.
[8] Apple, ‘Apple Launches iPad,’ Apple Newsroom, 27 January 2010, https://www.apple.com/uk/newsroom/2010/01/27Apple-Launches-iPad/.

counterparts in a trade-off of portability against functionality.[9] By 2017 this was arguably no longer the case, with Apple advertising the iPad Pro as a complete computer which made desktops and laptops redundant.[10]

Within this project, the term ‘computer’ is defined as ‘that which performs computations’. This encompasses human, mechanical and digital computers. This project concerns computers in their broadest sense, but with a bias towards the PC due to my own aforementioned software engineering background.

Aid: To aid a process is not equivalent to automating it. There is a fine distinction between the two terms which is not always observed in common parlance. The OED describes aid in terms of giving “help, support, or assistance to (a person)” and relieving their ”difficulty or distress” and then continues “To be or constitute an aid to (a person or thing); to promote or encourage; to facilitate.” Whereas to automate is to “make automatic,” and an automatic process is one that “works by itself under fixed conditions with little or no direct human control.” With aid, the person being aided retains control, conversely automation removes that control.

This project concerns how a person may be aided in their creative process. Aid, as defined above, has dual approaches: to reduce a negative impact, or to bolster a positive aspect. Whether either or both approaches are taken, there should be a positive affect on the creative process, its outcome, or both. It is beyond the scope of

[9] Andrew Lasane, ‘6 Things You Can Still Do With a First-gen iPad (Hint: Not Much),’ Mental Floss, 26 August 2015, http://mentalfloss.com/article/67829/6-things-you-can-still-do-first-gen-ipad-hint-not-much.
[10] Apple, *iPad Pro — What’s a Computer?* accessed 17 October 2018, https://www.youtube.com/watch?v=sQB2NjhJHvY&feature=youtu.be.

this project to make any attempt to prove that all writers will benefit from the aids proposed here. Instead for the purposes of this work, aids will be evaluated in terms of their potential benefits. As Charles Bukowski writes:

> I am aware that a
> computer can't create
> a poem
> but neither can a
> typewriter.[11]

I, likewise, do not propose to use computers to *generate* better poetry, but instead I will explore how I and other creative writers, could be aided in our endeavours by computers.

Computer-aided: The concept of computer-aided work is well established. As mentioned above, human computers have have long utilised mechanical tools within their own calculation processes. The human computers at the National Aeronautics and Space Administration (NASA) worked "by hand, using slide rules, curves, magnifying glasses, and basic calculating machines…, which could multiply and calculate square roots."[12] Writing almost half a century ago, David Prince claimed that it was the beginning of "a new era of enhanced creativity and productivity made possible by *computer-aided design."*[13] He defined 'computer-aided design' (CAD) as an "augmentation of the human intellect [that] is a product of man-computer synergism: a partnership between the man and the computer, combining the best qualities of each to form a capability of great power."[14]

[11] Charles Bukowski, 'My Computer,' in *Bone Palace Ballet: New Poems* (Santa Rosa, CA: Black Sparrow Press, 1997), 309.
[12] Sarah McLennan and Mary Gainer, 'When the Computer Wore a Skirt: Langley's Computers, 1935–1970,' *NASA History Programme Office News & Notes* 29, no. 1 (7 August 2017): 30.
[13] M. David Prince, *Interactive Graphics for Computer-aided Design* (Reading, Mass: Addison-Wesley, 1971), 1.
[14] Ibid.

This project explores that same symbiosis of human and computer where the strengths of each may compensate for the weaknesses of the other. I agree with XioYing Lui et al who argued forty years after Prince, that computer-aided creative design systems are effective because they harness the "superiorities of both computer and human."[15] My use of the term *computer-aided* encompasses that same goal, for both human and computer each to *play* to their own strengths.

Constrain: To constrain is to "restrict the motion of (a body or particle) to a certain course, e.g. along a fixed curve." If the motion of the body is restricted, then the options as to how it may move are reduced to those which comply with that restriction. A body which moves in accordance with a set of rules may appear to be similarly constrained. In common parlance the two terms are often used interchangeably. There is, however, a fine distinction between rules and restrictions. They approach the task from opposite directions. The rule will generate only options that comply with it. The restriction will filter all existing options until only those in compliance remain. The rule generates the path (bottom-up) whereas the restriction adjusts the pre-existing path (top-down). The difference between rules and restrictions is in process not outcome.

This project concerns not 'constrain' (present) but 'constrained' (past) and so considers 'constrain' to include both restrictions and rules. When observing the motion, it is not possible to determine whether the motion of a constrained body was affected by rules or restrictions, a combination of the two, or neither. The OuLiPo themselves use these

[15] XiaoYing Liu et al., 'Research on Computer-aided Creative Design Platform Based on Creativity Model,' *Expert Systems with Applications* 38 (2011): 9973.

terms interchangeably when it comes to writing constraints with the Oulipian Prisoner's Restriction[16] and the Oulipian Mathews's Algorithm[17] being by definition a restriction and a set of rules, respectively. This project, therefore takes a broader view on the definition of 'constrain' than the OED and aligns itself to the OuLiPo's use of writing constraints which encompass both rule- and restriction- based writing.

WRITING: Writing is the "action of composing and committing to manuscript; expression of thoughts or ideas in written words; literary composition or production." Writing is about words. There are forms of writing which appear to eschew words, for example, visual poetry does not always include words. Such poetry highlights the absence of words by their deliberate exclusion, or else it would not claim to be visual poetry but instead align to a non-word medium such as drawing. In visual poetry, words are still important despite not necessarily being present. Even when words are not apparent, therefore, writing is nonetheless, about words. Words can be used for fiction and non-fiction, in creative ways and in non-creative ways, in all combinations of such and everything in between.

My creative practice sits on the border between text and visual art. The shortest composition within this collection, *Wet Hair*, is formed from just two words. The terms, "manuscript… composition or production," give a broad scope to the possible output formats of the writing. This collection includes both two- and three- dimensional

[16] The Oulipian Prisoner's Restriction restricts writing to letters which do not have ascenders or descenders. This is described in detail in the Chapter 1 (see also Constraint Glossary).

[17] The OED describes an algorithm as a "procedure or set of rules." Much like computers (as discussed in the introduction), algorithms are not restricted to software. The Oulipian Mathews's Algorithm is a specific set of rules which may be applied to one text to produce a variant new text (see Constraint Glossary).

compositions, hand bound books and a novella-length manuscript. This thesis explores the writing process, while its accompanying creative collection displays the results of those experiments. I have taken 'composition' as a broad term, equating it to the creative embodying of ideas in words (including visual poetry as described above).

Constrained Writing: 'Constrained writing' may have its roots in the definitions above, but it is also a term in its own right. The OuLiPo "is a literary group whose works have defined and elaborated the practice of writing under constraint."[18] The term 'constrained writing' instead of 'writing under constraint' is used in this project to remove the ambiguity which could otherwise arise between 'computer-aided writing | under constraint' and 'computer-aided | writing under constraint'. The former implies that the computer-aid itself is under constraint and that is not the subject of this thesis. For this thesis, it is the writing which is constrained.

The writing constraints used within this project were not limited to those defined by the OuLiPo. As mentioned above, it was the difficulties I experienced while writing under the Oulipian Sequence which inspired this project. From its inception, this project has focused on the constrained writing process not the constraints themselves, nor those who defined them. Writing to both rules and restrictions and to constraints defined by the OuLiPo and those developed independently, will all be considered as constrained writing. In the course of this project I have defined several writing constraints.[19] Some are variations on Oulipian constraints; others are new.

[18] Jan Baetens, 'OuLiPo and Proceduralism,' in *The Routledge Companion to Experimental Literature*, ed. Joe Bray, Alison Gibbons, and Brian McHale, Routledge Companions (Abingdon: Routledge, 2012), 117.
[19] These will be described within the text as they arise, but may also be found within the Constraint Glossary.

COMPUTER AIDED CONSTRAINED WRITING: Combining all these definitions, this discourse on computer-aided constrained writing

- concerns:
  - human,
  - mechanical, and
  - digital computation tools,
- which:
  - reduce difficulties, and/or
  - promote improvements,
- to the process of composing text:
  - according to rules, and/or
  - which complies with restrictions.

iii: The three project aims

The primary aim of this project was to design computer tools to render aid for specific constrained writing tasks. This led to two primary outputs, first a collection of computer-aids and second, a collection of creative work written with their aid.

The secondary aim of this project was to define and discuss the key themes within computer-aided constrained writing. I have been unable to find existing work which directly discusses this topic. This project, therefore, cannot build directly upon existing

work, but is instead proposing a new area of study; the ‘field’ of computer-aided constrained writing. I have defined the term above, but the key questions, themes and considerations of this new field will become apparent through pursuit of the primary aim of this project. This investigation led me to propose Grunt Theory.

The tertiary aim of this project was to describe a software application for computer-aided constrained writing. This software would build upon the work from the first two aims. It would include general functions for computer-aided constrained writing which could be applied to multiple tasks, instead of being constraint and task specific as with the primary aim. This aim led me to outline the concept of the *WRules* software application.

iv: Existing knowledge

I am proceeding on the basis that computer-aided constrained writing is a new field, or perhaps more accurately, a new combination of existing fields. This project is interdisciplinary and it draws upon many fields, disciplines and areas of existing work. The methodology comes from software engineering, but the practical experiments are pieces of creative writing and employing writing constraints, as described by of the OuLiPo. Aspects of mathematics and visual art are also present. It was only towards the end of this project, once I had explored and defined this new field, that its close neighbours and ancestors became apparent, as will be discussed at the end in the conclusion. Since I could not identify a body of literature on computer-aided

constrained writing, there is no dedicated literature review in this thesis, beyond the background covered in this section. I shall, instead, integrate existing knowledge into the discussions throughout this thesis.

Software is engineered to solve problems. With well-defined problems, this process may be straightforward. Engineering software to control the lights on a pelican crossing was a school homework task from the same year that I wrote *Dusty*. The task specified when the lights were to switch on and off. The problem was defined. In comparison, engineering a computational tool that may 'aid' a writer is not a defined problem, even when the scope is restricted to constrained writing. What would aid the writer? This is no longer about turning lights on and off under specific conditions. Instead the problem is more nebulous, it requires further understanding of what a writer might consider an aid. This understanding will only emerge as the problem is explored.

The spiral model of software engineering addresses undefined problems through a combination of iterative prototyping and fixed milestones. It is an evolutionary process model and as such does not require a well-defined goal at the outset.[20] I used the spiral model to structure this project around a series of Experiments and used the PhD progress boards as milestones. The spiral model is a software engineering workflow, but in this project a computer-aid is not restricted to software and so I have used the model as a guide but not a prescriptive workflow.

[20] Roger S. Pressman and Bruce R. Maxim, *Software Engineering; a Practitioner's Approach*, Eighth International Edition (New York: McGraw-Hill Education, 2015), 47-49.

Each of my Experiments[21] involved prototyping a new computer-aid to address a specific problem within that writing process. Prototypes evolved by building upon the knowledge gained from each other. My Experiments did not conform to a linear timeline; I moved from one to another as concepts and tasks connected. Where a computer-aid prototype was successful in one Experiment, I would explore further by applying a similar approach in another. In this way, my research has *spiralled* around the Experiments, with prototypes being paused and resumed as each task brought new understanding to others. The notable exceptions being the final two Experiments which I do not describe until the final chapter of this thesis. They were conceived and executed towards the end of this project as a backwards check on my theories.

My software prototypes are scripted in Javascript.[22] They are webpages. I chose this for its potential longevity in the midst of rapidly changing technology. When this project began, touch screen devices and mobile data were changing the personal computer from an office or home-based machine to one that accompanied the person, accessible and connected wherever they were. With the technology in flux, choosing a single operating system (OS)[23] was dependant on the fortunes of that system. A web browser based software could be used on Windows,[24] MacOS[25] and other OS alike and was potentially compatible with smartphones and other touchscreen devices as they were

[21] The term Experiment refers to each item in the accompanying creative collection and the work done to create it. One of the 12 Experiments is a series of Workshops, but the majority are pieces of creative writing.
[22] Javascript can be used to add functionality to webpages, for example to make something happen when a button is clicked (see Software Glossary).
[23] The operating system is what gives a computer its basic functionality. Windows and *MacOs* (for Apple computers) are both operating systems. Smartphones and tablets also have operating systems, including *iOS* (for Apple devices) and *Android* and *Amazon Fire OS* (for Kindle Fire devices) as well as mobile versions of *Microsoft Windows* (see also Software Glossary).
[24] *Microsoft Windows* - the OS for Microsoft computers (see Software Glossary).
[25] *MacOS* - the OS for Apple computers (see Software Glossary).

developed. I believed that the internet browser was far more likely to remain current and popular technology throughout this project than any single computer operating system. In hindsight my concerns were and are shown to be valid. The user access statistics for the popular website, Wikipedia, show that in 2011 70% of users were running *Microsoft Windows*, while in 2018 this had fallen to 34%. Meanwhile mobile devices (running *iOS* and *Android*) accounted for 15% in 2011, rising to 48% in 2018.[26] My final choice of Javascript was a personal preference, having considered other web browser based options such as Perl and Python[27].

My Experiments either directly employ, or extend, Oulipian constraints. The OuLiPo analyse and identify existing constraints (anoulipism) and synthesise new forms (synthoulipism).[28] This has led them to define constraints, both old and new. Harry Mathews and Alastair Brotchie distilled these definitions from the publications of the members of the OuLiPo, into the *Oulipo Compendium*.[29] For ease of reference, their definitions of constraints mentioned in this thesis are reproduced in the Constraint Glossary.

While I could not find any literature that discussed computer-aided constrained writing, I could find examples of such aids. These target specific constraints and include both

[26] Dashiki, 'User Agent Breakdowns,' Wikimedia Foundation. accessed 24 October 2018. https://analytics.wikimedia.org/dashboards/browsers/#all-sites-by-os/os-family-timeseries.
'Usage Share of Operating Systems,' Wikipedia, the free encyclopedia, accessed 4 November 2012. http://en.wikipedia.org/wiki/Usage_share_of_operating_systems.
[27] Perl and Python are both programming languages (see also Software Glossary).
[28] Warren Motte, ed., *Oulipo: A Primer of Potential Literature*, trans. Warren Motte (London: Dalkey Archive Press, 2007), 1-2.
[29] Harry Mathews and Alastair Brotchie, eds., *Oulipo Compendium* (London: Atlas Press, 2005).

hardware such as Allison Parrish's *Oulipo Keyboard*[30] and software, for example the *N+7 Machine* on the Spoonbill Generator website.[31]

The *Oulipo Keyboard* is a standard computer keyboard with all the vowels except `e` disconnected.[32] This is an aid which reduces computation by preventing those vowels from being used, keeping the writing consistent with an Oulipian Univocalism.[33] If the writer were to use a standard keyboard, there could be no certainty that some of those vowels were not typed accidentally. The text would then require careful checking. The *Oulipo Keyboard*[34] removes the need to determine whether the count of vowels other than `e` is zero, by making it impossible to accidentally type those keys in the first place.

The *N+7 Machine*[35] is a software implementation of the Oulipian N+7[36]. With this constraint, the nouns in an existing text are substituted for those seven nouns later within a dictionary. The machine generates fifteen different versions of a given text, from `n + 1` to `n + 15` inclusive. This reduces the writer's work in finding all the nouns, then looking each up in a dictionary and counting down to find their replacements. This machine automates the computation that takes `n` to `n + 7` and in so doing, reduces the writer's workload.

[30] Allison Parrish, 'New Interfaces for Textual Expression,' accessed 29 August 2018, http://www.decontextualize.com/projects/nite/.
[31] 'N+7,' Spoonbill Generator, accessed 15 October 2012, http://www.spoonbill.org/n+7/.
[32] Parrish, "New Interfaces for Textual Expression."
[33] The Oulipian Univocalism constrains the text to use no more than one vowel throughout (see Constraint Glossary).
[34] Parrish, "New Interfaces for Textual Expression."
[35] "Spoonbill Generator."
[36] see also Constraint Glossary.

Both of these computational aids target a particular constraint, but their approach has potential for other constraints. Keyboards could be modified for other Oulipian Univocalisms and indeed further, for other Oulipian Lipograms.[37] The *N+7 Machine*[38] already extends to other values than seven. This approach of automated text substitutions is an example of how automation of a small task can be used as an aid to a larger one. Both these computer-aids are examples of the existing knowledge upon which this project is built and are the starting point for my own exploration into how computers could aid people with constrained writing.

The *Atelier de Littérature Assistée par la Mathématique et les Ordinateurs* (ALAMO) is a 'computer-orientated Oulipian research [group and] was conceived in 1980 by Paul Braffort and Jacques Roubard."[39] ALAMO translates as *The Workshop of Literature Assisted by Mathematics and Computers*. While initially the work of the ALAMO appeared to be highly relevant to this project, their website states, "One of the goals ALAMO is the automatic generation of literary texts, given certain constraints sentences, poems, ads, scripts."[40] That is the only goal listed. This focus on automatic generation of text clashes with the aims of this research and is why I began with my own practical investigation rather than build upon their work.

[37] The Oulipian Lipogram is text which deliberately does not include the whole alphabet. This is a general term and encompasses both the Oulipian Prisoner's Restriction and the Oulipian Univocalism (see Constraint Glossary).
[38] "Spoonbill Generator."
[39] Mathews and Brotchie, *Oulipo Compendium*, 46.
[40] ALAMO, 'ALAMO,' accessed 28 October 2013, http://www.alamo.free.fr/pmwiki.php?n=Alamo.Accueil.

v: Contribution to knowledge

In this thesis I will analyse my Experiments in terms of the project aims, but each of these experiments is a creative work and as such they also explore artistic themes that are outside the theoretical scope of this thesis. My interest in dimensions began when I attended a mathematics masterclass on perspective at the Royal Institution. We were shown an animation of a hypercube.[41] This led to a fascination with the woodcuts of M.C. Escher, particularly his impossible perspective images of stairs that went nowhere and his drawings of Möbius strips. Escher also produced several works that merged from one image to another, including *Metamorphosis I*, *II* and *III*, where a manipulation of positive and negative space sees one image give way to the next. In my own work I have explored the relationship between text dimension. I have considered how text may change over time through *Snippets of Persuasion*. I have explored folding, i.e. the movement of a two-dimensional page through a third dimension, in order to create *Me and You*. I have considered how one text can metamorphose into another with *Mixed Messages*. Mathematics comes to the fore with writing on flexagons as seen in *Knowing Nothing*. My Experiments have led me to gain new skills in bookbinding and paper crafting.

In this thesis I will only briefly describe the artistic motivations for each Experiment despite the clear link between the academic themes of this project and the artistic themes of my Experiments. Understanding how dimension related to computer-aided

[41] SecondEricSanderson, *Hypercube Rotation*, accessed 30 August 2018, https://www.youtube.com/watch?v=q5Qh2XpoCsY.
This animation is similar to the one described. It shows an approximation of a four dimensional cube.

constrained writing was a key breakthrough in my work. I spent much of this project exploring it, both academically and artistically. I have no doubt that these two modes of research influenced each other, but this thesis does not focus on how I developed my concept of text dimension, but rather on how it may be used for computer-aided constrained writing. Neither does this thesis require a critique of the output of each Experiment, but rather it builds upon an analysis of the writing process. In order to achieve the aims of this thesis, what is pertinent is the *how* of the writing process within each Experiment, in particular the *how* of the computations involved.

As I have already stated, a key part of this project was for the human writer to retain creative control, while being aided by the computer, rather than for the computer to in any way ape creativity. I have not at any point attempted to define creativity. There has been a long debate on how to do so from many different disciplines and I do not propose to enter into that argument.[42] I believe that I do not need to define what a creative process is, in order to determine whether a process is not creative. I propose splitting activities in two discrete parts, first: the decisions, and second: the work done to research and then carrying out those decisions. While not all decisions may be creative, I will argue that the work done to carry them out, itself devoid of any decision-making, cannot be creative. Whether it be done by a digital computer, a human or a monkey, the only difference would be one of efficacy.

[42] Robert J. Sternberg, ed., *Handbook of Creativity* (Cambridge University Press, 1999)
This includes many different approaches to the definition of creativity, indicating there is some debate on the matter.

I began this project by prototyping computer-aids through Experiments, with each subsequent experiment building upon an evaluation of its predecessor. Grunt Theory and *WRules* began to take shape around half way through and thereafter I shifted my experiments from researching computer-aids to refining Grunt Theory and *WRules* by testing them against new constraints. In the second half of the project, I taught several constrained writing Workshops during which I observed how my computer-aid prototypes were received. In this way, while the project 'spiralled' throughout, with each experiment including design, implementation and evaluation phases, all with associated documentation, the overall project can be roughly divided into four parts. First there was exploration (Experiments), then a hypothesis (Grunt Theory and *WRules*), which was followed by testing of the hypothesis (further Experiments) and the final phase was the synthesis and communication of my findings via this thesis.

Through this project, my contribution to knowledge is threefold. I have developed a collection of computer-aids for specific constrained writing tasks. Secondly, I have proposed a new theory, 'Grunt Theory,' to guide the development of further computer-aids. Thirdly, I have set out a proof of concept for *WRules*, a software application which incorporates the first two. *WRules* aids constrained writing in general, rather than targeting individual constraints. These three contributions are discussed respectively in the three chapters of this thesis.

The first chapter of this thesis discusses the development of bespoke computer-aids, as used in the composition of individual creative works within this creative collection. Both their development and their employment are evaluated, to determine what effect those

particular computer-aids had on my writing process. This chapter covers both the creation of bespoke computer-aids and the customisation of existing ones. A script running within a bespoke webpage to display the lines of a palindrome in reverse order to facilitate their composition would be the former, while the latter would be facilitating the same calculation by modelling it within pre-existing spreadsheet software (e.g. Microsoft Excel). This chapter sets out the research upon which Grunt Theory is based.

The second chapter of this thesis analyses the practical research from Chapter 1, using it to build a theoretical foundation for Chapter 3. It distills the Experiments on computer-aids for a small number of writing constraints into a theoretical framework for computer-aided constrained writing. It uses the specific to inform the general. The chapter begins with the proposal of 'Grunt Theory' which can be used to identify parts of the constrained writing process that involve no creative work and so will produce the same results whether performed by a human or a machine. I shall argue that these tasks may therefore be automated without impinging on the creative control of the writer and I shall explore whether such an automation can be considered an aid.

The third and final chapter of this thesis implements the theoretical framework set out in its predecessor within a design proof of concept[43] for a software application. This software would be a computer-aid, facilitating the writing process when employing constraints both currently defined and unknown. The chapter also considers the computational aids that were prototyped during the Experiments discussed in Chapter 1. It considers how such aid might be rendered from within this software application,

[43] A proof of concept design describes what would be new and unique about this software, allowing what is straightforward and well known to be assumed.

negating the need for aids bespoke to each constraint. This final chapter concludes with two further Experiments, illustrating how this software could aid new constraints.

Thus the primary, secondary and tertiary aims of this project are each described within their respective chapter of this thesis. The Experiments upon which this work has been built form the accompanying creative collection and are used to illustrate the argument of this thesis.

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